No. 646,663. Patented Apr. 3, 1900.

A. S. HILL.

STEAM ENGINE.

(Application filed May 27, 1899.)

(No Model.) 2 Sheets—Sheet 1.

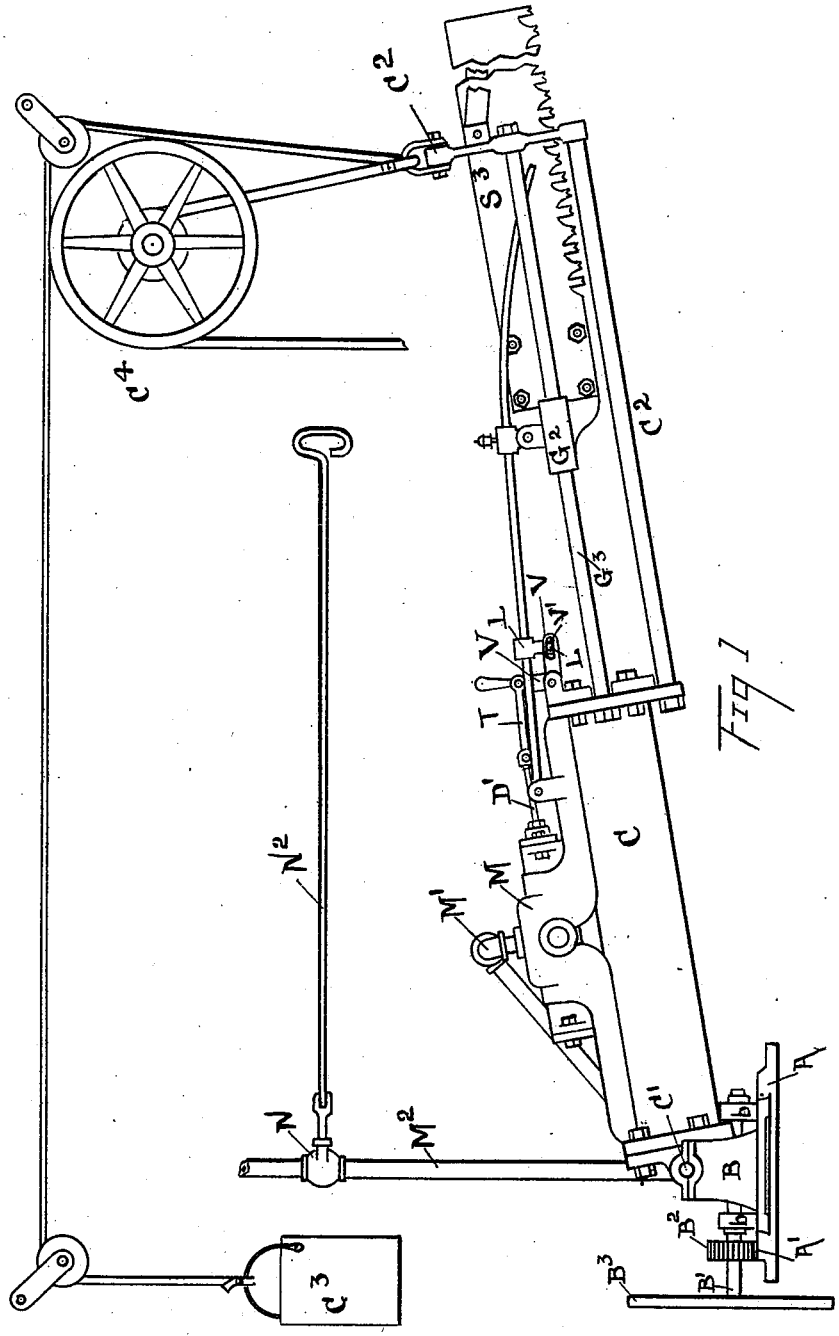

Fig 1

WITNESSES
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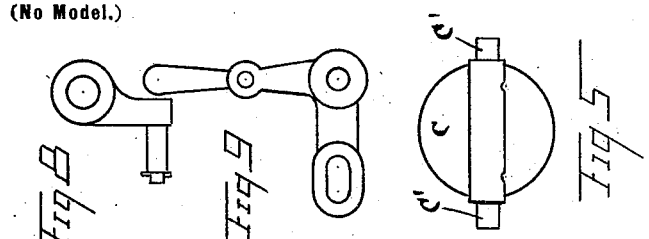

Fig 8 Fig 9 Fig 5

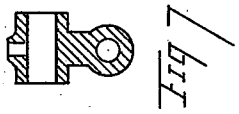

Fig 7

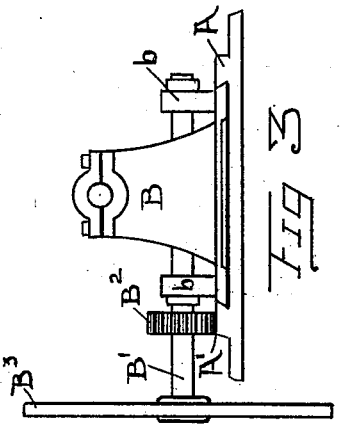

Fig 3

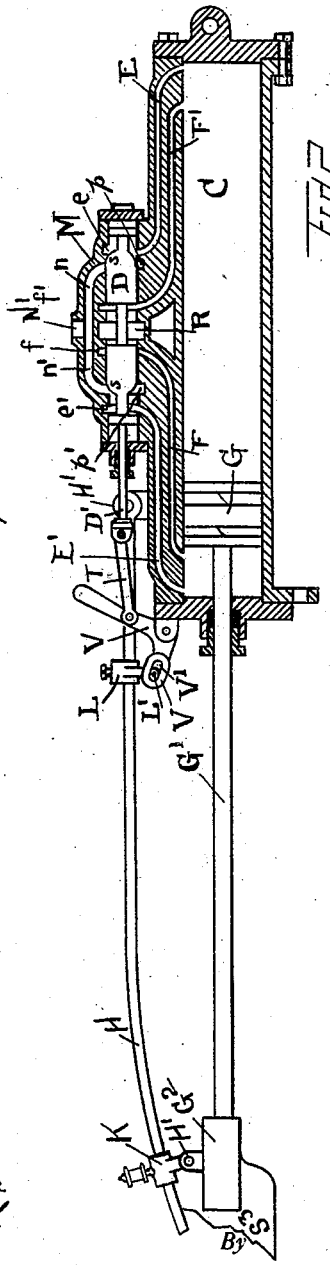

Fig 2

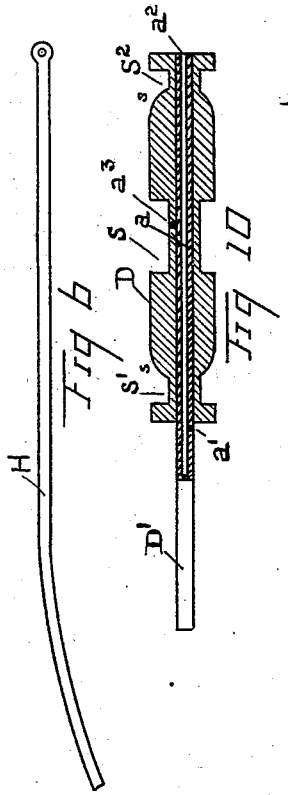

Fig 6 Fig 10

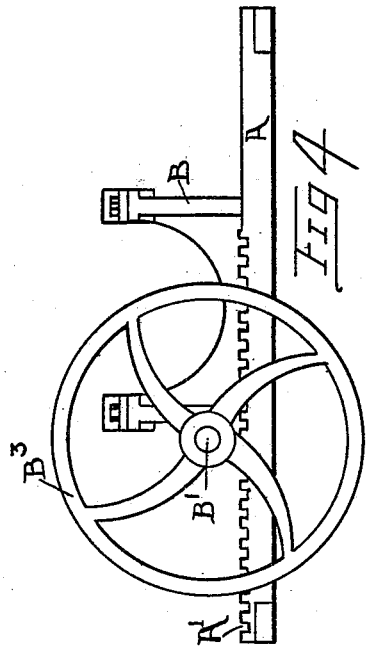

Fig 4

WITNESSES

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UNITED STATES PATENT OFFICE.

ANTHONY S. HILL, OF KALAMAZOO, MICHIGAN.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 646,663, dated April 3, 1900.

Application filed May 27, 1899. Serial No. 718,488. (No model.)

To all whom it may concern:

Be it known that I, ANTHONY SALTSMAN HILL, a citizen of the United States, residing at Kalamazoo, county of Kalamazoo, State of Michigan, have invented a certain new and useful Improvement in Steam-Engines; and I declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same, reference being had to the accompanying drawings, which form a part of this specification.

My invention relates to improvements in direct-acting steam-engines which are especially adapted for use in actuating drag-saws and for similar uses. Its objects are to provide a structure of the valves and ports enabling the engine to run at a high rate of speed without unduly increasing the length, thickness, and weight of the cylinder and other parts, also to provide in such an engine an improved cushioning means for the piston in combination with the valve and valve motion, and also to provide an improved valve mechanism, all of which is hereinafter set forth in the accompanying specification and pointed out in the claims.

In the drawings, Figure 1 is a side elevation of the engine adapted for use in connection with a drag-saw. Fig. 2 is a longitudinal vertical detailed sectional elevation through the cylinder and adjacent parts, the piston, piston-rod, connecting mechanism, and valve mechanism being left in full lines. Fig. 3 is a detailed side elevation of the base by means of which the engine is supported and adjusted when used to operate a drag-saw. Fig. 4 is an end elevation of the mechanism shown in Fig. 3. Fig. 5 is an end view of the steam-cylinder, showing the trunnions. Fig. 6 is a detailed view of the cam-rod for actuating the engine-valve. Fig. 7 is a detailed view of the slide secured to the cross-head of the engine and adapted to reciprocate upon the cam-rod. Fig. 8 is a detailed end view of the bracket secured to the cam-rod, carrying an angular journal-pin by means of which the cam-rod actuates the valve mechanism. Fig. 9 is a detailed view of the bell-crank by means of which the bracket of Fig. 8 acts upon the valve-rod. Fig. 10 is a longitudinal detail sectional view of the valve, the stem being shown in full lines.

A represents the base, carrying a pillow-block B, which is adjustable back and forth by the pinion B^2, acting on the rack A', the pinion B^2 being actuated by the hand-wheel B^3 by means of the shaft B', the shaft being appropriately journaled at *b b* on the pillow-block B. This adjustable feature is not claimed in the present application, as it is the subject-matter of an application already filed, being Serial No. 676,485.

The steam-cylinder C is supported on the pillow-block by means of the trunnions C' and in this adaptation of the engine carries a framework C^2, which is supported by a counterbalance C^3 and controlled by hand-wheel C^4, by which the same can be raised or lowered. As shown in this application, also, it carries a drag-saw S^3, which is rigidly attached to the cross-head G^2, traveling upon a guide G^3, the cross-head being attached to a piston-rod G', as shown in the drawings, Fig. 2. A steam-chest M is supported upon the top of the cylinder, to which steam is admitted by a pivoted steam-pipe M'. This pipe is jointed at the trunnion and receives steam from the fixed pipe M^2, controlled by the throttle-valve N, which may be operated by a reach-rod N^2. These features of construction are incidental to the use of this improvement in connection with the drag-saw, as illustrated. Of course it will be understood that if the cylinder were fixed in its position, as in a steam-pump or other analogous structure, much of the detail of the jointing of the steam-pipes would not be required.

The valve D is fixed to a stem D', as shown in section in Fig. 10. A passage *a* extends through the stem, having an opening *a'* at the forward end of the valve and an opening a^2 at the rear of the valve. A broad annular port S is made by constricting the center of the valve, and also annular ports S' and S^2 are formed by constrictions at either end thereof. In the port S there is a small hole a^3 through the valve-stem, communicating with the interior passage. As will be noticed particularly in Figs. 2 and 10, the body of the valve is rounded off at its ends *s s*, leading into the annular ports S' and S^2, thus secur-

ing, when operated by the cam-rod and in conjunction with the valve-seat, a gradual opening of the ports which in some instances is very desirable. It also secures a free action of the valve with little friction.

The valve-casing M is provided with annular ports, that to the rear being marked *e* and that to the front of the casing marked *e'*. The port *e* connects with the passage E, leading to the extreme rear end of the cylinder C, while the port *e'* connects with the passage E', leading to the extreme front end of the cylinder. A broad annular eduction-port R is centrally located in the steam-chest M. The steam-chest M receives steam through the steam-pipe M' at N', which divides into passages *n n'*, the terminals of these passages forming annular ports *p p'* around each end of the body of the valve D.

With the valve in the position shown in Fig. 2 it will be noted that there is a free passage for steam from the opening N' through the passage *n'* and port *p'* past the rounded end of the valve and its port S' and thence through the port *e'* and E' to the forward end of the cylinder while the passage *n* and the corresponding port *p* are closed off by the valve, although the port *e* and passage E are open to the port S^2 at the opposite end of the valve. There is therefore no passage at the opposite end of the valve between the port E and any port in the steam-chest. In the body of the casting forming the steam-chest and passages there are formed ports *f* and *f'*, which by means of the passages F and F' lead, respectively, to the front and rear ends of the cylinder, but terminate therein at a little distance from the extreme end and from the ports E and E', respectively. As shown in Fig. 2, the port *f* and passage F are closed by the valve D, whereas the port *f'* is open to the exhaust-port R.

The valve-stem D' extends through the usual stuffing-box in the steam-chest and is pivoted to a pitman T, which in turn is pivoted to the bell-crank V, fulcrumed at any convenient point, as on the end of the cylinder. The opposite end of the bell-crank V is provided with a slot V'.

A curved rod H is pivoted at its rear end at any convenient point at the top of the cylinder, the pivot being substantially on the same horizontal plane as the valve-stem, as shown at H'. The curve in this rod is peculiar and preferably only involves the other half or third of the cam-rod, and in consequence of its action I term it a "cam-rod." The curved forward end of the rod extends through a guide K, which is pivoted to the cross-head G^2 of the piston-rod, although it might be to some other connected moving part, and therefore the guide reciprocates upon the rod H in accordance with the stroke of the piston and piston-rod. Adjustably secured to the rod H is a bracket L, having a pin L', which engages in the slot V' of the bell-crank V. It is obvious that when the engine is in operation and the slide K reciprocates upon the cam-rod H it swings up and down upon the pivot H', the movement and character of this oscillation depending upon the curvature given the rod and upon the adjustment of the bracket L. The bracket L being adjustable longitudinally upon the rod H and its office being to connect the bell-crank V with the rod in such a way that the vertical oscillation of the rod will transform the vertical reciprocations to horizontal reciprocations of the valve by means of the connected bell-crank and valve-stem, it is obvious that the amplitude of the vertical reciprocations can be adjusted by means of the adjustable bracket, as it can be moved longitudinally along the rod, approaching to or receding from its center of oscillation at H'. Of course this would correspondingly vary the amplitude of the motion of the valve, and as a means of adjustment it may be used in conjunction with that of bending the rod as described. Thus it will be seen that the bending of the rod at its extremity may be utilized to vary the rate of motion at different portions of the travel of the valve, making it slower or quicker, as desired, while the amplitude of that motion can be varied by means of an adjustment of the bracket L upon the rod, as described. The oscillation of the cam-rod H thus produced is transferred into the reciprocating action of the valve D by means of the adjustable bracket L, bell-crank V, and pitman T, and it is obvious that the reciprocation of the valve can be controlled and adjusted by means of the curvature given to the rod H, and thus almost any assignable variation of motion can be created by varying the curves of the rod H, and this in itself is a valuable feature of adjustment, as the rod H is capable of being sprung more or less as a method of adjusting the motion of the valve.

In the operation of the valve in connection with the ports E E' F F' the position shown in Fig. 2 is that of the beginning of the return stroke, with the ports *f* closed and *e'* open and with the ports *f'* open and *e* closed. As the return stroke proceeds the cam-rod H will be drawn downward, so that each portion of it as the bracket K passes over it will be in a horizontal line established by the reciprocation of the point of engagement with the bracket. This gradually draws the valve forward by means of the connections described until as the piston approaches the opposite end of the cylinder the port *e'* is closed and the port *f* is opened into the exhaust-passage R; but as the piston G approaches the end of the cylinder, the port *e* not being opened, (or, if opened, connected with the live-steam passage *n*,) the piston is cushioned after passing the passage F', while the port *f* is opened into the exhaust-port R. On the return of the piston the action is to gradually force the valve backward by the rising of the cam-rod H and then to sharply accelerate its motion

by virtue of the curvature at the extreme end of the rod, it being obvious that the curve of the rod can be so proportioned as to give almost any assignable range or quality of motion to the valve at different portions of the stroke, so as to insure the best results. The rounding of the ends of the valves leading into ports S' S^2 tends to admit steam gradually, and therefore prevent sudden shocks which would otherwise be caused by the sudden admission, and this insures smooth action even under very rapid reciprocations.

It will be noted that the elongated opening V' in the cam V may also be so proportioned and arranged as to allow the valve to remain quiescent during a certain portion of the stroke by permitting a cam-rod H to pass through a certain range of movement before actuating the bell-crank and valve, and this, if properly done, would also result in a gradual action in starting the valve, inasmuch as the opening can be so proportioned as to prevent sudden shocks by starting it gradually.

The hollow valve-stem through the valve, communicating, as it does, by means of the opening a^3 with the exhaust and by means of the openings a' a^2 communicating to small chambers formed at each end of the steam-chest, permits a certain degree of cushioning and balancing of the valve, which adds greatly to its smoothness of action, especially with an engine running rapidly.

It will be noted that the steam-passages E and E' are always induction-ports, and F and F' are always eduction-ports. Steam is always admitted through passages E and E' and always exhausted through F and F'. This of itself insures either the confinement of steam before and behind the piston after it passes the ports F and F' or contact with live steam, depending on whether or not the ports *e* and *e'* are opened by the valve in the steam-chest. If when the piston reaches and passes the ports F and F' in the cylinder the ports *e* and *e'*, respectively, are not yet opened, the steam will be confined between the piston and the heads of the cylinder at each end of the stroke. If, however, the ports *e* and *e'* are already opened or opened to a slight extent, the piston will be met by live steam and will be cushioned thereby.

It is obvious that by changing a curvature of the cam-rod H and adjusting the connections the valve may be adjusted to meet any required condition in this respect.

What I claim is—

1. In an engine, the combination of a cylinder, a piston, an engine-valve, valve-seat, and steam-chest, a cam-rod pivoted at one end and movable at the other end as specified and having a curvature as described, means carried by the moving part of the engine to reciprocate over said rod, and means adjustably attached to said rod and connected to the valve-stem to actuate the engine-valve, substantially as described.

2. In an engine, the combination of a cylinder, piston, and valve-chest, double steam-ports at each end of said cylinder, induction-ports adjacent to the cylinder-head, and eduction-ports a short distance therefrom, a piston-valve having a central stricture connecting with the discharge-port and an annular stricture at each end adapted to coöperate with the induction-ports, a cam-rod pivoted at one end and carrying adjustable means engaging a reciprocating part attached to the cross-head and connected to said valve, said rod being adapted for changing its curvature whereby the motion of the valve may be effectuated and controlled, substantially as specified.

3. In an engine, the combination of a cylinder, piston, piston-rod, and cross-head, a steam-chest, a valve located therein, a cam-rod pivoted at one end near the steam-chest, means connected with a cross-head adapted to engage and reciprocate upon said cam-rod, and means longitudinally adjustable thereon connecting said cam-rod to the engine-valve, said rod being straight for a large portion of its length adjacent to the cylinder, and the outer portion of the rod being curved substantially as described.

4. In an engine, the combination of a cylinder, piston, piston-rod, and cross-head, a piston-valve located in a steam-chest contiguous to said cylinder, induction-ports leading from the extremities of the valve-chest and valve to near the piston-heads in said cylinder, eduction-ports leading from a short distance from the cylinder-heads to a central discharge in said steam-chest, said valve having annular strictures near its ends, the inner faces of said strictures being rounded off for the purpose of coöperating with the action on said valve of the adjustable cam-rod, substantially as and for the purpose described.

5. In a steam-engine, the combination of a steam-cylinder, piston and piston-rod operating therein, a steam-chest, a piston-valve seated therein with an annular bearing, passages for the admission of steam to the valve-seat, means for actuating said valve, induction-ports leading from the extremities of the cylinder to the extremities of the valve-chamber, eduction-ports leading from points located at a short distance from either end of the cylinder, and to substantially the central portion of the valve-chamber, whereby when the piston passes the eduction-ports it is cushioned by confined steam due to the location of the valve over the induction-port, the said valve being incapable of being raised to liberate the confined steam, substantially as described.

6. In a steam-engine, the combination of a cylinder, piston and piston-rod, a steam-chest in which the steam-space is largely filled by a piston-valve with an annular central stricture and two elongated heads, ports leading from the steam-pipe to either end of the

steam-chest, induction-ports leading from the extremities of the steam-chest to the extremities of the cylinder, the passages leading from the steam-pipe and the induction-ports in the steam-chest not being coincident, the steam-ports being located at a short distance beyond the passages from the steam-pipe in such manner that the passages from the steam-pipe may be closed by the valve while the induction-port is open to the steam-cylinder, substantially as and for the purpose described.

In testimony whereof I sign this specification in the presence of two witnesses.

ANTHONY S. HILL.

Witnesses:
JAY D. DRIVER,
FRANK S. WESTON.