Jan. 13, 1942. F. S. BARKS ET AL 2,269,423

VALVE MECHANISM

Filed Sept. 30, 1940 3 Sheets-Sheet 1

FIG. 1.

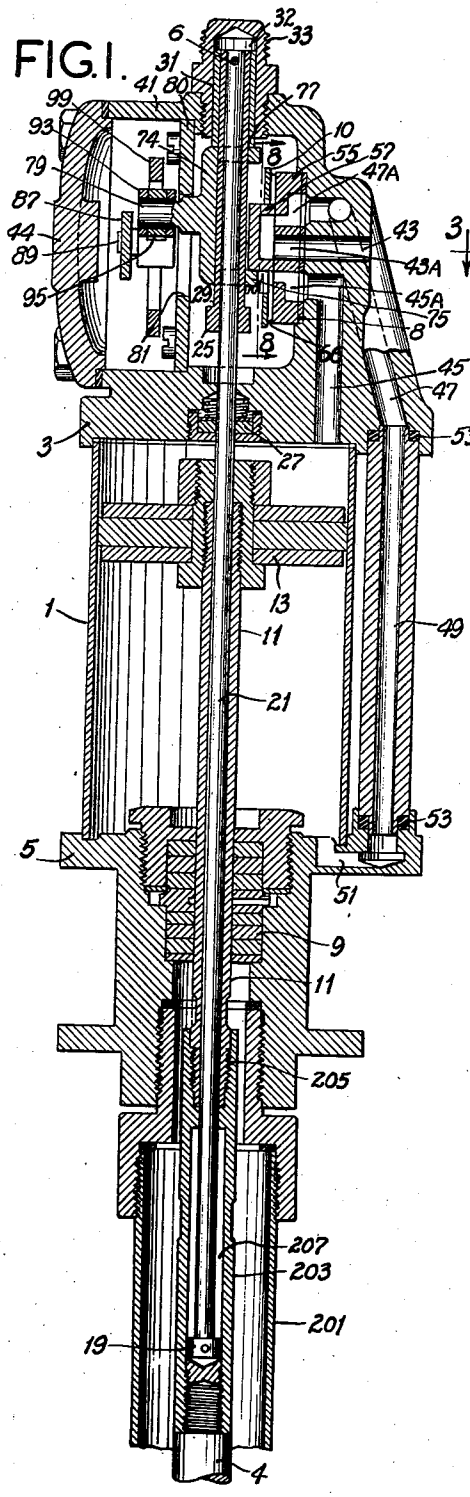


FIG. 2.

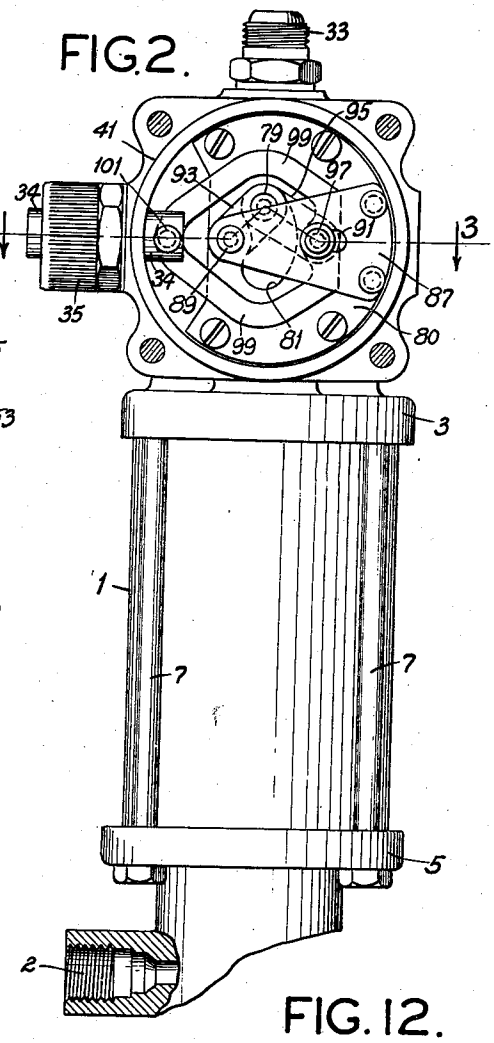
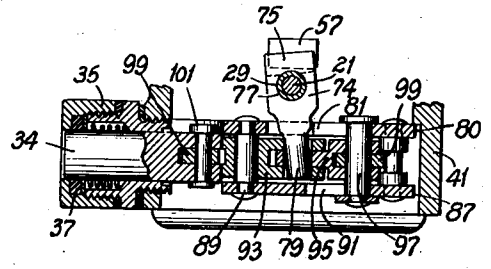


FIG. 12.



Frank S. Barks,
Victor D. Klein,
Inventors;
Haynes and Thorne
Attorneys.

Jan. 13, 1942. F. S. BARKS ET AL 2,269,423

VALVE MECHANISM

Filed Sept. 30, 1940 3 Sheets-Sheet 2

FIG. 4.

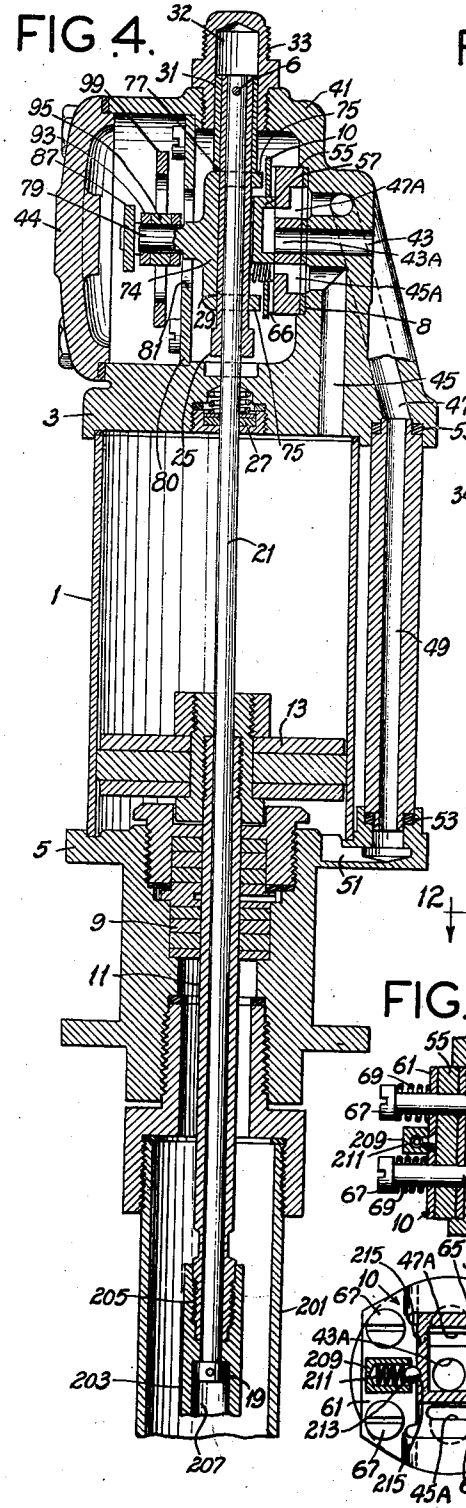


FIG. 13.

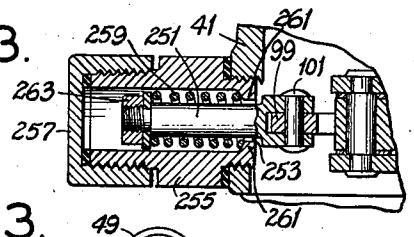


FIG. 3.

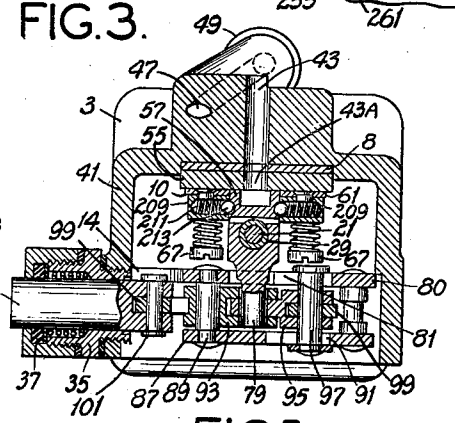


FIG. 5.

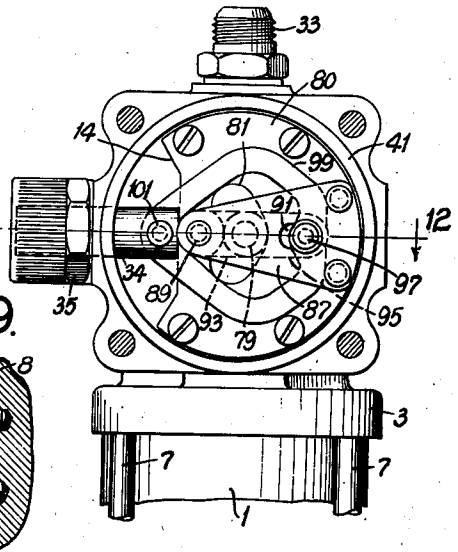


FIG. 9.

FIG. 8.

Frank S. Barks,
Victor G. Klein,
Inventors.
Haynes and Koenig
Attorneys.

Jan. 13, 1942. F. S. BARKS ET AL 2,269,423

VALVE MECHANISM

Filed Sept. 30, 1940 3 Sheets-Sheet 3

FIG.6.

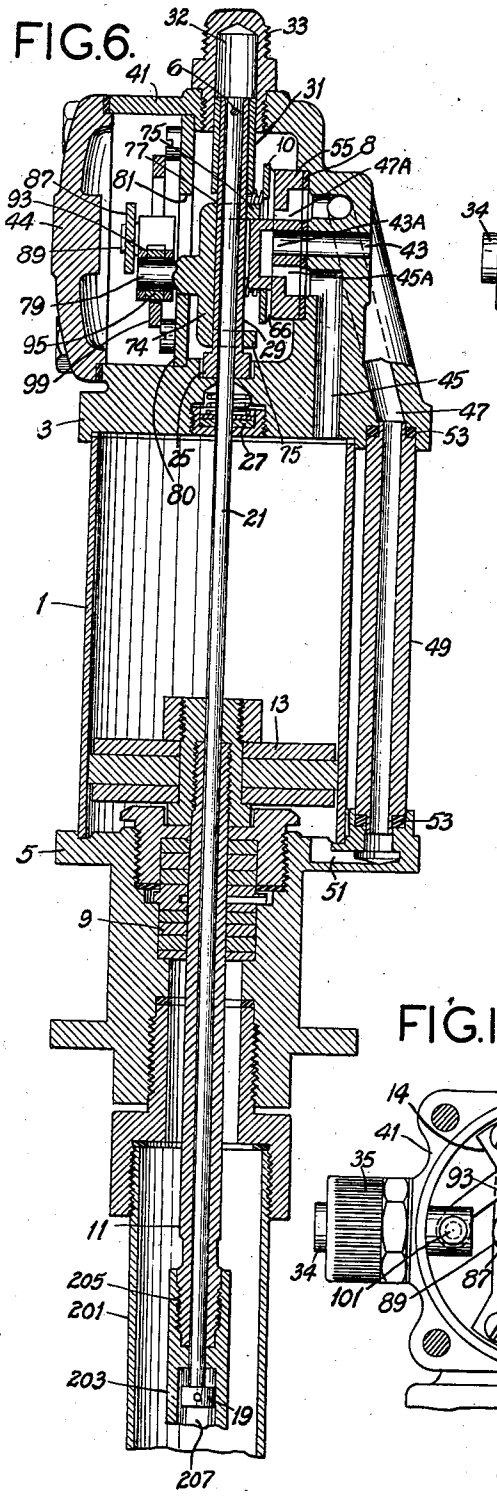


FIG.7.

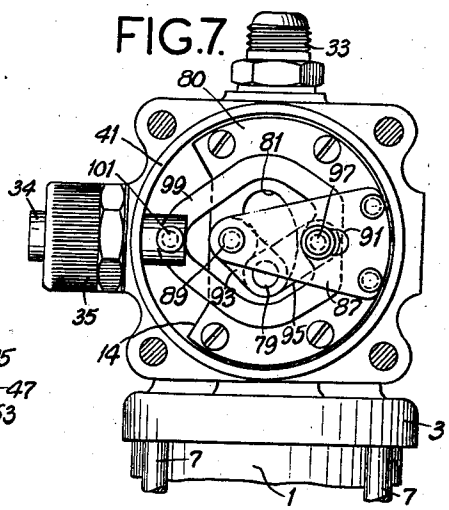


FIG.10.

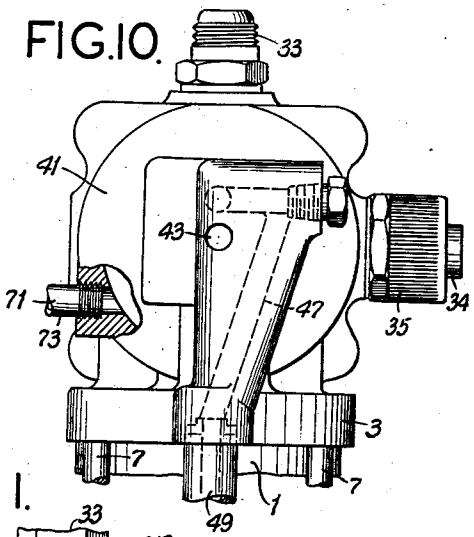
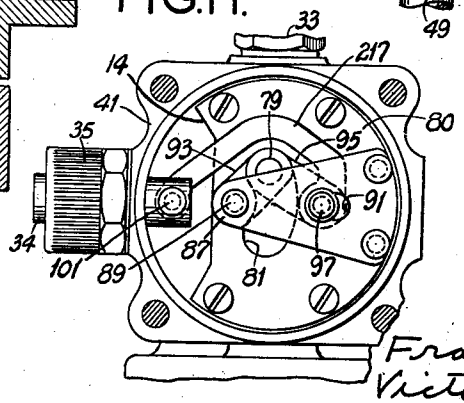


FIG.11.



Frank S. Barks,
Victor D. Klein,
Inventors.
Haynes and Koenig
Attorneys.

Patented Jan. 13, 1942 2,269,423

UNITED STATES PATENT OFFICE

2,269,423

VALVE MECHANISM

Frank S. Barks and Victor G. Klein, St. Louis, Mo., assignors to Lincoln Engineering Company, St. Louis, Mo., a corporation of Missouri

Application September 30, 1940, Serial No. 359,034

16 Claims. (Cl. 121—164)

This invention relates to valve mechanisms, and with regard to certain more specific features, to a full-stroke valve mechanism for reciprocating engines.

This invention is an improvement upon that described in the United States patent of Victor G. Klein for Valve mechanism, No. 2,215,852.

Among the several objects of the invention may be noted the provision of a full-stroke valve mechanism of the type shown in said patent, in which very compact structure is effected, and in which the forces between an operating piston and the toggle mechanism which it operates are substantially co-planar, thereby avoiding undesirable misalignment or cocking of said piston; and the provision of a device of the class described in which wear and leakage are reduced by said more advantageous disposition of parts. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly comprises the elements and combinations of elements, features of construction, and arrangements of parts which will be exemplified in the structures hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which are illustrated several of various possible embodiments of the invention,

Fig. 1 is a vertical section showing the invention applied to a reciprocating air or fluid engine, the piston being shown up;

Fig. 2 is a fragmentary left side elevation of Fig. 1, cover parts being removed to show the valve gear;

Fig. 3 is a horizontal section taken on line 3—3 of Fig. 2;

Fig. 4 is a view similar to Fig. 1 showing the piston almost down and a toggle mechanism on center about to trip a valve;

Fig. 5 is a fragmentary view similar to Fig. 2 showing the conditions of Fig. 4;

Fig. 6 is a view similar to Fig. 4, showing the piston in final downward position with the toggle mechanism tripped over center with the valve moved to its opposite position;

Fig. 7 is a fragmentary view similar to Fig. 5, but showing the conditions of Fig. 6;

Fig. 8 is a vertical section taken on line 8—8 of Fig. 1;

Fig. 9 is a vertical section taken on line 9—9 of Fig. 8;

Fig. 10 is a fragmentary right-hand elevation of Fig. 1;

Fig. 11 is a view corresponding to Fig. 5, but showing an alternative form of the invention;

Fig. 12 is a horizontal section taken on line 12—12 of Fig. 5; and,

Fig. 13 is a fragmentary section of a piston showing an alternative form.

Similar reference characters indicate corresponding parts throughout the several views of the drawings.

In said Klein patent, the piston which was exposed to fluid under pressure and which served the purpose of actuating the toggle mechanism was connected to the toggle mechanism by a pin on one side of the piston. This placed the piston-operating forces in a plane which was offset with respect to the forces in the toggle mechanism and tended to cock the piston. This required more careful piston design for best results. The present application discloses an arrangement whereby these forces are made coplanar, thus making it possible to manufacture the piston at less cost. All side thrust and cocking on the piston is eliminated on the present design, while at the same time the design is made more compact.

Referring now more particularly to Fig. 1, there is shown at numeral 1 an engine cylinder having an upper head 3 and a lower head 5 connected by suitable draw studs 7 (Fig. 2). The lower head 5 is supported upon and communicates with the cylinder 201 of a lubricant pump and carries a stuffing gland 9 through which reciprocates a hollow piston rod 11. A pump outlet is provided at 2. The piston rod 11 extends down to operate the pump, being connected with connecting rod 203 by threads 205. The connecting rod 203 is hollow, as shown at 207. It is attached to a pump rod 4.

Within the engine cylinder 1 is a reciprocating piston 13 which is fixed upon the end of the piston rod 11. Slidable within the hollow piston rod 11 is a valve trip rod 21 which extends upward through a packing gland 27 in the head 3 and downward into said hollow portion 207. Here it is provided with a fixed head 19. Since the piston 13, hollow piston rod 11, connecting rod 203 and pump rod 4 reciprocate together, they move as a unit with respect to the head 19 on the trip rod 21. Thus the first point of differentiation of the present construction, over that shown in said Klein patent, is that the lost-motion connection between the head 19 and the ends of the hollow portion 207 is below the packing 9 and in the pump cylinder 201, rather than above said packing and within the engine cylin-

der 1. An advantage of this construction is that since the lost-motion connection 19, 207 is below the packing 9, the sliding piston rod 11 which goes through the packing may be made of a reduced diameter and consistent with certain volumetric ratios desired in cylinder 201 and depending upon the intrusion of a certain size of the rod 11.

The trip rod 21 has affixed at its end above the packing 27 a member providing a lower shoulder 25. Above the shoulder 25 is a reduced portion 29 and above this reduced portion is a member forming a second shoulder 31, which slides in and is guided by a bearing 32 in a cap 33. The portions 21, 25, 29 and 31 are movable up and down as a unit, a pin 6 holding them together.

At numeral 34 (Fig. 3) is shown a piston movably fitted into a guide 35 which carries therein a spring-pressed packing 37. The guide 35 is in the side wall of an air-tight casing 41 which forms an extension from the head 3. The casing is enclosed and sealed shut by means of a cover 44. There is thus provided a casing in which the internal pressure may be raised by leading in air or other fluid under operating pressure over passage 71 (see Fig. 10). Thus the piston 34 tends normally to be forced out from the guide 35.

At this point may be pointed out the second distinction from said Klein patent which consists in placing the piston 34 so that its motion is lateral or normal with respect to the trip rod 21. This permits of the co-planar relationship above mentioned and later to be particularized.

The casing 41 is cored or drilled to form an exhaust port 43 and two feed ports 45 and 47. The feed port 45 passes to the upper end of the cylinder 1, and port 47 passes to the lower end of said cylinder by way of a connecting pipe 49 and a passage 51 in the lower head 5. The pipe 49 is clamped in position between the heads 3 and 5 by the tension in the studs 7, suitable packing 53 being used for sealing purposes.

The portion of the casing 41 adjacent the ends of the passages 43, 45 and 47 is machined circularly in a vertical plane to receive a circular valve plate 55. The plate 55 carries an exhaust port 43A which forms the valved end for the exhaust port 43; and also inlet ports 45A and 47A which form the inlet valve ports for the feed ports 45 and 47, respectively. Packing 8 is used to seat the plate 55.

The purpose of the valve plate 55 is to obtain a convenient hard-surfaced member for sealing cooperation with a D-valve 57. Valve 57 rides on the plate 55 in such a way as to connect the exhaust port 43A either with the inlet port 45A or the inlet 47A, depending upon position. The port 45A or 47A which is uncovered is thus placed in communication with the fluid under pressure inside of the enclosing casing and cover 41 and 44.

Since the passages 45 and 47 communicate with the opposite ends of the cylinder 1, it is clear that the motion of the D-valve 57 controls distribution of fluid (air under pressure in the present example) to the opposite ends of the cylinder. At the time that a given passage 45 or 47 is open to its respective cylinder end, the other passage 45 or 47 is in communication with the exhaust passage 43 by way of the hollow inside of the D-valve. For example in Figs. 1 and 4 the D-valve is in its upper position in which the passage 45 is delivering fluid to the upper end of the cylinder 1 and the passage 47 is in communication with the exhaust passage 43.

A plan view of the valve assembly is shown in Fig. 8. It consists of a member 10 on the plate 55 having side portions 61 for longitudinally guiding the D-valve 57 (see also Fig. 9). The side portions 61 are connected by raised bridge portions or end stops 65 for limiting the stroke of said D-valve 57. The stops being raised from the plate 55 serve for the reception of foreign material which the valve may push toward the ends of its stroke. Such foreign material then does not build up in any corner to unseat the valve or to shorten its stroke, but is pushed under and out of the respective stop 65. This space is shown at 66 (Figs. 1, 4 and 6).

The plates 10 and 55, are held down by headed studs 67 which are loosely passed through openings in said members and threaded into the housing 41. Springs 69 reacting between the heads of the studs 67 and the portions 61 serve resilient to hold the plate assembly in place. The purpose of thus resiliently holding down this assembly is to prevent distortion of the plate 55 which is very accurately surfaced in connection with the bottom surface of the D-valve, in order to obtain a good seal. Any substantial distortion, such as might be employed by directly bolting down the plate 55, might cause leakage between valve 57 and its seat. The packing means 8 used under the disc 55 serves also to limit distorting stress.

Spring holding cylinders 209 are held on the side members 61. Springs 211 therein force detent balls 213 into receiving pockets 215 in the D-valve 57. Thus the D-valve is forced to assume a predetermined position at each end of its stroke.

Fluid under pressure in the housing 41 tends to hold the D-valve 57 against its seat on the plate 55. Fluid is brought in over the passage 71 by means of an inlet pipe 73 which communicates with a suitable supply of fluid under pressure (not shown).

The D-valve 57 is operated by a trip shoe 74 which is in the shape of a fork, the legs 75 of which include openings 77 around the reduced portion 29 associated with the trip rod 21. The reduced portion 29 is of a length which is somewhat greater than the distance between the outside surfaces of the legs 75. The trip shoe 74 therefore has a lost motion engagement with respect to the trip rod 21 and may slide between the limits determined by the heads 25 and 31.

The distance between the insides of legs 75 is greater than the length of the outside length of the D-valve 57, so that there is also lost motion between here. As shown in Figs. 1 and 6, the legs 75 of the trip shoe 74 are long enough to contact with the ends of D-valve 57, and they are separated an amount to provide said lost motion. Part of the lost motion is shown as being taken up in Fig. 4.

Extending from the back of the trip shoe is a pin 79 which reaches through an opening 81 of a stationary supporting plate 80. The opening 81 is large enough to accommodate the necessary vertical and lateral movements of the pin 79. The plate 80 includes also cut-away portion 14 for clearing a pin to be described.

The purpose of the plate 80 is, with a fixed member 87, to support a linkage shown in Figs. 1–7. The plate 80 and support 87 support a pivot 89 at the left and guide slots 91 at the right (Fig. 3). A clevis shaped member 93 oscillates on the

pivot 89. A clevis shaped connecting rod 95 is articulated to the clevis 93 by means of a loose connection with the pin 79. This clevis 95 carries in its right-hand forked portion a pin 97 which slides in the guides 91. Around the pin 97 and within the forked portion of the clevis 95 is the pivot end of a surrounding yoke 99. The opposite end of the yoke is pinned to the piston 34 at 101. The connection between pin extension 79 (from the trip shoe 74) and the two clevises 93 and 95 is loose enough to accommodate sideward swing of the pin 79 necessitated by the fact that the end of the clevis 93 moves to the right in an arc (Fig. 12).

The two clevises 93 and 95 function as a toggle having one end pivoted at 89 and the other end pivoted on the sliding pin 97. Since the sliding pin 97 is pivoted to the yoke, any centering of the toggle links 93 and 95 will coincide with an inward (right) position of the piston 34 (Fig. 5), and conversely a broken position of the toggle corresponds to an outward (left) position of the piston 34 (Figs. 2 and 7).

Operation of the device is as follows:

Assume that the driving piston 13 is up as shown in Fig. 1, and that it has reset the valve 57 so that fluid under pressure is flowing from the inside of the casing 41 into the open port 45 and to a point above the piston. The piston will then descend, carrying with it the hollow piston rod 11 and the hollow connecting member 203. The hollow portion 207 then traverses the stationary head 19 of the then stationary trip rod 21. The fluid under pressure at this time forces the piston 34 to the left so that the yoke 99 has collapsed the toggle links 93, 95 into the upward angled position shown in Fig. 2.

Travel of the piston 13 downward finally results in all of the lost motion being taken up at the recess 207, that is, the head 19 is contacted by the upper end of 207. When this occurs, downward motion is transmitted to the trip rod 21, and the shoulder 31 begins to force down the shoe 74. Thus the shoe is pulled down until the extension pin 79 straightens the toggle linkage 93, 95 to the position shown in Figs. 4 and 5, wherein the piston 34 is drawn inwardly against the fluid under pressure within the chamber 41. In Figs. 4 and 5 the toggle linkage is about to overcenter. Some clearance remains between the upper leg of the shoe 74 and the D-valve 57.

A slight further movement results in the toggle over-centering, whereupon the fluid under pressure forces out the piston 34 to draw the yoke 99 over to the left, thus angling down the toggle links 93 and 95 into the position shown in Figs. 6 and 7. This further forces down the shoe 74 with a snap action due to the connection between the toggle linkage with the shoe through the pin 79. The result is as shown in Figs. 6 and 7 wherein the shoe 74 has taken up the clearance between it and the D-valve and then has moved the D-valve to the Fig. 6 position. Upon this occurring, the fluid under pressure is delivered to a point below the piston 13 via the port 47 and pipe 49 while the fluid above the piston is exhausted over ports 45, 45A, 43A and 43.

The action on the upward stroke is the reverse of that described above. The piston 13 moves to the upper end of its stroke, taking up lost motion with respect to the head 19, and thereafter the trip rod 21 is moved upwardly causing the toggle links 93 and 95 to straighten out. This draws in the piston 34 against the fluid under pressure in the chamber 41. Thereafter the toggle linkage over-centers upward and moves the shoe 74 upward with snap action to take up the clearance between the shoe 74 and the D-valve 57 and thereafter to move the valve with a snap movement to the initial position shown in Figs. 1, 2 and 3.

An examination of Figs. 3 and 12 will show that the center line of the piston 34 and central plane of the toggle mechanism are coextensive and that therefore there is no cocking of the piston 34. This reduces the wear on the cylindric portions of the guide 35 with a resulting better seal of the piston 34. In said Klein application the piston which corresponds to piston 34 herein transmits its force through a side lug which introduces some cocking side wear.

Another feature of the present invention is that the center line of the toggle mechanism and the piston 34 are crosswise of the center line of the valve and trip rod assembly and of the travel of the shoe 74, so that a more compact arrangement is accomplished.

Fig. 11 shows how the yoke 99 may have substituted therefor an equivalent one-sided yoke 217. This is to illustrate the point that the shape of the yoke need only be such as to clear the toggle links 93 and 95 in all positions, and that the only controlling factor as regards its action on the toggle linkage is the centered, co-linear relationship of the centers of the pins 101, 89 and 97. Another reason for compactness is the fact that the toggle mechanism is carried within the arch of the yoke 99 or its equivalent 217.

The bifurcated end of the link 93 and the central tongue of the link 95 provide an interlock for maintaining alignment. This is also true of the bifurcated end of the link 95 and the yoke 99. Although the links 93 and 95 are referred to herein as toggle links, they may also be considered in the following light:

The link 93 is a short oscillating lever on the center 89 and is pivoted by means of the pin 79 to the member 95 which functions as a connecting rod with the slider 97. This slider is yoked by means of the yoke 99 with the piston slider 34, the yoke being arched around the link mechanism.

It will be understood that the fluid used for operating the engine and valve may be air, or oil, or the like.

In Fig. 13 is shown how the construction of the means for providing overcentering action may still further be simplified. This is done by substituting for the piston 34 a drag link 251 reaching through an opening 253 in a body 255 which is capped shut by means of a cap 257. A spring 259 reacts against a shoulder 261 around the opening 253, and also against a head 263 on the drag link 251. The spring is of the compression variety and normally biases the drag link 251 to the left in Fig. 13. This construction introduces a spring for overcentering the toggle linkage. This Fig. 13 and accompanying description is inserted for the purpose of showing that a mechanical equivalent of the piston 34 may involve a spring, and further to emphasize the advantageous linkage form disclosed herein.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in

the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

We claim:

1. A valve mechanism comprising a valve, a trip shoe having a lost-motion engagement with the valve, a trip rod having a lost-motion engagement with the trip shoe, a toggle linkage having its center line lying crosswise with respect to the motion of the shoe and comprising two toggle links, one of which has a fixed pivot and the other of which has a sliding pivot, said toggle links being pivoted to one another by means of a pivot connection with said trip shoe, and means biasing said movable pivot toward the fixed pivot.

2. A valve mechanism comprising a valve, a trip shoe having an engagement with the valve, a toggle linkage having a center line lying crosswise with respect to the trip shoe motion and comprising two toggle links, one of which has a fixed pivot and the other of which has a sliding pivot, said toggle links being also pivoted to one another by means of a pivot connection with said trip shoe, and means biasing said sliding pivot toward the fixed pivot, said last-named means comprising a pressure-operated piston, and a yoke connecting said piston with said movable pivot means.

3. A valve mechanism comprising a valve, a trip shoe having a lost-motion engagement with the valve, a trip rod having a lost-motion engagement with the trip shoe, a toggle linkage having a center line lying crosswise with respect to the valve motion and comprising two toggle links, one of which has a fixed pivot and the other of which has a sliding pivot, said toggle links being pivoted to one another by means of a pivot connection with said trip shoe, and means biasing said movable pivot toward the fixed pivot, said last-named means comprising a pressure-operated piston, and a yoke connecting said piston with said movable pivot means, said yoke surrounding at least part of the toggle linkage and being in its plane of action.

4. Valve gear comprising an air-tight compartment having superatmosphere pressure of fluid therein, a valve-operating shoe operative along one line in said compartment, a piston member in sealing engagement with an opening in the wall of the compartment and movable substantially at right angles to the movement of the shoe, a toggle linkage having a fixed pivot and a sliding pivot and an oscillating pivot between said fixed and sliding pivots, said oscillating pivot being articulated to said shoe, and a yoke connecting the sliding piston and said sliding pivot.

5. Valve gear comprising a fluid-tight compartment having superatmospheric pressure therein, a valve-operating shoe operative along one line in said compartment, a piston member in sealing engagement with an opening in the wall of the compartment and movable substantially at right angles to the movement of the shoe, a toggle linkage having a fixed pivot and a sliding pivot and an oscillating pivot between said fixed and sliding pivots, said oscillating pivot being attached to said shoe, and a yoke connecting the sliding piston and the movable pivot, the pivot connection with the shoe being loose enough to provide for lateral movement of the shoe normal to its axial movement.

6. In a valve mechanism, a valve-operating shoe movable in a given direction, a reciprocating piston movable substantially at right angles to said shoe, a pivot pin extending from the shoe into the plane of piston movement, a yoke pivoted to the piston and passing around the pivot pin in any position that the latter may assume in its reciprocation, a fixed pivot, a sliding pivot, an oscillating member on the fixed pivot and a connecting rod attached to said sliding pivot, said yoke being also attached to said sliding pivot, said oscillating member and said connecting rod being pivoted by means of the pivot from the shoe.

7. In a valve gear, a fixed support, an oscillating member pivoted at one point in said support, a connecting member having one end pivoted to said oscillating member and the other pivoted to a slide in the support, a sliding piston adjacent to the fixed pivot, and a connecting member between said sliding piston and said sliding pivot.

8. In a valve gear, a fixed support, an oscillating member pivoted at one point in said support, a connecting member having one end pivoted to said oscillating member and the other pivoted to a slide in the support, a sliding piston adjacent to the fixed pivot, and a connecting member between said sliding piston and said sliding pivot, said last-named member comprising a yoke lying in the operating plane of said oscillating and connecting members and shaped to clear said oscillating and connecting members in all positions of the same.

9. In a valve gear, a fixed support, an oscillating member pivoted at one point in said support, a connecting member having one end pivoted to said oscillating member and the other pivoted to a slide, a sliding piston adjacent to the fixed pivot, and a connecting member between said sliding piston and said sliding pivot, said last-named member comprising a yoke lying in the plane of said oscillating member and the connecting member and shaped to clear said oscillating and connecting members in all positions of these members, and a valve-operating shoe movable substantially at right angles to the line of movement of said piston and having a pivot forming the connection between the oscillating and connecting members.

10. Valve gear mechanism comprising spaced frame plates, a fixed pivot pin between said plates at one point, an oscillating member on said pivot having the form of a clevis, a connecting rod having also the form of a clevis with a tongue in the clevis of the oscillating member, a sliding pin in the clevis of the connecting rod, guides for the sliding pin in said spaced frame plates, a sliding piston adjacent the fixed pivot formed also as a clevis, and a yoke pivoted in the clevis of the piston and to the sliding pivot within the clevis of the connecting rod, a shoe sliding normally to the line of action of the piston, said shoe having a pivot pin reaching into the connection between the oscillating member and the connecting rod.

11. Valve gear mechanism comprising spaced frame plates, a fixed pivot pin between said plates at one point, an oscillating member on said pivot having the form of a clevis, a connecting rod having also the form of a clevis with a tongue in the clevis of the oscillating member, a sliding pin in the clevis of the connecting rod, guides for the sliding pin in said spaced frame plates, a sliding piston adjacent the fixed pivot formed also as a clevis, and a yoke pivoted in the clevis of the piston and to the sliding pivot within the clevis of the connecting rod, a shoe sliding normally to the line of action of the piston, said shoe having a pivot pin reaching into the connection between the oscillating member and the

connecting rod, the connection including enough lost-motion to permit the lateral movement required of the shoe by the oscillations of the oscillating member.

12. Valve gear mechanism comprising spaced frame plates, a fixed pivot pin between said plates at one point, an oscillating member on said pivot having the form of a clevis, a connecting rod having also the form of a clevis with a tongue in the clevis of the oscillating member, a sliding pin in the clevis of the connecting rod, guides for the sliding pin in said spaced frame plates, a sliding piston adjacent the fixed pivot formed also as a clevis, and a yoke pivoted in the clevis of the piston and to the sliding pivot within the clevis of the connecting rod, a shoe sliding normally to the line of action of the piston, said shoe having a pivot pin reaching into the connection between the oscillating member and the connecting rod, the connection including enough lost-motion to permit the lateral movement required of the shoe by the oscillations of the oscillating member, one of the fixed plates having an opening accommodating the extension from the shoe in all of its required positions.

13. Valve gear mechanism comprising spaced frame plates, a fixed pivot pin between said plates at one point, an oscillating member on said pivot having the form of a clevis, a connecting rod having also the form of a clevis with a tongue in the clevis of the oscillating member, a sliding pin in the clevis of the connecting rod, guides for the sliding pin in said spaced frame plates, a sliding piston adjacent the fixed pivot formed as a clevis, and a yoke pivoted to the clevis of the piston and to the sliding pivot within the clevis of the connecting rod.

14. Valve gear mechanism comprising spaced frame plates, a fixed pivot pin between said plates at one point, an oscillating member on said pivot having the form of a clevis, a connecting rod having also the form of a clevis with a tongue in the clevis of the oscillating member, a sliding pin in the clevis of the connecting rod, guides for the sliding pin in said spaced frame plates, a sliding piston adjacent the fixed pivot formed as a clevis, a yoke pivoted to the clevis of the piston and to the sliding pivot within the clevis of the connecting rod, a shoe sliding normally to the line of action of the piston, said shoe having a pivot pin reaching into the connection between the oscillating member and the connecting rod, the connection including enough lost-motion to permit the movement required of the shoe by the oscillations of the oscillating member, and a fluid-tight compartment surrounding the mechanism having a wall opening accommodating the piston.

15. Valve gear mechanism comprising spaced frame plates, a fixed pivot pin between said plates at one point, an oscillating member on said pivot having the form of a clevis, a connecting rod having also the form of a clevis with a tongue in the clevis of the oscillating member, a sliding pin in the clevis of the connecting rod, guides for the sliding pin in said spaced frame plates, a sliding piston adjacent the fixed pivot formed as a clevis, and a yoke pivoted to the clevis of the piston and to the sliding pivot within the clevis of the connecting rod, said yoke comprising a hollow member having an opening therethrough accommodating the oscillating member and connecting rod in all positions thereof.

16. Valve gear mechanism comprising spaced frame plates, a fixed pivot pin between said plates at one point, an oscillating member on said pivot having the form of a clevis, a connecting rod having also the form of a clevis with a tongue in the clevis of the oscillating member, a sliding pin in the clevis of the connecting rod, guides for the sliding pin in said spaced frame plates, a sliding piston adjacent the fixed pivot formed as a clevis, and a yoke pivoted to the clevis of the piston and to the sliding pivot within the clevis of the connecting rod, said connecting rod comprising an arch-shaped member reaching around the oscillating member and the connecting rod in one of their extreme positions.

FRANK S. BARKS.
VICTOR G. KLEIN.