No. 662,678. Patented Nov. 27, 1900.

C. H. PECK, F. LEACH & N. A. JOHNS.

HYDRAULIC ENGINE.

(Application filed May 16, 1899. Renewed Apr. 6, 1900.)

(No Model.) 4 Sheets—Sheet 1.

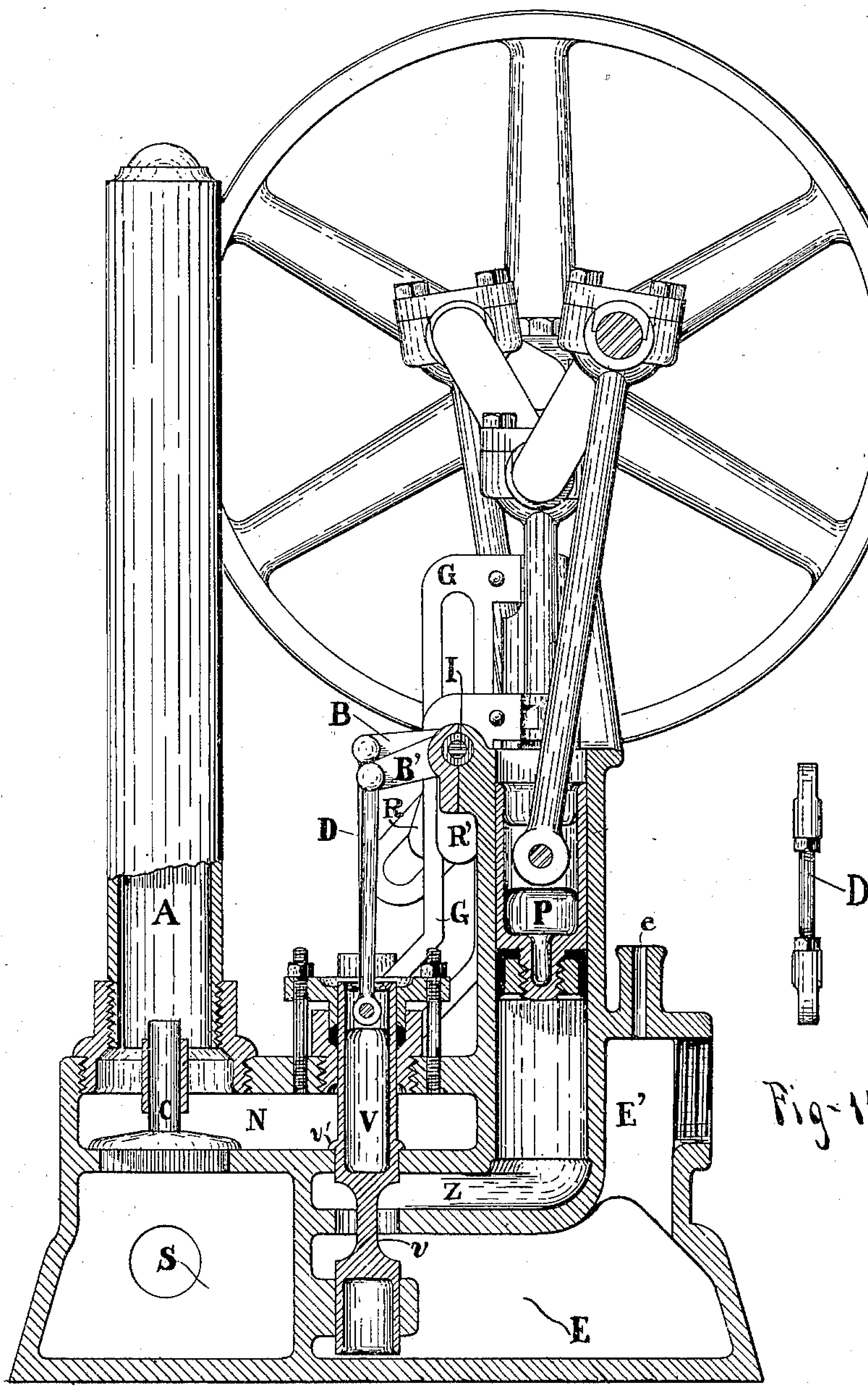


Fig-11.

Fig-1.

WITNESSES:

A. S. Diven

C. Tracey Hagg.

INVENTORS

Caid H. Peck

Frederic Leach

and Norman A. Johns

BY

Eugene Diven

ATTORNEY

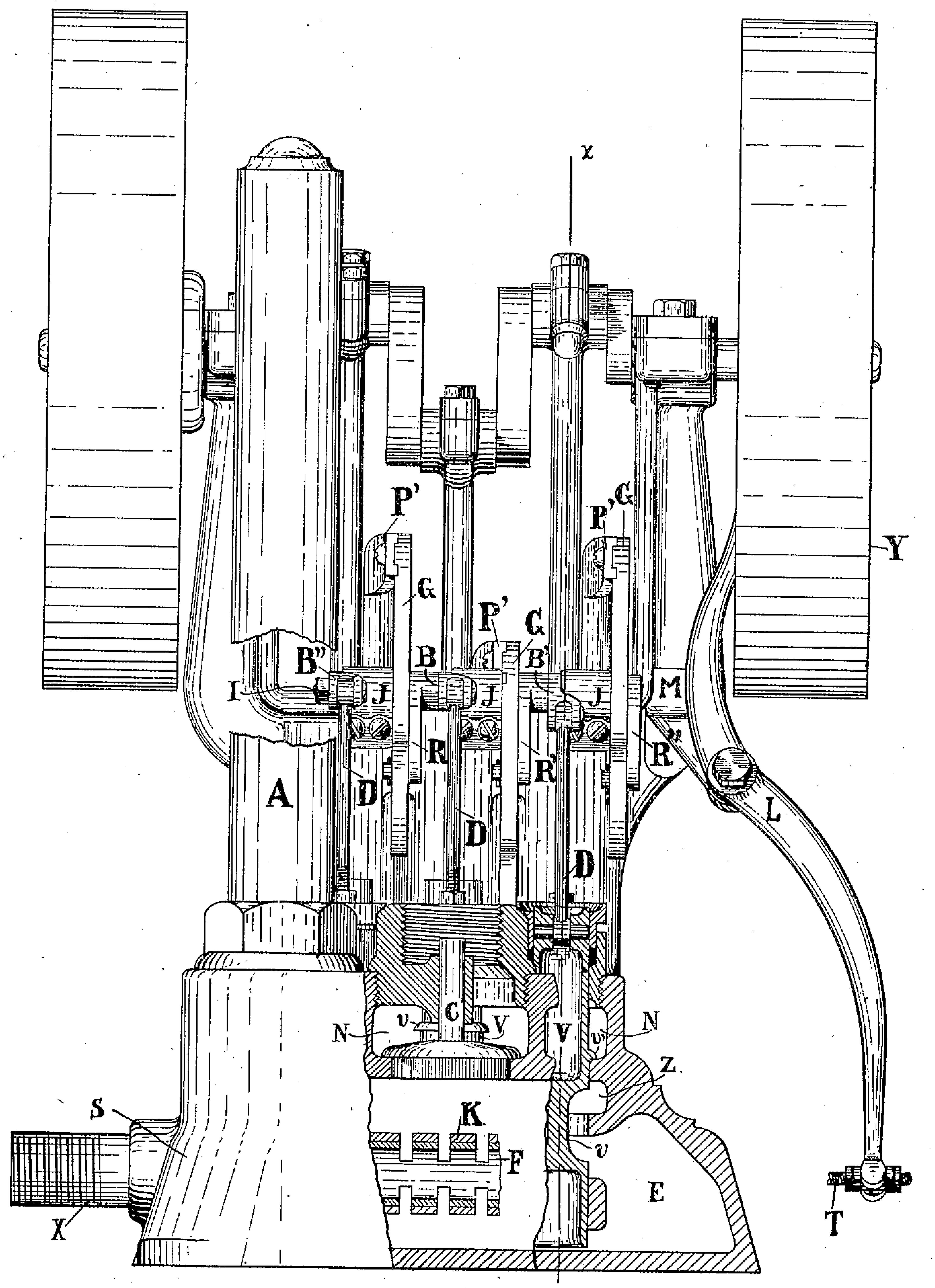
No. 662,678. Patented Nov. 27, 1900.

C. H. PECK, F. LEACH & N. A. JOHNS.

HYDRAULIC ENGINE.

(Application filed May 16, 1899. Renewed Apr. 6, 1900.)

(No Model.) 4 Sheets—Sheet 2.



WITNESSES:

A. S. Diven

C. Tracey Stagg.

Fig-2.

INVENTORS

Carl H. Peck

Frederic Leach

and Norman A. Johns

BY

Eugene Diven

ATTORNEY

No. 662,678. Patented Nov. 27, 1900.

C. H. PECK, F. LEACH & N. A. JOHNS.

HYDRAULIC ENGINE.

(Application filed May 16, 1899. Renewed Apr. 6, 1900.)

(No Model.) 4 Sheets—Sheet 3.

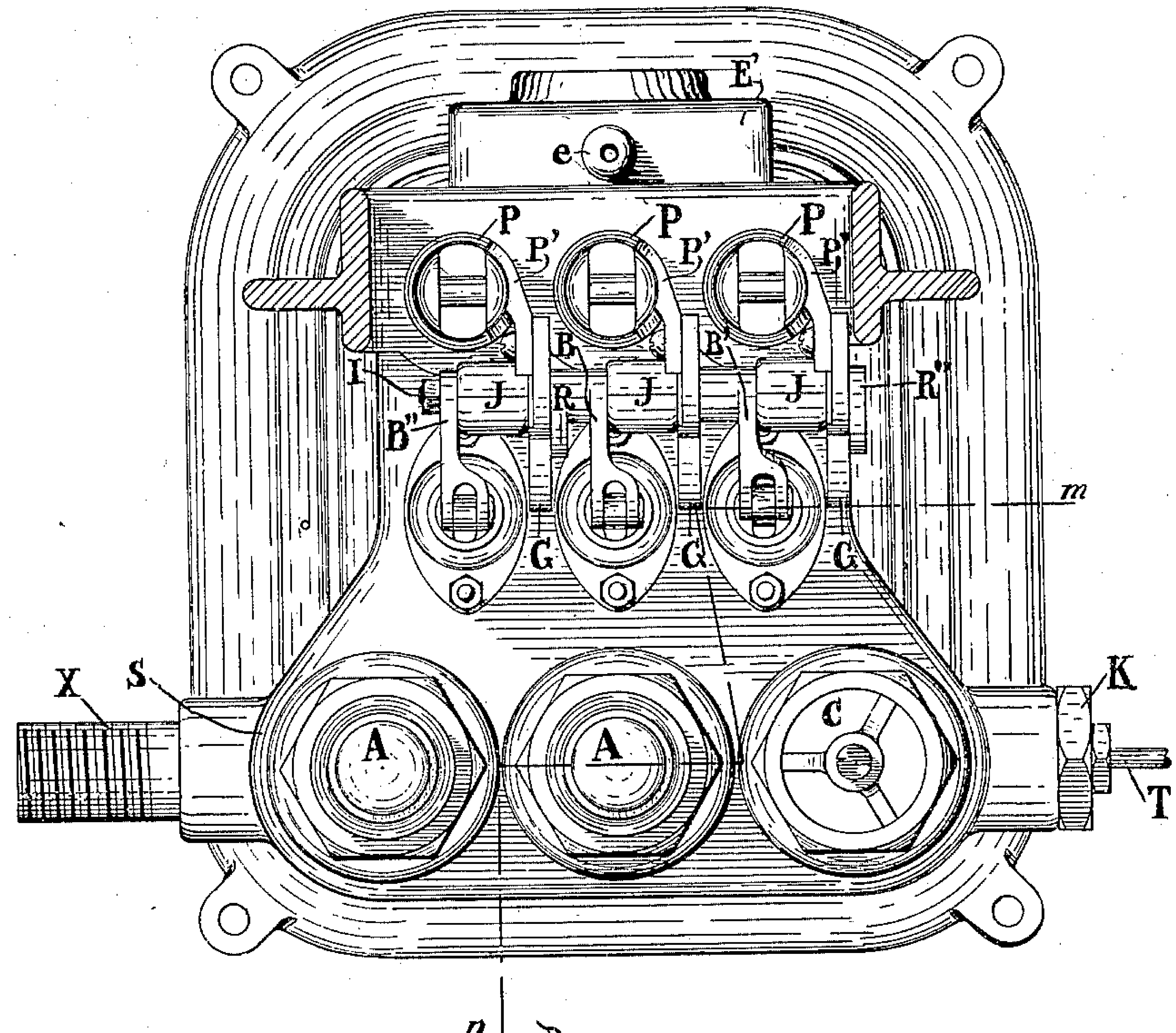


Fig-3.

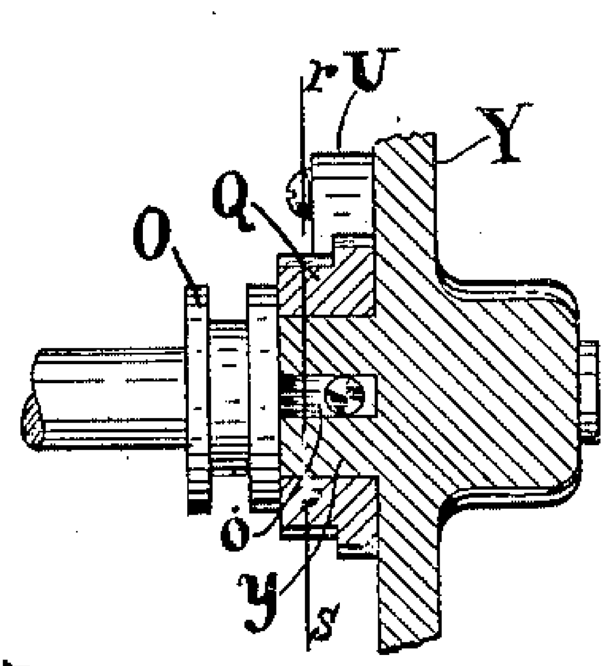


Fig-9.

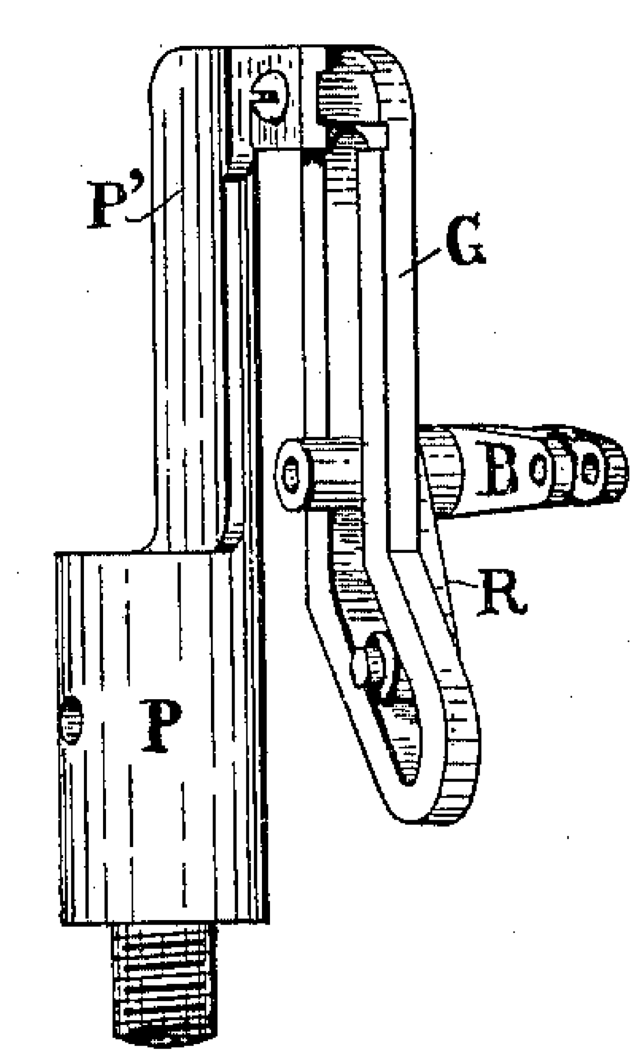


Fig-4.

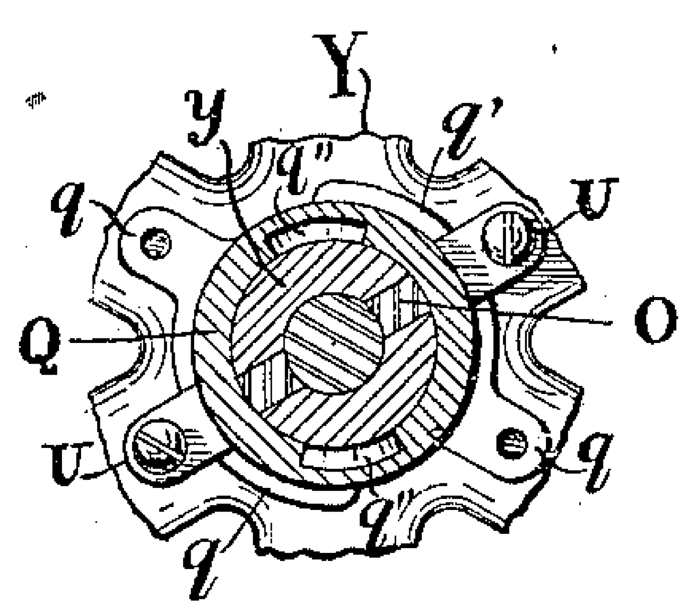


Fig-10.

WITNESSES:

A. S. Diven

C. Tracey Stagg.

INVENTORS

Caid H. Peck

Frederic Leach

Norman A. Johns

BY

Eugene Diven

ATTORNEY

No. 662,678. Patented Nov. 27, 1900.

C. H. PECK, F. LEACH & N. A. JOHNS.

HYDRAULIC ENGINE.

(Application filed May 16, 1899. Renewed Apr. 6, 1900.)

(No Model.) 4 Sheets—Sheet 4.

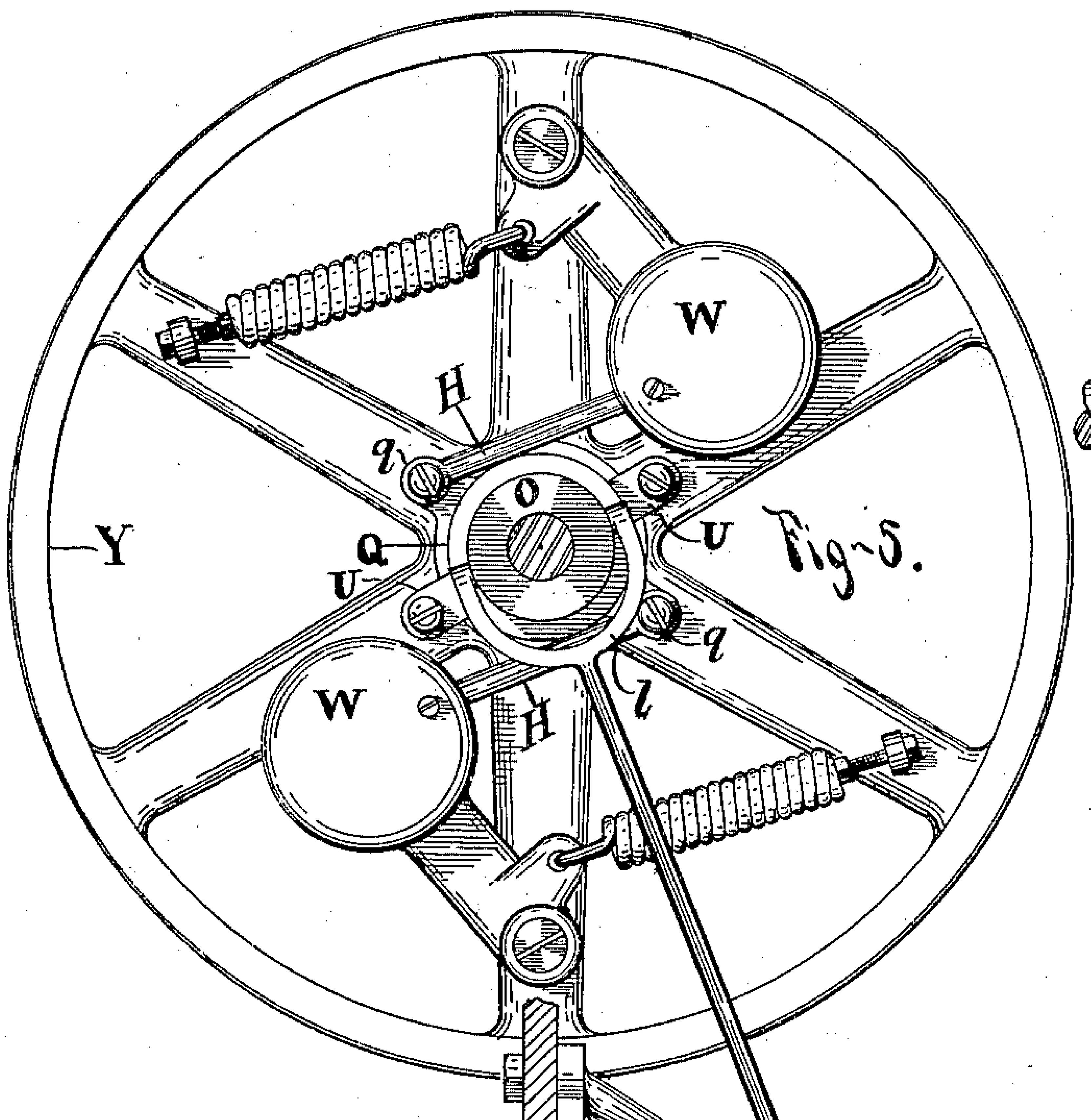


Fig. 5.

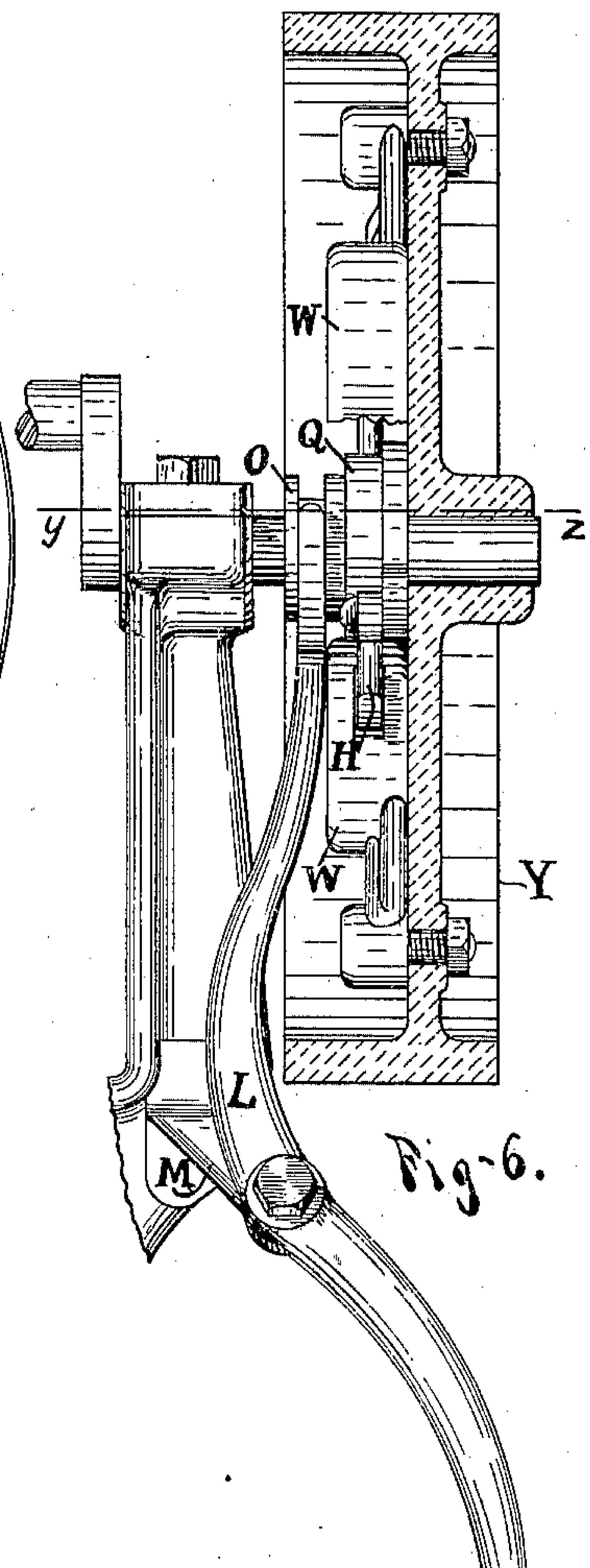


Fig. 6.

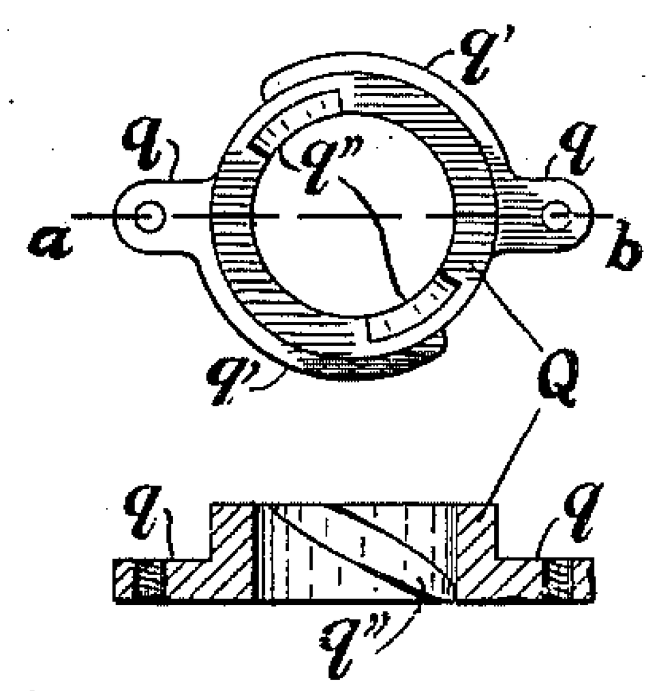
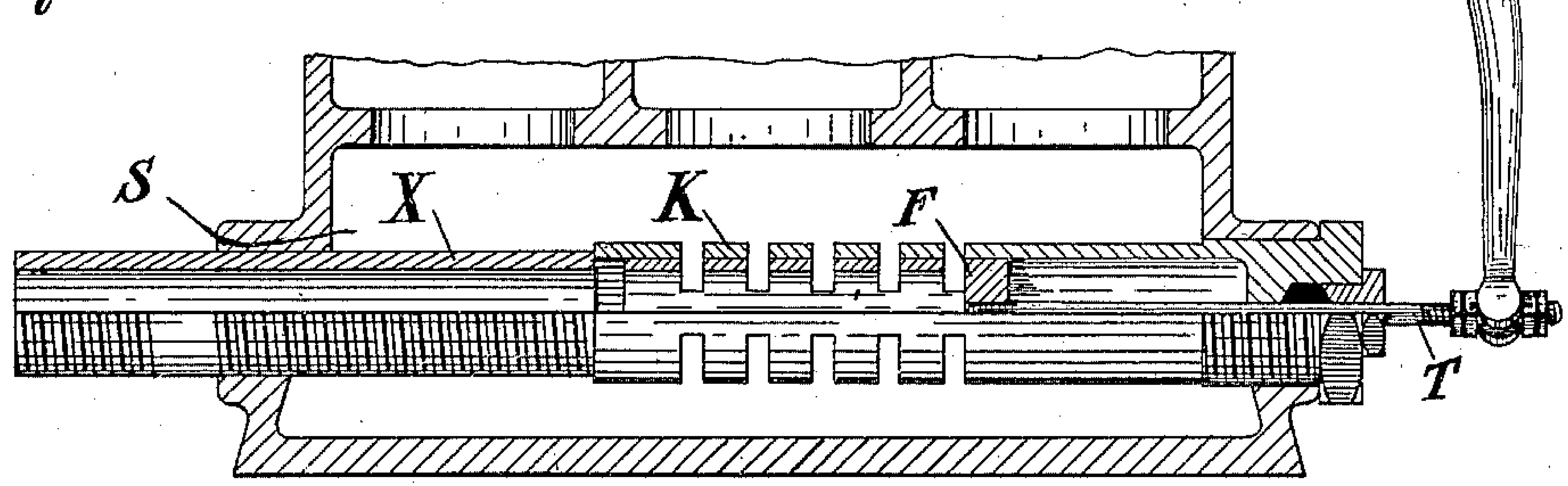


Fig. 7.



WITNESSES:

A. L. Diven

C. Tracy Flagg

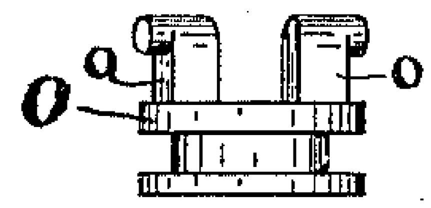


Fig. 8.

INVENTORS

Caid H. Peck

Frederic Leach

and Norman A. Johns

BY

Eugene Diven

ATTORNEY

UNITED STATES PATENT OFFICE.

CAID H. PECK AND FREDERIC LEACH, OF ELMIRA, NEW YORK, AND NORMAN A. JOHNS, OF HUNTINGTON, VERMONT, ASSIGNORS, BY DIRECT AND MESNE ASSIGNMENTS, TO ADELBERT E. CARROLL, OF NEW YORK, N. Y.

HYDRAULIC ENGINE.

SPECIFICATION forming part of Letters Patent No. 662,678, dated November 27, 1900.

Application filed May 16, 1899. Renewed April 6, 1900. Serial No. 11,897. (No model.)

To all whom it may concern:

Be it known that we, CAID H. PECK and FREDERIC LEACH, residing at Elmira, in the county of Chemung and State of New York, and NORMAN A. JOHNS, residing at Huntington, in the county of Chittenden and State of Vermont, citizens of the United States, have invented certain new and useful Improvements in Hydraulic Engines, of which the following is a specification.

Our invention relates to improvements in hydraulic engines wherein the water is admitted periodically to the cylinders; and the object of our improvements is to produce and utilize in such an engine as a motive power and in addition to the power given by the direct pressure of any given head of water the pressure or blow produced by suddenly checking the momentum of the water flowing to the cylinder by the closing of the inlet-valve to said cylinder, or, in other words, to apply the principle of the hydraulic ram to a hydraulic engine. We accomplish these objects by the mechanism illustrated in the accompanying drawings, wherein we have shown our improvements as applied to a single-acting vertical reciprocating hydraulic engine, and in which—

Figure 1 represents a side elevation of the engine, partly in section, on the line $x\ y$ in Fig. 2; Fig. 2, a front elevation, parts being shown in section on the line $m\ n$ in Fig. 3; Fig. 3, a plan view of the engine, with the crank-shaft and connecting-rods removed; Fig. 4, a perspective view of the piston and a portion of the valve-gear; Figs. 5, 6, 7, 8, 9, and 10 details of the governor, and Fig. 11 a preferred form of valve-rod.

Similar letters refer to similar parts throughout the several views.

To obtain the best results, we prefer to use a three-cylinder engine, and have illustrated herewith our improvements as applied to a vertical single-acting engine of this type. The three cylinders rise from a chambered base, preferably all formed in one casting.

S represents the supply-chamber, which is common to all of the cylinders. From this chamber separate inlet-passages N lead to the valves for each cylinder, a check-valve C being provided to prevent backflow to the supply-chamber. Above each of the inlet-passages is an air-chamber A. Back of the supply-chamber and beneath the cylinders is an exhaust-chamber E, and between this chamber and each of the inlet-passages N are ports Z, which open to the bottom of the cylinders and are put in communication alternately with the passages N and the common exhaust-chamber E by the valves V. An outlet passage E′ is carried up above the exhaust-chamber, and the exhaust-pipe is coupled into this outlet-passage at a point to hold the water in the ports and clearance-spaces in the cylinders against the pistons when at the ends of their return strokes. The water is thus trapped in the exhaust-chamber, in the ports Z, and in the cylinders and is held in contact with the pistons when they have completed their return strokes, but without exerting back pressure upon them. This prevents the formation of a partial vacuum or the admission of air below the pistons. To prevent siphonage of water from the exhaust-chamber through the exhaust-pipe, we provide the vent-pipe *e* at the top of passage E′.

Within the cylinders are the pistons P, which are connected to the crank-shaft above in any usual and preferred manner, the cranks being set at angles of one hundred and twenty degrees. At one side of each piston is a vertical extension P′, to which is connected a slotted cam-arm G, which extends downward at the front of the cylinders and is provided with an outward bend at the bottom end. At the front and top of the cylinders and journaled in suitable boxes J J J is a series of valve-levers B R, B′ R′, B″ R″, the arms R R′ R″ of these valve-levers being provided with pins carrying rollers, which run in the slots in the cam-arms G, and the arms B B′ B″ being connected to the valve-rods D D D for operating the combined inlet and exhaust valves V. Each of the valve-levers B R and B′ R′ is provided with a hollow hub, which hubs are journaled in the boxes J J J. From the arm R″ of the valve-lever B″ R″ a rock-shaft I runs through the hollow hubs of the other valve-levers, connecting said arm R″ with the arm B″.

The valves V, as will be seen, are balanced valves of the piston type, being open at the top to the atmosphere and at the bottom to the exhaust-chamber, which is also under atmospheric pressure, the valve-stem having the same diameter as the valve. A shoulder v' seats on the partition between passage N and port Z, and by constructing the valve-rods as illustrated in Fig. 11 the length of these rods may be so adjusted as to bring this shoulder v' properly on its seat when the valve is in its lowest position. The bent-out portions of the slotted cam-arms G and the reduced portions v of the valves are so located and of such length and formation as to cause the valves to open the port Z to passage N immediately after each piston has begun its upward stroke, and to close the port Z to passage N and open it to the exhaust-chamber E just before the pistons reach the top of their stroke in order that the water may follow the pistons for the full stroke and that there shall be no back pressure against the pistons on their return stroke.

In operation the water from the main-supply will pass into the supply-chamber S through the pipe X and thence into the inlet-passages N according to the opening of the valves V. In the position of the parts illustrated in the drawings the piston in the left-hand cylinder in Fig. 2 is about to complete its upstroke, rotation being to the right in Fig. 1, and the valve corresponding thereto has just been closed, this closure being effected by the cam-arm G, attached to the right-hand piston, which acts upon the arm R″ of the valve-lever B″ R″ through the rock-shaft I to throw the arm B″ down. The piston in the left-hand cylinder, being near the top of its stroke, has raised the cam-arm G, attached thereto, so as to bring the arm R of the valve-lever B R into engagement with the bent-out portion of said arm, and the valve for the middle cylinder has been partly raised thereby, but not enough to admit water. This middle valve is therefore just on the point of opening the port for admission to the middle cylinder, the crank for this middle cylinder being shown on its lower dead-center. As the piston of the middle cylinder rises it will bring the cam-arm G, attached thereto, into operation upon the valve-lever B′ R′ to operate the valve for the right-hand cylinder, so as to admit water just after the piston for that cylinder has passed the bottom of its stroke, and this cycle of operation will continue, each piston when nearing the top of its stroke actuating the valve for the next cylinder in order, holding the valve full open while it pauses at the top of its stroke and closing the valve quickly on its descent. Upon the quick closing of each valve V there will be a sudden stoppage of the flow of water through the corresponding passage N; but the water will continue to flow from the supply-chamber S past the check-valve C into the air-chamber A, compressing the air therein until the momentum of the water is checked, after which the check-valve C will close, holding the air in chamber A in a compressed state, this compression varying according to the size of the air-chamber and the pressure of the water-supply. Upon the next opening of the valve V the compressed air in the air-chamber will force the water under this increased head or pressure into the cylinder during the initial up or forward stroke of the piston, this increased pressure gradually diminishing until the normal pressure of the water-supply has been reached, after which the check-valve C will open and water will flow in from the supply-chamber through the passage N until the next closing of the valve V, after which compression in the air-chamber will again take place.

Since the water is held in the ports and against the pistons by reason of the raised exhaust-outlet when admission takes place, the compressed air in the air-chamber will have effect directly upon the pistons through a continuous interposed water-piston, and none of the effect will be lost upon the pistons, as would be the case were air allowed to accumulate or a partial vacuum produced below the pistons. The passages N being closed to the ports Z during somewhat more than half a revolution of the engine or during the return of the pistons and their pauses at the ends of their stroke ample time is given for the momentum of the water in the inlet-passages to fully expend itself in compressing the air in the air-chambers and for the water trapped by the check-valves C to become quiescent, ready for the next period of admission to the cylinders. It is only by this pause between admission periods that this ram action can be fully accomplished, and it will be seen, therefore, that such periods of shut-off from the inlet-passages to the cylinder-ports must be provided in whatever type of engine our invention is applied. Thus, in a double-acting reciprocating-engine there must be an inlet-passage with its check-valve and air-chamber for each end of the cylinder. It is also important that the check-valves should have a small lift and close quickly in order that the black flow to the supply-chamber shall be checked immediately the flow of water into the air-chambers has ceased, and we may therefore use more than one check-valve for each inlet-passage, especially in the larger sizes of engines. It is also important that all air should be excluded from the ports, passages, and exhaust-chamber, and for this purpose suitably-located air-cocks will be provided whereby any entrapped air will be driven out when the engine is first started. Finally, the valves V and ports are preferably proportioned to give an area of opening to the cylinders equal to or greater than the cylinder areas to attain the best results.

By employing a three-cylinder engine the crank-shaft receives three impulses in excess of the nominal water-pressure during each revolution, and the total mean effective pressure is greater and more evenly imparted to the crank-shaft than in the case of a one or two cylinder engine. Experiment has demonstrated that by the proper utilization of this ram action in a hydraulic engine there is a gain in efficiency, which varies according to the head, speed, and size of air-chamber.

In Figs. 5 to 10, inclusive, is illustrated our governor, Fig. 5 representing an inside elevation of the fly-wheel, showing all the attachments; Fig. 6, a front elevation with the fly-wheel in section, this figure also showing the throttle-valve, which is located in the supply-chamber S; Fig. 9, a detail of parts of the governor, in section, on the line *y z* in Fig. 6. Fig. 10 is a section on the line *r s* in Fig. 9. Fig. 7 represents two views of the collar Q, one being a section on the line *a b* in the other view. Fig. 8 is detail of the grooved ring which is engaged by the lever L for actuating the throttle-valve. This governor is of the centrifugal fly-wheel type, and comprises two weights W W, pivoted to the arms of the fly-wheel and provided with tension-springs in the usual manner. From the weights W W run connecting-rods H H, which are coupled to ears *q q* on the collar Q, this collar Q being mounted to turn on the hub *y* of the fly-wheel Y, as shown more particularly in Figs. 9 and 10. This collar is also provided with flanges *q' q'*, which are engaged by guide-blocks U U, fastened to the fly-wheel and projecting over said flanges, whereby the collar is rendered free to revolve upon the hub *y*, but is held from longitudinal motion. On the inside of the collar Q are provided two spiral grooves *q''*, which engage pins on the rearwardly-projecting arms *o o* on the ring O. These arms *o o* on the ring O slide in slots in the hub *y*, (see Figs. 9 and 10,) whereby the ring is carried around with the main shaft and fly-wheel, but is free to be given longitudinal motion along the shaft by the action of the spiral grooves *q''* upon the pins on the arms *o o*. An arm L is pivoted to a bracket M projecting from the frame of the engine, and at the upper end is provided with a yoke *l*, having inwardly-turned projections which engage the groove on the ring O. At the other end the lever L is connected to the rod T, which passes through a stuffing-box in the end of the ported pipe K, which abuts against the inlet-pipe X in the supply-chamber S. A ported valve F is attached to the rod T, and the position of this valve with reference to the ports in the pipe K determines the amount of flow from the water-main into the supply-chamber S.

The operation of the governor is as follows: When the speed of the engine increases, the weights W W are thrown out, causing the collar Q to turn to the right in Fig. 5. This revolution of the collar Q on the hub of the fly-wheel Y causes the ring O to travel away from the fly-wheel, thus throwing the valve-rod T outward and causing the valve F to close the ports in the pipe K more or less and regulating the supply of water to the chamber S, according to the speed of the engine.

While we have described our improvements as applied to a three-cylinder vertical single-acting engine, they may be applied as well to engines of a greater or less number of cylinders, to double-acting and to horizontal engines, and even to rotary engines, it being only important that each inlet-passage with its check-valve and air-chamber shall have a period of cut-off from the cylinder port or ports sufficient to complete the compression of air in the air-chambers in order to attain the highest efficiency. Certain details of the valve gear and governer we also believe to be novel, and we do not wish to be confined to their particular application as herein set forth. Nor do we confine ourselves to the application of our improvements to engines wherein the admission and exhaust to and from the cylinder pass through the same port, as they may be applied as well to engines wherein separate admission and exhaust valves are used.

Having thus described our improvements, what we claim as our invention, and desire to secure by Letters Patent, is—

1. In a hydraulic engine, the combination, with the admission port or ports, of an inlet-passage leading thereto from the source of supply, a check-valve to prevent backflow from said passage, an air-chamber in communication with said passage, and valve mechanism whereby the flow from the passage to a port is suddenly checked and whereby the passage is closed to the port or ports after each cut-off for a period of time sufficient for the momentum of the water in said passage to be expended in compressing the air in said air-chamber.

2. In a hydraulic engine, the combination, with a cylinder or cylinders provided with a plurality of admission-ports, of a common supply-chamber, a separate inlet-passage leading from said chamber to each admission-port, a check-valve in each passage to prevent backflow to said chamber, a separate air-chamber for and in communication with each of said passages, and valve mechanisms whereby the flow from each inlet-passage to its admission-port is suddenly checked and whereby each said passage is given a period of cut-off sufficient for the momentum of the water in said passage to be expended in compressing the air in the air-chamber connected therewith.

3. In a hydraulic engine, the combination with the cylinder, of an inlet-passage from the source of supply, a check-valve to prevent backflow from said passage, an air-chamber in communication with said passage, a port to the cylinder, an exhaust-outlet, and valve mechanism whereby the inlet-passage and

the exhaust-outlet are opened alternately to the port and whereby the inlet-passage is given a period of cut-off after each opening to the port sufficient for the momentum of the water in said passage to be expended in compressing the air in said air-chamber.

4. In a hydraulic engine, the combination with a cylinder or cylinders provided with a plurality of ports, of a common supply-chamber, a separate inlet-passage leading from said chamber to each port, a check-valve in each said passage to prevent backflow to said chamber, a separate air-chamber for and in communication with each said passage, a common exhaust-chamber, and valve mechanisms whereby each port is opened alternately to its corresponding inlet-passage and to the exhaust-chamber, and whereby each inlet-passage is given a period of cut-off after each opening to its port sufficient for the momentum of the water in said passage to be expended in compressing the air in the air-chamber connected therewith.

5. In a reciprocating hydraulic engine, the combination, with an admission-port to the cylinder, of an inlet-passage leading thereto from the source of supply, a check-valve to prevent backflow from said passage, an air-chamber in communication with said passage, and a valve mechanism, whereby the flow from the inlet-passage to the port is suddenly checked at or near the end of the piston-stroke and air is compressed in the air-chamber by the momentum of the water in said passage during the return stroke of the piston.

6. In a hydraulic engine, the combination, with the admission and exhaust ports, of an inlet-passage leading from the source of supply to the admission-port, a check-valve to prevent backflow from said passage, an air-chamber in communication with said passage, an exhaust-outlet positioned to retain water in the ports and against the piston when exhaust is cut off, and a valve mechanism to actuate the admission and exhaust at the proper periods as and for the purpose set forth.

7. In a hydraulic engine, the combination with a plurality of cylinders and their admission-ports, of a supply-chamber common to all the admission-ports, passages between said chamber and ports, a check-valve and air-chamber for each said passage, valve mechanisms coöperating with the check-valves whereby air is compressed in the air-chambers while the admission-ports are closed, a supply-pipe leading into the supply-chamber, a throttle-valve within said chamber to control the opening from said pipe to said chamber, and a governor actuated by the engine to regulate the throttle-valve.

In testimony whereof we have affixed our signatures in presence of two witnesses.

CAID H. PECK.
FREDERIC LEACH.
NORMAN A. JOHNS.

Witnesses:
A. S. DIVEN,
C. TRACEY STAGG.