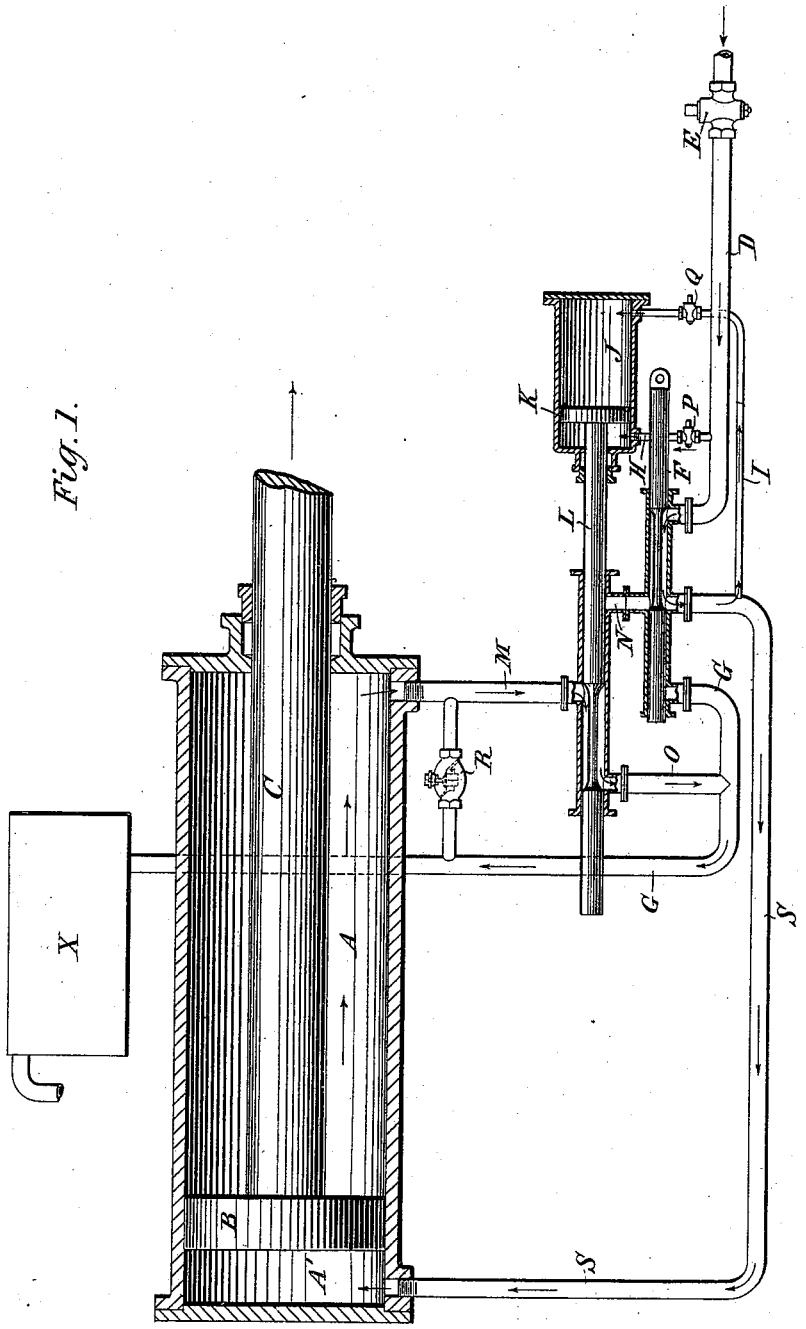
(No Model.) 5 Sheets—Sheet 1.

R. H. THORPE.

APPARATUS FOR REGULATING HYDRAULIC POWER.

No. 523,419. Patented July 24, 1894.

Fig. 1.



Witnesses.
Philip M. Goshie
Albert Barnes Jones

Inventor
R. H. Thorpe

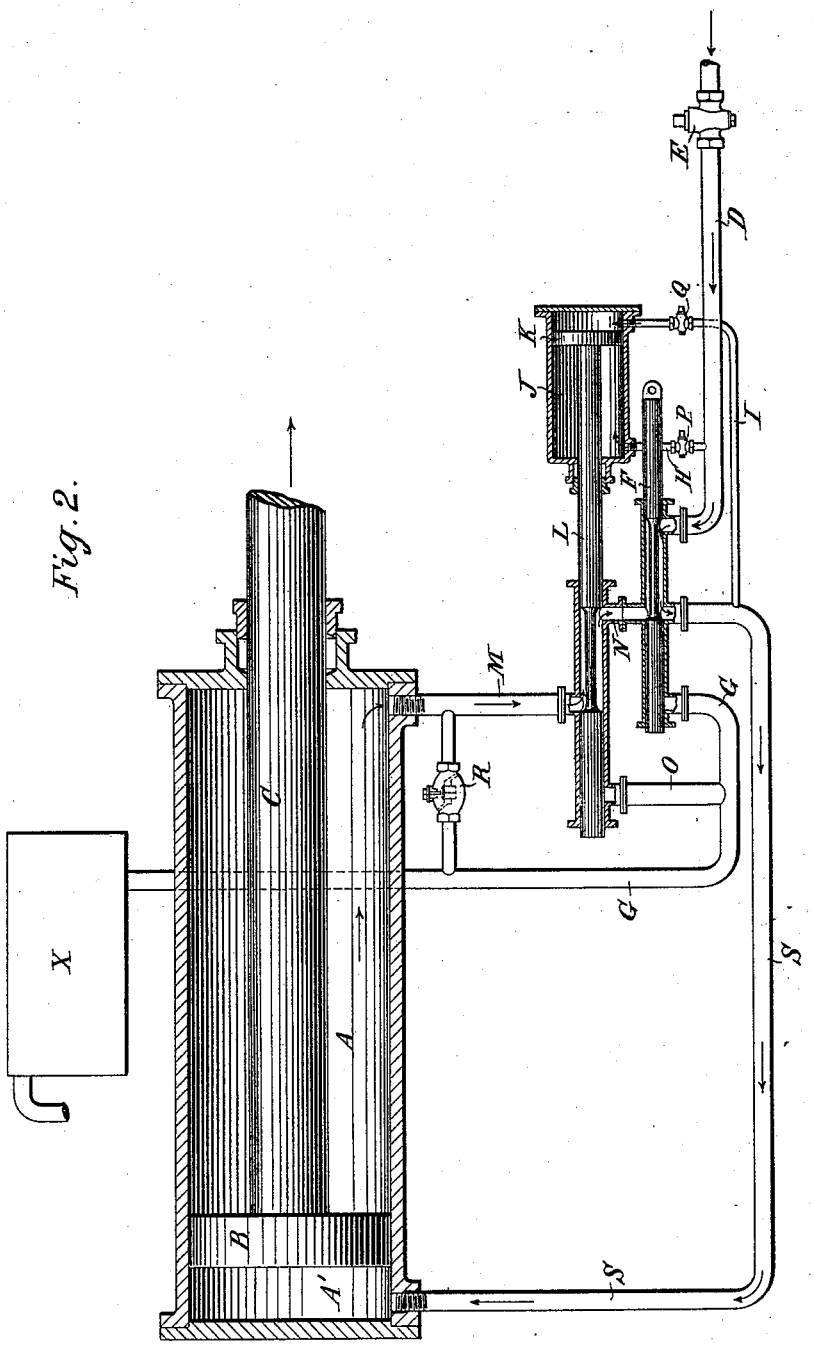
(No Model.) 5 Sheets—Sheet 2.

R. H. THORPE.

APPARATUS FOR REGULATING HYDRAULIC POWER.

No. 523,419. Patented July 24, 1894.

Fig. 2.



Witnesses.
Philip M. Jenkins
Allen Parry Jones

Inventor.
R. H. Thorpe

(No Model.) 5 Sheets—Sheet 3.

R. H. THORPE.

APPARATUS FOR REGULATING HYDRAULIC POWER.

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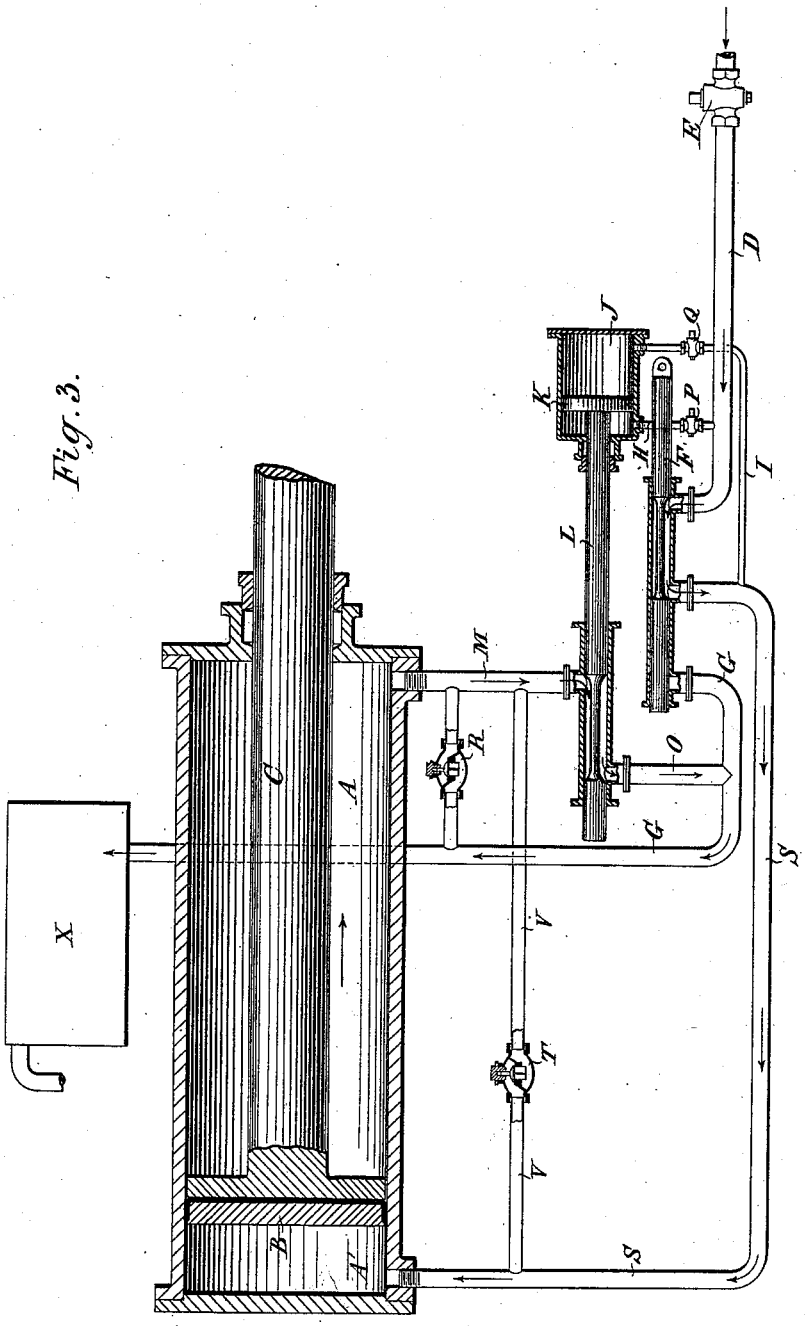
Fig. 3.



Witnesses.
Philip M. Jenkins
Allen Parry Jones

Inventor.
R. H. Thorpe

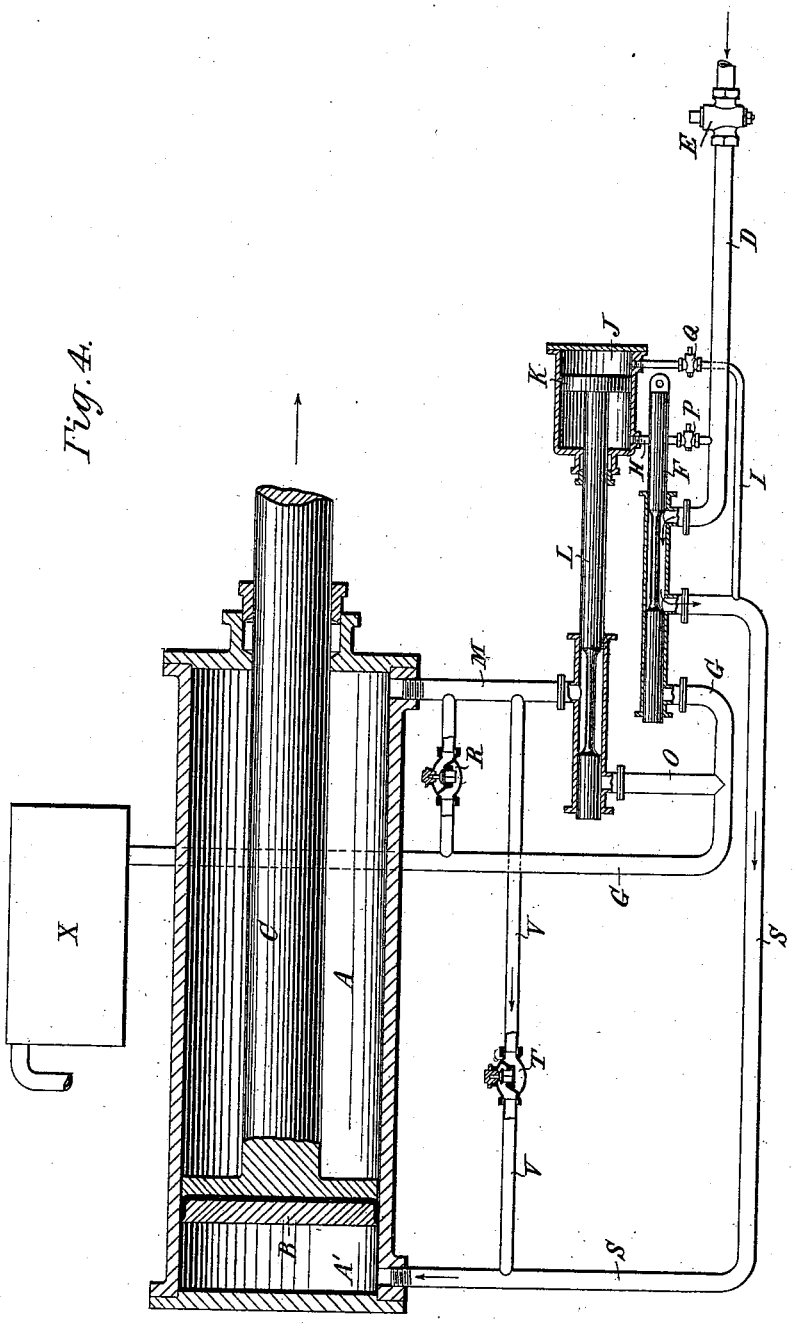
(No Model.) 5 Sheets—Sheet 4.

R. H. THORPE.

APPARATUS FOR REGULATING HYDRAULIC POWER.

No. 523,419. Patented July 24, 1894.

Fig. 4.



Witnesses.
Philip M. Justice
Allen Parry Jones

Inventor.
R. H. Thorpe

(No Model.) 5 Sheets—Sheet 5.

R. H. THORPE.

APPARATUS FOR REGULATING HYDRAULIC POWER.

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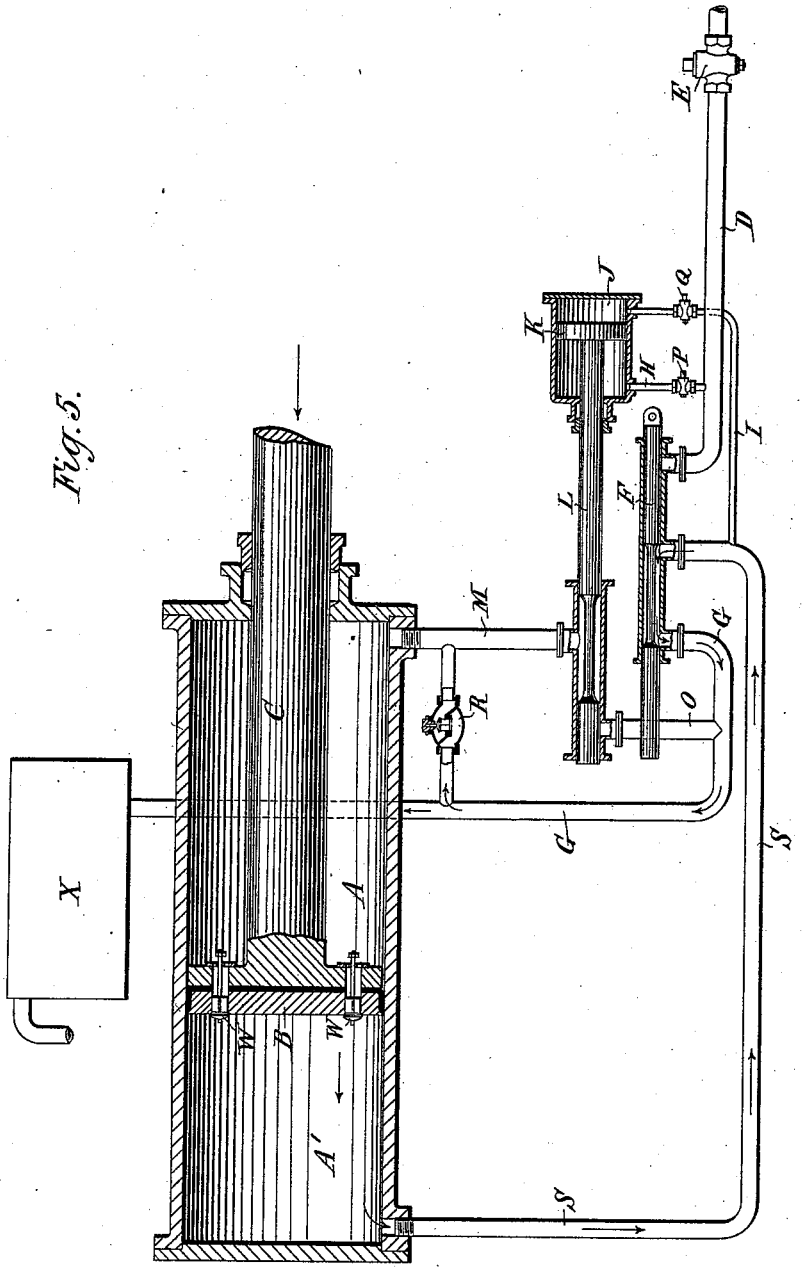
Fig. 5.



Witnesses.
Philip M. Justice
Allen Davy Innes

Inventor:
R. H. Thorpe

UNITED STATES PATENT OFFICE.

ROBERT HENRY THORPE, OF LONDON, ENGLAND.

APPARATUS FOR REGULATING HYDRAULIC POWER.

SPECIFICATION forming part of Letters Patent No. 523,419, dated July 24, 1894.

Application filed December 9, 1891. Serial No. 414,492. (No model.) Patented in England December 9, 1891, No. 21,528.

To all whom it may concern:

Be it known that I, ROBERT HENRY THORPE, engineer, a subject of Her Majesty the Queen of Great Britain, residing at 4 Queen Victoria Street, in the city of London, England, have invented certain new and useful Improved Apparatus for Regulating Hydraulic Power, of which the following is a specification.

This invention as set forth in my British Patent No. 21,528, of December 9, 1891, relates to that class of apparatus designed for the purpose of regulating the power and to a certain extent the quantity of high or main pressure liquid employed for effecting the desired quantity of work, or in other words to vary the resultant power depending upon the work it is called upon to perform, the high or main pressure being assumed as remaining constant in either case.

The invention mainly consists of improvements upon the inventions set out in specifications of United States Patents No. 429,664 and No. 446,799, and in order that the same may be clearly understood, reference is made to the accompanying drawings, which form part of this specification, and in which—

Figures 1 to 5 illustrate the invention as applied to a single motor cylinder.

In the drawings Fig. 1 represents the position of the parts when full power is applied, and Fig. 2 with decreased power and reduced consumption of high or main pressure liquid. In Figs. 3, 4 and 5 the position of one of the parts or connections shown in Figs. 1 and 2 is somewhat changed while still enabling the same result to be attained, Fig. 3 representing the parts in position to admit full power, while Fig. 4 indicates their position for reduced power with proportionate reduction of high or main liquid consumption, while Fig. 5 represents the high or main pressure as being entirely shut off the liquid circulating from end A′ to A, and to exhaust.

Considering first Figs. 1 and 2 it will be noted that end A′ of the cylinder is connected to main or supply pipe D by pipe S, the inflow being governed by stop valve E and operating valve F, the latter also governing the direct exhaust through pipe G from end A′ of cylinder. A branch pipe I with regulating valve Q connects end A′ of cylinder through pipes S and I with cylinder J behind piston K. A branch pipe H with regulating valve P connects cylinder J in front of piston K with main or other source of supply D at a point outside of valve F, so that the full main pressure may be exerted thereon.

It will be noted that the piston rod of the piston K has a considerable cross section and that the area of the piston K which is exposed to pressure from the main is therefore less than the area of the opposite side of the piston. The piston K and the cylinder J with its connections form an automatic operating device for the valve L. This device differs from those shown in my prior patents in that it is not in any way affected by weights or springs, but is operated entirely by the difference in effective pressure upon opposite sides of the piston K. It does not depend upon the absolute pressure in the main, but, upon the difference between the pressures in the main and the working cylinder, whether they are high or low. With prior devices of this nature the valve would not be operated automatically if the pressure in the main were lower than the normal pressure for the reason that in addition to the differential piston or pistons used, a weight or spring was added to assist in controlling the valve thus creating a constant resistance. In my present invention the piston K is usually moved automatically on account of the difference between the main and the initial pressure. Should the main and the initial pressure in any instance be exactly equal however, the valve will still be moved on account of the differential piston K. In either case therefore there will be an effective difference between the main and the initial pressure which will operate the valve.

When the valves are in position shown in Fig. 1 full pressure entering through D is exerted behind piston B, the other end of the cylinder being open to tank X by exhaust G through valve L by pipes M and O, initial pressure, that is, the operating pressure of the cylinder being exerted behind piston K through pipes S and I, and full main pressure in front of piston K through pipe H. The piston B having completed its desired stroke valve F is moved to the left shutting off supply through D opening direct exhanst from behind B to G, when the pressure behind K

being relieved, the direct pressure from main in front of K overcomes friction of valve L which is moved in the direction of least resistance over to the position shown in Fig. 2, in which position it will remain until piston B is called upon to perform work which requires the larger power. On return stroke of piston B the water in end A′ is caused to flow back through pipe S and operating valve F to exhaust pipe G, enough passing through check valve R (which will allow water to pass from G to M but not to return) to fill end A the remainder which is equal to the quantity displaced by piston rod C going to tank X.

With the parts as shown in Fig. 2 the apparatus is adapted to work at decreased power with a decreased consumption of high or main pressure water, as the ends A and A′ of cylinder are both open to pressure, the power exerted being proportionate to the sectional area of piston rod C. So long as the work to be done by C can be effected at the reduced power so long will the pressure in front of K be sufficient to hold valve L in position shown in Fig. 2 against pressure behind K, which as is well known will vary in proportion to resistance of piston B, or of the work to be done. The area of piston K can be proportioned so that full effective power shall only be put on piston B when the resistance or work to be done calls for a pressure above a certain number of pounds per square inch.

For the purpose of illustration let it be assumed it will take a pressure of five hundred pounds per square inch behind K to equal the pressure from main plus the friction, then so long as the work required to be done by piston B does not require a greater number of pounds per square inch, so long will valve L remain in position shown in Fig. 2, and as the work is being done the water displaced by travel of B will be passed through M, L, N, F and S to other side, thereby only using the water required for the first or reduced power of the motor.

For the purpose of further illustration let it be assumed that the work to be done requires a greater number of pounds per square inch than will be sufficient to overcome the pressure from main on K plus friction, then the initial pressure per square inch will rise according to the resistance of piston B and be transmitted through pipes S and I to cylinder J, and will cause K to travel in direction of least resistance or over to the position shown in Fig. 1, thus opening the end A of cylinder to exhaust G through pipes M and O, and causing the apparatus to work on the larger power, as soon as the work has been done and the motor stopped initial pressure behind K is relieved and the valve L is automatically moved back into its normal position as shown in Fig. 2. When moving from the small to larger power as soon as valve L has moved forward sufficiently to throttle the outlet N without sufficiently opening exhaust port O the resistance to B in cylinder will be increased, and it will be impossible for this reason for the valve to return while piston B is moving forward performing work, thus the larger power being provided will not change until motor comes to rest when it will be free to return to the smaller power.

If valve L be constructed so that port N is entirely cut off from pipe M before the latter is put into communication with O, then the result would be as stated, but it may be so constructed that there is a slight passage between O and M, and M and N when the valve is midway, said passage being insufficient to allow water from the main to go to waste, but yet sufficient to allow the water from M to take the direction O or N without materially checking the motion of piston B in the cylinder.

The special value of valve R is to allow water from the exhaust or discharge to pass into end A of the cylinder whenever piston B shall be on the return stroke, thus avoiding the possibility of there ever being a vacuum in end A of said cylinder whatever the position of valve L. When piston B is returning there will always be sufficient water coming through pipe S to fill end A of cylinder, but notwithstanding I generally prefer to use a discharge tank placed in such a position that the water shall run from it by gravity through check valve R into said end.

When it is desired to obviate any possibility of valve L closing pipe N and failing to open the discharge from M through O to G, a connection may be made directly from pipe M to pipe S, such connection V being provided with a check valve T which will permit a flow from M but not from S. Such a connection is illustrated in Figs. 3, and 4, and renders the use of pipe N unnecessary.

If it be assumed that valve F has been moved allowing pressure from the main to be exerted behind piston B through pipe S, and that the resistance of piston B has caused initial pressure behind K in cylinder J to be raised sufficiently to overcome the pressure from the main in front of K plus the friction, then valve L would be moved over to position represented in Fig. 3, thus opening the end A of the cylinder to exhaust G through M and O, and the motor would then be working on the larger power. After the motor has been stopped the initial pressure behind K being relieved valve L is automatically moved back as already described, to the position shown in Figs. 4 and 5, cutting off communication from front of piston B to exhaust G.

If it be assumed that the pressure from the main is being exerted behind piston B but the resistance given is not enough to raise initial pressure behind K sufficiently to overcome the resistance in front, then the water which is in front of piston B would be put under pressure and owing to the difference in area of piston B on opposite sides the piston will travel forward, the water displaced by such travel being compelled to pass to end A′ of

the cylinder through pipe V and check valve T, the valves L and F being in position shown in Fig. 4, and the motor working on the lower power with decreased consumption of high or main pressure water.

Instead of check valve T communication may be made between the ends of cylinder by means of valves W placed in piston B, or by so constructing the piston and packing that the water can pass from the end A to end A′ of the cylinder as shown in Fig. 5.

In the practical operation of an apparatus such as I have described, it is necessary that the change in the position of the valve L, and the piston K which governs its movements, from that position which causes the reduced power to be exerted upon the piston B, to the position which permits the full power to be exerted thereon,—as in the starting with a heavy load,—should take place very rapidly in order that there should not be a moment's delay; and therefore the water must pass through the pipes I and H, and through the regulating valves therein, with great rapidity and the utmost freedom. On the other hand when the valve L is moved in the opposite direction, as it will whenever the lesser or reduced power may operate the apparatus, it is important and necessary that the return should be made very slowly in order that the water from the supplemental cylinder J should not be forced too suddenly into the main cylinder, as this would cause the car to jump. To this end, the valves P and Q, which I term the regulating valves, are so constructed that they permit the water to flow freely and rapidly when moving in the direction to cause the piston K to move from the position shown in Fig. 2 to that shown in Fig. 1, but which operate to cause a retarding of the movement of the water when the piston is moving in the opposite direction. In using the term "regulating valve," therefore, in this specification, I mean a valve having the characteristics of operation just referred to.

What I claim is—

1. The combination, with a motor cylinder, the piston therein, the channels, and a valve governing the inlet and exhaust channel from the working end of the said cylinder, of a valve governing the discharge from the piston rod end of the cylinder, means for operating the latter valve automatically by the effective difference between the main pressure and initial pressure, even if these vary from time to time, and a supplementary passage provided with an automatic valve connecting the opposite ends of the motor cylinder, substantially as set forth.

2. The combination with a motor cylinder, the piston therein, the channels, and a valve governing the inlet and exhaust from the working end of the said cylinder, of a valve which governs the discharge from the piston rod end of the said cylinder, means for operating the said valve automatically by the effective difference between the main pressure and initial pressure, and a supplemental passage provided with a check valve connecting the discharge pipe from the piston rod end of the motor cylinder with the exhaust pipe, substantially as set forth.

3. The combination with a power cylinder piston channels, a valve governing the inlet and exhaust of the working end and a piston valve automatically operated by the effective difference between main and initial pressures governing the exhaust of the piston rod end, of regulating valves interposed between the supply pipe and the piston rod end of the piston valve cylinder and between the working end of said cylinder and the working end of the power cylinder, substantially as set forth.

4. The combination with a power cylinder and piston, of a valve governing the exhaust from the piston rod end of the cylinder and automatically operated by the effective difference between main and initial pressures, a supplementary passage provided with an automatic valve connecting the piston rod end of the motor cylinder with the exhaust passage way and an automatic supplemental valve interposed between the piston rod end and the working end of said cylinder, substantially as set forth.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

ROBERT HENRY THORPE.

Witnesses:
PHILIP M. JUSTICE,
ALLEN PARRY JONES.