A. ENGLAND.

COMPOUND STEAM PUMPING ENGINE.

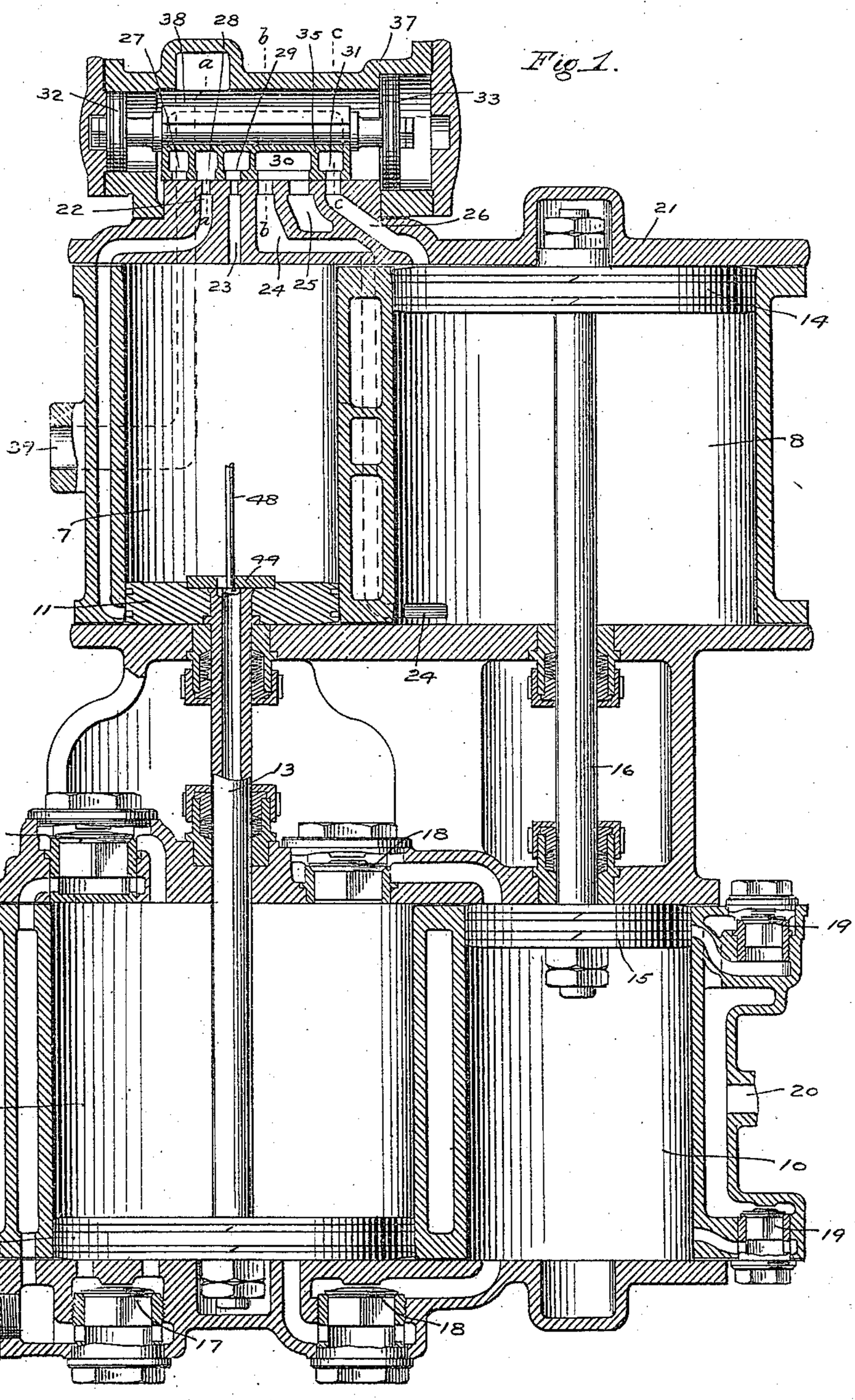
APPLICATION FILED DEC. 15, 1905.

965,573.

Patented July 26, 1910.

2 SHEETS—SHEET 1.

Fig 1.



WITNESSES

F. H. Parke

J. B. MacDonald

INVENTOR

Alexander England

by E. H. Wright

Att'y.

A. ENGLAND.

COMPOUND STEAM PUMPING ENGINE.

APPLICATION FILED DEC. 15, 1905.

965,573.

Patented July 26, 1910.

2 SHEETS—SHEET 2.

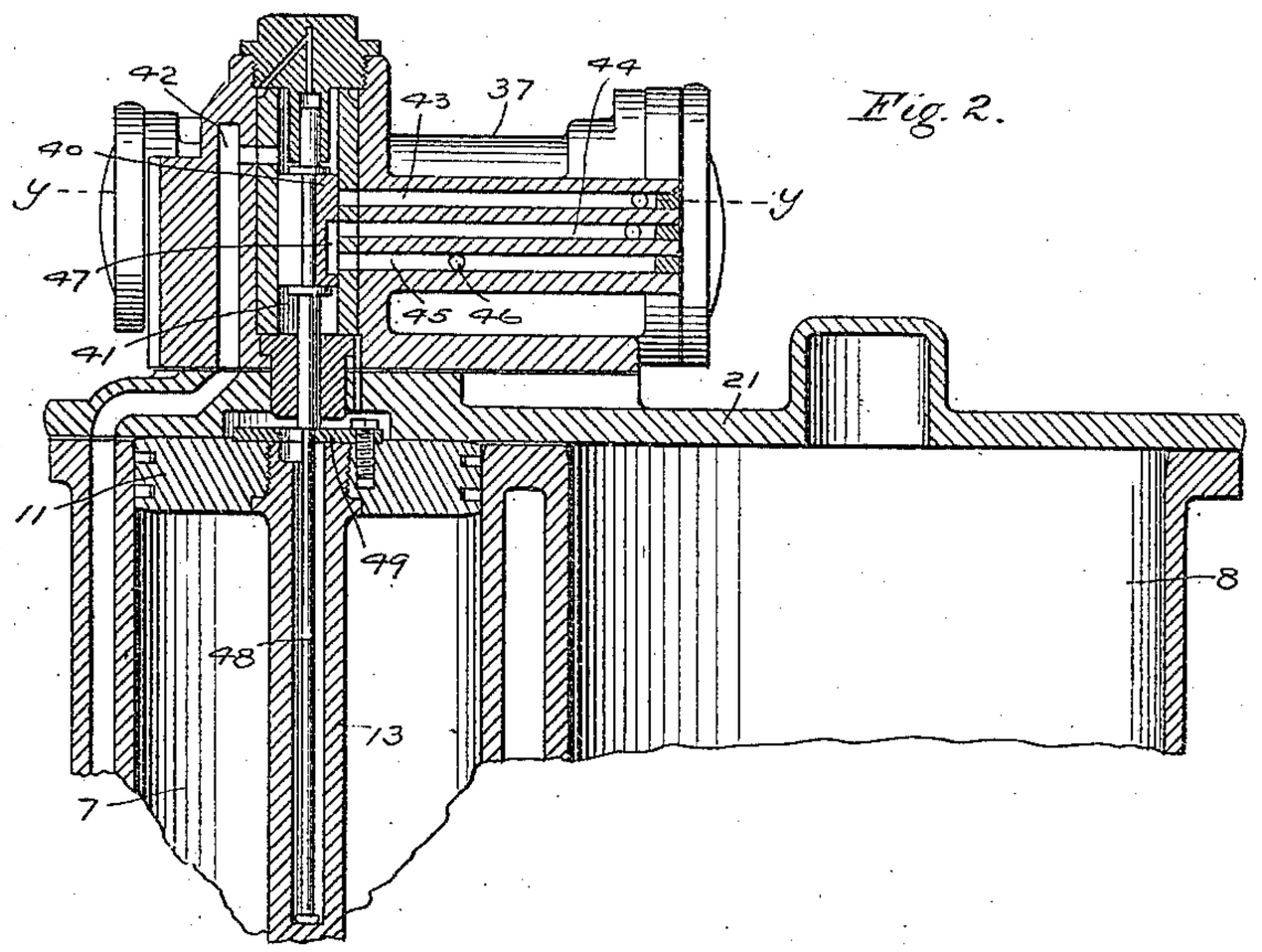


Fig. 2.

Fig. 4.

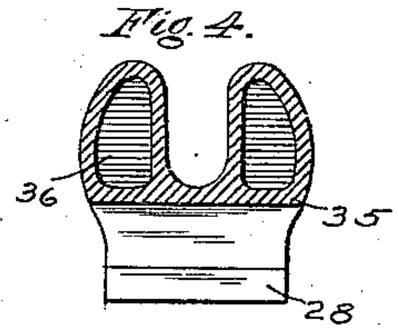


Fig. 5.

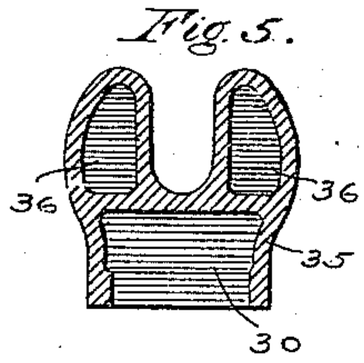


Fig. 6.

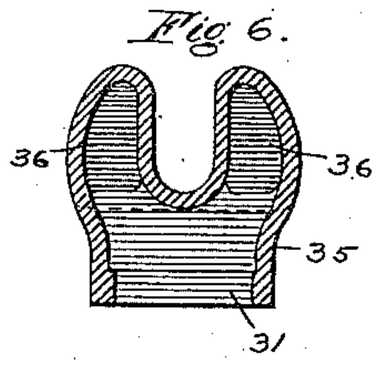
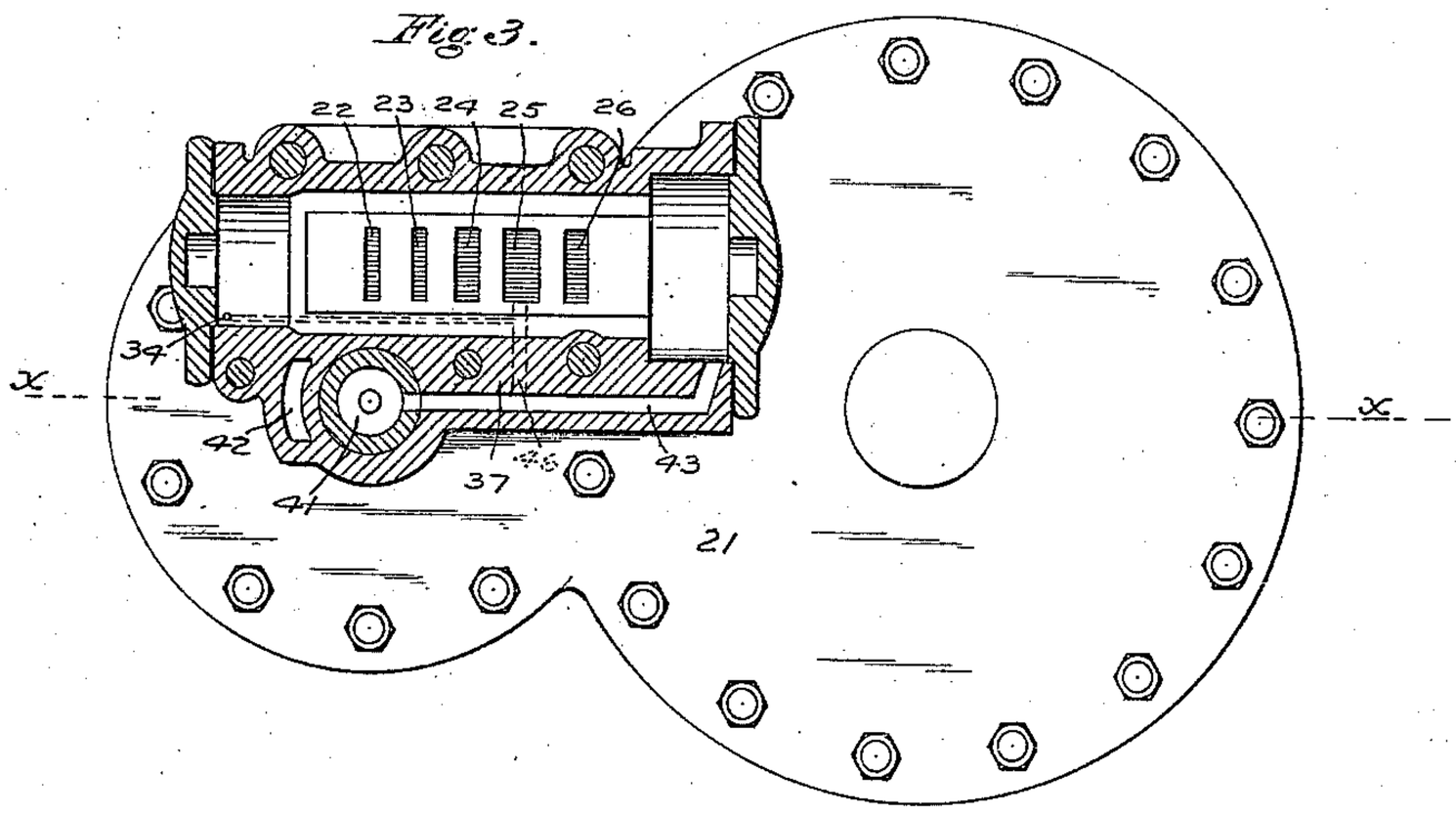


Fig. 3.



WITNESSES

F. H. Paine

J. B. MacDonald

INVENTOR

Alexander England

by E. H. Wright

Att'y.

UNITED STATES PATENT OFFICE.

ALEXANDER ENGLAND, OF WILKINSBURG, PENNSYLVANIA, ASSIGNOR TO THE WESTINGHOUSE AIR BRAKE COMPANY, OF PITTSBURG, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

COMPOUND STEAM PUMPING-ENGINE.

965,573. Specification of Letters Patent. Patented July 26, 1910.

Application filed December 15, 1905. Serial No. 291,844.

To all whom it may concern:

Be it known that I, ALEXANDER ENGLAND, a citizen of the United States, residing in Wilkinsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Compound Steam Pumping-Engines, of which the following is a specification.

This invention relates to compound steam pumping engines of the direct acting vertical type, in which the pump pistons are directly connected to the rods of the steam pistons, particularly adapted for use in compressing air for storage reservoirs of air brake systems, or for other purposes, and is in the nature of an improvement on that covered by prior U. S. patent to Westinghouse, No. 441,209, of Nov. 25, 1890. According to this prior construction the pistons of the high pressure engine cylinder and of the high or final compression pump cylinder are directly connected together and the valve mechanism of the engine is operated by the movement of said pistons, while the low pressure engine piston is directly connected to the piston of the initial or low pressure pump cylinder. With this construction there is nothing to determine the length of stroke made by the low pressure pistons, since these pistons float freely in their cylinders and have no connection with the high pressure pistons nor the engine valve mechanism. Consequently, during the period that the high pressure piston is making a full stroke the low pressure piston may or may not make a complete stroke, according as the air pressure and corresponding resistance acting upon the pump piston at final compression is high or low. When the pumping engine is first started, and there is little or no pressure in the reservoir into which the air is being compressed, the high pressure piston moves much more rapidly than it does after a high degree of pressure has accumulated in the reservoir, and therefore makes a complete stroke, while the low pressure piston makes only a partial stroke. Then as the high pressure piston operates to shift the valve mechanism at each end of its traverse, it follows that the low pressure piston may make only one-half or other fractional part of their full stroke, thereby reducing the amount of free air displaced by the piston of the initial compression cylinder of the pump and diminishing the efficiency to that extent. These objections are overcome according to my present invention by connecting the high pressure engine piston directly to the piston of the low or initial compression cylinder of the pump, and the low pressure engine piston with the piston of the high or final compression cylinder, while the valve mechanism is operated by the movement of the high pressure steam piston. By this means the low pressure air piston is required to make a complete traverse before the valve mechanism is shifted at each end of the stroke of the pump, consequently the maximum displacement of free air will occur at each stroke, thereby maintaining the maximum efficiency of the pump at all speeds. It has also been heretofore proposed to operate the valve mechanism of the compound pumping engine by the movement of the low pressure steam piston connected to the low or initial air compressing piston, as disclosed in prior U. S. patent to Moore, No. 441,185, of Nov. 25, 1890, and while such a construction insures the complete traverse of the initial air compressing piston at each stroke before the shifting of the valve mechanism, it is subject to the objection that when the pump stops the pistons settle to such positions that it will not start automatically when the steam supply valve is again opened. As it is the practice to control the steam supply valve of nearly all air compressors of this type by a pressure governor subject to the fluid pressure of the reservoir, it is essential that the pump shall start promptly when the pressure has reduced to a predetermined point at which the governor acts to open the steam valve. This desired result is also secured by my improvement, since the valve mechanism is operated by the movement of the high pressure steam piston and is always in position to supply steam to the right side of said piston to start the pump whenever the supply valve is opened.

Another object of my invention is to provide an improved form of valve mechanism which shall be efficient, durable, and convenient of access for inspection and repairs.

In the accompanying drawings, Figure 1 is a vertical sectional view of a compound steam pumping engine embodying my improvements; Fig. 2 a vertical section of the

upper portion of the engine, taken on the line *x*—*x* of Fig. 3; Fig. 3 a horizontal section, taken on the line *y*—*y* of Fig. 2; and Figs. 4, 5 and 6 transverse sections of the main distribution slide valve, taken on the respective lines *a*—*a*, *b*—*b*, and *c*—*c*.

According to the construction shown, the compound pumping engine comprises a high pressure engine cylinder 7 and a low pressure engine cylinder 8 arranged vertically side by side and over the initial compression pump cylinder 9 and the final compression pump cylinder 10, respectively, the high pressure steam piston 11 being directly connected by rod 12 with the low pressure air piston 13, and the low pressure steam piston 14 being connected by rod 15 with the high pressure air piston 16.

The initial compression pump cylinder 9 is provided with the usual suction valves 17, and discharge valves 18, for delivering the air to the final compression cylinder 10, which is of smaller volume and has final discharge valves 19 for delivering the compressed air to the outlet 20 leading to a storage reservoir.

A single integral head 21 may be employed for the upper ends of both steam cylinders, and preferably carries a horizontal valve seat having ports 22 and 23 leading to opposite ends of the high pressure engine cylinder 7, and ports 24 and 26 leading to the opposite ends of the low pressure engine cylinder 8, and exhaust port 25 communicating with the atmosphere.

On the cylinder head and over the valve seat is mounted a valve casing 37, having a chamber 38 communicating by passage 39 with the live steam supply, and containing the steam actuated main distribution slide valve 35 movable on said seat and operated by the differential pistons 32 and 33, movable in chambers at opposite ends of the valve casing. The main valve is preferably provided with a through port 28, exhaust cavity 30, and ports 27, 29 and 31, communicating with each other through a passage 36 in said valve.

The inner faces of the differential piston heads 32 and 33 are constantly subject to the steam pressure in chamber 38 and the outer face of the smaller piston 32 is constantly subject to the exhaust or atmospheric pressure through ports 34 and 25.

The pressure upon the outer face of the larger piston 33, and the corresponding movement of the main slide valve, is controlled by a small auxiliary or reversing valve 40 actuated by the movement of the high pressure steam piston 11.

Live steam is supplied to the reversing valve chamber 41 through a port 42 and the reversing valve seat is provided with a port 43 leading to the extreme end of the chamber of the larger piston 33, another port 44 leading nearly to the end of said chamber, and an exhaust port 45 communicating by a port 46 with the engine exhaust port 25, while the reversing valve 40 has a cavity 47.

A striking plate 49 may be secured to the high pressure piston 11 for engaging shoulders on the reversing valve rod 48 and thereby effect the shifting of the valve at each end of the stroke, as will be readily understood.

If the high pressure steam piston 11 is at the bottom of its cylinder, as it usually is, when the governor valve opens the supply of live steam to the engine, the reversing valve is in its lower position with the port 43 open, so that the steam exerts full pressure upon the outer face of piston 33, while the outer face of piston 32 is open to atmospheric pressure, thereby causing the main distribution slide valve 35 to shift to position shown in Fig. 1. In this position live steam flows from chamber 38 through ports 28 and 22 to the underside of piston 11, while the cylinder above this piston is in communication with the upper end of low pressure cylinder 8 through ports 23, 29, 36, 31 and 26, and port 24 is open through cavity 30 to the exhaust port 25.

As the high pressure steam piston moves to the upper end of its traverse, it carries with it the initial or low pressure pump piston 12, thereby displacing a full initial cylinder full of air, and compressing the same into the smaller volume of the high pressure air cylinder 10. As the high pressure steam piston reaches the upper end of its stroke, it shifts the reversing valve to the position shown in Fig. 2, closing port 43 and opening communication from the chamber on the outer side of piston 33 through port 44, cavity 47, and ports 45, 46 and 25 to the exhaust, whereupon the excess steam pressure upon the differential piston heads instantly shifts the main slide valve to its opposite position. In this position live steam is admitted through ports 28 and 23 to the upper end of cylinder 7, and the steam beneath the piston 11 expands through ports 22, 27, 36, 29 and 24 into the lower end of low pressure cylinder 8, while the upper end of cylinder 8 exhausts to the atmosphere through ports 26, 30 and 25. It will therefore be seen that at each stroke of the high pressure steam piston the low pressure air piston also necessarily makes a complete stroke, thereby displacing the large initial compression cylinder full of free air at each traverse and developing a constant maximum efficiency. If, after a high pressure has accumulated in the reservoir and the resistance or work on the final compression piston 15 has correspondingly increased, there should be any tendency for this piston with its low pressure steam piston to lag or travel slower than the high pressure steam piston, it is

apparent that to the same extent additional work would be thrown upon the high pressure piston, thereby maintaining a perfect balance of the pressures and insuring a smooth and efficient action of the pump.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:—

1. In a compound pumping engine, the combination with a high pressure engine cylinder and piston, and a low pressure engine cylinder and piston, of an initial compression pump cylinder and a final compression pump cylinder, the piston of the initial compression pump cylinder being directly connected to the high pressure engine piston.

2. In a compound pumping engine, the combination with high and low pressure engine cylinders having pistons therein, of an initial compression pump cylinder having a piston directly connected to the high pressure steam piston, a smaller final compression pump cylinder having a piston connected to the low pressure steam piston, and a valve mechanism operated by the movement of the high pressure steam piston for effecting the admission and exhaust of steam to and from the engine cylinders.

3. In a compound pumping engine, the combination with a high pressure engine cylinder and a low pressure pump cylinder in line therewith, and a low pressure engine cylinder and a high pressure pump-cylinder, of a cylinder head having a valve seat with ports leading to the opposite ends of said engine cylinders, a steam-actuated slide valve for controlling said ports, and means governed by the movement of the high pressure steam piston for controlling the movement of the said slide valve.

4. In a compound pumping engine, the combination with high and low pressure engine cylinders, of initial and final compression pump cylinders, the high pressure steam piston being directly connected to the piston of the initial compression pump cylinder, a steam actuated distribution valve for the engine cylinders, and means governed by the movement of the high pressure steam piston for controlling the movement of the said distribution valve.

5. In a compound pumping engine, the combination with high and low pressure engine cylinders, of initial and final compression pump cylinders, the high pressure steam piston being directly connected to the piston of the initial compression pump cylinder, a steam actuated distribution valve for the engine cylinders, and an auxiliary reversing valve actuated by the movement of the high pressure steam piston for controlling the movement of the main distribution valve.

In testimony whereof I have hereunto set my hand.

ALEXANDER ENGLAND.

Witnesses:

R. F. EMERY,

J. B. MACDONALD.