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A. F. CAVANAUGH.  
COMPOUND DUPLEX PUMPING ENGINE.

APPLICATION FILED OCT. 21, 1903.

NO MODEL.

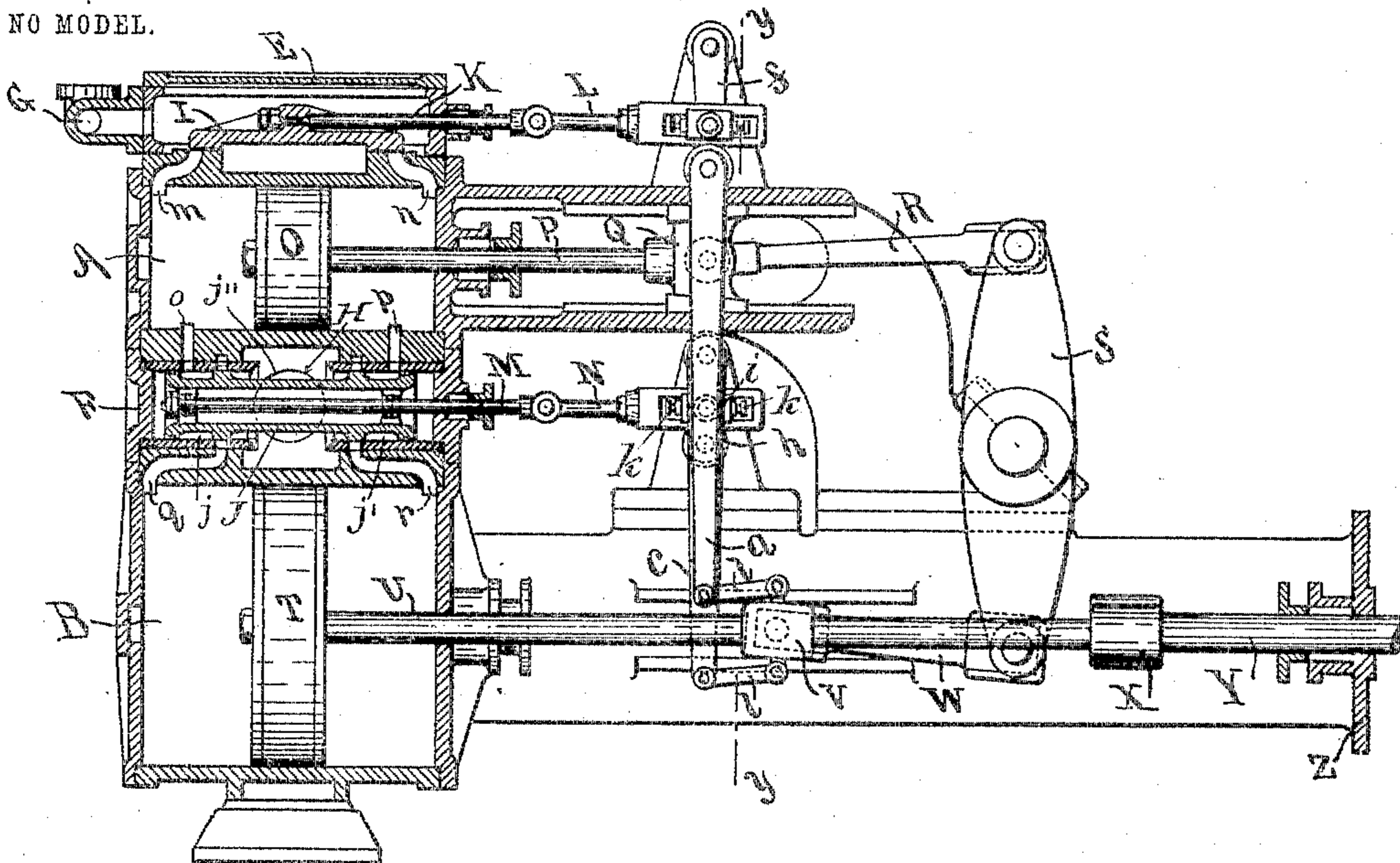
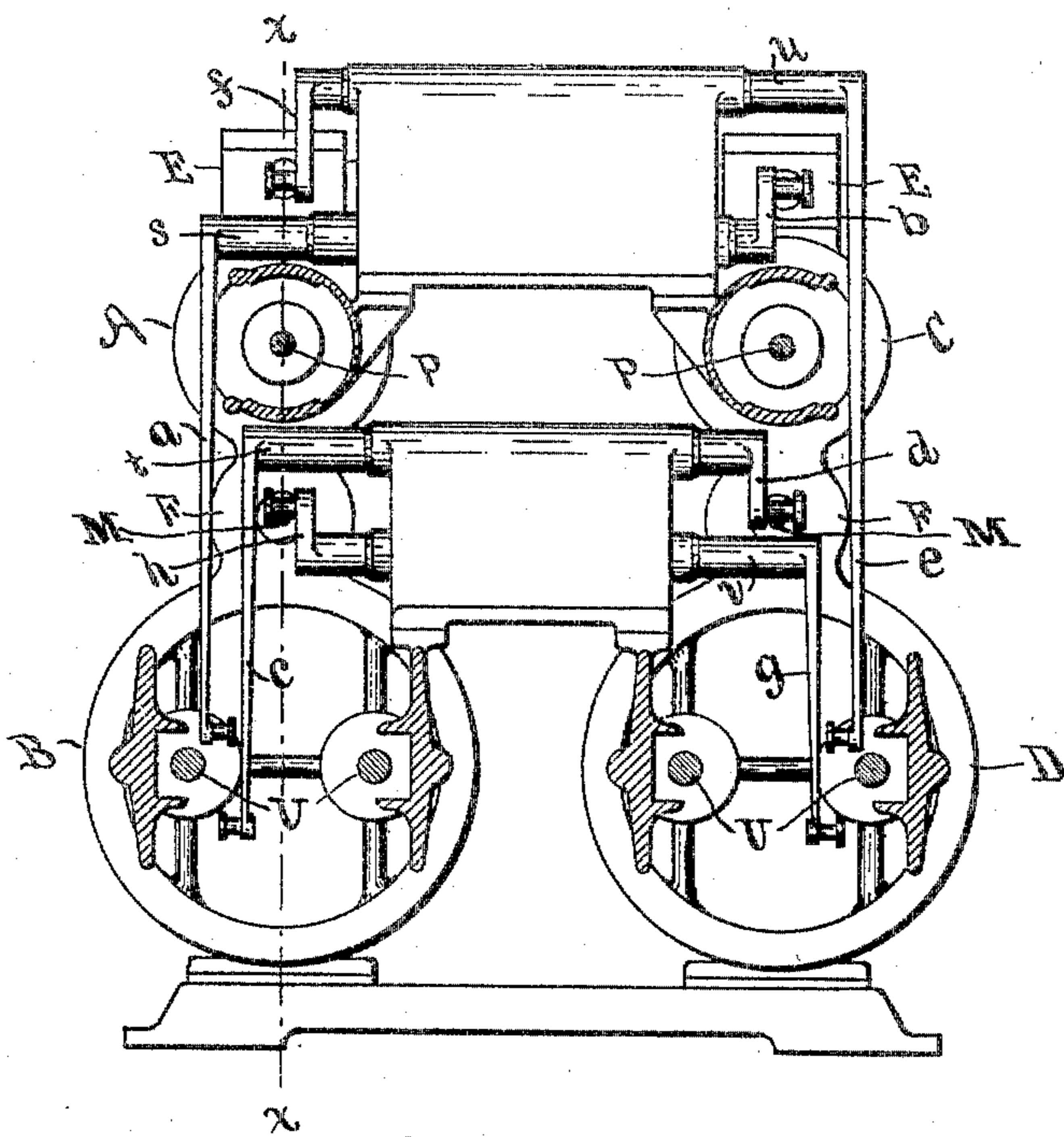


Fig. 1.



WITNESSES:

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Fig. 2.

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## COMPOUND DUPLEX PUMPING-ENGINE.

SPECIFICATION forming part of Letters Patent No. 777,495, dated December 13, 1904.

Application filed October 21, 1903. Serial No. 177,941. (No model.)

*To all whom it may concern:*

Be it known that I, ANDREW F. CAVANAUGH, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Compound Duplex Pumping-Engines, of which the following is a specification.

My invention relates to improvements in direct-acting duplex pumping-engines of the compound type; and my object is to provide certain novel relative arrangements of the steam-cylinders, slide-valves, and valve-gearing whereby an efficient engine of this type may be produced in a compact form.

I attain my object by means of the arrangement and construction of the several parts relatively to one another substantially in the manner illustrated in the accompanying drawings, in which—

Figure 1 represents a side elevation of a pumping-engine involving my improvements, the left-hand cylinders being shown in section on the line *xx* in Fig. 2; and Fig. 2 represents a cross-section on the line *yy* in Fig. 1 when looking in the direction of the steam-cylinders, the cross-heads being left out.

Like letters refer to like parts in the two views.

A and B represent, respectively, the high and low pressure cylinders on the left-hand side as the engine is viewed in Fig. 2, and C and D the right-hand high and low pressure cylinders, respectively. These high and low pressure cylinders are placed directly one above the other, with the valve-chests E E for the high-pressure cylinders at the top and the valve-chests F F for the low-pressure cylinders between the high and low pressure cylinders. Steam is admitted to the valve-chests E by a cross connection G, coupled to the steam-supply pipe, and the exhaust is taken from the valve-chests F by way of a cross connection H, coupled to the exhaust-pipe. In the high-pressure valve-chests I provide slide-valves I and in the low-pressure valve-chests piston-valves J. From the slide-valves I rods K lead out through suitable stuffing-boxes to links L, which are coupled to the valve-operating gear hereinafter to be described, and

the valve-rods M, which actuate the piston-valves J, are coupled to said gearing by links N. The high-pressure pistons O are connected by piston-rods P to cross-heads Q, which reciprocate in suitable guides provided in the upper portion of the engine-frame. These cross-heads Q are connected by links R to rock-arms S, one on each side of the engine, and the low-pressure pistons are connected with said rock-arms S through piston-rods U, cross-heads V, and links W. The piston-rods U for the low-pressure pistons are preferably double and are connected together at X by a yoke, to which is attached the rod Y, which actuates the plunger for the pump, (not shown,) this rod Y passing through a stuffing-box where the engine-frame at Z is attached in the usual manner to the pump-cylinders.

The valve-operating gear comprises a series of crank-arms and cross-shafts as follows: At the left-hand side of the engine a long crank-arm *a* actuates a shaft *s*, which in turn actuates a short crank-arm *b*, coupled to the link L, which actuates the high-pressure slide-valve on the right-hand side of the engine. The shorter crank-arm *c*, attached to shaft *t*, actuates, through the short crank *d*, the link N, which actuates the low-pressure valve for the right-hand cylinders. These crank-arms *a c* are coupled to the left-hand cross-head V by links *l l*. Crank-arms *e* and *g*, coupled by similar links to the right-hand cross-head V, actuate, through shafts *u* and *v*, the short crank-arms *f h*, coupled to the valves which actuate the left-hand pair of high and low pressure cylinders.

In my valve-motion I make provision for permitting the valves to rest for a short period of time at the end of their travel in each direction while the crank-arms are making their initial movements on each forward-and-back swing in order to give time for the proper admission and exhaust of the steam to and from the cylinders. To accomplish this, I provide the links L and N with slotted ends, in which are fitted slide-blocks *i*, carried by the crank-pins. These slide-blocks are provided with adjustable tappets *k* at each end, by means of which the throw of the valves is adjusted. In order that the piston-valves J

may remain stationary while the tappets are out of engagement with the ends of the slots in links N, they must be in balance within the valve-chests F, and to attain this balance I preferably make said valves hollow and arrange the ports and passages as represented in Fig. 1, the ports *o* and *p* from the high-pressure cylinders leading to grooves *j* and *j'*, formed at each end of the valve between suitable packing-rings, and the ports *q* and *r*, leading to the low-pressure cylinders, being so positioned as to be placed in communication, respectively, with the ports *o* and *p* by way of the grooves *j* and *j'* or with the exhaust H by way of the central groove *j''* as the valve is moved to one end or the other of its travel.

In operation, steam being admitted to the valve-chest E by way of the connection G, if the piston in the right-hand high-pressure cylinder be moved forward or in the direction of the pump the low-pressure piston on the right-hand side will be moved toward the rear or away from the pump by reason of the rock-arm connection between the piston-rods P and U on that side. As the right-hand cross-head V is thus moved to the rear or away from the pump the motion transmitted thereby to crank-arm *e* will transmit a rearward movement to crank-arm *f*, thereby throwing the slide-valve I for the left-hand high-pressure cylinder A to the rear and admitting steam to the forward end of that cylinder through port *n*, which will throw the piston O therein to the rear. At the same time crank-arm *g* will transmit a forward movement to crank-arm *h*, thereby throwing piston-valve J for the left-hand cylinder B forward, whereby the exhaust-steam from the cylinder A will be admitted through port *o*, around the groove *j* in valve J, and through port *q* to the rear of the piston T, throwing said piston forward. The exhaust from in front of piston T passes out through port *r* and groove *j''* to outlet H. The rearward motion of the piston O will be transmitted through link R, rock-arm S, and link W to assist the forward motion of cross-head V, transmitted thereto by piston-rods U as the piston T moves forward. As the cross-head V for the right-hand cylinders A and B moves forward toward the pump, motion will be transmitted, through the crank-arms *a* and *c*, to the crank-arms *b* and *d*, which are coupled to the rods for the high and low pressure slide-valves I and J for the right-hand cylinders, and said valves will be thrown, the valve I rearward and the valve J forward, whereby the piston in high-pressure cylinder C will be thrown to the rear and the piston in low-pressure cylinder D will be thrown forward. This forward motion of the piston in low-pressure cylinder D will throw the crank-arms *e* and *g* forward, thereby reversing the slide-valves for the high and low pressure cyl-

inders A and B on the left-hand side and reversing the strokes of the pistons therein, admission to cylinder A then taking place through port *m* and the steam passing from cylinder A to cylinder B through ports *p* and *r* by way of groove *j'* on valve J. Exhaust from cylinder B now passes from port *q* to outlet H by way of groove *j''* on said valve.

It will be noted that the exhaust-ports *o* and *p* in the high-pressure cylinders are located at some little distance from the ends of the cylinders, whereby the pistons in said cylinders as they approach the ends of their stroke in either direction will cut off the exhaust, thereby forming a steam-cushion which will bring said pistons to a stop before they can strike the cylinder-heads. As all the working parts will be brought to a standstill at the same time, it will be seen that the low-pressure pistons will also be prevented from striking their cylinder-heads. This arrangement, it will be seen, provides a compact assemblage of the cylinders, valve-chests, and valve-gearing, the pressure exerted on the high-pressure pistons being transmitted to the cross-heads for the low-pressure piston-rods by way of the links R and W and the rock-arms S.

While I have described my preferred way of coupling together the pistons on one side, with the valve-motions on the other side, I do not wish to be confined strictly to this particular arrangement, as it will be plain that the valves of one set of cylinders can be operated by any moving part or parts which are actuated by steam in the other set of cylinders—that is to say, instead of connecting the valve-motion arms to the cross-heads by links, as shown, I may operate the valve-motion arms for one set of cylinders by connecting them to or actuating them by any other moving part or parts actuated by the steam in the other set of cylinders.

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

1. In a horizontal compound duplex pumping-engine, the combination of two pairs of high and low pressure cylinders set side by side, each pair comprising a high-pressure cylinder and a low-pressure cylinder one above the other, ports and passages leading from the one to the other and to the exhaust, a valve to control the passage of steam therethrough, a main valve to control the admission to the high-pressure cylinder, pistons in each pair of cylinders traveling in opposite directions, a connection between the members of each pair of pistons whereby motion is transmitted from one to the other and to a pump-plunger, and a valve-gear comprising two pairs of cross-shafts having crank-arms at each end, the crank-arms at the right-hand side of one pair of cross-shafts being actuated by the right-hand pistons, the crank-

arms on the left-hand side of said pair of cross-shafts being coupled to the valves for the left-hand pair of cylinders, and the crank-arms on the other pair of cross-shafts being  
 5 actuated in like manner on one side by the left-hand pistons and on the other side being coupled to the right-hand valves, whereby the valves are actuated in their proper relative directions to change the piston-strokes.

10 2. In a horizontal compound duplex pump-  
 ing-engine, a valve-gear comprising two pairs of cross-shafts having crank-arms at each end, the crank-arms at the right-hand side of one pair of cross-shafts being coupled to a mov-  
 15 ing part actuated by the right-hand pistons, the crank-arms on the left-hand side of said pair of cross-shafts being coupled to the valves for the left-hand cylinders, and the crank-arms on the other pair of cross-shafts being  
 20 connected in like manner on one side with a moving part actuated by the left-hand pistons and on the other side being coupled to the right-hand valves, the couplings between the crank-arms and valves comprising links  
 25 pivotally connected to the valve-rods at one end and slotted at the other end, slide-blocks on the crank-pins engaging said slots, and tappets at each end of the slide-blocks to strike the ends of said slots, whereby the valves are  
 30 actuated intermittently in their proper relative directions to change the piston-strokes.

3. In a horizontal compound duplex pump-  
 ing-engine, the combination of two pairs of high and low pressure cylinders set side by  
 35 side, each pair comprising a high-pressure cylinder and a low-pressure cylinder one above the other, ports and passages leading from the one to the other and to the exhaust, a

valve to control the passage of steam there-  
 through, a valve to control the admission to 40  
 the high-pressure cylinder, cross-heads at-  
 tached to the piston-rods for both high and low  
 pressure cylinders and reciprocating in guides  
 in the engine-frame, rock-arms carried by said  
 frame in line with each pair of cylinders, con- 45  
 necting-rods between said rock-arms and the  
 cross-heads whereby motion of the high-pres-  
 sure pistons is transmitted to the low-pres-  
 sure pistons, a pump-plunger in direct con-  
 nection with one piston-rod of each pair, and 50  
 a valve-gear comprising two pairs of cross-  
 shafts having crank-arms at each end, the  
 crank-arms at the right-hand side of one pair  
 of cross-shafts being coupled to one of the  
 cross-heads on the same side, the crank-arms 55  
 on the left-hand side of said pair of cross-  
 shafts being coupled to the valves for the left-  
 hand pair of cylinders, and the crank-arms on  
 the other pair of cross-shafts being coupled  
 in like manner on one side to a left-hand cross- 60  
 head and on the other side to the right-hand  
 valves, the couplings between the crank-arms  
 and valves comprising links pivotally con-  
 nected to the valve-rods at one end and slotted  
 at the other end, slide-blocks on the crank- 65  
 pins engaging said slots, and a tappet at each  
 end of the slide-blocks to strike the ends of  
 said slots, whereby the valves are actuated  
 intermittently in their proper relative direc-  
 tions to change the piston-strokes. 70

In testimony whereof I have affixed my sig-  
 nature in presence of two witnesses.

ANDREW F. CAVANAUGH.

Witnesses:

SAML. WRIGHT,  
 ADOLPH C. GRAF.