No. 774,688. PATENTED NOV. 8, 1904.

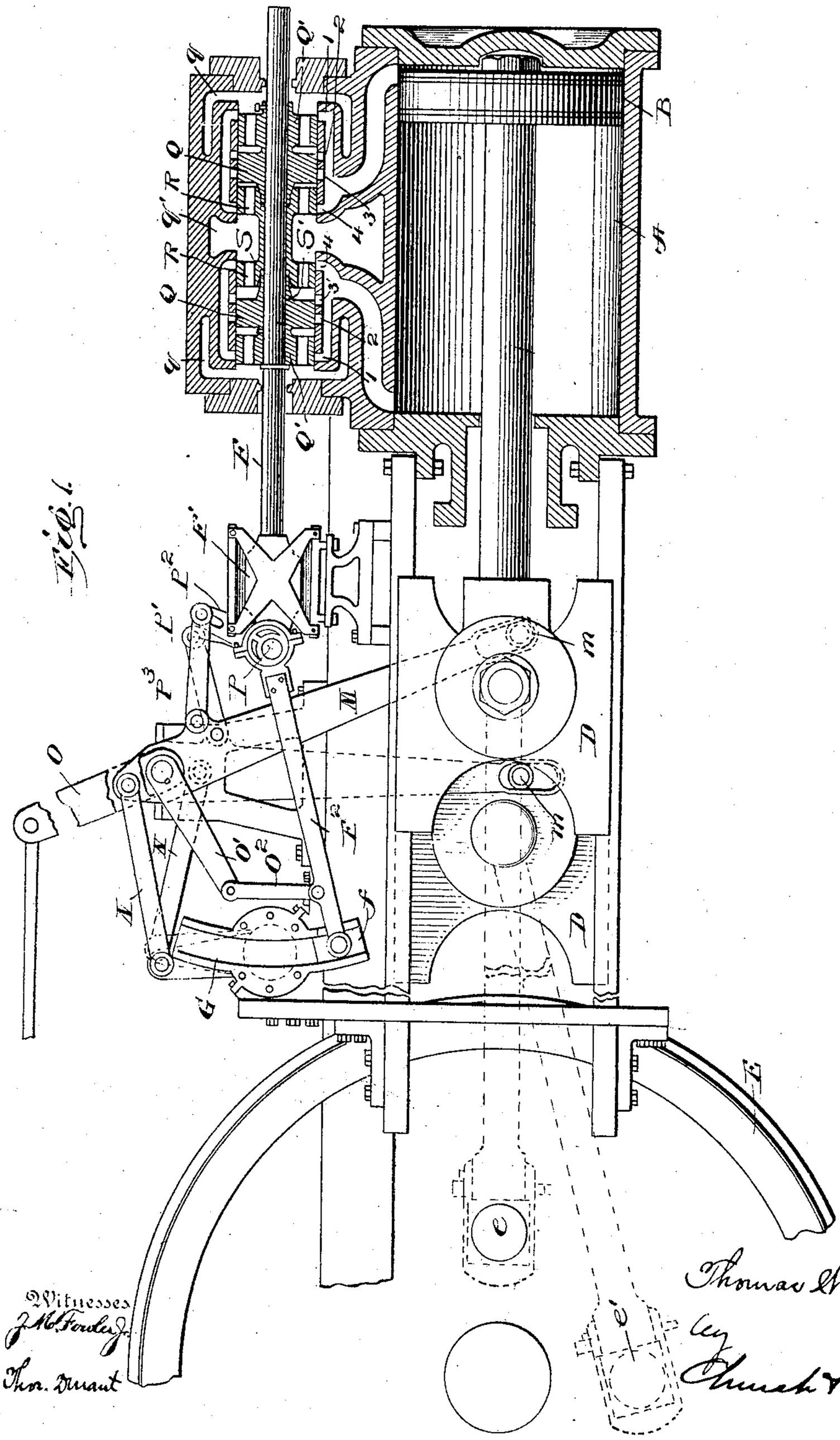
T. W. MITCHELL.

STEAM ENGINE.

APPLICATION FILED DEC. 18, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.



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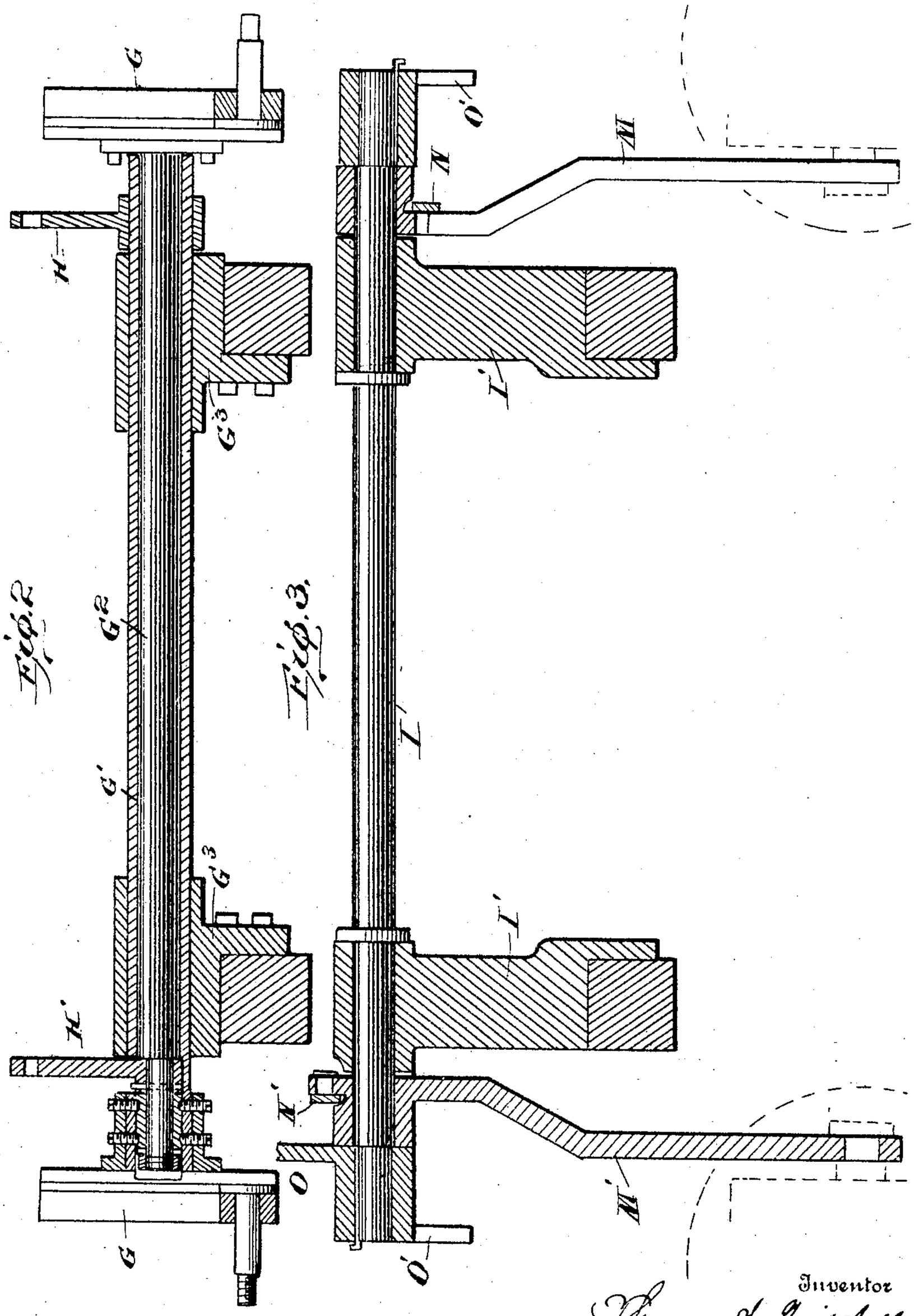

Fig. 2.

Fig. 3.

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No. 774,688. Patented November 8, 1904.

UNITED STATES PATENT OFFICE.

THOMAS W. MITCHELL, OF OMAHA, NEBRASKA.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 774,688, dated November 8, 1904.

Application filed December 18, 1903. Serial No. 185,739. (No model.)

To all whom it may concern:

Be it known that I, THOMAS W. MITCHELL, a citizen of the United States, residing at Omaha, in the county of Douglas and State of Nebraska, have invented certain new and useful Improvements in Steam-Engines; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming a part of this specification, and to the figures and letters of reference marked thereon.

This invention relates to improvements in steam-engines, and more particularly to the valve mechanism of locomotive-engines, the objects of the invention being to provide a valve mechanism which will occupy a minimum space, be easily and effectually controlled by the engineer, and give the valve a correct motion to secure the maximum efficiency with the least possible movement.

A further object of the invention is to minimize the lost motion or slip between the valves and pistons of a locomotive-engine embodying a link-motion in its construction.

The invention consists in certain novel details of construction and combinations and arrangements of parts, all as will be now described, and pointed out particularly in the appended claims.

Referring to the accompanying drawings, Figure 1 is a side elevation, partly in section and with parts broken away, of a valve mechanism embodying the present improvements. Fig. 2 is a vertical section through the links and parts directly connected therewith. Fig. 3 is a similar view showing the rock-shaft and link-operating arms connected therewith.

Like letters and figures of reference indicate the same parts.

The letter A indicates a cylinder on one side of the locomotive; B, the piston; D, the cross-head, and E a portion of one of the drive-wheels, the latter being shown in position for the application of a shorter connecting-rod than would ordinarily be employed in order that the center and crank pin positions may be indicated in the same view with the other portions of the mechanism. The parts referred to—namely, the cylinder-piston, cross-head, &c.—may be of any usual or preferred type and may be connected with the drive-wheels by a connecting-rod extending to the front or rear driver, it being understood, however, that the crank-pins of the drive-wheels on opposite sides of the locomotive are set at an angle of ninety degrees with respect to each other, as indicated by the full and dotted lines in Fig. 1, where *e* indicates the crank-pin on one driver and *e'* the crank-pin on the opposite driver.

In the present invention valve-operating mechanism is employed in which the motion is derived from the cross-heads or reciprocating parts of the engine rather than from eccentrics such as are most commonly used in locomotive-engines, and the power for moving the valve on one side of the locomotive is in the main derived from the cross-head or reciprocating part on the opposite side of the locomotive, a variation in the motions of the valve being, however, secured from the movement of the cross-head or reciprocating part on its own side of the locomotive.

The valve-stem F, which carries the valve to be presently described in detail, is preferably connected with a slide or cross-head F' and through a rod F^2 with a block *f*, adapted to slide in an arc-shaped link G. Similar connections for the parts are provided for each side of the locomotive, and the links G are mounted on shafts having coincident axes, one of said shafts, G', being in the form of a tube within which the other shaft, G^2, takes its bearing. The link on one side of the locomotive is mounted on one end of the shaft G^2, and the link at the opposite side is mounted on the opposite end of the shaft G', the latter shaft being mounted in bearings G^3 on the locomotive-frame, as best seen in Fig. 2 of the drawings.

For operating the links a driving connection is preferably made with arms H H' located on the shaft, arm H' being on the shaft G^2 and extending in through a slot in the shaft G', as shown at the left-hand end of Fig. 2. By this arrangement the link-operating arms H and H' are brought into proximity to or in the substantial plane of the cross-head on the

opposite sides of the locomotive from the links to be operated thereby. Thus, again referring to Fig. 2, it will be seen that the arm H′ operates the link G on the right-hand side, while the arm H operates the link G on the left-hand side of the figure.

Forward of the link-shafts G and G^2 there is mounted a rock-shaft I, preferably in bearings I′, extending up from the frame of the locomotive and adapted to have journaled upon it two operating-levers M and M′. The lower ends of these levers M and M′ are slotted and coöperate with pins *m* on the inner side of the cross-heads D, respectively, and rods N and N′ connect said operating-levers M and M′ with the arms H and H′, respectively, the connection between the arm H′ and operating-lever N′ being above the pivotal center of the lever, while the connection between the arm H and operating-lever M is below the pivotal center of the lever, whereby movements of the operating-levers in the same direction will oscillate the links in opposite directions and impart corresponding movements to the valves.

The connection between the valve-rods F^2 and the links G may be varied by turning the rock or tumbler shaft I from the locomotive-cab through the medium of the usual lever O and crank-arms O′, connected with the rods F^2 by connections O^2 of sufficient length to permit of the reciprocatory movements of the rods without causing the blocks *f* to shift in the links to an appreciable degree. Through the connections described the positions of the blocks *f* in the links may be readily varied to secure an early or late cut-off or to reverse in the well-understood manner, and the operating connections are such that the valves will be given full movements in either direction, if so desired, the timing of the movements being effectually controlled by the cross-heads, the relative position of the latter in turn being determined by the setting or relative positions of the cranks on the drive-wheels—*i. e.*, ninety degrees apart. The result is that the valve movements are properly timed to admit and exhaust steam from the cylinders in proper sequence to secure the desired reciprocatory movements of the piston, each valve being directly controlled in its movements by the cross-head and piston on the opposite side of the locomotive. The cranks being set quartering with respect to each other results in an acceleration of the valve movement as each piston nears and leaves the ends of the cylinder, inasmuch as the opposite piston is at such times moving at its highest velocity.

In order to properly control the valve travel and lead, a variable movement is imparted to the valve from the cross-head on its own side of the locomotive, the connections for effecting this being as follows: An eccentric P is journaled in the cross-head F′ of each valve-stem, and the valve-rods F^2 are provided with straps P′, embracing the eccentrics P, to form the connections between the valve-rods and valve-stems F. The eccentric P of each valve is provided with an arm P^2, preferably slotted at its outer end and connected by rod P^3 with the operating-lever M or M′ on its own side of the locomotive and at a point below the axis of said levers, the distance between the connections P^3 and the axis of the levers, however, being such as to only impose upon the movement of the valve a sufficient variation to subtract from the valve movement a travel at each end equal to the lap and lead of the ordinary valve, permitting of the use of a very short link or a link of such radius that the slip of the link-block is practically eliminated. For illustration, if the link-blocks were placed at the center of the links the eccentrics would impart a movement to the valve equal to the lap and lead only.

With the described construction of valve-operating gear the effect of the relative movements is to cause the valve on each side to be retarded during a portion of the intermediate stroke of its piston in each direction. In other words, the effective movement of the valve takes place during the time the piston is making the final portion of its movement toward and from each end of the cylinder, and the retardation decreases as the engine is "hooked up" or the cut-off increased until the block reaches the center of the link, when the valve movement equals the lap and lead only and is timed to accord with the piston movement. As the gear is hooked up the movement of the valve in closing the exhaust-ports is gradually accelerated, owing to the differential movements of the operating parts, thus affording an increased cushioning effect at high speed because an increased quantity of exhaust-steam will be trapped in the cylinder. With a valve mechanism of this character an ordinary valve—such, for instance, as the common D-valve—is ineffective, and hence a valve and valve-chest having a duplicity of both admission and exhaust ports is employed. As illustrated, the valve is of the piston type, having heads Q at each end for separating the live-steam spaces *q* from the exhaust *q′*, supplemental heads Q′ are formed outside of the heads Q with steam-passages therethrough, and the valve-chest is formed with ports 1, 2, 3, and 4, leading to the ends of the cylinder, the ports 1, 2, and 3 being controlled by the heads Q and Q′, so as to be simultaneously opened and closed.

Ports 1 and 2 are the inlet-ports, while 3 and 4 are the exhaust-ports; but the latter port—*i. e.*, port 4—is controlled by a supplemental valve having heads R similar in construction to the heads Q′. The supplemental valve, however, while it is moved by the main valve does not have a movement coextensive therewith; but sufficient play is left between the two to permit the supplemental valve to remain at rest, with the port 4 on the exhaust

side wide open, while the main valve is making the first portion of its return movement, the supplemental valve being picked up, the port 4 on the exhaust side closed, and that on the opposite side opened just as the steam is admitted in front of the piston, thus prolonging the period of expansion and preventing retardation or choking of the exhaust.

To prevent shock between the valves when they come together, the supplemental valve is recessed at S and the main valve provided with a projection S′, adapted to seat in the recess to form an air or steam cushion, as will be readily understood. Both valves are balanced valves, and the supplemental valve will remain in position by reason of its friction until moved by the main valve.

By combining the valve-operating mechanism described with the main and supplemental valves it will be noted that the period of expansion is prolonged, but at the same time the exhaust is free until the period of compression and lead is reached, the lead-steam being admitted practically simultaneously with the closure of the exhaust-ports. These results are secured by a short valve motion such as is practicable with a link mounted on a fixed axis and both short in length and of short radius.

It will be further noted that the employment of eccentrics P in the connections between each valve and the opposite piston permits of the shifting of the rods F^2 to vary the cut-off or reverse the engine without varying the length of the valve-rod, and, furthermore, the effect of the eccentric is the same with the rod F^2 in any position of adjustment.

In operation as each cross-head approaches the center of travel the movement of the valve on the opposite side and about to deliver lead-steam is accelerated, owing partly to the increased speed of piston travel at that portion of its stroke, partly to the advance of the lead eccentric, whose movement is in unison with the movement of the valve up to the time the cross-head has covered one-half of its stroke, and partly to the fact that the distance from the pin on the cross-head to the axis of the operating-lever is less when the cross-head is at half-stroke than at any other point. The acceleration due to the latter may be increased by shortening the operating-lever or placing the pin at the top of the cross-head, as will be readily understood.

The acceleration not only has the effect of more quickly and fully opening the admission-ports, but at the same time the exhaust-ports are thrown open with equal rapidity.

The tumbling-shaft, it will be noted, is located at a point forward of the links or between the links and valves. Thus the rock-arms move in arcs corresponding quite closely to the arcs of the links, and at the same time the mechanism is all brought into a small area, and the tumbling-shaft may be utilized as the pivotal support for both operating-levers. With this arrangement practically the entire operating mechanism is carried on two axes and frame-bearings, and liability of the mechanism becoming deranged through distortion is correspondingly reduced.

I do not claim herein the combination of the valve-operating gear with a valve and chest, each having a duplicity of inlet and exhaust ports, as this combination is made the subject-matter in my contemporaneous application, Serial No. 211,495, filed June 7, 1904.

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

1. In an engine embodying two cylinders, pistons therein and a crank-shaft with which both of the pistons are connected, the combination with the valves controlling the steam for the cylinders, of valve-operating mechanism embodying connections between the valve for each cylinder and the piston of the opposite cylinder, an eccentric interposed in each of said connections and means whereby the angular position of said eccentric is controlled by the piston to which steam is admitted by the valve with which the eccentric is associated; substantially as described.

2. In an engine embodying two cylinders, pistons therein and a crank-shaft with which both of the pistons are connected, the combination with the valves controlling the steam for the cylinders and eccentrics for varying the travel of the valves each controlled by the piston of its own cylinder, of valve-operating mechanism embodying connections between each valve and the piston of the opposite cylinder, said connections each embodying a link pivoted on a fixed axis and a shiftable connection therewith; substantially as described.

3. In an engine embodying two cylinders, pistons therein and a crank-shaft with which both of the pistons are connected, the combination with the valves controlling the steam for the cylinders, slides with which the valves are connected, eccentrics journaled on said slides and a connection between each eccentric and the piston of its own cylinder for varying its angular position, of valve-operating mechanism embodying connections between each eccentric and the piston of the opposite cylinder; substantially as described.

4. In an engine embodying two cylinders, pistons therein and a crank-shaft with which both of the pistons are connected, the combination with the valves controlling the steam for the cylinders, slides with which the valves are connected, eccentrics journaled on said slides and a connection between each eccentric and the piston of its own cylinder for varying its angular position, of valve-operating mechanism embodying connections between each eccentric and the piston of the opposite cylinder, said connections each embodying a

link pivoted on a fixed axis and a shiftable connection therewith; substantially as described.

5. In an engine embodying two cylinders, pistons therein and a crank-shaft with which both of the pistons are connected, the combination with the valves controlling the steam for the cylinders and connections between the valves and the pistons of their own cylinders for varying the travel of the valves, of valve-operating mechanism embodying separate links one for each valve mounted centrally on opposite ends of telescoping shafts journaled in the engine-frame, connections between each valve and its link and connections between each piston and the telescoping shaft carrying the link of the opposite cylinder, said last-mentioned connections coöperating with the shafts at points intermediate the links; substantially as described.

6. In an engine embodying two cylinders, pistons therein and a crank-shaft with which both of the pistons are connected, the combination with the valves controlling the steam for the cylinders and connections between the valves and the pistons of their own cylinders for varying the travel of the valves, of valve-operating mechanism embodying separate links one for each valve mounted centrally on opposite ends of telescoping shafts journaled in the engine-frame, connections between each valve and its link, a connection between one piston and the inner shaft, said connection coöperating with the inner shaft at a point between the links and in proximity to the link mounted on the outer shaft and a connection between the other piston and the opposite end of the outer shaft; substantially as described.

7. In an engine embodying two cylinders, pistons therein and a crank-shaft with which both of the pistons are connected, the combination with the valves controlling the steam for the cylinders and connections between the valves and the pistons of their own cylinders for varying the travel of the valves, of valve-operating mechanism embodying separate links one for each valve mounted centrally on opposite ends of telescoping shafts journaled in the engine-frame, the outer shaft having an opening therein near the end on which its link is mounted, connections between each valve and its link a connection between one piston and the inner shaft, said connection passing through the opening in the outer shaft and a connection between the other piston and the opposite end of the outer shaft; substantially as described.

8. In an engine embodying two cylinders, pistons therein and a crank-shaft with which both of the pistons are connected, the combination with the valves controlling the steam for the cylinders, of valve-operating mechanism embodying operating-levers, shifting connections between the pistons and levers for accelerating the movement of the latter during the travel of the pistons, separate links pivoted on fixed axes and connection with said levers, means for shifting the connections between the valves and links and eccentrics interposed between the links and valves with connections between said eccentrics and operating-levers; substantially as described.

9. In an engine embodying two cylinders, pistons therein and a crank-shaft with which both of the pistons are connected, the combination with the valves controlling the steam for the cylinders of valve-operating mechanism for each valve embodying an operating-lever controlled by the piston of the opposite cylinder, a link pivoted on a fixed axis and connected with said operating-lever, a shiftable connection between said link and valve and a manually-controlled tumbling-shaft for shifting said connection, the operating-levers being both journaled on said tumbling-shaft and the links being pivotally mounted on coincident axes independent of the tumbling-shaft; substantially as described.

10. In an engine embodying two cylinders, pistons therein, cross-heads connected with said pistons, a crank-shaft and connections between said crank-shaft and both cross-heads, of the valve-operating mechanism embodying a manually-controlled tumbling-shaft having arms thereon, operating-levers pivotally mounted on the tumbling-shaft and connected with the cross-heads, links pivotally mounted on fixed axes independent of the tumbling-shaft and connected with the operating-levers, shiftable connections between the links and valves and connections between the arms on the tumbling-shaft and said shiftable connections; substantially as described.

11. In an engine embodying two cylinders, pistons therein and a crank-shaft with which both pistons are connected, the combination with the valves controlling the steam for the cylinders, of links pivoted on fixed coincident axes, connections between the links and valves, operating-levers for the links pivoted on coincident axes independent of the links and located intermediate the links and valves, and connections between each lever and one of the links and one of the pistons; substantially as described.

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