(No Model.) 2 Sheets—Sheet 1.

B. C. VANDUZEN.

STEAM PUMPING ENGINE.

No. 260,337. Patented June 27, 1882.

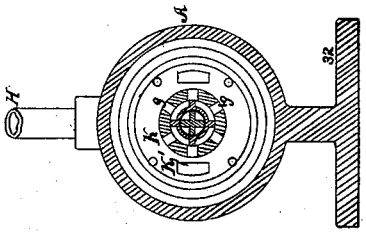

Fig. 3.

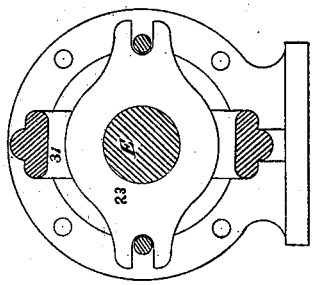

Fig. 2.

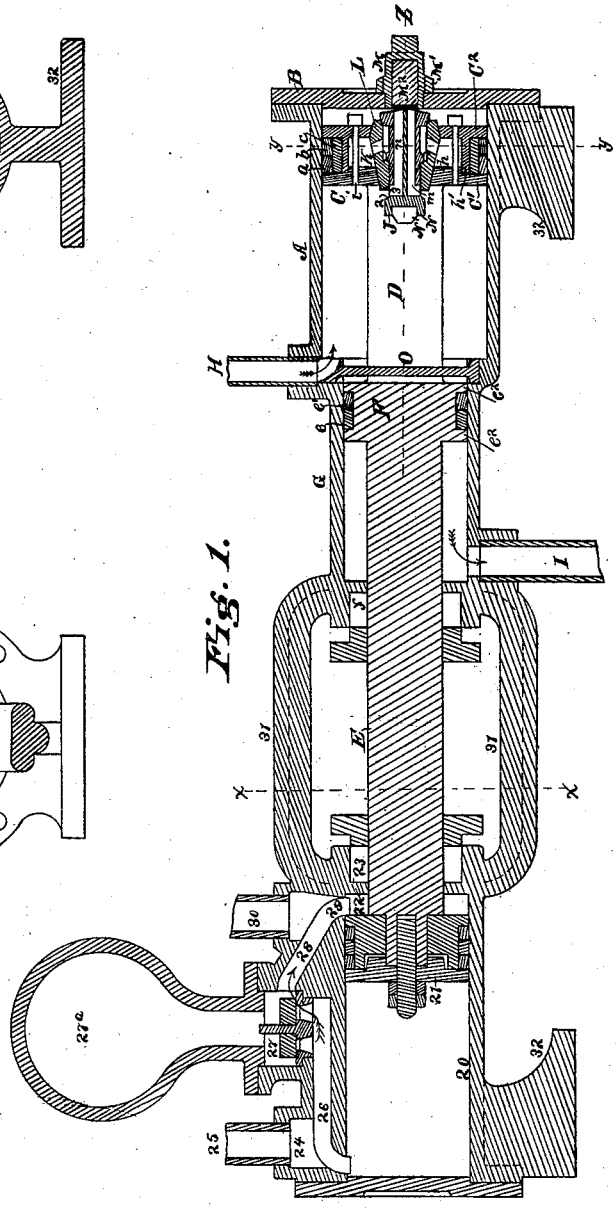

Fig. 1.

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(No Model.) 2 Sheets—Sheet 2.

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Fig. 4.

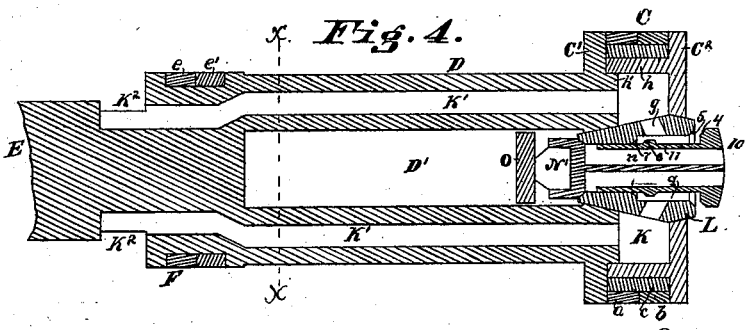


Fig. 5.

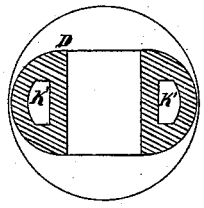


Fig. 6.

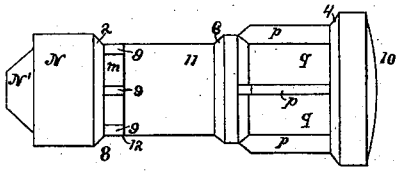
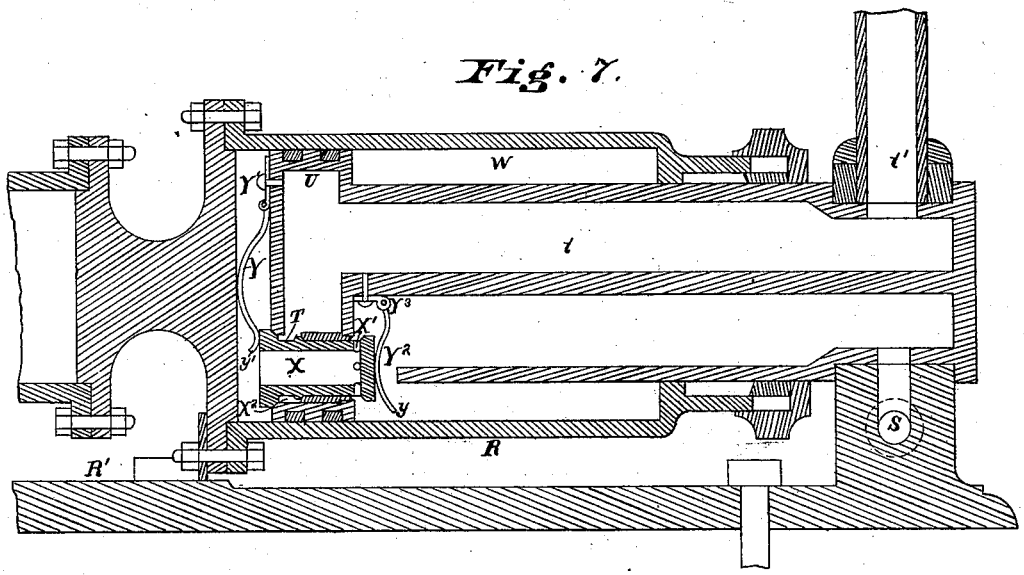


Fig. 7.



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UNITED STATES PATENT OFFICE.

BENJAMIN C. VANDUZEN, OF CINCINNATI, OHIO.

STEAM PUMPING-ENGINE.

SPECIFICATION forming part of Letters Patent No. 260,337, dated June 27, 1882.

Application filed August 6, 1881. (No model.)

To all whom it may concern:

Be it known that I, BENJAMIN C. VANDUZEN, of the city of Cincinnati, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Steam Pumping-Engines, of which the following is a specification.

The object of my invention is to produce a steam-engine which shall be cheap and easy of manufacture, simple in construction, effective in operation, and which shall accomplish a saving in steam and fuel.

The various features of my invention are apparent from the following description:

In the accompanying drawings, Figure 1 represents a vertical central longitudinal section of a steam-engine illustrating my invention, the steam-engine being shown as applied to a force-pump of one of the ordinary kinds. Fig. 2 is a section taken at line *x x*, Fig. 1. Fig. 3 is a section taken at the line *y y*, Fig. 1. Fig. 4 is a longitudinal section taken at the line Z, Fig. 1. Fig. 5 is a section taken at the line X X of Fig. 4. Fig. 6 is an enlarged view of the valve shown in Fig. 4. Fig. 7 is a sectional view, representing a modification of my invention.

A designates the cylinder of the engine, provided with head B, secured by bolts or in any other suitable manner to the cylinder.

C is the piston, provided with the usual packing-rings, *a b c*.

D is a connection between the piston C and the supplemental piston F, sliding in the supplemental cylinder G, and provided at its periphery with packing, preferably packing-rings *e e'*, held in place by the flanges e^2 of the said supplemental piston.

The supplemental piston may be connected to the connections D and the piston-rod E (which latter is located in front of the supplemental piston) in any suitable manner, with this proviso, that the exhaust-port of the piston C shall be connected by suitable conduits to the exhaust-ports of piston F. The preferable mode is that shown herein, where the connection D, supplemental piston F, and piston-rod E are all cast in one and the same piece. The piston-rod E passes through and plays in and is supported by the forward end or head of the supplemental cylinder G, said head being provided with a suitable packing-box, *f*, to prevent the steam from escaping around the piston-rod E.

The cylinder A and supplemental cylinder G are connected together in any suitable manner. They are preferably cast in one piece.

Steam is first admitted to the cylinder A by the port H, located at the forward end, and preferably at the upper part or top thereof, as shown. The final escape-port I for the steam is located at the forward end of the supplemental cylinder G, and is preferably placed at the lower side of the latter, so as to allow the water of condensation to pass out.

In order to render the subsequent description of parts more readily understood, it is here remarked that the steam entering the cylinder A through inlet-port H, acting against the port or left-hand face of the piston, pushes the latter from the forward to the rear end of the cylinder, and at the same time reverses the valve J, whereupon the piston and valve assume the position shown in Fig. 1. The same steam, by the altered position of the valve, is let into the rear end of the cylinder and behind the piston, and, acting upon the rear or right-hand face of the piston, pushes the latter forward to the front end of the cylinder, whereupon the valve is reversed and the steam allowed to pass into the space K in the piston, and thence through the longitudinal conduits or ports K′, in the connection D and piston F, (see Figs. 3, 4 and 5,) in the direction of the arrows, and thence to pass out of the said ports K′ at K^2 into the cylinder G, and thence out of the final escape-port I, so that one cylinder of steam serves to drive the piston once in each direction and causes it to travel the length of the cylinder twice. These escape-ports K′ lie in each side of the connection D and piston F, as shown, and instead of being independent pipes are preferably cast with the connection D and piston F. Thus the sides of the connection and piston-rod E, where the ports are located, are farther extended than the other sides thereof, thereby causing the connection and piston to assume a shape shown in the cross-section of the connection and piston shown in Fig. 5.

The escape-port K in the main piston C, as formed, consists of a space located wholly within the piston, and preferably of an annular form, embracing the valve-shell L. This space-port K connects with the ports K′, as shown in Fig. 4, and with the openings *g* in the valve-shell L.

The valve-shell may be fastened to the piston in any suitable manner. In the present instance the piston C and valve-shell are constructed so as to allow of the ready attachment or removal of the valve-shell. Such construction is preferably as follows, viz:

The piston is divisible into two discal pistons, C′ C², the portion C′ being provided with the rearward projection *h*, and the portion C² being provided with the annular projection *h*′, which latter fits over and upon the projection *h* and rests against disk C′. The disks are secured together in any desired manner. A preferred mode is that shown—viz., where bolts *i* pass through the disk C² and are screwed into the disk C′.

Upon separating the disks C′ C² the valve-shell can be readily taken out without disturbing the disk C′ and connection D, and either the valve-shell or valve, or both, can thus be reached for repairs when broken or worn out, or a new shell or valve, or both, can be attached to the piston.

The valve J slides longitudinally within the valve-shell, and, being carried forward and backward by and with the piston, is operated alternately by impinging against each end of the cylinder A or against a suitable impinging-block located near said cylinder ends. The ends of the valve and ends of the cylinder, or impinging pieces placed at the cylinder ends to receive said impingement, are to be mutually adapted to gently and without injury receive the blow of impact between the impinging end of the valve and the part which said end strikes against. In the present instance the rear end, B, of the cylinder is provided with a shell, M, preferably located in the center of the end B, but always opposite the end of the valve J, and rendered adjustable by means of a screw-thread on its periphery engaging a female screw in the cylinder end B. This screw also forms a convenient means of securing the shell M to the cylinder end.

An annular set-nut, M′, screwed upon the shell and against the cylinder end B, assists in keeping the shell in position after being adjusted against said cylinder end. This shell M is provided with a spring, M², of rubber or any other suitable material, against which the projecting center of the rear end of the valve J impinges as the piston approaches near the rear cylinder end, B.

The forward end of the valve J is provided with a shell, N, open in front and inclosing a spring, N′, of rubber or other suitable material, which latter projects forward some distance beyond the front edge of the shell N, so that when it (the spring) is compressed upon impingement at the end of the cylinder the end of the shell shall not strike against the opposing bumper, whatever that may be.

In the connection D is a central longitudinal opening or slot, D′. (See Fig. 4.) Into one end of this slot the forward end, N, of the valve J projects.

At the forward end of the cylinder A is located a vertical stop-piece or bumper, O, to receive the impingement of the spring N′ of the valve J. The bumper O is to be secured in position in any suitable manner. In the present instance the foot of it is stepped into a step or recess, O′, and the top, when necessary, may be secured to the upper part of the front cylinder end in any suitable manner. The bumper O passes vertically through the slot D′.

The construction of the valve J and the method in which it operates are as follows, viz: The valve has an annular seat, 2, which, when the valve is pushed rearward, impinges against a seat, 3, of the shell L. Directly behind the seat 2 are openings *m* in the valve, and these openings communicate directly with the conduits or ports *n*, which latter extend from the openings *m* through the valve to its rear end, and there open directly into the cylinder-space behind the piston C. The valve also has a seat, 4, which, when the valve is forced forward, rests upon the end 5 of the valve-shell L, and at the same time another seat, 6, of the valve rests upon the seat 7 of the said valve-shell. The wings *p* aid in guiding the valve. The spaces *q* between the valve and the shell in the vicinity of the wings *p* are exhaust-ports, and when the valve is moved rearward, the seat 4 being separated from seat 5, the steam is free to pass between said seats, and, entering said spaces *q*, passes from same directly into the exhaust-ports *g* of the shell, and, passing thence into the ports K, escapes through ports K′ K² aforementioned.

For convenience of construction and ease of removal and insertion the valve is preferably made in two parts or sections, of which one is the front end, (marked 8,) provided with the seat 2 and central pieces, 9, and the other section of the valve is the rear end, 10, provided with the cylinder 11, wings *p*, and valve-seats 4 and 6. When the two sections are combined together the central pieces, 9, pass within the cylinder, and, closely fitting the latter, form, in conjunction therewith, the central ports, *n*, aforementioned. The front end of the cylinder 11 rests against the abutments 12 of the front section of the valve. The two sections of the valve are connected together in any suitable manner, preferably by soldering.

Preferably the wings *p* are at their front ends partially beveled down before reaching the valve-seat 7, as shown, in order to enable the seat 7 to be more conveniently ground and reground.

The steam-engine aforedescribed is shown applied to work a force-pump. 20 designates the cylinder of the pump, and 21 the piston

connected to the piston-rod E aforementioned. The rear end, 22, of the cylinder is provided with a packing-box, 23. The inlet-port 24 is provided with the usual puppet-valve, allowing water from the inlet-pipe 25 to pass down into the cylinder, but preventing all reflow of said water into said inlet-pipe. The exit-port 26 preferably is furnished with a puppet-valve, 27, allowing water to be forced through the port in the direction of the arrow and into the air-chamber 27^a and through port 28, but prevents all reflow of water into the cylinder in front or left of the piston 21. The port 29 operates alternately as an inlet and outlet port, and the port 30 is solely an outlet.

When the piston 21 is drawn rearward water from the inlet-pipe 25 passes through the port 24 and fills the cylinder 20 in front of piston 21, and when the piston moves forward, valve in the port 25 being closed, the liquid is forced through the port 26 and passes through port 28 out of port 30, and part passes through port 29 into the cylinder 20, behind piston 21, and when the piston is again retracted is forced out through ports 29 and 30, while another supply is being drawn through inlet-port 24 and into the cylinder in front of the piston.

Preferably the cylinder 20 and the cylinders G and A are all cast together in one piece, being connected by the arches 31, which enable the packing-boxes 23 and *f* to be readily reached and packed and repacked.

The engine is suitably supported. In the present instance, where the cylinders G and A are shown as cast in one piece with the pump-cylinder 20, the entire apparatus is supported on two feet or pillars 32, one located under the rear end of cylinder A and the other under the forward end of pump-cylinder 20.

The mode in which the various parts of the aforedescribed steam-engine operate having been quite fully specified in connection with the description of said parts, the general description of the mode in which the engine, as an entirety, operates is as follows:

Suppose the piston C to be at the front end of cylinder A, steam being admitted through inlet-port H impinges against the front face of piston C and also against the rear face of piston F, the front side of which latter is usually subjected to the pressure of the atmosphere coming through the exhaust-ports I; but inasmuch as the surface of piston C exposed to the action of the steam is double the area of piston F, the piston C is forced backward until it reaches the rear end of the cylinder, when the end 10 of the valve J strikes spring M^2 and is reversed, being forced forward, thus closing all entrance to the exhaust-ports of the valve and opening the front valve-ports, *m*, into which the steam then enters, and, passing through ports *m*, enters the rear end of the cylinder behind the piston C, and thus cushions the latter and prevents it from striking the rear end of the cylinder A. The steam is now pressing against the rear face and the front face of piston C and the rear face of piston F, the front face of the latter being subjected to atmospheric pressure; but on account of the whole rear end of piston C being acted upon by the steam the sum of the power to push the piston forward will exceed by one hundred per cent. the sum of the power to push the piston back, and hence it will move forward. When the piston C arrives at the forward end of the cylinder the front end spring, N′, of the valve strikes against the bumper-piece O and is reversed—that is, moved backward till the valve-seat 2 reaches seat 3 of the valve-shell and closes the ports *n* and separates valve-seat 6 from seat 7 of valve-shell L, and thus opens a passage-way from the space in the cylinder behind the piston for the escape of the steam in said space through spaces *qq* of the valve, thence through ports *g* of the valve-shell into port K of the piston C, thence through the ports K′ K^2 into supplemental cylinder G, and thence into and out through ports I. In this manner the steam behind the piston C is exhausted, and the steam entering from inlet-port H and pressing on the front face of the piston C moves the latter backward, as before mentioned, and in the manner aforedescribed the piston is moved alternately backward and forward.

The engine above described is applicable not only for pumping, but for all of the other purposes for which steam-engines are commonly employed—as, for example, to impart rectilinear or rotary motion to various descriptions of machinery, &c.

When employed to operate a pump the steam is used in the engine without expansion.

When employed to impart rotary motion in connection with the usual fly-wheel or equivalent devices for accumulating and storing up momentum, the expansion of the steam is to be utilized by employing a cut-off valve in the steam-inlet pipe H, and in such instances the saving of steam is very great, and of course much greater than where the steam is employed without expansion.

One of the principal features of my invention consists in the application of steam in such a manner that one cylinderful of steam is positively employed to cause the piston C to traverse the cylinder twice, once in each direction, said steam acting upon the front face and then upon both front and rear face of the said piston. This feature of my invention may be embodied in mechanism in many different ways, and the latter will constitute obvious modifications of the engine heretofore described. For example, the valve may be placed at some point in the piston other than in the center of the latter; also, the piston and its rod and the connecting mechanism of the latter may be stationary and the cylinder have a reciprocating movement. One form of such mechanism is apparent in the mechanism shown in Fig. 7, Sheet 2, of the drawings, in which R desig-

nates the cylinder sliding on the slideways R′. S is the inlet-port, and T the exhaust-port, located in the piston U and connected to exhaust-port *t* in the piston-rod W, which latter port is connected with the exhaust-pipe *t′*, as shown.

The valve X, arranged to slide in the piston, as shown, is provided with inlet-ports X′, admitting steam when the valve is moved to the cylinder-space of the piston, and causing the cylinder to move, and with exhaust-ports X^2 allowing the steam of the piston, when the cylinder has completed its stroke, to escape into port T, and thence make its exit through ports *t* and *t′*.

A spring, Y, pivoted at Y′ to front of the piston and resting against the front end of the valve X, and a spring, Y^2, pivoted at Y^3 to the rear of the piston and resting against the rear end of said valve, serve to quicken the action of the valve and to respectively break the sudden impact of the ends of the valve X against the ends of the cylinder, by each of which springs in turn the valve X is moved, point *y* moving the valve forward and point *y′* moving the valve backward.

In view of the previous description of the mode of operation of the engine first described it is presumed that the mode of operation of the engine last mentioned will be fully understood without additional explanation.

The supplemental piston F and supplemental cylinder G are always smaller than cylinder A and piston C.

What I claim as new and of my invention, and desire to secure by Letters Patent, is—

1. In combination with a piston of a fluid-engine, an automatic reciprocating valve located and operated entirely within the cylinder, the ports being arranged substantially as shown, by means of which the steam is admitted to the cylinder in front of the piston, and after the engine has made its first stroke the steam is admitted through the piston to the cylinder-space behind the rear face of the piston, (the cylinder-space in front of the piston at the same time continuing full of steam,) and after the engine has completed its return-stroke is exhausted through the piston-port, substantially as and for the purposes specified.

2. In combination with the main piston, the automatic reciprocating valve located and operating entirely within the cylinder, and exhaust-ports extending to supplemental piston, and final exhaust-ports in supplemental piston, substantially as and for the purposes specified.

3. The combination of steam-cylinder, piston provided with reciprocating valve located and automatically operated entirely within the cylinder, devices for softening the force of the impact of the meeting between valve and the part actuating said valve, exhaust-port combined with said piston and connected to exhaust-ports extending to supplemental piston, and final exhaust-port in supplemental cylinder, substantially as and for the purposes specified.

4. The combination of the cylinders A and G and supplemental piston F, and piston C, provided with reciprocating valve J and valve-shell L, and devices for softening the impact of either end of said valve, substantially as and for the purposes specified.

5. The combination of cylinders A and G, and supplemental piston F, and bumper O, and piston C, provided with reciprocating valve J, having spring N′, and cylinder end B, having spring M^2, substantially as and for the purposes specified.

6. The combination of reciprocating piston C, provided with reciprocating valve J, having spring N′, and cylinder end B, screw-shell M, and spring M^2, substantially as and for the purposes specified.

7. The reciprocating piston C, provided with reciprocating valve J, having spring N′, and cylinder end B, screw-shell M, spring M^2, and set-screw M′, substantially as and for the purposes specified.

8. The piston C, composed of the disk C′, having projection *h*, and disk C^2, having projection *h′*, and devices for securing same together, in combination with valve-shell L, containing the reciprocating valve J, substantially as and for the purposes specified.

9. The piston C, composed of the disk C′, having projection *h*, and disk C^2, having projection *h′*, secured together, and port K, in combination with valve-shell L, valve J, having ports *n m*, and exhaust-ports K′ K^2, substantially as and for the purposes set forth.

10. The valve J, having seats 2 4 6 and ports *m* and *n*, wings *p*, and exhaust-ports *q*, substantially as and for the purposes specified.

11. The valve J, having seats 2 4 6 and ports *m* and *n*, wings *p*, exhaust-ports *q*, and end 8, having spring N′, substantially as and for the purposes specified.

12. The valve J, having seats 2 4 6, ports *m* and *n*, constructed in two sections, one section composed of end 10, wings *p*, and having spaces *q* and cylinder 11, and the other section composed of the end 8, provided with spring N′, and the pieces 9, substantially as and for the purposes specified.

13. The piston provided with reciprocating valve, located and automatically operated entirely within the cylinder, in combination with the exhaust-port K and exhaust-port K′, extending longitudinally within the cylinder and connected to the supplemental piston having port K^2, substantially as and for the purposes specified.

14. The combination of the piston C, provided with reciprocating valve, provided with spring N′, bumper O, and exhaust-port K, and the connection containing the exhaust-ports K′ and slot D′, supplemental piston containing port K^2, and supplemental cylinder containing port I, substantially as and for the purposes specified.

15. The combination of cylinder A, having inlet-port H, piston C, having reciprocating valve J, provided with seats 2 4 6, ports *m n*, and exhaust-ports *q*, spring N′, sliding in shell L, having seats 3 5 7 and exhaust-ports *g* and the port K, and the connection D, containing ports K′ and the slot D′, supplemental piston F, having exhaust-port K^2, supplemental cylinder having exhaust-port I, bumper O, and cylinder end B, having spring M^2, substantially as and for the purposes specified.

16. The combination of cylinder A, supplemental cylinder G, pump-cylinder 20, and pistons C, F, and 21, arches 31, and reciprocating valve J, located and automatically operated entirely within the cylinder, substantially as and for the purposes specified.

17. The combination of cylinder A, supplemental cylinder G, and the piston C, provided with reciprocating valve J, connection D, and the supplemental piston F, and piston-rod E, the front disk of the piston C and connection D and supplemental piston F and piston-rod E being cast in one piece, substantially as and for the purposes specified.

18. The combination of cylinder A, supplemental cylinder G, and the piston C, provided with reciprocating valve J, connection D and the supplemental piston F, the front disk of the piston C and connection D and supplemental piston F being cast in one piece, substantially as and for the purposes specified.

BENJAMIN C. VANDUZEN.

Attest:

A. S. LUDLOW,

E. R. HILL.