W. P. VALENTINE.

GAS ENGINE.

APPLICATION FILED MAY 29, 1907.

945,296.

Patented Jan. 4, 1910.

2 SHEETS—SHEET 1.

Fig. 1.

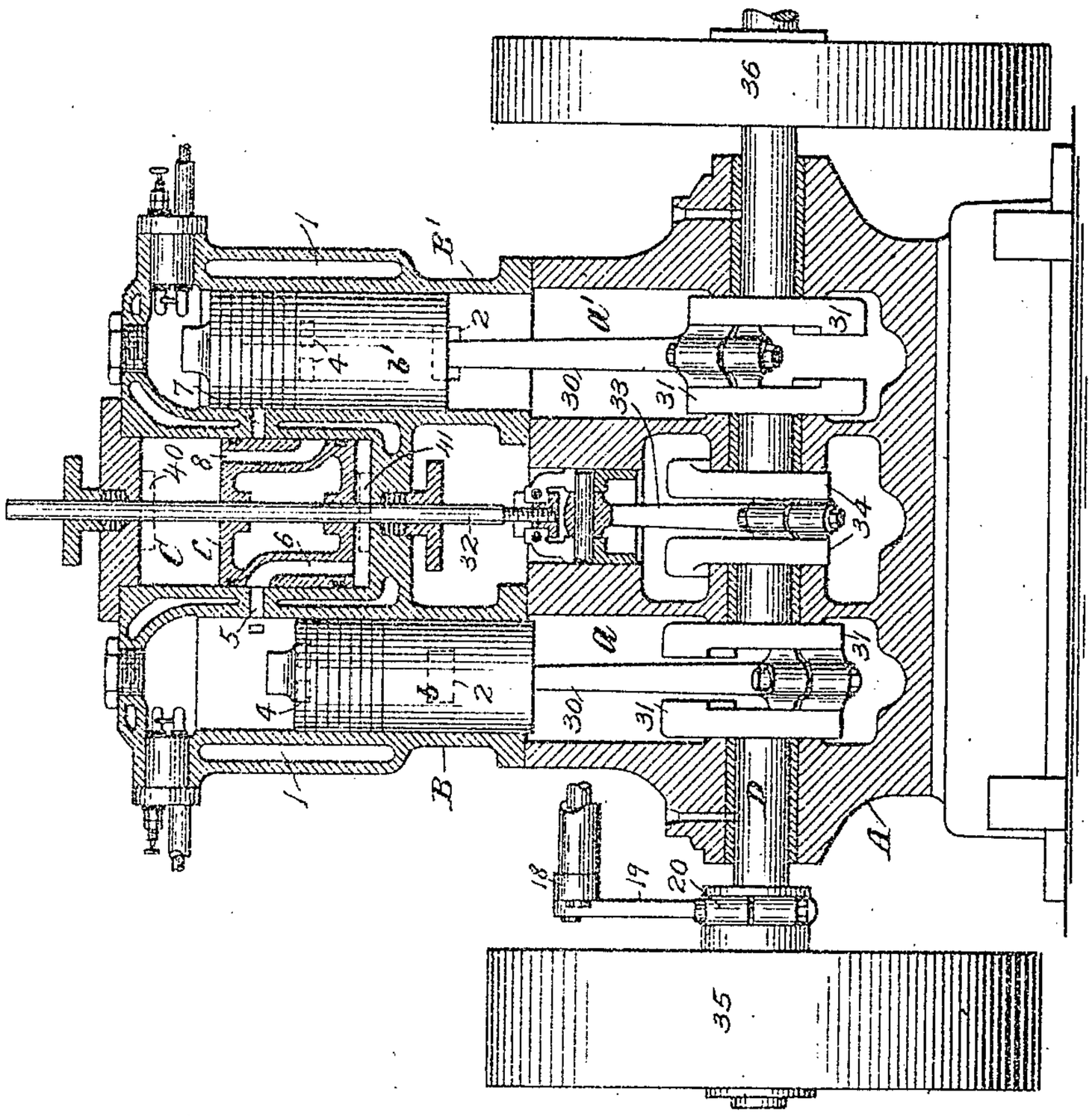
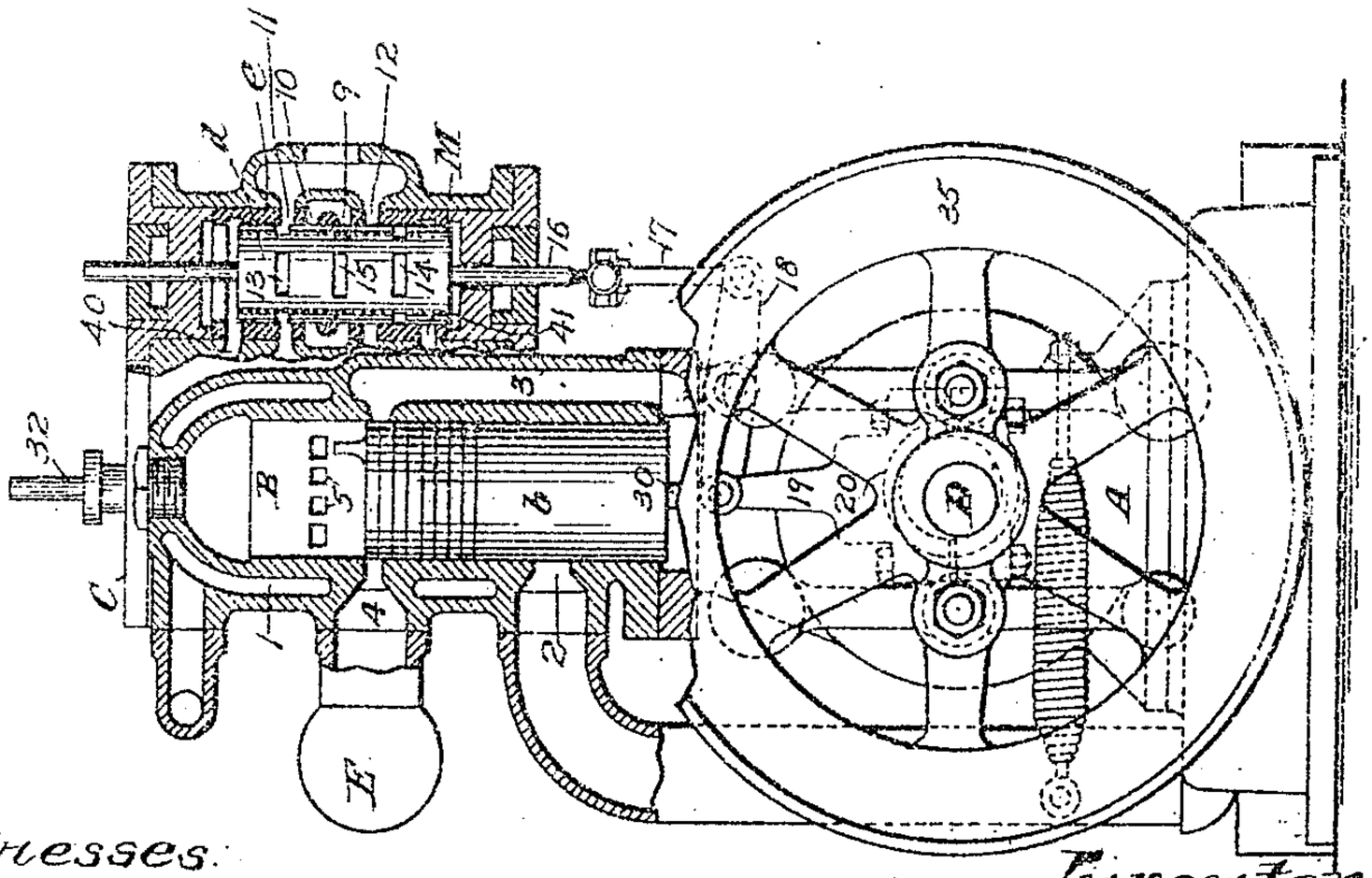


Fig. 2.



Witnesses:

C. F. Gourneau

Philip N. Tilden

Inventor:

Warren P. Valentine

by his Attys.:

Philip Thompson & Kennedy

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2 SHEETS—SHEET 2.

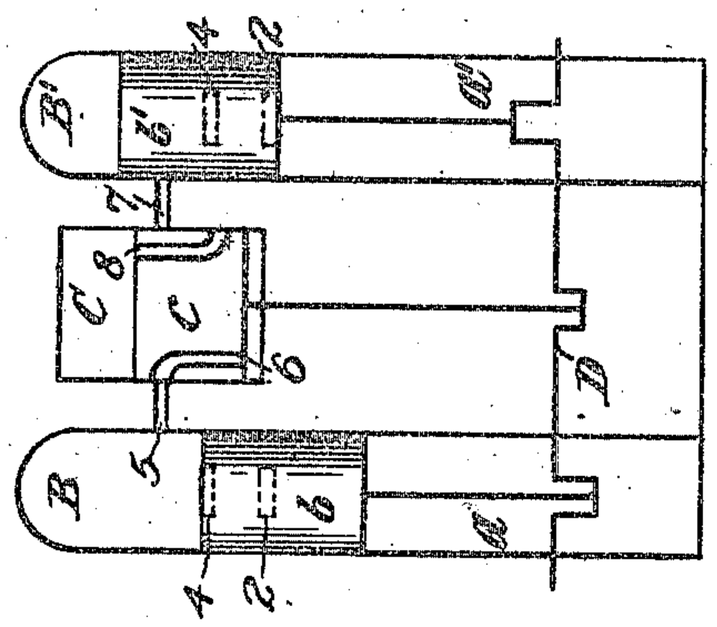


Fig. 4.

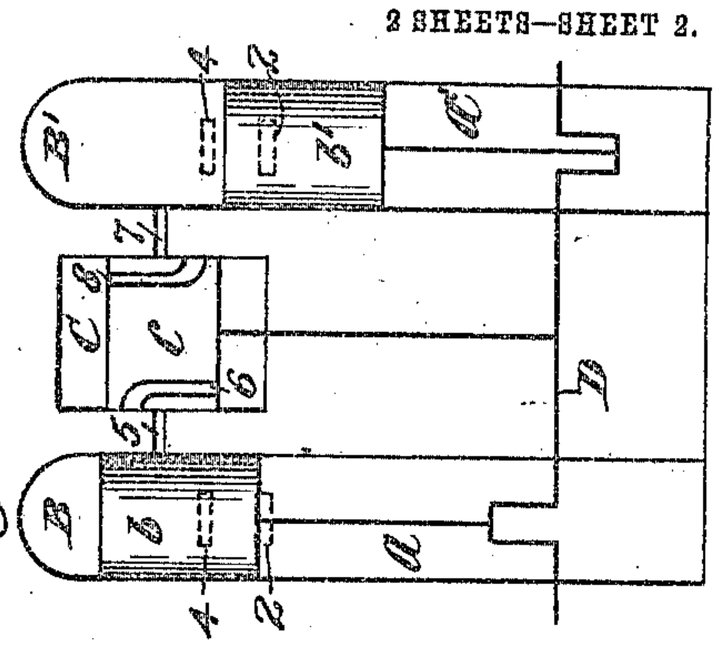
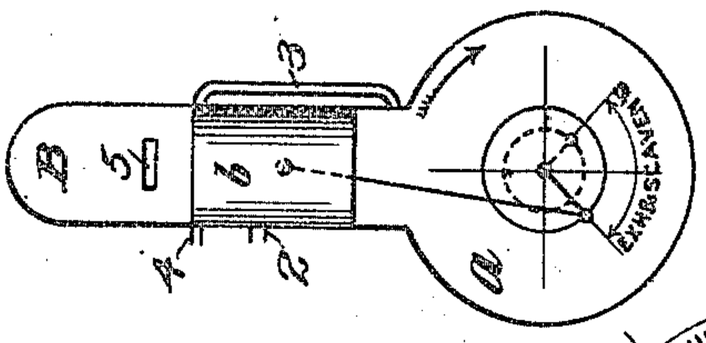
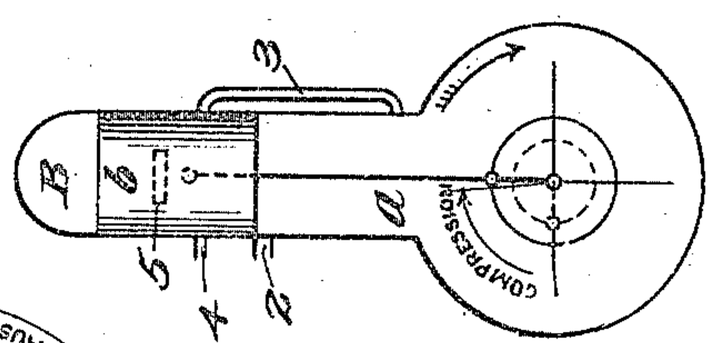


Fig. 6.





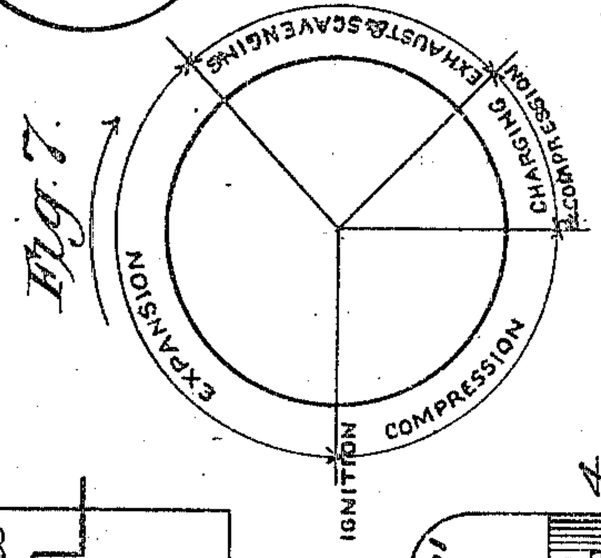


Fig. 7.

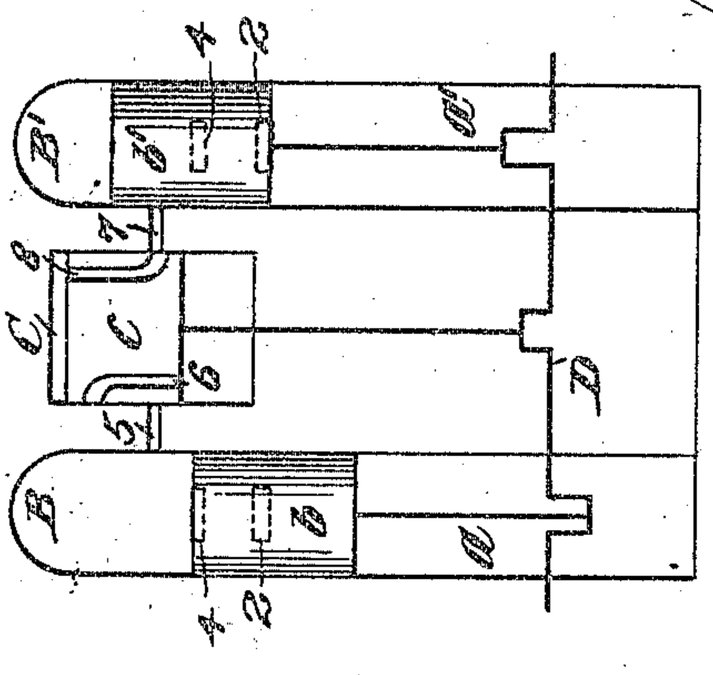


Fig. 3.

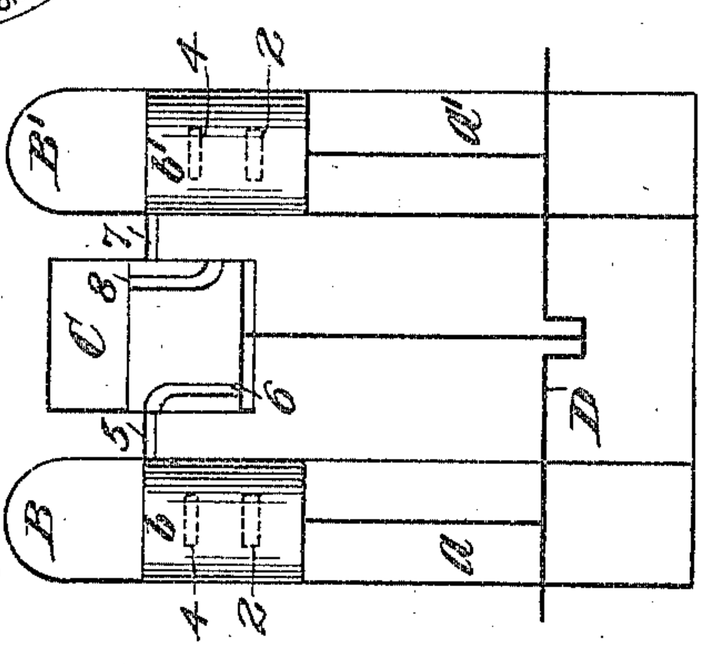
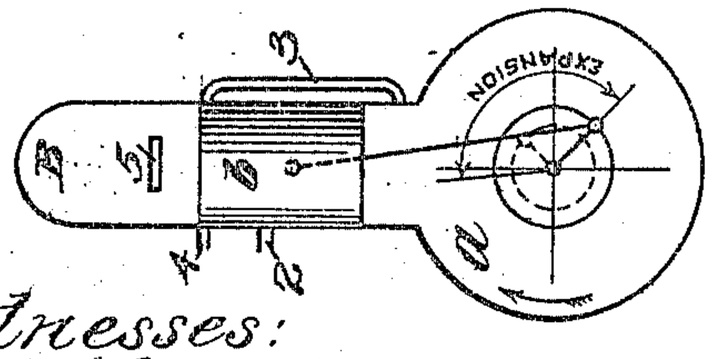
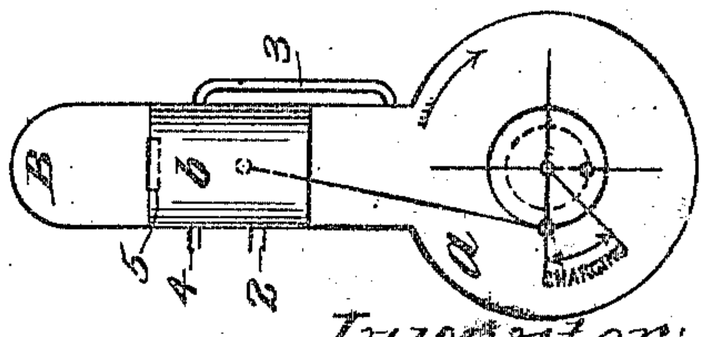


Fig. 5.





Witnesses:
W. P. Kennedy.
J. L. Graves

Inventor:
Warren P. Valentine
by his Atty's:
Fisher Sanger Sheehan & Kennedy

UNITED STATES PATENT OFFICE.

WARREN P. VALENTINE, OF WESTFIELD, NEW JERSEY, ASSIGNOR TO INTERNATIONAL STEAM PUMP COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

GAS-ENGINE.

945,296. Specification of Letters Patent. Patented Jan. 4, 1910.

Application filed May 29, 1907. Serial No. 376,244.

To all whom it may concern:

Be it known that I, WARREN P. VALENTINE, a citizen of the United States, residing at Westfield, county of Union, and State of New Jersey, have invented certain new and useful Improvements in Gas-Engines, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to an improved gas engine, the special object being to provide a simple, cheap, light and durable gas engine which may be run at high rates of speed with certainty and economy.

The invention consists in certain novel features of construction and combinations of parts, all as fully described hereinafter and specifically pointed out in the claims.

In the accompanying drawings forming a part of this specification, and in which is shown a gas engine embodying the invention in its preferred form—Figure 1 is a sectional elevation of the engine through the crank shaft; Fig. 2 is a sectional end elevation the section being taken through one of the power cylinders and the regulating valve chamber. Figs. 3 to 6 are diagrams showing the pistons in different positions corresponding to the divisions of the cycle shown in Fig. 7; and Fig. 7 is a cycle diagram of the engine shown.

Referring to the drawings, which show a two cylinder engine, A is a base casing, which forms air chambers *a*, *a'* in which air is compressed for scavenging, and upon this base casing A are mounted the power cylinders B, B' and fuel pump cylinder C, the power cylinders and fuel pump cylinder preferably being cast in one piece, as shown, to avoid leakage and for economy in construction. The power cylinders are shown as having the usual water jackets 1. The crank shaft D is mounted in the base casing A, and connected to the power pistons *b*, *b'* by pitmen 30 connected to cranks 31, 180° apart, and the fuel pump piston *c* has its rod 32 connected to the shaft D by pitman 33 and crank 34, which is 90°, or approximately 90°, from each power piston crank. The shaft is shown as having the two balance wheels 35, 36.

Each of the air chambers *a*, *a'* is provided with a port 2 for the admission of air, and these chambers are connected to the explosion end of the power cylinders B, B' by ports 3 opening into the power cylinders at or near the line of the exhaust ports 4 which connect with exhaust pipe E. The charge is admitted to the power cylinder B from below the pump piston *c* through port 5 in the cylinder wall and port 6 in the piston *c*, and the charge is admitted to the power cylinder B' from above the pump piston *c* through similarly arranged ports 7, 8, the admission ports thus being controlled by both the power and pump pistons, and admission to the power cylinders occurring only when both pistons are in the proper position.

The fuel employed is a mixture of gas and air, which is mixed with the fresh air in the cylinder after scavenging, this fuel being admitted alternately above and below the pump piston *c* through ports 40, 41 from a mixing chamber within the mixing and regulating valve *d* mounted in a casing M, 9, 10 being the gas admission ports and 11, 12 the air admission ports in the casing which are controlled by the valve *d*. The valve *d* is a cylindrical valve sliding in a cylindrical housing *e*, and the valve has three ports, the two outside ports 13, 14 being for air and the middle port 15 for gas. The stem 16 of the valve *d* is connected by link 17, to lever 18 which is operated by eccentric rod 19 from eccentric 20 on the shaft D, the position of this eccentric 20 being controlled by a governor so as to vary the position of the valve *d* and regulate the charge in accordance with the load. Any form of governor, either ball or wheel, may be used, but there is shown in the drawings a common form of wheel governor.

The housing *e* not only provides a wearing sleeve for the valve *d*, which may readily be replaced when worn, but may be used to adjust the amount of gas relatively to the air, the ports 9, 10 and 15 preferably being divided to form a plurality of ports opened more or less by the rotation of the housing *e*, so that the rotation of the housing *e* varies the amount of gas admitted relatively to the air to suit the kind of gas employed, without affecting the rate and time of closure of the air and gas ports. The housing may be rotated as desired by removing the cover which closes the top of the casing. The air admission ports in the valve and housing may be continuous or otherwise, so that the rotation of the housing may not or

may adjust the air admission. The air and gas ports preferably are of the same width and have the same time and rate of closing.

Other forms of mixing and regulating valves may be used, and the broader features of the invention are not limited to any particular form of devices for supplying the charge to the pump.

The operation of the engine will be understood from a brief description in connection with the drawings.

In Figs. 1 and 2 the parts are shown in position, as in Fig. 4, during the admission of the charge to cylinder B. In the diagram, Figs. 3 to 6, the parts are shown in position with the power piston *b* at the ends of the cycle divisions shown in Fig. 7, the piston *b* thus being at the end of the expansion operation and just about to open the exhaust and scavenging ports in Fig. 3, at the end of the exhaust and scavenging operation and having just closed the exhaust and scavenging ports in Fig. 4, at the end of the charging operation and just closing the inlet port in Fig. 5, and at the end of the compression operation and admitting air to the air chamber *a* in Fig. 6. The mixing and regulating valve *d*, in Fig. 2, is in position to admit gas and air through the mixing chamber and port 40 to the upper end of the pump cylinder C.

Referring especially to the diagrams, the power piston *b*, starting from the position shown in Fig. 3 at the end of the expansion operation, on its further downward movement opens exhaust port 4 and scavenging port 3, so that the air compressed in chamber *a* during the expansion operation of the piston *b* rushes into the cylinder B, hastens the exhaust and sweeps the cylinder clear of all gases, so that the charge, when admitted, is mixed with no waste gases but with pure air. This exhaust and scavenging operation continues past the dead center and until the piston *b* reaches the position shown in Fig. 4, when the scavenging and exhaust ports 3, 4 are closed by the piston *b*, and the charge admitted and compressed below the pump piston *c* is admitted to the cylinder above piston *b* by port 6 in the piston *c* connecting with the port 5, admission being closed at the end of the charging operation, by the piston *b* passing and closing the port 5, as shown in Fig. 5. Compression of the charge by the piston *b* on its further upward movement now occurs and ignition at the end of the compression operation, the admission port being then closed by the power piston *b* and the pump piston *c*, as shown in Fig. 6. The piston *b* now moves downward through the expansion operation, closing the air port 2 and compressing air in the chamber *a*, and the closing of the inlet port 5 is maintained by the pump piston *c* after the power piston *b* has passed it, the parts being thus returned to the position shown in Fig. 3. The cycle of piston *b'* is the same, of course, as that of the piston *b*, and timed at 180° therefrom, as shown in the diagram.

The ports and movement of piston *c* may be such that no part of the charge is admitted until the piston *b* has closed the exhaust and scavenging ports, but it may be found preferable, especially at very high speeds, to secure a longer charging operation by opening the admission port partly or wholly before the exhaust and scavenging ports are closed. This assures a full charge with a longer scavenging operation and less compression in the pump than otherwise. This opening of the admission port before the closing of the exhaust and scavenging ports is indicated in Figs. 1 and 2 by the size and position of the ports in the pump piston *c*.

While the invention has been illustrated and described as applied to a two cylinder engine, in which a power stroke in each cylinder at each revolution is secured, the pump piston supplying the charge alternately to the two cylinders, and certain features of the invention are limited to such a construction, it will be understood that the claims not thus limited include an engine having but a single power cylinder, in which case the pump cylinder may be single acting instead of double acting, as shown.

It will be seen that the whole power end of the engine, including the two power cylinders and fuel pump cylinder, with their connecting web and ports, together with the mixing and regulating valve chamber, may be formed of a single casting without joints, as shown, and that there are no valves in contact with the hot gases of combustion, so that leakage of joints and the effect of gases on valves, are avoided.

What I claim is:—

1. In a gas engine, the combination with a power cylinder and pump cylinder and their pistons, an air chamber in which the engine compresses air, an inlet passage connecting the pump cylinder and power cylinder controlled by both the pump piston and power piston, a scavenging passage connecting the power cylinder with the air chamber and controlled by the power piston, and cylinder exhaust and air chamber inlet ports controlled by the power piston, of a mixing chamber connected to the pump and having air and gas inlets, and valve devices actuated by the engine for controlling the admission of air and gas to the mixing chamber and the admission of the charge from the mixing chamber to the pump.

2. In a gas engine, the combination with two power cylinders and a double acting pump cylinder and their pistons, air chambers in which the power pistons compress

air on the power stroke, inlet passages connecting the pump cylinder with the power cylinders, each passage being controlled by the pump piston and a power piston, scavenging passages connecting the power cylinders with the air chambers and controlled by the power pistons, and cylinder exhaust and air chamber inlet ports controlled by the power pistons, of a mixing chamber connected to the pump and having air and gas inlets, and valve devices actuated by the engine for controlling the admission of air and gas to the mixing chamber and the admission of the charge to the pump.

3. In a gas engine, the combination with two power cylinders and a double acting pump cylinder and their pistons, air chambers in which the power pistons compress air on the power stroke, inlet passages connecting the pump cylinder with the power cylinders, each passage being controlled by the pump piston and a power piston, scavenging passages connecting the power cylinders with the air chambers and controlled by the power pistons, and cylinder exhaust and air chamber inlet ports controlled by the power pistons, of a mixing chamber connected to the pump and having air and gas inlets, a regulating valve actuated by the engine for controlling the admission of air and gas to the mixing chamber and the admission of the charge to the pump, and a governor controlling said valve.

4. In a gas engine, the combination with a power cylinder and pump cylinder and their pistons, an air chamber in which the engine compresses air, a charge inlet passage connecting the pump cylinder and power cylinder controlled by both the pump piston and power piston, a scavenging passage connecting the power cylinder with the air chamber and controlled by the power piston, and cylinder exhaust and air chamber inlet ports controlled by the power piston, said ports and pistons being arranged to open the charge inlet port to admit a portion of the charge before the scavenging and exhaust ports are closed, of charging devices for supplying the explosive charge to the pump for compression before admission to the power cylinder.

In testimony whereof, I have hereunto set my hand, in the presence of two subscribing witnesses.

WARREN P. VALENTINE.

Witnesses:
W. M. FLEMING,
H. M. CHASE.