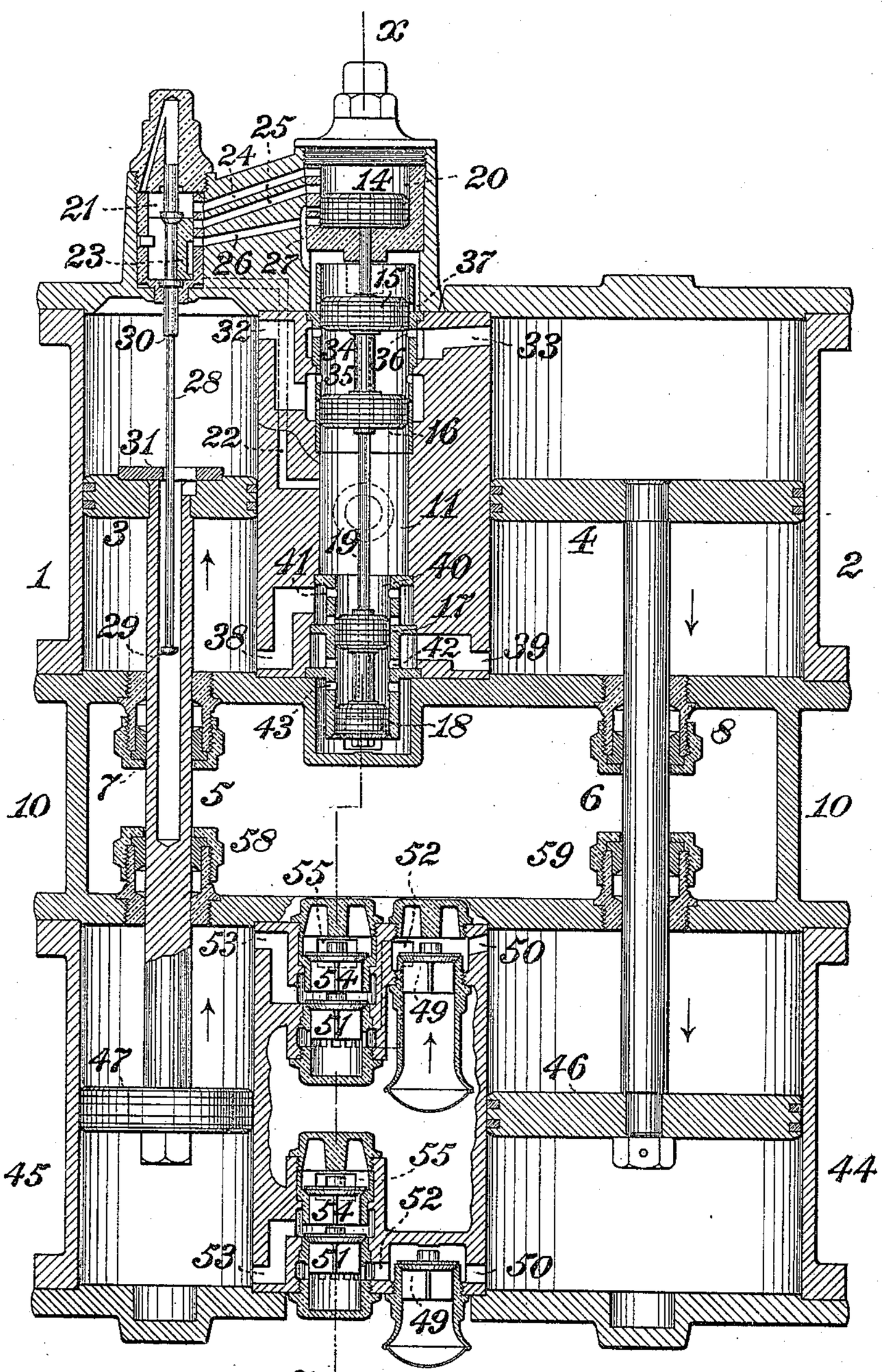
(No Model.) 2 Sheets—Sheet 1.

G. WESTINGHOUSE, Jr.

COMPOUND PUMPING ENGINE.

No. 441,209. Patented Nov. 25, 1890.

FIG. 1.



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(No Model.) 2 Sheets—Sheet 2.

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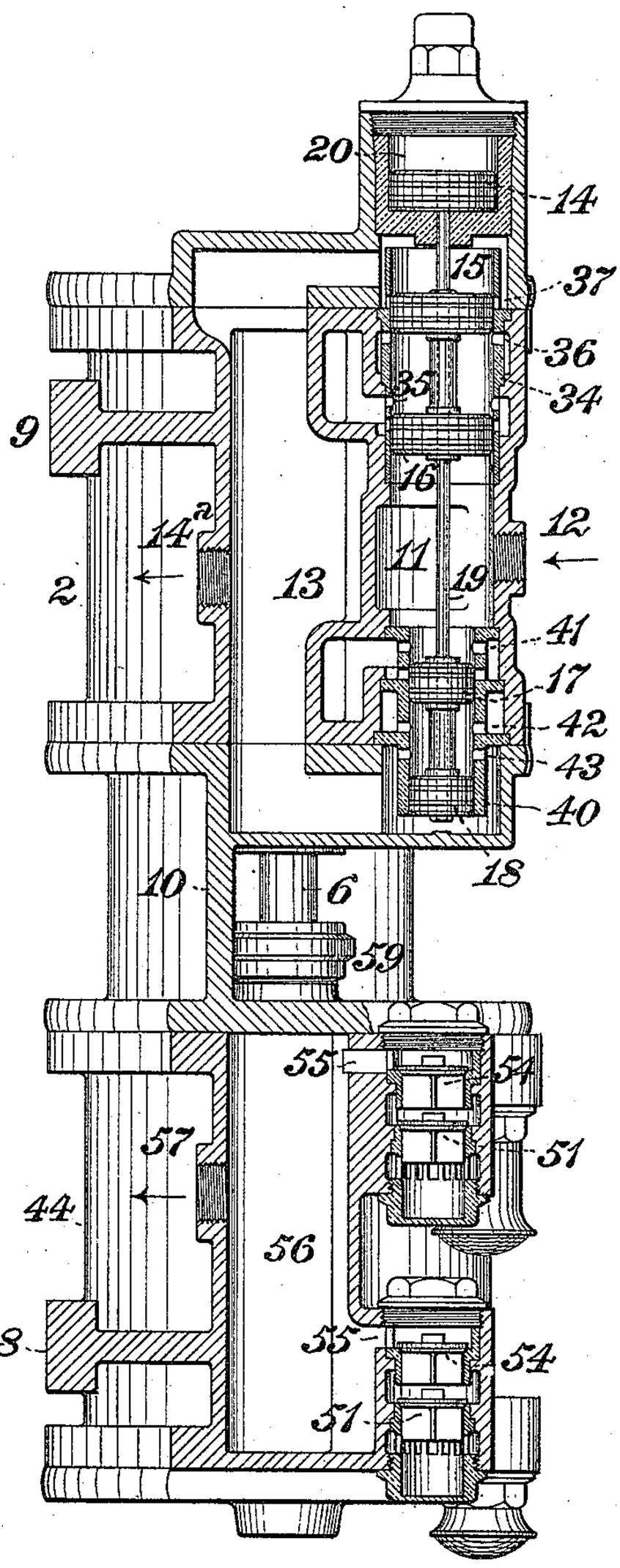
FIG. 2.



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UNITED STATES PATENT OFFICE.

GEORGE WESTINGHOUSE, JR., OF PITTSBURG, PENNSYLVANIA.

COMPOUND PUMPING-ENGINE.

SPECIFICATION forming part of Letters Patent No. 441,209, dated November 25, 1890.

Application filed August 6, 1890. Serial No. 361,175. (No model.)

To all whom it may concern:

Be it known that I, GEORGE WESTINGHOUSE, Jr., a citizen of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented or discovered a certain new and useful Improvement in Compound Pumping-Engines, of which improvement the following is a specification.

The object of my invention is to provide a pumping-engine for the compression of air and other gases in which a greater simplification of structure and a more economical utilization of motive fluid may be effected than heretofore.

To this end my invention, generally stated, consists in the combination of a compound non-rotative direct-acting engine and a compressing-pump having an initial compression-cylinder and a final compression-cylinder of lesser volume, the pistons of which are actuated by those of the engine.

The improvement claimed is hereinafter fully set forth.

In the accompanying drawings, Figure 1 is a vertical central section through the cylinders and valves of a compound pumping-engine embodying my invention, and Fig. 2 a transverse section through the same at the line *x x* of Fig. 1.

In the practice of my invention I provide a compound direct-acting engine having a high-pressure cylinder 1 and a low-pressure cylinder 2, fitted, respectively, with properly-packed pistons 3 and 4, which are secured upon piston-rods 5 and 6, passing through stuffing-boxes 7 and 8 in the usual manner. The admission and exhaust of motive fluid to and from the opposite sides of the pistons 3 and 4 is effected by a single distribution-valve, which is preferably steam-actuated and of the piston type, and constructed and operated in a manner according in general principle with that exemplified in Letters Patent of the United States, No. 159,782, granted and issued to me under date of February 16, 1875, certain modifications being, however, made in the valve and accessories to admit of its desirable adaptation to the functions required under my present invention. A flange 9, formed or fixed upon one side of the cylinders 1 and 2, admits of their attachment to a suitable standard or support, and their lower heads may be cast integral with a frame or casing 10, to the opposite end of which is connected a compound fluid-compressing pump, presently to be described. In the instance shown the distribution-valve of the engine is fitted to reciprocate in a valve chest or casing 11, located between the cylinders 1 and 2, and provided with an inlet or supply nozzle 12 for the connection of the supply-pipe, the valve-chest communicating near its upper and lower ends with an exhaust-chamber 13, having an outlet or discharge-nozzle 14^a for the connection of an exhaust-pipe.

The distribution-valve is composed of a series of pistons 14, 15, 16, 17, and 18, the four latter of which are secured upon a common stem 19, the piston being, for convenience of construction, fixed upon a separate stem, and working in a chamber 20, which communicates on one side of the piston 14 with the exhaust-chamber 13, and on the other with a chamber 21, into which a passage 22 leads from that portion of the valve-chamber 11 which is constantly open to the supply-inlet 12. An auxiliary slide-valve 23 works in the chamber 21, and controls ports 24, 25, and 26, leading from the chamber 21 to the chamber 20, the port 26 communicating with a port 27, leading from the chamber 20 to the exhaust-chamber 13. The valve 23 is fixed upon a stem 28, which fits freely within a central bore in the piston-rod 5 of the high-pressure cylinder, and is provided with a collar 29 on its lower end and a shoulder 30 near the upper end of the high-pressure cylinder, the valve being reciprocated in opposite directions by the contact of a slotted plate 31, fixed upon the top of the high-pressure piston 3, with the shoulder 30 as the piston approaches the upper limit of its stroke, and with the collar 29 as it approaches the lower limit. Ports 32 33 lead from the upper ends of the high and low pressure cylinders 1 and 2, respectively, to chambers inclosing a sleeve or bushing 34, fitted in the valve-chamber, within which bushing the valve-pistons 15 and 16 work. The bushing 34 is provided with ports 35, communicating with the high-pressure-cylinder port 32, ports 36 communicating with the low-pressure-cylinder port 33, and ports 37 communicating with the ex-

haust-chamber. Ports 38 and 39 lead from the lower ends of the high and low pressure cylinders, respectively, to chambers inclosing a sleeve or bushing 40, in which the valve-pistons 17 and 18, which are of smaller diameter than the other valve-pistons 14, 15, and 16, are fitted to reciprocate. The bushing 40 is provided with ports 41, communicating with the high-pressure-cylinder port 38, ports 42 communicating with the low-pressure-cylinder port 39, and ports 43 communicating with the exhaust-chamber.

A compound compressing-pump having an initial compression-cylinder 44 and a final compression-cylinder 45 is secured to the lower side of the casing or frame 10, the cylinders of the pump being in line with those of the engine and having their pistons secured upon the piston-rods thereof. In the instance shown the initial compression-cylinder 44 of the pump is located in line with the low-pressure cylinder 2 of the engine, and has its piston 46 secured upon the piston-rod 6 thereof, and the final compression-cylinder 45 of the pump is in line with the high-pressure cylinder 1 of the engine, and has its piston 47 secured upon the piston-rod 5 thereof.

A flange 48 upon the pump-cylinders is provided for attachment to a standard or support similarly to the flange 9 of the engine-cylinders, and the heads of the pump-cylinders are preferably formed integral with the casing 10, suitable stuffing-boxes 58 and 59 being provided for the piston-rods 5 and 6 in the pump-cylinder heads.

The initial compression-cylinder 44 is provided at each end with an inlet or receiving valve 49, controlling communication between the atmosphere and a port 50 in the cylinder, and the final compression-cylinder 45 is provided at each end with an inlet or receiving valve 51, which acts also as the delivery-valve of the initial cylinder, said valve controlling communication between a port 52, which is continuously open to the initial-cylinder port 50, and a port 53, leading into the adjacent end of the final compression-cylinder 45. Said cylinder is likewise provided at each end with a delivery-valve 54, controlling communication between its port 53 and a discharge-port 55, leading into a delivery-chamber 56, having an outlet-nozzle or passage 57, to which is connected a delivery-pipe leading to a suitable reservoir for the storage of the compressed fluid.

In operation and in the position shown in the drawings steam or other motive fluid passes from the valve-chest 19 through the ports 41 and 38 into the high-pressure cylinder 1 on the lower side of its piston 3, effecting the upward stroke thereof and of the connected piston 47 of the final compression-cylinder 45 of the pump. The motive fluid which has effected the preceding downward stroke of the pistons 3 and 47 is exhausted through the ports 32, 35, 36, and 33 into the low-pressure cylinder 2 on the upper side of its piston 4, effecting the downward stroke thereof, and of the connected piston 46 of the initial compression-cylinder 44 of the pump. The motive fluid which has effected the preceding upward stroke of the pistons 3 and 47 and of the pistons 4 and 46 is exhausted from the low-pressure cylinder 2 through the ports 39, 42, and 43 to the exhaust-chamber 13, and thence to the atmosphere or to a condenser, as the case may be. The air or other fluid to be compressed is in the traverse of the pistons drawn into the initial compression-cylinder 44 through its upper port 50, and the air which has been drawn into said cylinder through its lower port 50 in the preceding upward stroke is compressed therein to a certain determined degree—as, say, a pressure of twenty-five pounds or thereabout to the square inch—and forced through the lower port 52, raising the lower inlet-valve 51 of the final compression-cylinder 45, and passing into said cylinder, which it fills when the pistons 3 and 47 have reached the upper limit of their traverse. As the piston 3 approaches this position the plate 31 on its top strikes the shoulder 30 of the valve-stem 28 and moves the auxiliary slide-valve 23 upwardly, so as to place the interior of the chamber 20 above the valve-piston 14 in communication with the exhaust-chamber 13 through the ports 26 and 27 and the exhaust-cavity of the valve 23. The preponderance of motive-fluid pressure in the valve-chest 19 on the valve-piston 16, above that on the opposite valve-piston 17, thereupon raises the distribution-valve, admitting motive fluid to the high-pressure cylinder 1 above its piston 3 through the ports 35 and 32 and effecting the succeeding downward stroke of the pistons 3 and 47. The motive fluid which has effected the upward stroke of the piston 3 is exhausted into the low-pressure cylinder 2, on the lower side of its piston 4, through the ports 38, 41, 42, and 39, and the motive fluid, which has effected the downward stroke of the piston 4 is exhausted from the low-pressure cylinder 2 into the exhaust-chamber through the ports 33, 36, and 37. As the piston 3 approaches the downward limit of its traverse, the plate 31 strikes the collar 29 of the valve-stem 28, returning the auxiliary slide-valve 23 to the position shown in the drawings, and thereby admitting motive fluid to the chamber 20 above the valve-piston 14. The preponderance of downward pressure upon the distribution-valve, which is then and thereby instituted, moves the distribution-valve to the position shown in the drawings, in which it performs the admission and exhaust functions requisite for the next succeeding upward stroke of the piston 3, as before explained. In the downward stroke of the pistons 3 and 47 the air, which has been initially compressed in the cylinder 44 during the preceding downward stroke of the pistons 4 and 46, is compressed to the final degree, which corresponds substantially to the pressure exerted upon

the high-pressure piston 3 of the engine, and passes through the lower port 53, and past the delivery-valve 54, which is lifted by the pressure below it through the discharge-port 55 into the delivery-chamber 56, and thence through a suitable delivery-pipe into the storage-reservoir or to the point of utilization, as the case may be.

While I have illustrated as the preferable application of my invention a construction in which the piston of the initial compression-cylinder of the pump is connected to that of the low-pressure cylinder of the engine and the piston of the final compression-cylinder of the pump to that of the high-pressure cylinder of the engine, I do not desire to limit myself to such specific relative arrangement of cylinders, as it will be obvious that by proportioning their diameters so that the pressure requisite to effect compression to the desired and determined final degree shall be exerted upon the piston of the final compression-pump cylinder said piston may be actuated by that of the low-pressure-engine cylinder and the piston of the initial compression-pump cylinder by that of the high-pressure engine. Such transposition of cylinders would be within the ability of those skilled in the art under the foregoing description of the structural and operative features of my invention and would not involve a departure from the spirit and essential principle thereof.

My invention enables the economic utilization of motive fluid to be effected in the compression of air and gases by an apparatus which by reason of its simplicity of structure and small compass is specially adapted to uses—such as a locomotive-pump for air-brake mechanism—to which a rotative engine would be wholly inapplicable and further differs from all prior devices in this branch of the art, so far as my knowledge and information extends, in the particular that the engine-pistons not being connected to a crank-shaft, as in the case of rotative engines, their movements, instead of being necessarily synchronous or in invariable relation, are capable of such relative variation as may be adapted to accord with variations of pressure of the fluid to be compressed in its traverse from the inlet to the discharge-passages of the pump.

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

1. In a compound pumping-engine, the combination, substantially as set forth, of a compound non-rotative direct-acting engine and a compound compressing-pump having an initial compression-cylinder and a final compression-cylinder of lesser volume, the pistons of the pump-cylinders being connected to and actuated by those of the engine-cylinders.

2. In a compound pumping-engine, the combination, substantially as set forth, of a high-pressure-engine cylinder, a low-pressure-engine cylinder, pistons adapted to reciprocate in said cylinders independently one of the other, a distribution-valve effecting the admission and exhaust of motive fluid to and from said cylinders, an initial compression-pump cylinder, a final compression-pump cylinder of lesser volume, pistons fitting said pump-cylinders and connected to the piston-rods of the engine-cylinders, and inlet and discharge valves adapted to admit fluid to the initial pump-cylinder and discharge it therefrom to the final pump-cylinder, and thence to a discharge-passage.

3. In a compound pumping-engine, the combination, substantially as set forth, of a high-pressure-engine cylinder, a low-pressure-engine cylinder, a single distribution-valve controlling the admission and exhaust of motive fluid to and from cylinders, and a compound compressing-pump whose pistons are directly connected to the pistons of the engine.

4. In a compound pumping-engine, the combination, substantially as set forth, of a high-pressure cylinder, a low-pressure cylinder, a single steam-actuated distribution-valve for controlling the ports of the high and low pressure cylinders, and an auxiliary valve actuated by the piston of the high-pressure cylinder and controlling the movement of the distribution-valve.

5. In a direct-acting compound pumping-engine, the combination, substantially as set forth, of a high-pressure-engine cylinder, a low-pressure-engine cylinder, an initial compression-pump cylinder, a final compression-pump cylinder, pistons fitting said cylinders and directly connected to the engine-pistons, a single distribution-valve controlling the ports of the high and low pressure engine cylinders, and an auxiliary valve actuated by the piston of the high-pressure-engine cylinder, substantially as set forth.

6. A direct-acting compound pumping-engine having a single distribution-valve for the high and low pressure cylinders, and an auxiliary valve which controls the movements of the distribution-valve, said auxiliary valve being actuated by the high-pressure steam-piston, substantially as set forth.

In testimony whereof I have hereunto set my hand.

GEO. WESTINGHOUSE, JR.

Witnesses:

W. D. UPTEGRAFF,

J. SNOWDEN BELL.