G. I. Washburn,

2 Sheets. Sheet. 1.

Slide Valve.

No. 98,725. Patented Jan. 11. 1870.

FIG. 1

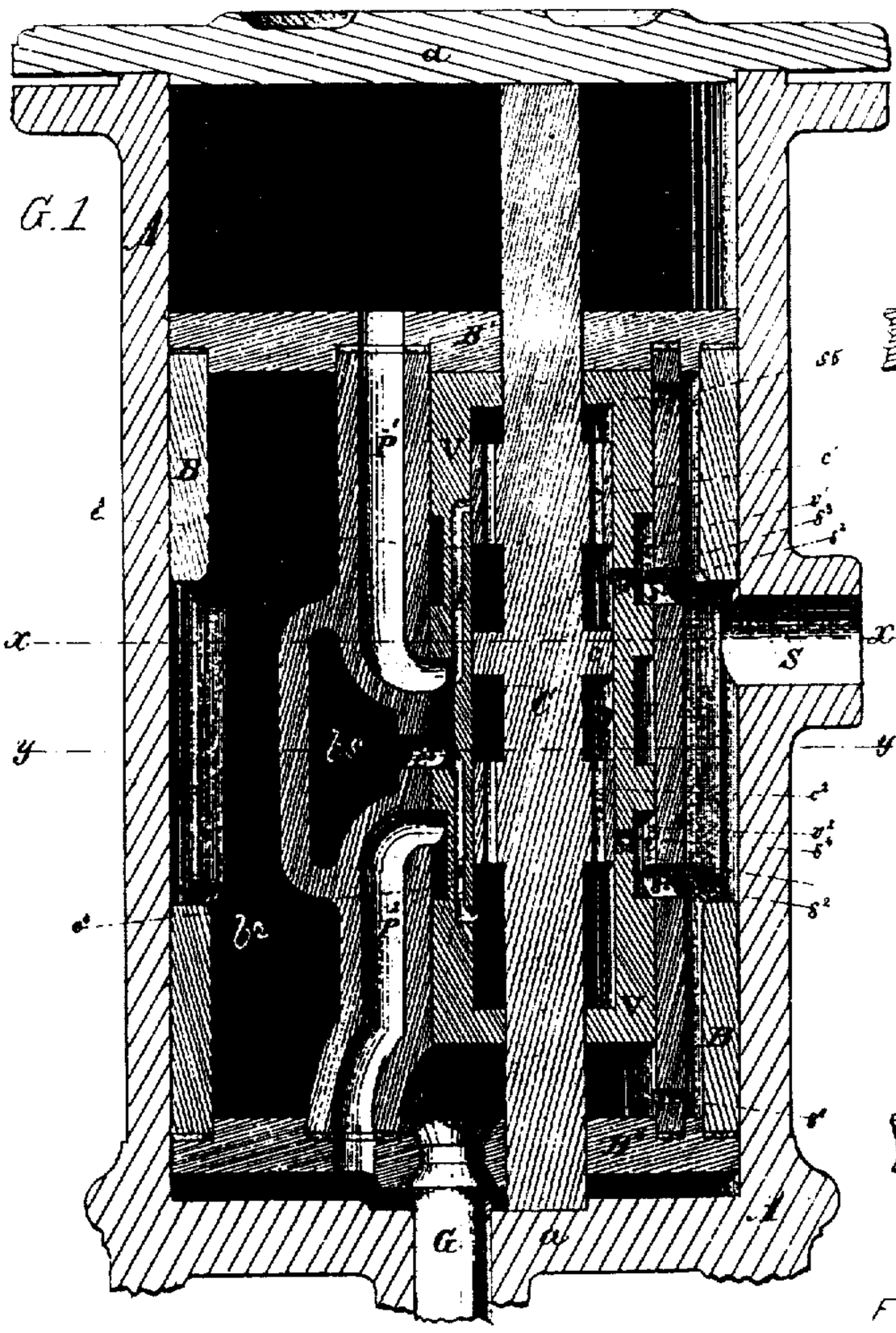


FIG. 4

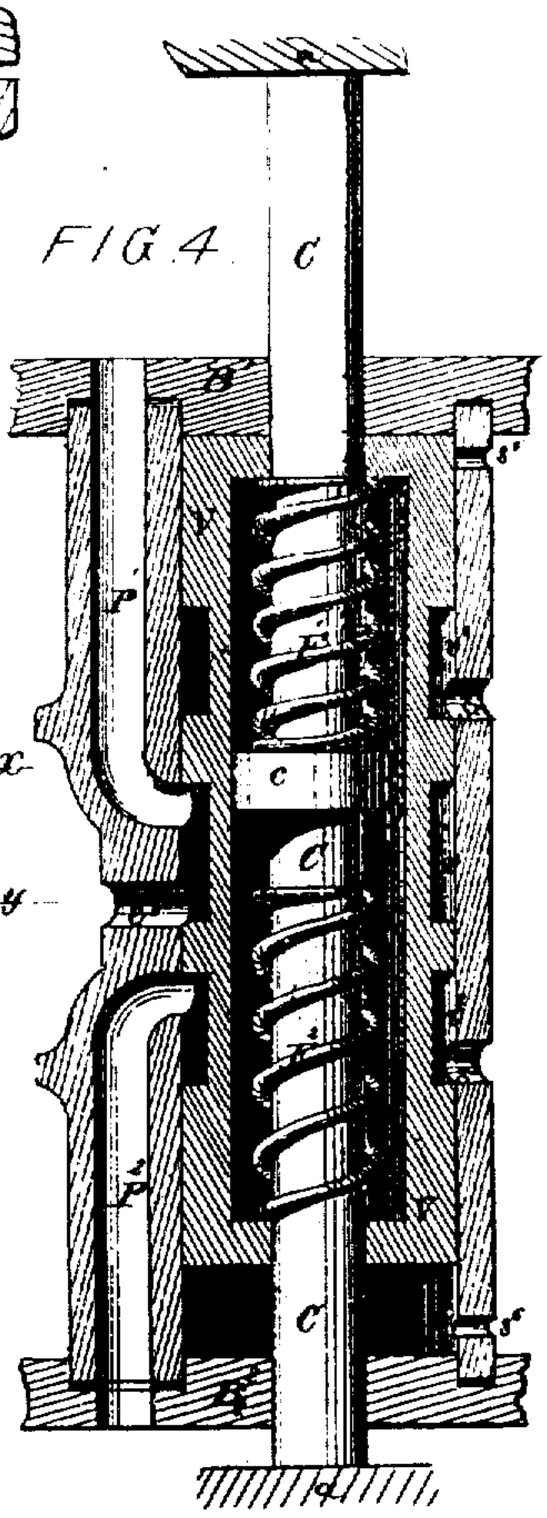


FIG. 2.

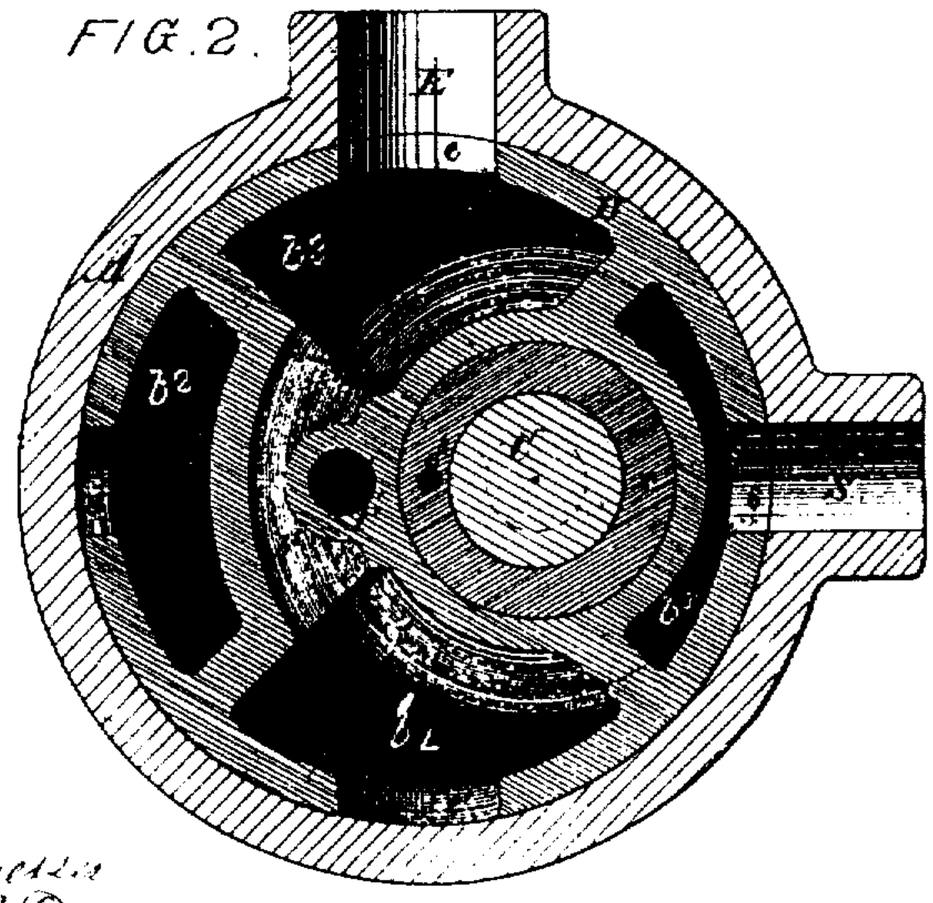
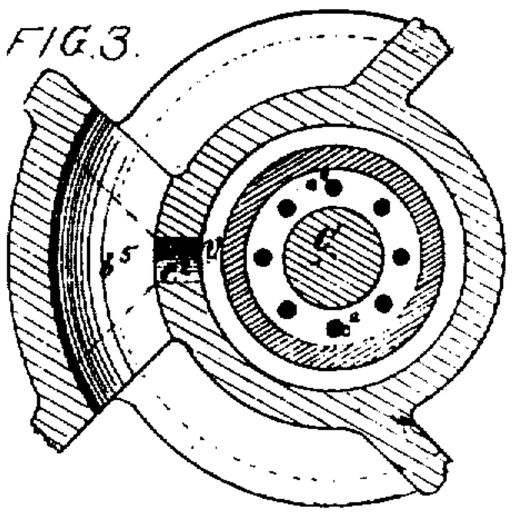


FIG. 3.



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2. Sheets Sheet 2

G. I. Nashburn.

Slide Valve.

No. 98,725. Patented Jan. 11. 1870.

FIG. 7.

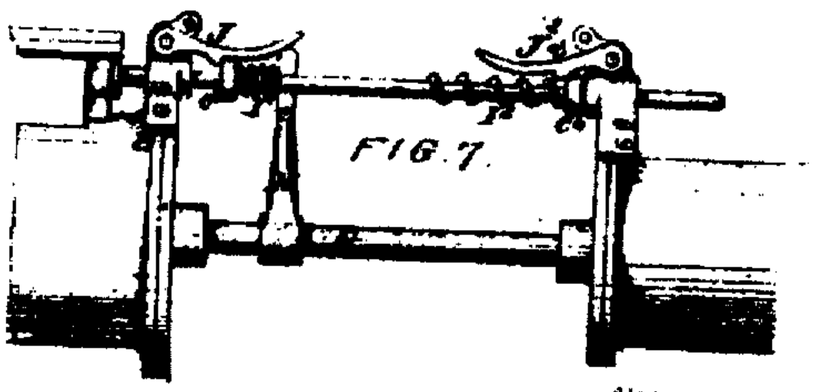
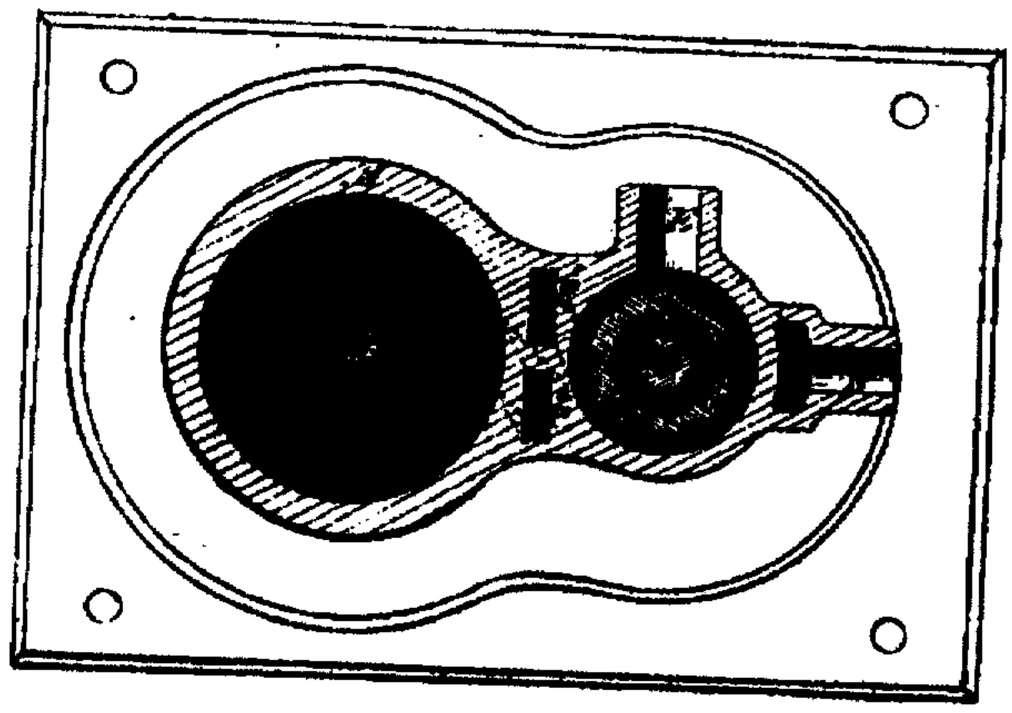


FIG. 5.

FIG. 6.



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UNITED STATES PATENT OFFICE.

GEORGE I. WASHBURN, OF WORCESTER, MASSACHUSETTS.

MODE OF OPERATING VALVES IN STEAM-ENGINES.

Specification forming part of Letters Patent No. **98,725**, dated January 11, 1870.

To all whom it may concern:

Be it known that I, GEORGE I. WASHBURN, of Worcester, in the county of Worcester and State of Massachusetts, have invented certain new and useful Improvements in Valve-Movements for Steam and other Engines; and that the following is a sufficiently full and exact description of my said invention to enable one skilled in the art to which it appertains to carry it into effect, reference being had to the accompanying drawings, which are made part of this specification.

The primary object of my invention is to so actuate and control a valve that when the motion of the steam or other fluid is to be reversed or changed the valve will be caused to move instantaneously, without waiting for the accumulation of pressure, and without a possibility of it resting on any dead-point.

To this end I operate the valve in the following manner: First, loading it so that it cannot move; second, applying pressure in the direction in which the valve is to move, insufficient to overcome the load referred to, but fully sufficient to move the valve when released; third, when the time comes to move the valve and reverse the steam upon the main piston, (or any other fluid which is to be controlled,) removing or balancing the pressure first referred to, so that the pressure secondly referred to will throw the valve instantaneously and without fail.

My invention, as above set forth, may be embodied in various ways, of which I shall proceed to describe four, all involving the same principles of operation, and each susceptible of various modifications.

In the drawings, Figure 1 represents a longitudinal section of a steam-cylinder and piston, with the valve mechanism placed inside the piston, and adapted to be moved by steam-pressure. Fig. 2 is a transverse section of the same, in the plane indicated by the line *x x*, Fig. 1. Fig. 3 shows a transverse section of a part thereof, at *y y*, Fig. 1. Fig. 4 is a longitudinal section, showing a similar valve located within the piston, and adapted to be thrown by the agency of springs. Fig. 5 is a longitudinal section, representing the valve mechanism on the outside of the main cylinder, and operated by the pressure of steam. Fig. 6 is a transverse section at *z z*, Fig. 5. Fig. 7 represents, in elevation, the adjacent ends of a steam-cylinder and pump-cylinder, with a piston-rod common to both, and an arm by which the steam-valve is thrown, through the medium of springs, as hereinafter described.

Like letters of reference indicate like parts in all the figures.

The steam-cylinder A, with its heads *a a*, may be of any common or suitable construction.

In the form of the invention represented in Figs. 1, 2, and 3, I employ a hollow piston, B, the interior of which is divided into four chambers, of which two, b^1 b^2, which are opposite to each other, are always in communication with the steam-supply port S, and the other two, b^3 b^4, which are also opposite each other, are in constant communication with the exhaust-port E.

In order to maintain the communication of the chamber b^1 with the steam-port S at all parts of the stroke, I provide a slot, *s*, Figs. 1 and 2, the length of which exceeds that of the stroke of the piston.

The chamber b^3 communicates with the exhaust-port E through a similar longitudinal slot, *e*.

In order to balance the pressure on the opposite sides of the piston, the chamber b^3 communicates with the chamber b^4, through an open passage, b^5, Figs. 1, 2, and 3; the chamber b^1 communicates with the chamber b^2 by one or more similar passages, indicated by dotted lines in Fig. 2; and slots s^1 and e^1 are formed in the walls of the piston, corresponding in area, and diametrically opposite in position, to the slots *s* and *e*, respectively.

The steam is introduced to and withdrawn from the ends of the cylinder alternately through ports P^1 P^2, whose inner ends are made to communicate with the steam and exhaust chambers alternately by a valve, V, consisting of a hollow cylinder, with three parallel grooves, v v^1 v^2, extending around its periphery. The width of each of these grooves longitudinally of the valve is slightly greater than the length of the stroke or throw of the valve within the piston.

The central groove *v* communicates con-

stantly with the exhaust, through the ports e^2 b^5 e, and alternately with the ports P^1 P^2 of the piston.

The grooves v^1 v^2 communicate constantly with the steam-chamber b^1, through the ports s^2 s^2, and alternately with one or other of the ports P^1 P^2, one of the grooves v^1 v^2 being used for each of the ports P^1 P^2, so as to introduce the steam-pressure to the said ports alternately.

Within the cylindrical valve V is a plug or rod, C, which projects out through the ends of the valve and of the piston, and is provided at its longitudinal center with a flange or collar, c, upon which the valve works steam-tight, and which constitutes an abutment for the steam or other motor to act against, as will presently be explained.

My description thus far applies to the form of the invention illustrated in Fig. 4, as well as that shown in Figs. 1, 2, and 3. In the illustration given in Fig. 4, springs F^1 F^2 are employed to impart the endwise throw to the valve, which, in the illustration shown in Figs. 1, 2, and 3, is effected by steam-pressure within the hollow valve.

To admit the steam within it, the hollow valve V, Figs. 1, 2, and 3, is constructed with ports s^3 s^4, communicating with the steam-grooves v^1 v^2, respectively, the said ports being located so far apart that neither of them may pass or reach the central flange or collar c of the stationary plug C as the valve moves. Two additional flanges or collars, c^1 c^2, on the stationary plug C, serve to close one or other of the ports s^3 s^4 as the valve moves, the arrangement of the said ports and flanges being such that one of the ports will be closed as the other is opened, and vice versa. The steam-chambers at the respective ends of the hollow valve communicate, also, with the exhaust-groove v through passages e^3 e^4, which are, in like manner, so controlled by the stationary flanges or collars c^1 c^2 that one only of them is open at a time, and the parts c^1 c^2 s^3 s^4 e^3 e^4 are so constructed and relatively arranged that, while the steam-port s^3 at one end of the valve is open, the exhaust-port e^4 at the other end will be open, and s^4 and e^3 closed; but while the steam-port s^4 is open, the exhaust-passage e^3 will be open, and s^3 and e^4 closed.

As the flanges or collars c^1 c^2 are employed only to open and close steam inlets and outlets to and from the interior of the valve, and not as an abutment for the steam in moving the valve, the said flanges or collars are perforated, as shown in Figs. 1 and 3, to allow the steam to pass freely through them, and equalize the pressure on their opposite sides. Additional steam-ports s^5 s^6 are located near the ends of the valve-chest, so that the valve will close one of them at each extremity of its stroke, but in its intermediate position will be subjected to a balanced pressure of steam upon its ends. G represents the piston-rod.

Operation: The drawings represent the piston at the termination of its downward stroke, with the valve reversed, so as to cause the upward movement of the piston, which will be effected by the pressure of steam admitted through the passages S s s^2 v^2 P^2 to the lower end of the cylinder. At the same time, the pressure of steam admitted through the port s^6 into the valve-chest causes the valve to move upward with the piston, this effect being assisted by the pressure of steam admitted through the port s^3 to the upper end of the interior of the valve, and acting against the stationary abutment c, the lower end of the interior of the valve being in communication with the exhaust through the passage e^4.

The upward motion of the valve soon admits steam-pressure into the lower end of the valve V, by uncovering the port s^4 and closing the passage e^4 by the collar c^2, and at the same time the steam-port s^3 is closed by the collar c^1, and the upper end of the interior of the valve is exhausted through the passage e^3. A downward pressure is thus applied to the interior of the valve, but this does not immediately move the valve, because it is overbalanced by pressure upon the exterior of the lower end of the valve, the area of which is greater than that of the interior surface upon which the downward pressure is exerted.

Before the piston completes its upward stroke the lower end of the valve comes in contact with the stationary collar c^2. The motion of the valve being thus arrested, the continued movement of the piston B immediately uncovers the port s^5, admitting steam to the upper end of the valve-chest, the downward pressure of which upon the valve balances the upward pressure against the lower end of the valve, and permits the pressure within the valve to throw the latter down against the lower end B^2 of the piston, so that the upper end of the cylinder will receive steam through the passages S s s^1 v^1 P^1, and the lower end will be exhausted through P^2 v e^2 b^5 e E. The downward stroke is then made, and the valve again reversed in the manner already described in relation to the upward stroke. In each case the entire steam-pressure which is to move the valve is applied to it before the time comes for it to move; but is overbalanced by a greater pressure until the proper moment for it to move, when the load being either counterbalanced or removed, the entire pressure of the steam acts to throw the valve instantaneously.

I am thus enabled to control the piston with absolute certainty, however rapid its motion, and I avoid all the difficulty commonly experienced with valves operated by steam in waiting for the passage of steam or the accumulation of pressure.

In the illustration given in Fig. 4 the springs F^1 F^2 within the hollow valve perform the same functions as the pressure of steam within the valve in the arrangement already described. Fig. 4 shows the position of the

parts at the instant that the valve has been reversed and the piston has begun its upward stroke. As the piston descended, the valve which rested against the lower head B^2 under pressure of steam entering through the port s^5, compressed the spring F^1 until the resistance of the latter overcame the steam-pressure on the valve. The continued motion of the piston then uncovered the port s^6, permitting steam to enter the lower part of the valve-chest and exert an upward pressure against the lower end of the valve, which, balancing the downward pressure upon the upper end, permits the spring F^1 to throw the valve instantaneously to the position shown in the drawing, so that steam is admitted to the lower end of the cylinder through the passages s^2 v^2 P^2, and exhausted from the upper end through P^1, v, e^2, b^5, and e. The valve V then rises with the piston until the resistance of the spring F^2 overcomes the pressure of steam admitted through the port s^6, when the port s^5 is again uncovered, admitting a balancing pressure to the upper end of the valve-chest, when the valve is again instantaneously reversed by the action of the spring F^2. Steam is thus admitted to the upper end of the cylinder, through the passages v^1 and P^1, and the steam in the lower end exhausted through P^2 v e^2 and their connections before named. In both these forms of the invention I prefer to provide or permit a slight leak for the steam where the plug C passes through the piston-heads, so that any steam imprisoned in either end of the valve-chest may escape into the exhaust as soon as the valve is reversed; but this leak is not so great as to destroy the cushioning effect on the valve, which is caused by locating the ports s^5 s^6 at a little distance from the ends of the valve-chest.

Figs. 5 and 6 illustrate the invention applied under a modified form—that is to say, with the valve working in a stationary steam-chest, external to the main cylinder and actuated by steam-pressure under control of a central plug, C, which is moved near the termination of each stroke of the piston B by an arm, H, attached to the piston-rod G, and acting against tappets c^3 c^4 upon the rod C′, to which the plug C is attached.

Fig. 5 represents the piston approaching the downward termination of its stroke, the arm H having already come in contact with the tappet c^4, so as to force down the plug C and valve V until the steam-port s^5 is opened so as to admit steam to the upper end of the valve-chest, the downward pressure of which upon the upper end of the valve balances the upward pressure of the steam admitted through the port s^6. The external pressure on the valve being thus balanced, the valve is instantaneously thrown down by pressure of steam already admitted to the lower part of the interior of the valve through the port e^4. By this motion of the valve the passage P^2 is placed in communication with steam through the groove v^1, and the passage P^1 in communication with the exhaust through the groove v, and thus the upward stroke of the piston is produced, the valve and all its accessories remaining stationary until the arm H, striking the tappet c^3, moves the plug C upward. The port s^3 is thus uncovered, admitting steam within the upper end of the valve, which steam, acting against the collar c as an abutment, and passing freely through the perforated collar c^1, exerts an upward pressure upon the valve, but not sufficient to overcome the external pressure of steam admitted through the port s^5 to the upper end of the valve-chest. The valve, therefore, does not move until the contact of the collar c^1 with its upper end raises it sufficiently to uncover the port s^6, when the external pressure, being again balanced, the internal pressure in the upper end throws the valve up, placing the steam-groove v^2 in communication with the passage P^1, and the exhaust-groove v with the passage P^2, and thus imparting the downward stroke to the piston.

In the illustration given in Fig. 7, springs I^1 I^2 are interposed between the arm H and tappets c^3 c^4 on the valve-rod C′, and, instead of employing steam-pressure to load the valve until the time comes to move it, the rod is locked by catches J^1 J^2 engaging alternately with the tappets c^3 and c^4. In Fig. 7 the piston-rod is represented as moving from right to left. The arm H, carrying the spring I^1 before it, compresses it with considerable force against the tappet c^3 until the said arm, in passing under the inclined face of the catch J^1, raises it, releasing the tappet c^3, and causing the valve to be thrown instantaneously by the action of the spring I^1. When used in a steam-pump operated by exhaust-steam, or any other steam having very low pressure, the arrangement last described has this peculiar value, that the whole area of the main piston is made available for moving the valve through the medium of the springs, whereas, if the valve be moved by direct pressure of steam, its area must be large or the propelling force applied to it proportionately small. A balanced valve is preferable for this purpose, but any form of valve may be used.

My principle of loading or locking the valve against an elastic pressure, which will throw it instantaneously when the resistance is removed or counterbalanced, may be embodied in any of the forms above described, or in various others which will suggest themselves to the skilled mechanic or engineer. For example, the plug C may be as long as the cylinder, as in the present illustration, or it may be shorter. The device will work equally well in a cylinder of any length. The plug, projecting from the piston in the direction in which the latter is moving, will not act upon the valve until its own motion is arrested by contact with the cylinder-head, and then it will check the valve, so as to cause the latter to

be thrown by internal pressure, as explained. Again, the plug may be fastened to the cylinder at one end, instead of resting against both heads of the cylinder; and again, the invention may be used with a stationary piston and a moving cylinder.

The invention is applicable to steam-engines, steam-pumps, water motors or meters, or any other purpose where a valve is required to control the movement of a piston or its equivalent.

In the common mode of operating valves by steam, they receive the pressure only when their motion should take place, and, unless the steam acts instantly, the main piston is liable to strike the cylinder-head. Again, as the valve starts as soon as the pressure upon it equals its own resistance, the valve will not generally act under full boiler-pressure. Now, as (under the ordinary arrangement) the steam which moves the valve is immediately cut off from it, the valve is liable to move over only a part of its stroke before its steam is cut off. My valve is subjected to full boiler-pressure before it is allowed to move, and this pressure remains on it during a part of the return stroke of the main piston. Hence, no valve-motion within my knowledge, except when a connection is made with a balance-wheel, can be so reliable as mine.

I claim and desire to secure by Letters Patent—

A valve-operating mechanism, in which the valve is first locked or loaded in opposition to the direction in which it is to move, and then subjected to pressure, which will move it instantaneously when the resistance first referred to is removed or counterbalanced, substantially as set forth.

GEO. I. WASHBURN.

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