(No Model.)

R. HARDIE.

DIRECT ACTING ENGINE.

No. 405,409. Patented June 18, 1889.

Fig. 1.

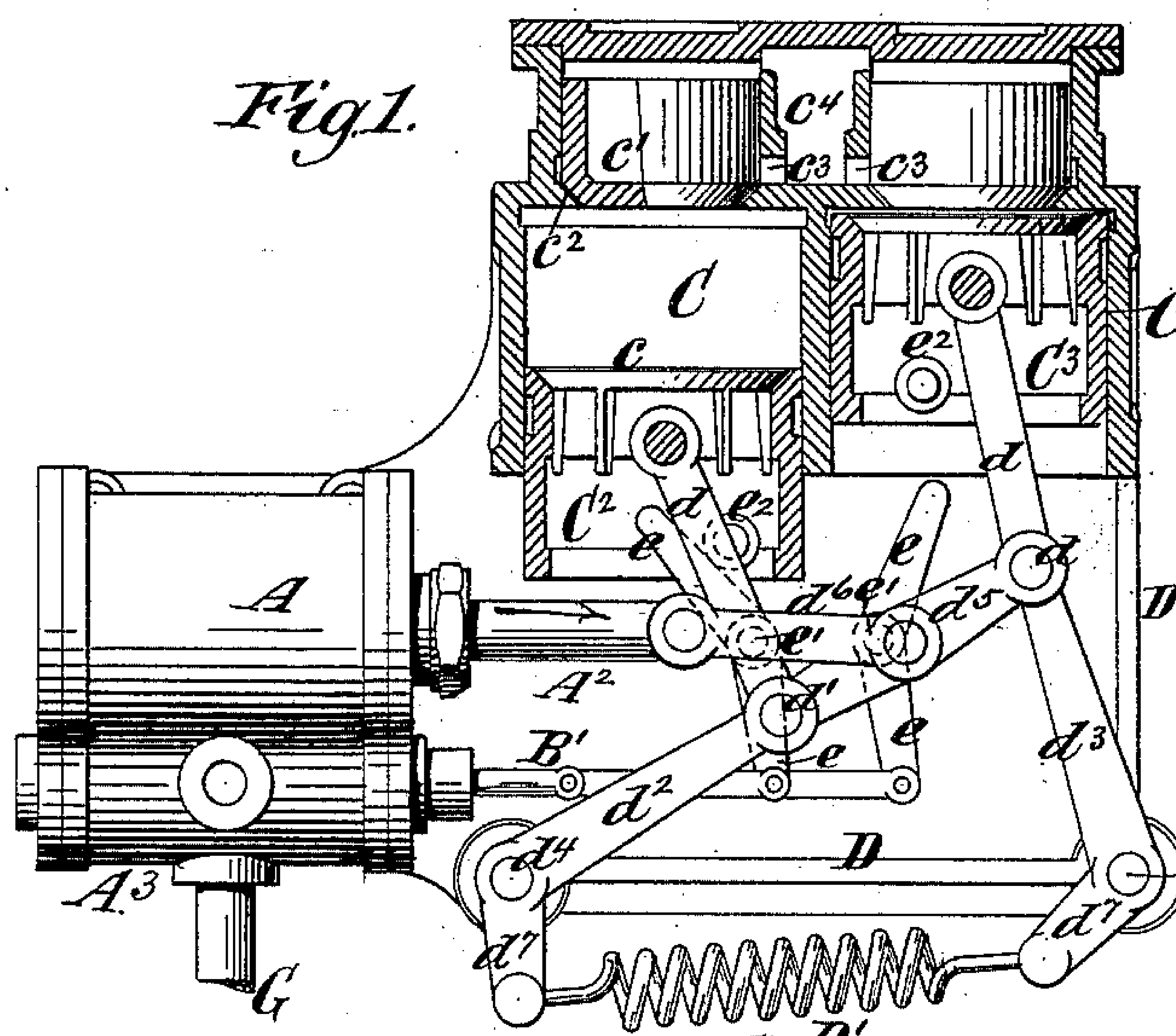


Fig. 2.

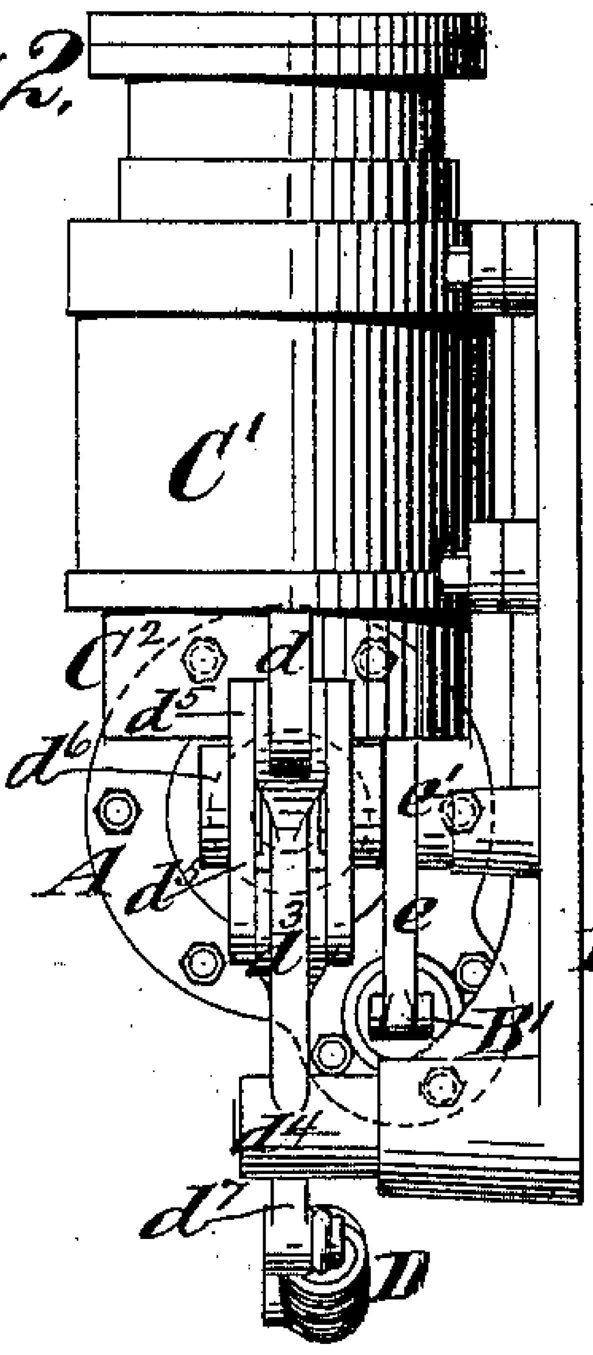


Fig. 3.

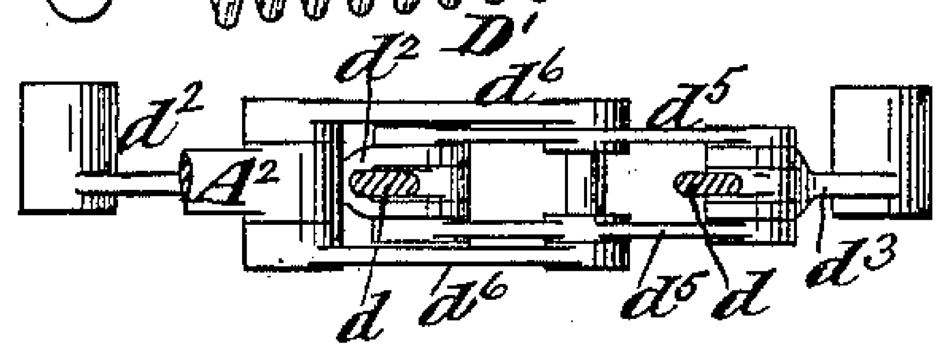
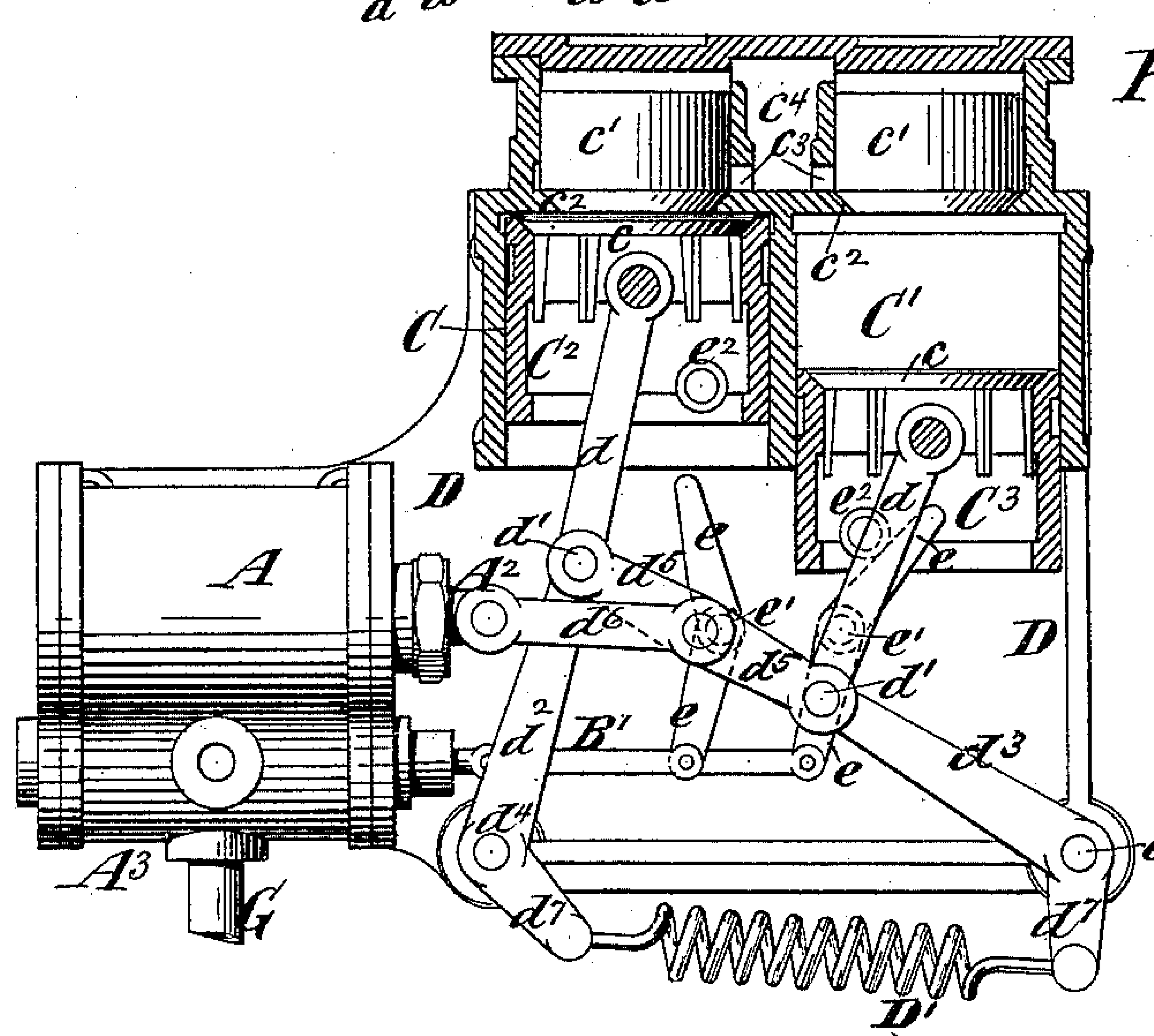


Fig. 4.



Witnesses.
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ROBERT HARDIE, OF SCHENECTADY, NEW YORK.

DIRECT-ACTING ENGINE.

SPECIFICATION forming part of Letters Patent No. 405,409, dated June 18, 1889.

Application filed March 8, 1888. Serial No. 266,547. (No model.)

To all whom it may concern:

Be it known that I, ROBERT HARDIE, of Schenectady, in the county of Schenectady and State of New York, have invented a new and useful Improvement in Direct-Acting Engines, of which the following is a specification.

The invention will be hereinafter more fully described, and pointed out in the claims.

In the accompanying drawings, Figure 1 is an elevation of a direct-acting motor cylinder and piston, including a vertical section of two single-acting pump-pistons connected with the motor-piston according to my invention. Fig. 2 is an end elevation of the apparatus. Fig. 3 is a plan of the link-work, whereby the pump-pistons are connected with the motor-piston. Fig. 4 is an elevation corresponding to Fig. 1, but showing the pump-pistons the reverse of Fig. 1—that is to say, the pump-pistons being shown in Fig. 4 the left hand as at the upper end of its stroke, while in Fig. 1 the left-hand and right-hand pistons are respectively represented at the lower end and at the upper end of their strokes.

Similar letters of reference designate corresponding parts in all the figures.

A designates a motor-cylinder, within which is a piston, (not shown,) which piston transmits its motion through a piston-rod A^2, working through one end of the cylinder A. Adjacent to and extending parallel with the cylinder A is a valve-chest A^3, within which operates a valve, and this valve is operated during the first part of its movement through the valve-stem B′, and during the latter portion of each movement the valve is operated by the pressure of steam or other motive fluid upon it.

For purposes of illustration I have here represented my invention as embodied in an air pumping or compressing apparatus for supplying compressed air to operate a system of brake appliances. I have here shown two pump-cylinders C C′, and the pump-cylinders C C′, as well as the motor-cylinder A, are secured to a back plate or frame D, which is suitably supported in position upon a locomotive, as is usual.

Within the pump-cylinders C C′ operate single-acting pistons C^2 C^3, and in each piston is an inlet air-valve or induction-valve c, through which air enters the pump-cylinder. I have represented a large puppet discharge-valve c', which is contained in the casing above each pump-cylinder C C′, and which closes upon a seat c^2. The bore or cylindric cavity within which the discharge-valves c' move communicates by passages c^3 with an intermediate chest c^4, into which the air is compressed and from which the compressed air may be taken for use.

It will be observed that the pistons or plungers C^2 C^3 of the pumps are in the form of hollow trunks, and the suction or induction valve c of each trunk is at the upper end and occupies nearly the whole area of the trunk, while the delivery-valve c', which is also large, is just inside of the top head and in such a position that the induction or suction and the eduction or delivery valves come very close to each other at the inner or upper limit of travel of each piston. The downward movement of each pump-piston C^2 C^3 will aid the opening of the suction-valve by the inertia of the latter, and air will be taken into the cylinder by the open trunk; but for pumping gases or liquids another form of pump-piston would have to be employed. It will therefore be seen that, inasmuch as the induction-valves at the upper ends of the movement of the pump-pistons come close to the discharge-valves c', there will be the smallest possible amount of clearance in the pump-cylinders, and the pumps will therefore work most economically.

I will now describe the connections which are employed between the motor-piston A′ and the pump-pistons C^2 C^3. Each pump-piston C^2 C^3 has pivotally connected with it a link d, and these links are jointed at d' to levers d^2 d^3, which are fulcrumed at d^4. It therefore follows that each link d and the lever d^2 or d^3, which is connected with it, constitute toggle-levers, which are brought into line or deflected out of line to perform the strokes of the pump in one or other direction. The two movable joints d' of the toggle-levers are connected by a link d^5, and the main piston-rod A^2 of the motor-piston is connected by a link d^6 with the link d^5 at a point about midway of the length of said latter link. As best shown in Fig. 3, the links d^5 d^6 are each double.

As represented in Fig. 1, the piston-rod A^2 is supposed to have just completed its movement in a direction indicated by the arrow in that figure, and during such movement the toggle-levers d d^3 have gradually been brought into approximately a straight line and the pump-piston C^3 has been moved upward at a gradually decreasing speed. At the same time the toggle-levers d d^2 have been deflected from a straight line, thereby drawing down the pump-piston C^2, and such movement has continued until the lever d^2 and the link d^5 have been brought into direct alignment, as shown in Fig. 1. This fixes the limit of movement of the main piston-rod A^2, and as the toggle levers d d^3 are brought toward a straight line it will be seen that the speed of movement of the pump-piston C^3 gradually slackens or decreases relatively to the movement of the main piston-rod A^2, and therefore the motor-piston exerts a more powerful compressing action upon the pump-piston C^3.

The power behind the motor-piston A′ is of course gradually decreasing as said motor-piston makes its stroke, and this decreasing power is compensated for by the decreasing length of movement of the pump-piston C^3, resulting from the operation of the idle arc or toggle-levers for operating such pump-piston. The motor piston-rod having performed its full stroke toward the right, the valve will be shifted, as I shall soon describe, and then the motor piston-rod A^2 moves toward the left to the opposite extreme of its stroke, as shown in Fig. 4. By this operation the toggle-levers d d^3 have been deflected to their fullest extent and the pump-piston C^3 pulled down, while the toggle-levers d d^2 have been straightened into line, or thereabout, and have moved the pump-piston C^2 to the top of its stroke. At this time the lever d^3 and the link d^5 have come into true alignment, as shown in Fig. 4, and therefore the working-piston A′ can move no farther toward the left. When the piston-rod A^2 is at the extreme limit of its travel in either direction, one of the levers d^2 or d^3 comes into line with the link d^5, thus positively and definitely fixing the limit of travel of the motor-piston A′, so that the piston cannot strike the cylinder-heads, while the other lever d^3 or d^2 forms a toggle-joint with its pump connecting rod or link d, and gives the greatest leverage upon the pump-piston at the moment of greatest resistance of the pump and at the moment of least effort of the motor-piston. It may also be observed that the pump-plunger will reach a fixed and definite point at the inner end of its travel, so that it may be made to approach as closely as possible to the top head of the pump-cylinder, thus reducing the clearance to the utmost practicable limit. This is obviously a very important feature in a pump used for compressing air, and enables much higher efficiency to be obtained than is possible with an ordinary direct-acting pump. Probably for this reason alone a pump constructed on this principle will compress as much air as an ordinary direct-acting pump of nearly twice its size.

I have represented a spring D′, which is employed to arrest the momentum of the pump-plungers C^2 C^3 at the lower end of their travel. Each end of the spring D′ is attached to a projecting toe d^7 upon the levers d^2 and d^3, and the angle of the toe d^7 is such that when either one of the pump-plungers C^2 C^3 is at the lower end of its travel the spring D′ will be about at right angles to the toe d^7 of the lever d^2 or d^3 with which that pump-piston is connected. As shown in Fig. 1, the pump-piston C^2 is at the lower end of its stroke, and its further downward movement is prevented by the pull which the spring D′ has upon the toe d^7 of the lever d^2. At this moment the opposite end of the spring exerts very much less pull upon the toe d^7 of the lever d^3, and therefore any further downward movement of the piston C^2 would tend to distend the spring D′, and therefore by this arrangement the momentum of the pump-pistons in their downward movement is cushioned or prevented from having any ill effect.

e designates two levers, both of which are connected with the valve-stem B′. These levers *e* are fulcrumed at e', and upon them act truck-rolls or projections e^2, which are applied one upon each pump-piston C^2 C^3. In the position of parts shown in Fig. 1 the truck-roll e^2 upon the pump-piston C^2 has by its descending movement acted upon the lever *e*, with which it is in contact, and has thereby moved the valve-rod B′ toward the right hand; but as the pump-piston C^2 ascends and the pump-piston C^3 descends the truck-roll e^2 upon such latter piston will act upon the right-hand lever *e*, and will then move the valve-rod B′ in the reverse direction or toward the left hand of Fig. 1, and as particularly shown in Fig. 4.

The several fulcrums for the levers d^2 d^3, and also for the valve rockers or levers *e*, may all be mounted upon the back plate or support D, as is shown in Figs. 1 and 2.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The combination, with a direct-acting motor piston and cylinder, of two single-acting pump pistons and cylinders, two pairs of toggle-levers for the pump-pistons, each pair having a fixed fulcrum and connected with the pump-pistons and the two pairs being connected together, so that the levers of one pair straighten into line as those of the other pair deflect from a straight line, and a connection between the rod of the motor-piston and the movable joints of the toggle-levers, substantially as herein described.

2. The combination, with a direct-acting motor piston and cylinder, of two single-acting pump pistons and cylinders, two pairs of toggle-levers, each pair consisting of two mem-

bers d^2 or d^3 and d, jointed together at d', the former d^2 or d^3 fulcrumed at d^4, and the latter d connected with its pump-piston, the link d^5, connecting the movable joints of the two pairs of levers, and the link connecting said link d^5 at a point between its ends with the motor piston-rod, substantially as herein described.

3. The combination, with a direct-acting motor piston and cylinder, of two single-acting pump pistons and cylinders, two pairs of toggles consisting of the levers d^2 d^3, fulcrumed at d^4 and having the toes or arms d^7, connected by the spring D′, and the rods d, jointed to said levers and to the pump-pistons, and a connection between the motor piston-rod and the movable joints of the pairs of toggle-levers, substantially as herein described.

4. The combination, with a direct-acting motor piston and cylinder, and a valve for controlling the movements of said piston, of two single-acting pump pistons and cylinders and pairs of toggle-levers through which said pump-pistons are operated by the motor-piston, and levers e, connected with the valve-rod of the motor-cylinder and which are operated on alternately by the pump-pistons in their descending movements to move the valve, substantially as herein described.

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