S. H. LEWIS.

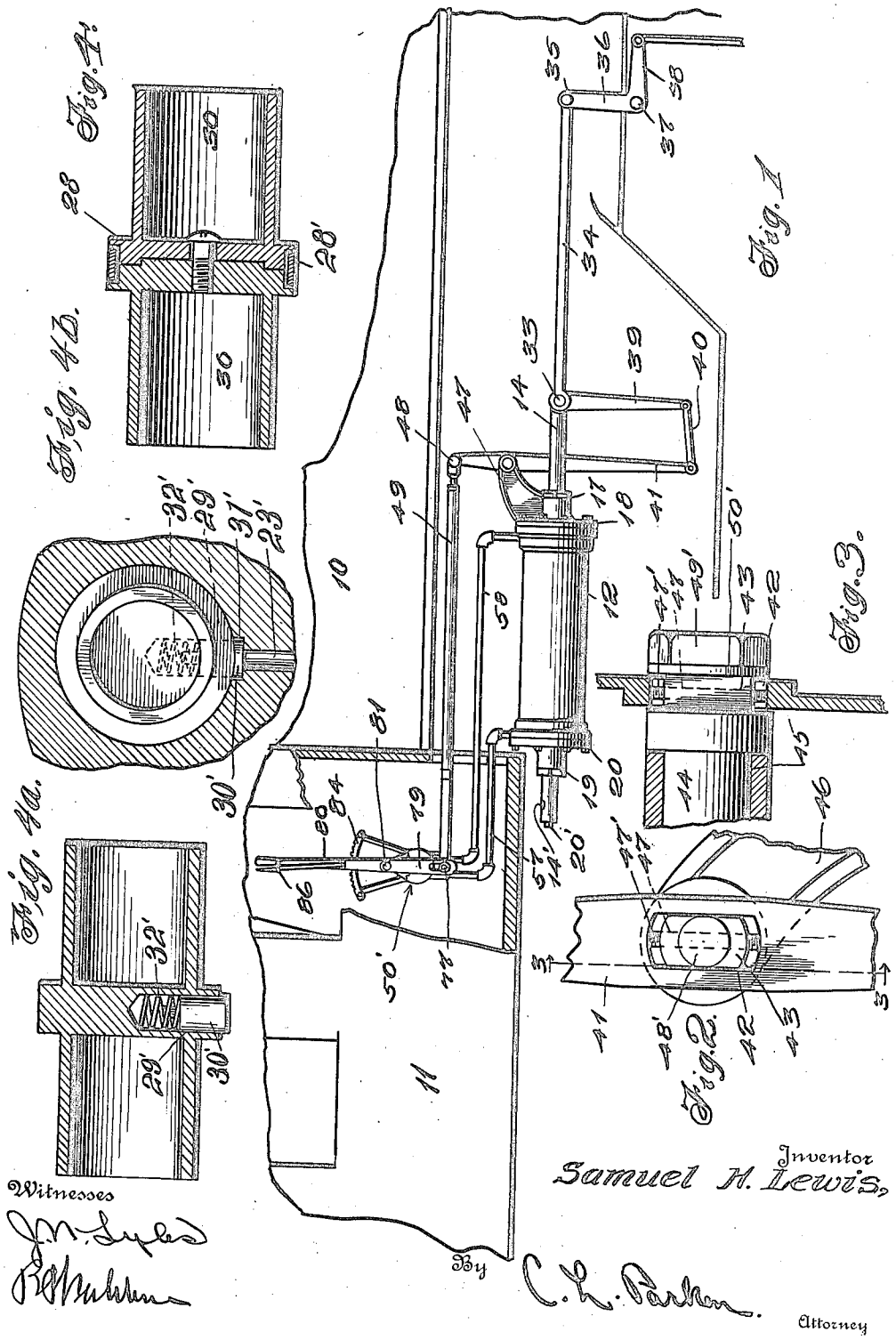
PRESSURE OPERATED VALVE GEAR SHIFTING MEANS.

APPLICATION FILED SEPT. 23, 1915.

1,183,213.

Patented May 16, 1916.

4 SHEETS—SHEET 1.



Witnesses

Inventor

Samuel H. Lewis,

By C. L. Parker.

Attorney

S. H. LEWIS.

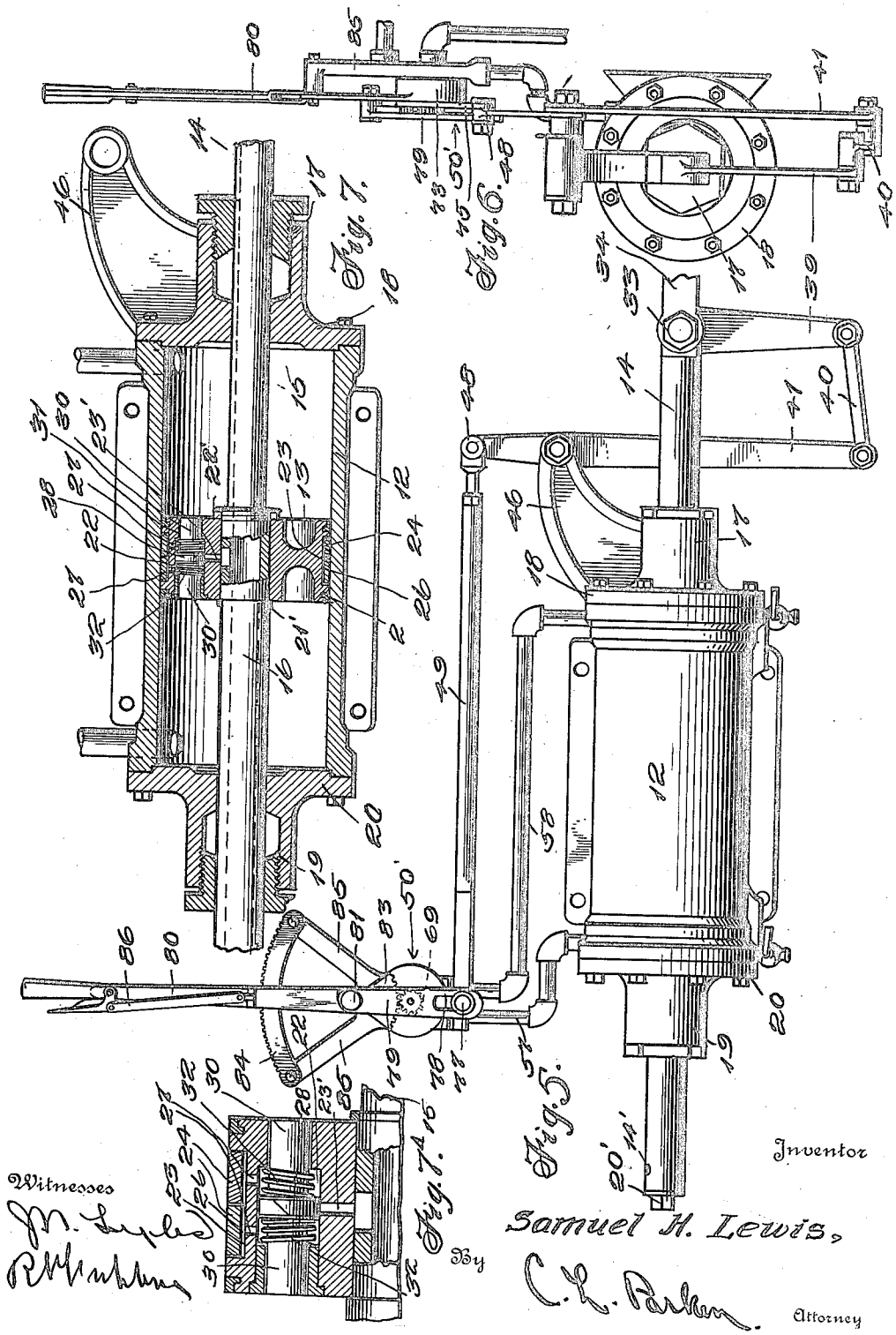
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4 SHEETS—SHEET 2.



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Samuel H. Lewis,

By C. L. Parker

Attorney

S. H. LEWIS.

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4 SHEETS—SHEET 3.

Fig. 9.

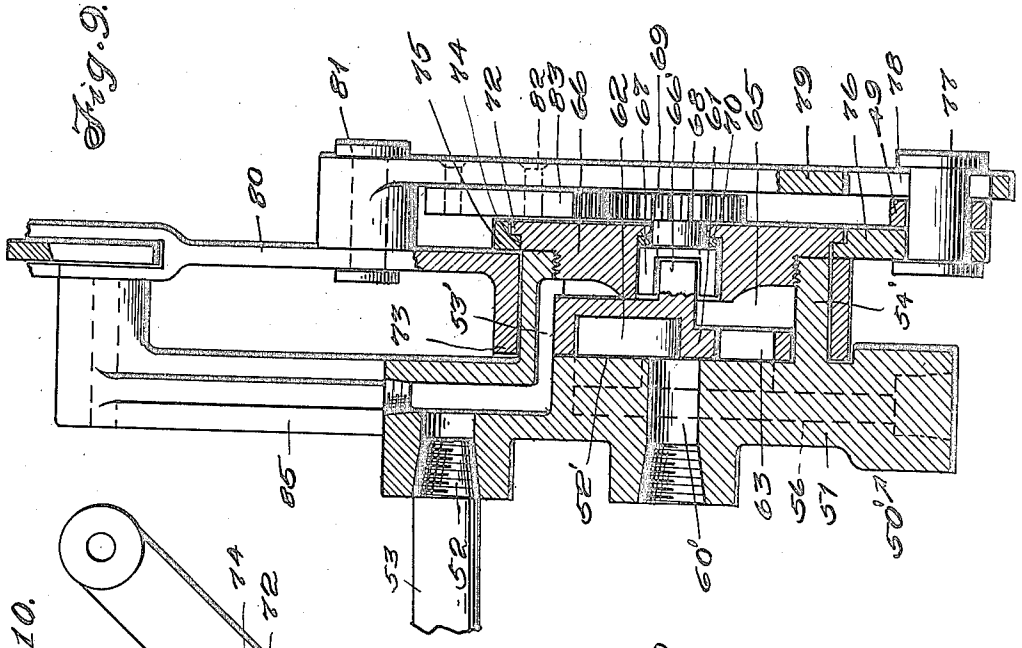


Fig. 10.

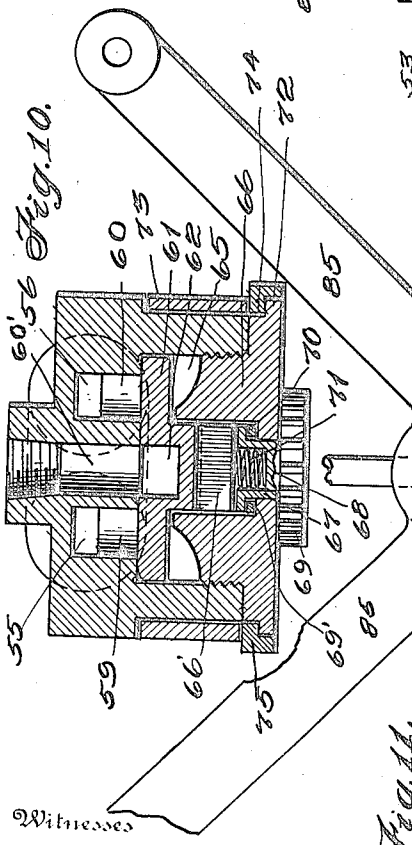


Fig. 8.

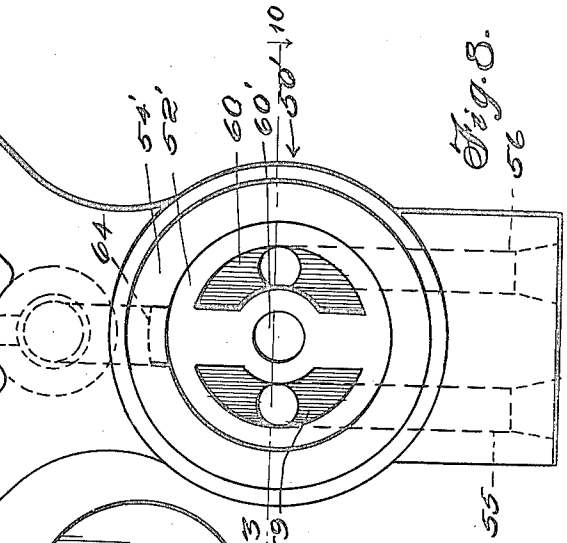
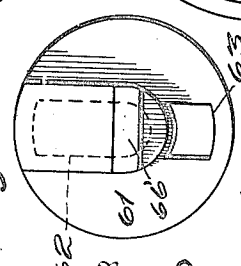


Fig. 11.



Witnesses

Inventor

Samuel H. Lewis.

By C. L. Parker.

Attorney

S. H. LEWIS.

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4 SHEETS—SHEET 4.

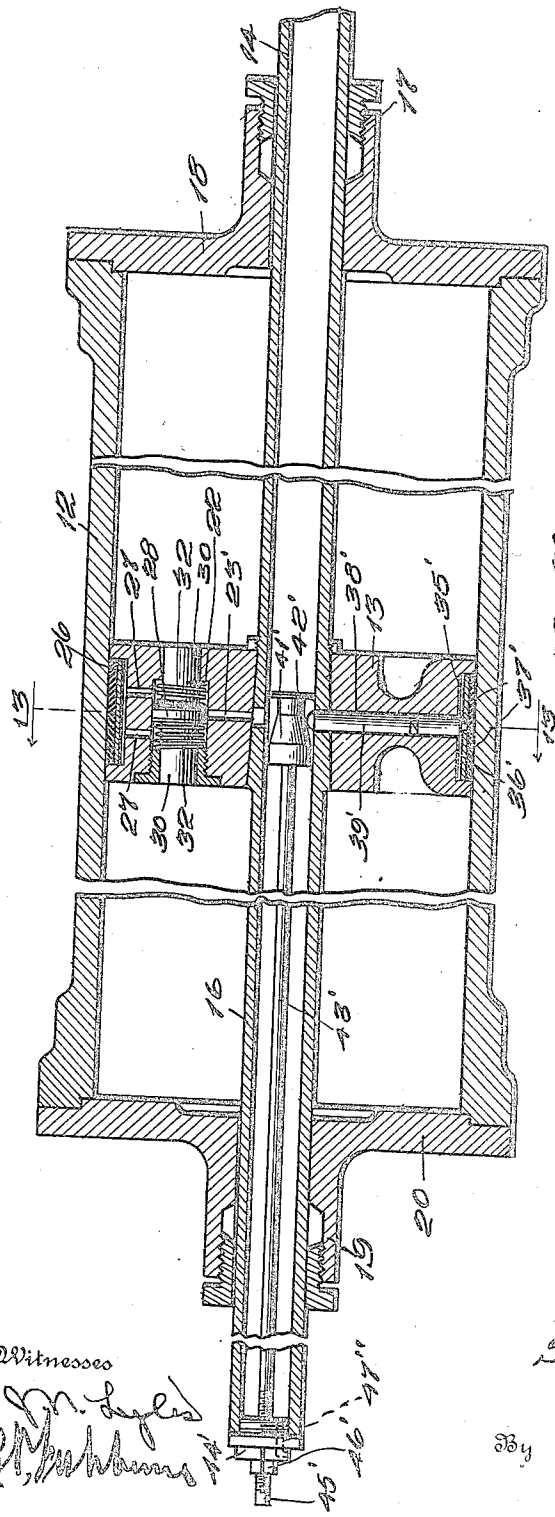


Fig. 12.

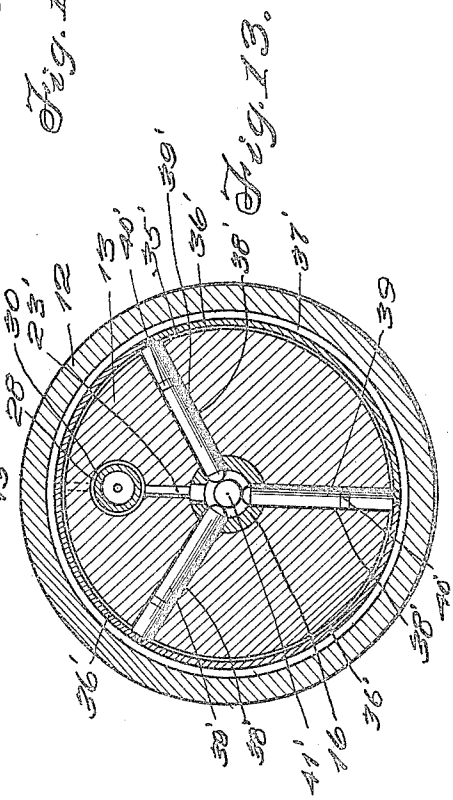


Fig. 13.

Witnesses

R. Lyles

R. M. Williams

Inventor

Samuel H. Lewis,

By C. H. Carlton, Attorney

UNITED STATES PATENT OFFICE.

SAMUEL H. LEWIS, OF RICHMOND, VIRGINIA.

PRESSURE-OPERATED VALVE-GEAR-SHIFTING MEANS.

1,183,213. Specification of Letters Patent. Patented May 16, 1916.

Application filed September 23, 1915. Serial No. 52,167.

To all whom it may concern:

Be it known that I, SAMUEL H. LEWIS, a citizen of the United States, residing at Richmond, in the county of Henrico and State of Virginia, have invented certain new and useful Improvements in Pressure-Operated Valve-Gear-Shifting Means, of which the following is a specification.

My invention relates to improvements in fluid pressure operated apparatus for operating or shifting the valve gear of steam engines, particularly railway locomotives, while not necessarily restricted to this use.

An important object of the invention is to provide means for holding the movable member or piston, which shifts the valve gear, against movement when such piston is inactive.

A further object of the invention is to provide means whereby the opposite sides of the piston have different areas, causing different pressure to be exerted upon opposite sides thereof, to overcome or balance the pull upon the piston, by the valve gear or parts thereof.

A further object of the invention is to improve in general the construction of such apparatus, with a view of simplifying them, rendering the same less expensive to manufacture, and more convenient in use.

A further object of the invention is to provide apparatus of the above mentioned character, which may be installed upon various types of railway locomotives, without materially altering the construction of the locomotive or its valve gear.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawings forming a part of this specification and in which like numerals are employed to designate like parts throughout the same, Figure 1 is a side elevation of apparatus embodying the invention, showing it applied to a railway locomotive, Fig. 2 is an enlarged side elevation of a pivot connection, embodied in the invention, Fig. 3 is a detail sectional view taken on line 3—3 of Fig. 2, Fig. 4 is a central vertical longitudinal sectional view through a piston valve, Fig. 4ª is a similar view of a different form of piston valve, Fig. 4ᵇ is an end elevation of the same, Fig. 5 is an enlarged side elevation of the apparatus, removed from the engine, Fig. 6 is an end elevation of the same, Fig. 7 is a central vertical longitudinal sectional view through a cylinder and piston, associated elements being shown in elevation, Fig. 7ª is a fragmentary enlarged section through a portion of the piston and associated elements, Fig. 8 is a side elevation of a valve casing, parts being removed, Fig. 9 is a central vertical sectional view through the valve structure, Fig. 10 is a horizontal sectional view taken on line 10—10 of Fig. 8, Fig. 11 is a side elevation of the control valve, Fig. 12 is a central vertical longitudinal sectional view through the cylinder and piston, showing manually operated means for expanding the piston rings, together with the pressure operated means to expand them for locking the piston against movement, and Fig. 13 is a transverse sectional view taken on line 13—13 of Fig. 12.

In the drawings, wherein for the purpose of illustration is shown a preferred embodiment of my invention, the numeral 10 designates the boiler of a railway locomotive, equipped with a cab 11, as is customary.

The numeral 12 designates a preferably horizontally arranged cylinder, preferably disposed beneath the boiler 10, forwardly of and near the cab 11, while the cylinder may be attached to any other suitable part of the locomotive. This cylinder is rigidly secured to the boiler 10 by any suitable means.

As more clearly shown in Fig. 7, a piston 13 is disposed to reciprocate within the cylinder 12, and is rigidly connected with a tubular piston rod 14, the rear end of which communicates with the atmosphere, as shown at 14′, in Fig. 1. As clearly shown in Fig. 7, this piston rod has portions 15 and 16 of different diameters, the portion 15 having a smaller diameter. The forward portion 15 of the piston rod operates through a forward stuffing box 17, carried by a head 18, while the rear portion 16 of the piston rod operates through a rear stuffing box 19, carried by a head 20. The rear end of the tubular piston rod 14 is closed by a plug 20′. Preferably having screw-threaded engagement therewith. The function of having the portions 15 and 16 of the piston rod of

different diameters will be apparent hereinafter. The piston 13 has its rear side engaging a shoulder 21′ and its opposite side engaged by a clamp nut 22′ whereby this piston is locked to the piston rod 14. The rear portion of the bore or opening of the tubular rod 14 discharges into a chamber or cavity 22, formed in the piston 13, through the medium of a port 23′. The piston 13 is provided in its periphery with an annular groove 23, receiving preferably split expansible and contractible combined packing and clamping ring or rings 24, preferably formed of iron, while other suitable material may be employed. The split portions of these rings are preferably arranged to break-joint, to prevent leakage. The annular groove 23 is sufficiently deep to provide an annular space 26, beneath the rings 24, and ports 27 establish communication between the space 26 and the chamber 22.

Disposed to reciprocate within the chamber 22 is a piston-valve 28 (see Fig. 4) adapted to normally cover the inlet end of the port or passage 23′. This piston has an annular groove for receiving packing 28′. The piston-valve 28 carries upon its opposite sides preferably tubular extensions 30, mounted to reciprocate within openings 31, formed in the piston 13. These tubular extensions are constructed slightly smaller in diameter than the openings 31, allowing pressure to enter the chamber 22 upon opposite sides of the piston-valve 28, whereby such pressure balances the piston-valve and passes through ports 27 into the space 26. The fluid pressure in the space 26 serves to hold the rings 24 in clamping engagement with the inner wall of the cylinder 12, to lock the piston 13 thereto, in any desired position. The piston valve 28 is held in the neutral position, when the pressure upon the opposite sides thereof is equal, by springs 32, surrounding the tubular extensions 30, as shown. When the pressure upon one side of the piston 13 is suddenly reduced, a corresponding reduction in pressure is effected upon the piston-valve 28, whereby the greater pressure upon the opposite side thereof shifts the piston-valve to the side having the lower pressure, the piston-valve uncovering the intake end of the port 23′ and the pressure within the space 26 exhausting to the atmosphere. The exhausting of the pressure within the space 26 permits the rings 24 to contract, whereby they do not have clamping contact with the cylinder but permit the piston 13 to move, said rings however still serving as ordinary packing rings, while the piston is free to move.

In Fig. 4ª the construction of the piston-valve 28 is slightly altered. The packing 28′ is dispensed with and the piston-valve is provided with a radially disposed opening 29′, receiving a slide valve 30′ operating in a groove 31′, communicating with the port 23′. The slide valve 29′ is moved toward the port 23′ by a spring 32′. It is obvious that the slide valve 30′ prevents the rotation of the piston-valve 28 and serves to cover and uncover the intake end of the port 23′. The construction and mode of operation of the piston-valve is otherwise identical with that hereinabove stated.

In Figs. 12 and 13, I have shown a slightly different form of means for locking the piston 13 against movement within the cylinder 12. This piston is provided with the annular groove 35′, within which are mounted split inner metallic rings 36′, which may be formed of iron or the like. Arranged upon the outer sides of these metallic rings 36′ are split packing rings 37′, preferably formed of rubber or other fibrous material. The outer rings 37′ travel in contact with the inner wall of the cylinder 12. The same space 26 is provided for the reception of steam pressure, for expanding the rings 36′ and 37′, and locking the piston 13 to the cylinder and the same piston valve 28 and associated elements, operated by pressure upon opposite sides of the piston 13, in the manner hereinbefore described, are employed. In addition to the provision of this means, the piston 13 is provided with radially disposed openings 38′, within which reciprocate pins 39′, preferably having annular grooves for receiving packing 40′. The outer ends of these pins contact with the ring or rings 36′ while their inner ends are rounded or beveled and project into the tube 16. The inner ends of the pins 39′ have contact with a tapered spreading or wedging head 41′, provided with a flange 42′, to limit the movement of the expanding or wedging head 41′ in one direction. The head 41′ is sufficiently smaller in diameter than the bore of the tube 16, whereby pressure may pass rearwardly beyond it. Rigidly connected with the head 41′ is a rod 43′, having screw-threaded engagement within a screw-threaded opening formed through a plug 44′, screw-threaded into the end of the tube 16. The rod 43′ preferably has its end 45′ formed square in cross-section so that it may be turned by a suitable tool and this rod preferably carries a lock nut 46′ for preventing its accidental rotation. The plug 44′ has an exhaust port 47″, passing to the atmosphere, and corresponding to the port 14′. It is thus apparent that by rotating the rod 43′ so that the head 41′ is moved forwardly, the pins 39′ will move outwardly, expanding the rings 35′ and 36′, whereby they will firmly contact with the inner wall of the cylinder 12, preventing the passage of pressure beneath them and the cylinder wall, but it is to be understood that this manually operated means for expanding

the rings 35′ and 36′ is not adapted to create sufficient frictional contact between the rings and the wall of the cylinder 12, whereby the piston 13 will be held against movement, as separate pressure operated means are employed for locking the piston against movement.

The forward end of the piston rod 14 is pivotally connected, as shown at 33, with a pitman or link 34, pivotally connected, as shown at 35, with an arm 36, which is rigidly mounted upon a lift-shaft 37, extending transversely beneath the boiler 10, as is customary. Each end of the lift-shaft 37 carries a horizontal arm 38, with which is connected the vertically movable link (not shown) of the valve gear.

It is to be understood that the invention is not restricted to operating any particular type of valve gear, as it is adapted for use in connection with various types.

Rigidly connected with the forward end of the tubular piston rod 14 is a depending arm or crank 39, having its lower end pivotally connected with a link 40, pivotally connected with the lower end of a preferably vertically swinging lever 41. The vertically swinging lever 41, (see Figs. 2 and 3), is provided between its ends with a longitudinal opening 42, receiving a flat lug or extension 43, formed integral upon a pivot element or bolt 44. This pivot element or bolt is rotatably mounted in an opening 45 extending transversely through the end of a bracket 46. The flat lug or extension is provided with a screw-threaded longitudinal opening 47, receiving an adjusting screw 47′. The opening 42 is longer than the lug 43 and the adjusting screw 47′ engages the end walls of this opening. It is obvious that by turning the adjusting screw 47′ it will be shifted longitudinally with respect to the lug 43, and will hold the lever 41 at a different position with respect thereto, whereby the pivot point of this lever may be adjusted up and down. Formed upon the lug 43 is a screw-threaded extension 48′ receiving a nut 49′ with a washer 50′ preferably interposed between the nut and the lever 41. The function of adjusting the pivot of the lever 41 is to regulate the operation of the piston with respect to returning the controlling valve to the neutral position.

Pivotally connected with the upper end of the lever 41, as shown at 48, is a preferably longitudinally adjustable or extensible reach rod 49, as shown.

The numeral 50 designates a valve structure as a whole, comprising a casing or casting 51, having a flat face 52′ and provided with an inlet port 52, communicating with a pipe 53, which leads to a source of pressure, such as a compressed air storage tank (not shown). This inlet port 52 communicates with an inlet port 53′, passing through an annular flange 54′, formed upon the casting 51, as shown. Arranged upon opposite sides of the inlet port are ports 55 and 56, which lead into pipes 57 and 58, discharging into the opposite ends of the cylinder 12. The ports 55 and 56 have their upper ends discharging into segmental grooves 59 and 60, arranged upon opposite sides of the inlet port.

The numeral 60′ designates an exhaust port, extending through the face 52′ of the casting and disposed between the grooves 59 and 60.

Mounted to rotate within the flange 54′ in slidable contact with the face 52′, is a valve 61, having its inner side provided with a surface groove or port 62, the inner end of which is in permanent registration with the exhaust port 60′, while its outer end is adapted to be alternately moved into registration with the grooves 59 and 60. The valve 61 is provided in its lower portion with a transverse port or opening 63. This transverse opening 63 is arranged between the segmental grooves 59 and 60 and when the valve 61 is in the normal position the opening 63 preferably has its ends arranged in line to line relation with the grooves 59 and 60, whereby a leakage of pressure is permitted into the grooves 59 and 60, such pressure passing to the opposite ends of the cylinder 12, to normally retain the pressure equal upon opposite sides of the piston. The port 53′ discharges into a chamber 65, disposed between the valve 61 and a head 66, which closes this chamber. The pressure from the port 53′ thus circulates upon the top of the valve which serves to retain it securely seated.

The valve 61 is provided with a post 66′, for turning it which is rectangular in cross-section and adapted to fit within an opening 69′ formed in a head 67 of a stud 68, rigidly connected with a pinion 69. The head 67 is adapted to contact with a washer 70, and a compressible coil spring 71 is arranged between the post 66′ and the end wall of the opening 69′, thus serving to hold the valve 61 upon its seat and the head 67 in contact with the ring or washer 70, for preventing leakage.

The head 66 is provided with a flange 72, forming with a ring or collar 73, an annular groove 74, for receiving a suspension collar or strap 75. This suspension collar or strap is provided at its lower end with a depending apertured knuckle 76, carrying a pivot element 77. The reach rod 49 has its rear end apertured for receiving the pin 77, whereby it is pivotally connected with the knuckle 76. The pin 77 extends outwardly into a longitudinal opening or slot 78, formed in the lower end of a vertically swinging combination lever 79.

This combination lever extends upwardly for pivotal connection with a controlling lever 80, by means of a pin 81 or the like. This controlling lever carries the ring 73, which is preferably formed integral therewith and pivotally mounted upon the flange 54′. Rigidly connected with the upper portion of the combination lever 79, by means of bolts 82 or the like, is a toothed segment or gear 83, engaging the pinion 69, for turning it. The control lever 80 operates in proximity to a stationary toothed quadrant 84, rigidly secured to the upper ends of the arms 85, formed integral with the casting 51. The lever 80 is provided with latch means 86, to coöperate with a quadrant 84 and lock the lever in the desired adjusted position.

The operation of the apparatus is as follows: When the control lever 80 is in the neutral position, the valve 61 is in the neutral or normal position, whereby the ends of the admission port 63 are arranged substantially in line to line relation with the lower ends of the grooves 59 and 60. There is then a passage of fluid pressure from the transverse opening or port 63 into the segmental grooves 59 and 60, whereby it is conducted through the pipes 57 and 58 to the opposite ends of the cylinder 12, upon opposite sides of the piston 13, thus equalizing the pressure upon such opposite sides. The springs 32 now hold the piston valve 28 in its central position, covering the inlet end of the port 23′. The pressure upon the opposite sides of the piston 13 passes about the tubular extensions 30, through openings 31, and through ports 27, to the space 26, tending to force the rings 24 outwardly, to have clamping engagement with the inner wall of the cylinder 12. By this means the piston is locked in the desired position. When it is desired to shift the valve gear to drive the locomotive forwardly, the control lever 80 is swung forwardly. When this is done, the upper end of the combination lever 79 is swung forwardly, carrying with it the segmental gear 83, whereby the pinion 69 is turned clockwise. This clockwise movement of the pinion 69 turns the valve 61 clockwise, whereby the port 63 is moved into registration with the segmental groove 59 and out of registration with the segmental groove 60, the exhaust port 62 being simultaneously moved into registration with the groove 60. It is thus apparent that pressure will pass through the port 52, port 53, chamber 65, opening 63, port 55, pipe 57, into the left end of the cylinder 12, while pressure will exhaust from the opposite end of this cylinder through the pipe 58, port 56, groove 60, port 62, and through port 60′ to the atmosphere. When this takes place, the pressure being suddenly reduced in the forward end of the cylinder 12, the greater pressure in the rear end of the cylinder will act upon the piston-valve 28, shifting it forwardly, whereby it uncovers the intake end of the port 23′. The pressure in the space 26 will now pass through port 23′ and through the bore of the tubular piston rod 14 to the atmosphere. The pressure being removed from the inner surface of the rings 24, such rings are allowed to contract, to break the clamping or locking engagement with the inner wall of the cylinder, whereby the piston 13 is free to move. The pressure upon the left or rear side of the piston 13 moves it forwardly. This movement of the piston is transmitted to the rod 34, which moves the arm 36 forwardly, whereby the arm 38 is lowered, and the valve gear shifted to drive the engine forwardly. Upon the forward movement of the piston rod 14, the depending arm 39 is moved forwardly, swinging the lower end of the lever 41 forwardly and its upper end rearwardly. The rearward movement of the upper end of the lever 41 is transmitted to the reach rod 49, and by it to the combination lever 79. The lever 80 being locked in the new position by the latch means 86, the combination lever 79 will turn upon the pin 81 as a pivot, and when its lower end is swung rearwardly, the segmental gear 82 is swung rearwardly, whereby it turns the pinion 69 counter-clockwise, for returning the valve 61 to the neutral position. When the valve 61 is returned to its neutral position, the pressure equalizes upon opposite sides of the piston 13, preventing further movement of the piston in either direction and the lock means again holding the piston 13 in the desired position. By this means the extent of movement of the piston in either direction is always proportional to the movement of the control lever in the same direction. When the control lever 80 is swung rearwardly, the reverse of this operation takes place which is thought to be obvious from the foregoing description.

A particular advantage in my construction is that when the control lever 80 is in either of the extreme forward or rear positions, it may be quickly swung to the opposite extreme position, to operate the valve gear, to reverse the direction of travel of the locomotive, as the rotary valve exhaust port 62 and its admission port 63 will be in communication with opposite ends of the power cylinder from the initial to the maximum opening of these ports and it is impossible in my construction for the exhaust port 60′ to be placed in communication with the space or chamber 65, containing the fluid pressure.

It is evident that the position of the reverse lever indicates the point of cut-off or degree of steam expansion at which the locomotive valves are adjusted. The reversing

valve reach rod moves only when the power cylinder piston moves and serves to indicate at the reverse lever the piston travel. The control mechanism or reversing valve is separate and distinct from the power cylinder and may be removed and another applied in a few minutes in case repairs should be needed. The ratio between the stroke of the power cylinder piston and the throw of the control lever 80 is variable by means of the slotted lever 41; any change in the adjustment of lever 41 will change the maximum stroke of the power cylinder piston without changing the maximum throw or the total number of positions in which the reverse or control lever 80 may be adjusted. The ports in the rotary valve and its seat are so arranged that the valve chest pressure will enter one end of the cylinder whenever the opposite end of the cylinder is in communication with the atmosphere, through the exhaust ports, communication between opposite ends of the cylinder and the atmosphere cannot be made at the same time, communication between the valve chest and the atmosphere direct is impossible and it is impossible for either end of the cylinder to be in communication with the valve chest and the atmosphere at the same time. Due to the construction of the ports in the valve and valve seat the power cylinder piston responds to the movement of the reverse lever regardless of the speed with which the lever is moved, any distance within its range. The rotary valve may be assembled so the power cylinder piston will move in the direction the reverse lever is moved or in an opposite direction, in which case the pipes which lead to the power cylinder will not need to be crossed. The friction is not sufficient to hold the piston and reverse shaft under abnormal strains in the valve gear due to improper lubrication of the locomotive valves, or otherwise, and for this reason derangement or breakage of the valve gear parts is prevented.

It is to be understood that the form of my invention herewith shown and described is to be taken as a preferred example of the same, and that various changes in the shape, size, and arrangement of parts may be resorted to without departing from the spirit of the invention, or the scope of the subjoined claims.

Having thus described the invention, I claim:

1. In apparatus of the character described, the combination with a cylinder, of a piston mounted to move within the cylinder, means connecting the piston with a valve gear to operate it, a clamping ring carried by the piston to engage with the cylinder, means whereby pressure from the opposite sides of the piston is applied to the inner side of the clamping ring and released when the pressure upon one side of the piston falls below the pressure upon the opposite side of the piston, a valve seat having a pair of ports, pipes leading into the ports and into the opposite ends of the cylinder, a rotary valve provided with ports coöperating with the first named ports, a toothed segment arranged near the rotary valve, a pinion connected with the rotary valve and engaged by the toothed segment, an operating lever, a combination lever pivotally connected with the operating lever and having the segment rigidly secured thereto and provided near its lower end with a slot, a movable suspension member having an extension, to enter the slot of the combination lever, a reach rod connected with the extension of the suspension member, and means connecting the reach rod with the connecting means between the piston and the valve gear.

2. In apparatus of the character described, the combination with a cylinder, of a piston mounted to reciprocate therein and provided upon its periphery with an annular groove and having a chamber formed therein in communication with the annular groove, a clamping ring arranged within the annular groove and spaced from the bottom wall thereof for providing a pressure receiving passage, a tubular piston rod connected with the piston and extending beyond one end of the cylinder and having its bore adapted to communicate with the chamber of the piston, a piston-valve mounted to reciprocate within the chamber of the piston to cover and uncover the intake end of the bore of the tubular piston rod, a valve seat having a pair of inlet ports and an exhaust port arranged therebetween, pipes leading from the inlet ports into the opposite ends of the cylinder, a rotary valve slidably mounted upon the valve seat and having an exhaust port permanently registering with the first named exhaust port and adapted to be placed in communication with the inlet ports and having an admission port adapted to be placed into communication with the inlet ports, a pinion connected with the rotary valve to turn it, a toothed segment engaging the pinion, a combination lever rigidly connected with the toothed segment and provided near its lower end with a slot, a movable suspension member provided with an extension extending into the slot, a control lever pivotally mounted upon the control valve, means pivotally connecting the upper end of the combination lever with the lower end of the control lever, a reach rod connected with the extension of the suspension member, connecting means between the piston rod and the valve gear, and connecting means between the reach rod and the first named connecting means.

3. In apparatus of the character described, the combination with a cylinder, of a piston mounted to reciprocate therein, means for

connecting the piston with a valve gear for operating the latter, and means to lock the piston to the inner wall of the cylinder when the pressure upon opposite sides of the piston is substantially equal.

4. In apparatus of the character described, the combination with a cylinder, of a piston mounted to reciprocate therein and provided upon its periphery with a groove, and having a chamber formed therein in communication with the groove and having end openings, a tubular piston rod connected with the piston with one end of its bore leading into the chamber and the opposite end thereof communicating with the atmosphere, a piston-valve mounted to reciprocate in the chamber and adapted when in the neutral position to cover the intake end of the bore of the tubular piston rod and having extensions arranged in the end openings of the chamber to be engaged by pressure upon opposite sides of the piston, means connecting the tubular piston rod with a valve gear, and means for introducing pressure into and exhausting the same from the opposite ends of the cylinder.

5. In apparatus of the character described, the combination with a cylinder, of a piston mounted to reciprocate therein, a piston rod connected with the piston and having portions thereof upon opposite sides of the piston of different diameters and extending through the ends of the cylinder whereby the opposite sides of the piston have different areas, means for connecting the portions of the piston rod having the smaller diameter with a valve gear, and means for supplying pressure into and exhausting the same from the opposite ends of the cylinder.

6. In apparatus of the character described, the combination with a cylinder, of a piston mounted to reciprocate therein, a piston rod connected with the piston and having portions thereof upon opposite sides of the piston of different diameters and extending through the ends of the cylinder whereby the opposite sides of the piston have different available pressure areas, means to automatically lock the piston with the cylinder when the pressure upon opposite sides thereof is substantially equal, means for connecting the piston rod with a valve gear, and means for supplying pressure into and exhausting the same from the opposite end of the cylinder.

7. In apparatus of the character described, the combination with a cylinder, a piston to reciprocate therein, means for connecting the piston with a valve gear, pipes connected with the opposite ends of the cylinder, a valve seat having a pair of inlet ports communicating with the pipes and an exhaust port arranged between the inlet ports and a pressure supply port arranged outwardly of said ports, a single rotary valve provided with an exhaust port permanently communicating with the first named exhaust port and adapted to be placed in communication with the inlet ports and having a single admission port adapted to be placed in communication with the inlet ports, and means to turn the rotary valve.

8. In apparatus of the character described, the combination with a cylinder, of a piston mounted to reciprocate therein, means connecting the piston with a valve gear, means for controlling the admission and exhaust of pressure to and from the opposite ends of the cylinder embodying the rotary valve, a pinion connected with the rotary valve to turn it, a segment engaging the pinion, a combination lever carrying the segment, a reach rod connected with the lower end of the combination lever and with the connecting means between the piston and the valve gear, and a swinging control lever having pivotal connection with the upper end of the combination lever.

9. In apparatus of the character described, a cylinder, a piston mounted to reciprocate therein, connecting means between the piston and the valve gear, a valve structure for controlling the introduction of pressure into the opposite ends of the cylinder, manually operated means to operate the valve structure, a movable rod, means connecting the rear end of the movable rod and the valve structure, a hanger surrounding a portion of the valve structure and adapted to cause the rear end of the movable rod to travel in a fixed path, and means connecting the forward end of the movable rod with the first named connecting means.

10. In apparatus of the character described, the combination with a cylinder; of a piston to reciprocate therein; means connecting the piston with a valve gear; pipes connected with the opposite ends of the cylinder; a valve casing having a valve seat provided with segmental grooves, inlet ports leading into the segmental grooves and communicating with the pipes and an exhaust port arranged between the segmental grooves; a single rotary valve slidably mounted upon the valve seat and having an exhaust groove upon one side with its inner end in permanent registration with the exhaust port in the valve seat and its outer end adapted to alternately register with the segmental grooves and an inlet port passing through the opposite faces of the valve and adapted to alternately register with the segmental grooves; a cap covering the valve and providing a passage between it and the valve; means for discharging fluid pressure into the passage; and means for turning the valve.

11. In apparatus of the character described, a cylinder, a piston mounted to reciprocate therein and provided upon its pe-

riphery with a groove, an expansible ring mounted within the groove, radially disposed pins carried by the piston and engaging the ring to expand it, a tapered member for contacting with the pins to move them outwardly, means to move the tapered member, and pressure operated means to exert outward pressure upon the ring to lock the piston to the cylinder.

12. In apparatus of the character described, a cylinder, a piston mounted to reciprocate therein and provided upon its periphery with a groove, an expansible ring mounted within the groove, radially disposed pins carried by the piston and engaging the ring to expand it, a tapered member for contacting with the pins to move them outwardly, and means to move the tapered member.

13. In apparatus of the character described, a cylinder, a piston mounted to move therein, connecting means between the piston and a valve gear, a rotary valve for controlling the passage of pressure into opposite ends of the cylinder, manually operable means to move the valve from its neutral position, automatic means connected with the said connecting means to return the valve to its neutral position upon the movement of the piston for a predetermined distance, such automatic means including a pivoted lever, and means to adjust the pivot of the lever lengthwise thereof.

14. In apparatus of the character described, a cylinder, a piston mounted to reciprocate therein, connecting means between the piston and the valve gear, a valve for controlling the passage of pressure into opposite ends of the cylinder to move the piston, manually operated means to move the valve from its neutral position, automatic means connected with said connecting means between the piston and valve, to return the valve to its neutral position upon the movement of the piston for a predetermined distance, said automatic means including a relatively stationary support, a pivoted swinging lever and pivot means adjustable lengthwise of the swinging lever and connecting the lever and support.

15. In apparatus of the character described, a cylinder, a piston mounted to move therein, means connecting the piston with a valve gear, a source of fluid pressure supply, a valve adapted to admit fluid pressure from the source of fluid pressure supply to opposite ends of the cylinder to move the piston, manually operable means to rotate the valve in a desired direction to affect the movement of the piston, means operated by the movement of the piston to rotate the said valve in the opposite direction, and adjustable means between the piston and valve to vary the degree of rotation of the valve upon a given movement of the piston.

16. In apparatus of the character described, a cylinder, a piston mounted to move therein, means connecting the piston with a valve gear, a source of fluid pressure supply, a control valve adapted to admit fluid pressure from the source of fluid pressure supply to opposite ends of the cylinder, manually operable means to rotate the control valve to move the piston in one direction, means actuated by the movement of the piston to move the valve in the opposite direction to stop the movement of the piston, said last named means embodying an adjustable member adapted to vary the throw of the valve upon a given movement of the piston.

17. In apparatus of the character described, a cylinder, a piston mounted to move therein, means connecting the piston with a valve gear, a source of fluid pressure supply, a control valve adapted to admit fluid pressure from the source of fluid supply to opposite ends of the cylinder to move the piston, a manually operable lever to operate said valve, a combination lever pivoted at one end to said operating lever and adapted upon its movement relative to the operating lever to operate said valve, and means connecting the free end of said combination lever to the piston for swinging said combination lever relative to the operating lever upon the movement of the piston.

18. In apparatus of the character described, a cylinder, a piston mounted to move therein, means connecting the piston with a valve gear, a source of fluid pressure supply, a control valve adapted to admit fluid pressure from the source of fluid pressure supply to opposite ends of the cylinder to move the piston, a manually operable lever to operate said valve in a desired direction, a combination lever pivoted at one end to said operating lever to operate said valve in the opposite direction, and means connecting the free end of said combination lever to the piston for swinging said combination lever relative to the operating lever upon the movement of the piston, said means engaging the combination lever at a constant distance from a fixed point, the point of engagement between the connecting means and combination lever traveling in a fixed path in the arc of a circle.

19. In apparatus of the character described, a cylinder, a piston mounted to move therein, means connecting the piston with a valve gear, a source of fluid pressure supply, a control valve adapted to admit fluid pressure from the source of fluid supply to opposite ends of the cylinder to move the piston, a manually operable lever to operate said valve, a combination lever pivoted at one end to said operating lever and adapted upon its movement relative to the operating lever to operate said valve, means

connecting the free end of said combination lever to the piston for swinging said combination lever relative to the operating lever upon the movement of the piston, a hanger surrounding a portion of the control valve and adapted to rotate thereon, and means connecting the lower end of the hanger with the means connecting the combination lever with the piston at the point of operative engagement of the latter with the combination lever, whereby such connecting means at its point of engagement with the combination lever moves in the arc of a circle about the control valve.

20. In apparatus of the character described, a cylinder, a piston mounted to move therein, means connecting the piston with a valve gear, a source of fluid pressure supply, a valve structure adapted to admit fluid pressure therefrom to opposite ends of the cylinder, said valve structure comprising a valve provided with a single admission port and a fixed valve seat provided with a plurality of ports connected with opposite ends of the cylinder, the valve port and seat ports being adapted and arranged to admit fluid pressure to opposite sides of the cylinder when the valve is in its neutral position.

21. In apparatus of the character described, a cylinder, a piston adapted to reciprocate therein, means connecting the piston with a valve gear, a source of fluid pressure supply, a rotary control valve provided with a single admission port and an exhaust cavity, a valve housing provided with a plurality of ports, said valve and valve housing permitting the flow of fluid pressure to one side of the piston and the escape of fluid pressure from the opposite side of the piston when the control valve is moved from its neutral position.

22. In apparatus of the character described, a cylinder, a piston mounted to reciprocate therein, means connecting the piston with a valve gear, a source of fluid pressure supply, a control valve, a control lever, a combination lever pivotally attached to the control lever and flexibly connecting the control lever with the control valve, said combination lever being movable independently of the control lever, whereby the control valve is independently operated by the movement of the control lever, and by the movement of the combination lever independently of the control lever, and means connecting the combination lever with the piston whereby the combination lever is moved when the piston moves.

23. In apparatus of the character described, the combination of a source of fluid pressure supply, a control valve, a control lever, a combination lever flexibly connecting the control lever and the control valve; a power cylinder, a piston mounted to move therein, means connecting the piston with a valve gear, and a pivoted lever adapted to be oscillated by the piston, said lever being connected to the combination lever and serving to automatically operate the control valve.

24. In apparatus of the character described, the combination of a source of fluid pressure supply, a control valve, a control lever, a combination lever flexibly connecting the control lever and the control valve, a cylinder, a piston mounted to move therein, means connecting the piston with a valve gear, means adapted to be operated by the piston, said means being connected with the combination lever, a guide supporting one end of the connecting means between the combination lever and piston, said means serving to maintain a constant relation between the mid-throw of the control lever and the mid-stroke of the piston.

25. In apparatus of the character described, the combination of a source of fluid pressure supply, a control valve, a ported valve seat, a control lever, a combination lever pivotally attached to the control lever and flexibly connecting the control valve and the control lever, a cylinder, a piston mounted to move therein, means connecting the piston with a valve gear, a pivoted lever adapted to be oscillated by the piston, a rod connecting the pivoted lever with the combination lever and guide means for the end of the said rod at its point of connection with the combination lever whereby the end of the rod travels in a fixed path.

26. In apparatus of the character described, the combination with a source of fluid pressure supply, a control valve, a control lever, a combination lever flexibly connecting the control valve and the control lever, a power cylinder, a piston mounted to move therein, means connecting the piston with a valve gear and a pivoted lever adapted to be oscillated by the piston, said lever being connected to the combination lever, the control lever serving to manually change the position of the control valve to permit fluid pressure to flow to one side of the piston and to escape from the opposite side of the piston, and the combination lever through its connection with the piston, serving to automatically return the control valve to its neutral position thereby shutting off the escape of the fluid pressure from the cylinder and admitting fluid pressure to opposite sides of the piston to terminate the piston movement.

27. In apparatus of the character described, the combination of a power cylinder, a piston therein adapted to operate a valve gear, a valve structure, a source of fluid pressure supply, a valve therein provided with inlet and outlet means for fluid pressure from said source of supply, and a

valve seat having a plurality of ports, said ports being connected with the opposite ends of the cylinder and said ports being adapted to register with the inlet and outlet means throughout their travel from a neutral position after initial registration therewith.

In testimony whereof I affix my signature in presence of two witnesses.

SAMUEL H. LEWIS.

Witnesses:
JAMES L. CRAWFORD,
C. L. PARKER.