

(No Model.)

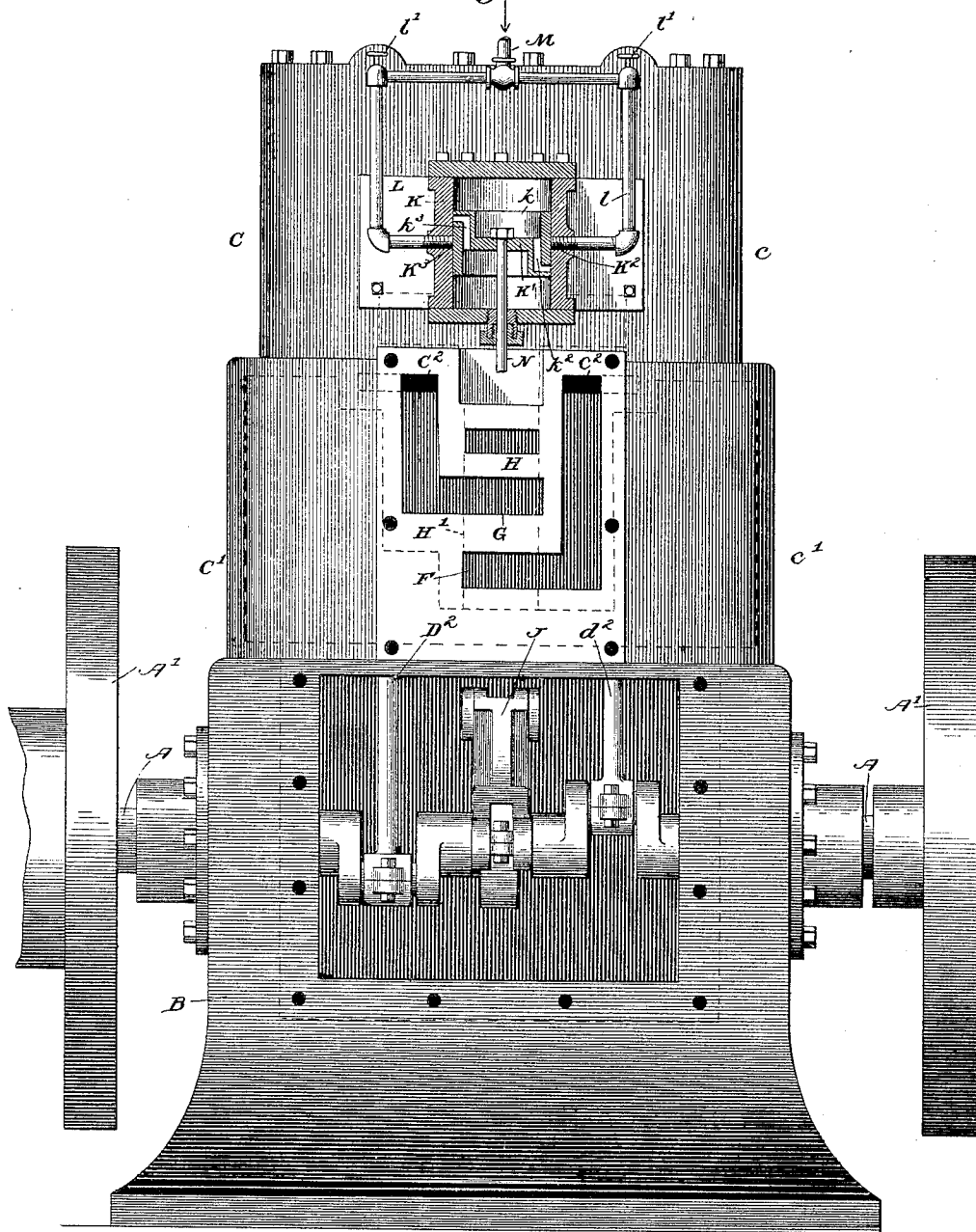
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W. O. WORTH.
GAS ENGINE.

No. 581,683.

Patented Apr. 27, 1897.

Fig. 1.



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(No Model.)

2 Sheets—Sheet 2.

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Fig. 2.

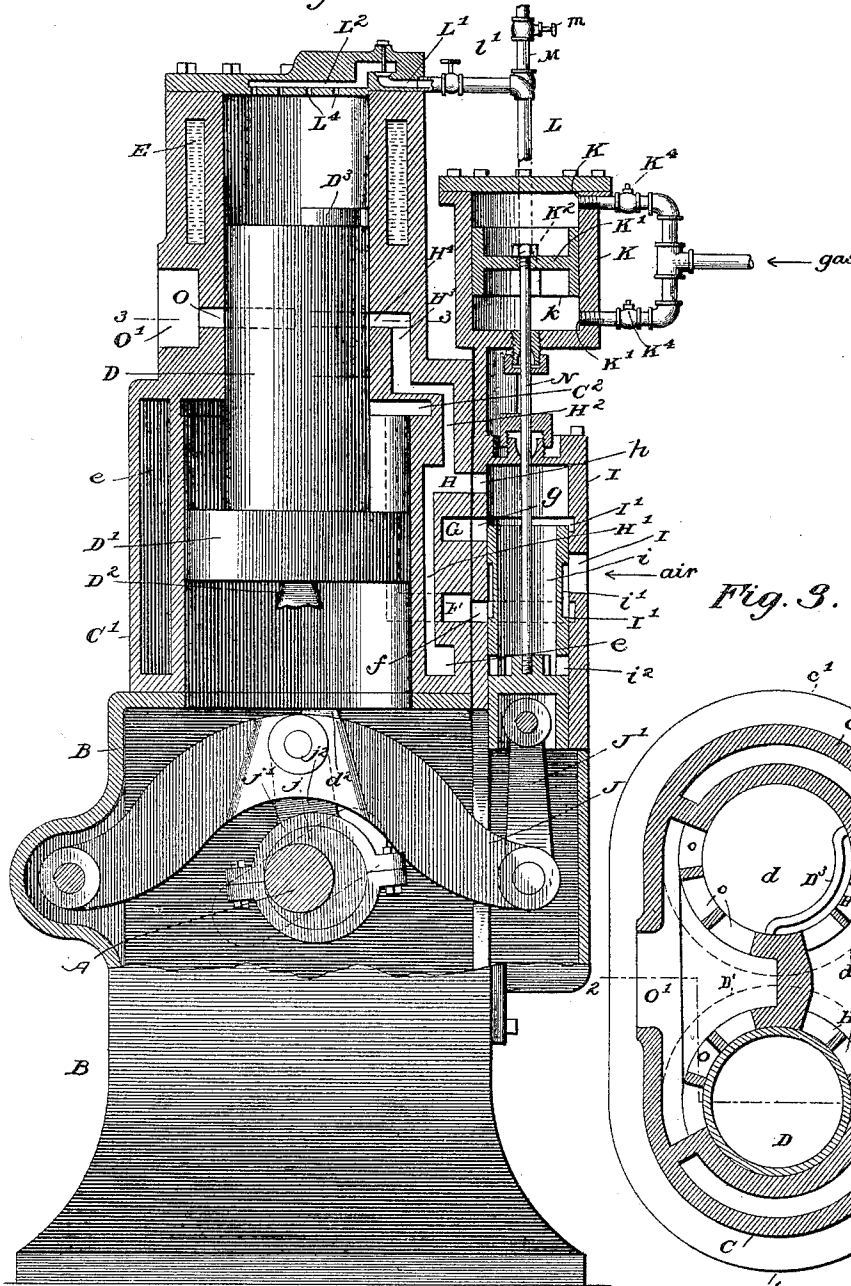
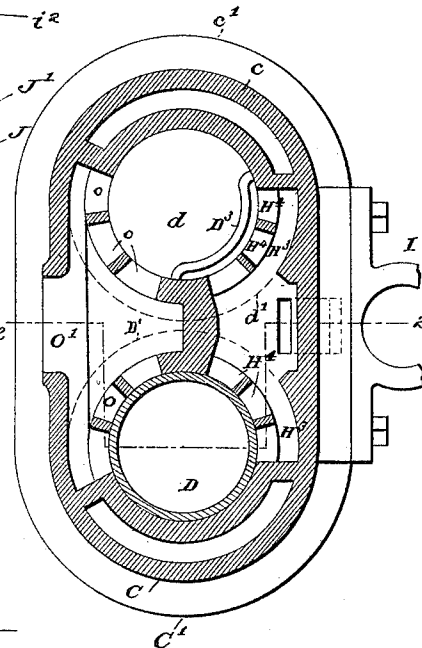


Fig. 3.



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UNITED STATES PATENT OFFICE.

WILLIAM O. WORTH, OF BENTON HARBOR, MICHIGAN.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 581,683, dated April 27, 1897.

Application filed June 17, 1895. Serial No. 553,091. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM O. WORTH, of Benton Harbor, in the county of Berrien and State of Michigan, have invented certain
5 new and useful Improvements in Gas-Engines; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form part of this
10 specification.

This invention is an improvement in gas or explosive engines; and its objects are to increase the efficiency of the engine, to economize fuel, to prevent premature explosions
15 or back firing, to prevent lubricating-oil getting into the air chambers or cylinders, to entirely clear the working cylinder of burned gases and fill it with fresh air after each explosion, and to make the working parts few
20 and simple in construction, so that the engine will be durable and not require a skilled engineer to operate it.

The invention is best defined in the claims, and the accompanying drawings illustrate a
25 duplex engine, one of the best forms known to me for carrying the invention into practice; but the invention is also applicable to single engines, as will be obvious to those skilled in the art when the duplex engine is
30 understood.

In said drawings, Figure 1 is a side elevation of the engine with one of the casing-checks and the main valve-box removed and
35 the gas-pump in section. Fig. 2 is a vertical section through the engine on line 2 2, Fig. 3. Fig. 3 is a transverse section on line 3 3, Fig. 2.

The main shaft A, carrying fly-wheels A', of the engine is journaled in suitable bearings in the ends of a hollow casing B, which is mounted on any suitable foundation and supports the pair of twin cylinders C C' and
40 c c'. Cylinders C c are the working cylinders and are directly over and smaller in diameter than the pump-cylinders C' c'. The working pistons D d in cylinders C c, respectively, are about as long as said cylinders and are rigidly fastened to the short pump-pistons
45 D' d', working in cylinders C' c'. The pistons D D' and d d' are tandem, and obviously may be formed in one piece, if desired,

and the cylinders C C' and c c' may be cast in one piece, as C C' and c c' are parts (but
55 of different diameters) of the same bore.

The pistons D' d' are respectively connected by pitmen D² d² to cranks on shaft A, which, as illustrated in drawings, are diametrically
60 opposite. Thus one cylinder is raised by the depression of the other.

The cylinders C' c' are substantially surrounded by an air-chamber e, and the firing or working parts of cylinders C c are surrounded by a water-jacket E, as shown.

At the rear side of the engine, in the walls
65 intermediate and exterior to cylinders C' c', are formed three air-passages F G H, which terminate exteriorly one above the other. (See Figs. 1 and 2.) The lowest passage F leads upward and then passes inward through
70 the rear wall of the cylinder-casting to an annular channel c² at the upper edge of cylinder c' and communicating therewith. The intermediate passage G leads upward and then passes through the wall of the cylinder-casting and communicates with an annular
75 passage C² at top of cylinder C'. The upper passage H passes inward and branches up and down, one branch, H', extending down to and communicating with the air-chamber
80 e (see Figs. 1 and 2) and the other branch, H², extending upward and communicating with a small air-chamber H³ intermediate the lower ends of cylinders C C', which communicates with the cylinders C c through ports
85 H⁴ when the latter are uncovered by the pistons D d, which act as main valves for cylinders C c.

On top of pistons D d are deflectors D³, which cause the inflowing air to pass up in
90 the cylinder instead of short-circuiting to the outlet-port. Over the outer ends of passages F G H is bolted a valve-casing I, which has three ports f g h, that register, respectively, with the ends of passages F G H, and within
95 this casing is a hollow cylindrical valve i, having an annular groove i' adapted to alternately register with ports f g as the valve is reciprocated and to simultaneously register with slots I' in the side of the casing, so that
100 air can enter cylinders C' or c' at proper times by passing through slots I', groove i', port f or g, and passage F or G, according to which port groove i' registers with.

When the valve *i* is lowered, so as to register groove *i'* with port *f*, it cuts off communication between port *g* and the atmosphere and establishes communication between ports *g* and *h*, so that compressed air can rush from chamber *e* through passage *G*, port *g*, casing *I*, port *h*, and passages *H H'* into chamber *e*, the air being at that time forced under pressure from cylinder *C'*, the piston *D'* in which is rising, while the piston *d'* is being lowered and sucking air into cylinder *c'* through port *I'*, groove *i'*, port *f*, and channel *F*. As the valve *I* rises it cuts off communication between ports *g h* and establishes communication between groove *i'* and channel *G*. At the proper moment in the upstroke of the valve a port *i²* therein is brought into register with port *f*, allowing air to pass from passage *F* through the hollow valve *I* up to port *h* into passage *H* and chamber *e*, as above described, air being then forced under compression from cylinder *c'*, while air is being sucked into cylinder *C'*. Valve *I* is raised and lowered at the proper times by means of a lever *J*, lying across the main shaft and pivoted at one end to the casing and at the other end pivotally connected by a link *J'* to the lower end of valve *I*. Said lever is oscillated by an eccentric *j* on the main shaft, the strap *j'* of which has an arm *j²* pivoted to the lever, so as to cause it to vibrate at the proper time.

Above casing *I* is a gas-pump cylinder *K*, having inlet-ports *K'* in its ends provided with check or other self-closing valves *K⁴*, also having opposite ports *K² K³* in its sides about midway of its length, which are respectively connected by pipes *L l* to passages *L'* in the heads of cylinders *C c*, respectively, these heads having interior chambers *L²*, communicating with passages *L'* and also with the interior of the cylinder through numerous openings *I⁴*, as shown, and check-valves *l'* are placed in passages *L'*, so as to prevent back firing of gases.

Hydrocarbon oils can be introduced into pipes *L l* near the cylinder-heads through needle-valves *m* from pipes *M*, as indicated in drawings.

Within cylinder *K* is a cylindrical combined double valve and piston *k*, which is reciprocated by means of a rod *N*, attached to a partition *K'* in valve *k* and to valve *i* and passing through suitable stuffing-boxes on upper end of casing *I* and lower end of cylinder *K*.

In one side of valve *k* is a port *k²*, which commences above partition *k'* and extends down below the same through an enlargement of the wall of the valve and terminates near the lower edge of valve in position to register with port *K²* when the piston is at or near the end of its upstroke. At the opposite side of the valve is another port *k³*, which commences below partition *k'* and extends up to near the top edge of valve and is adapted to register with port *K³* when the piston is at or near the lowest end of its

stroke. Thus the piston compresses air on both upward and downward strokes, and not until it about completes a stroke is the compressed air allowed to escape. Then it suddenly and violently passes through pipe *L* or *l* into the cylinder *C* or *c*, carrying with it the hydrocarbon dropped into the pipe through valve *m*. The violence of the draft and the form of the passages *L'* and chambers *L²* insure the thorough atomization of the oil and commingling thereof with the air, and the heat in chamber *L²* also assisting in volatilizing and diffusing the explosive mixture.

The oil-pipe *M* may be provided with a governor-valve operated mechanically from the engine, so as to regulate the supply; but as the function and mode of connecting a governor of this character are common and well known illustration and description thereof are not necessary.

In the front sides of cylinders *C c*, near their lower ends, are exhaust-ports *O o*, respectively communicating with a chamber *O'*, that connects directly or indirectly with the atmosphere.

Operation: In operation the tandem pistons are forced down by the exploding gases and air is sucked into the pump-cylinder, and when they near the lowest points of their stroke the exhaust-port of the working cylinder is opened and the gases pass out into the atmosphere, and immediately thereafter the air-inlet port is opened (the working piston itself being the main valve for said ports) and air under pressure flows in from chamber *e*. As the pump-cylinders are of much greater diameter than the working cylinders, a much greater amount of air is compressed into the air-chamber at each stroke of the pump-pistons than is required to refill the cylinders. The object of this extra charge of air is to insure the thorough cleansing out of the working cylinder after each explosion, for as soon as port *H⁴* is uncovered two or three volumes of cool air rush into and through the cylinder, cleaning out all the burned gases, reducing the temperature of the cylinder, and leaving it full of pure air, and as there is no gas or oil in chamber *e* there can be no back firing therein, particularly as the exhaust-port of the cylinder is opened and reduces the pressure of the burned gases in cylinders prior to the opening of the air-inlet port, which, when opened, allows air under great pressure to flow into the cylinder. As the pistons rise the air-inlet port is shut off, then the exhaust-port is closed, and thereupon the piston-valve *k*, having compressed a charge of air, allows it to suddenly escape into the cylinder and charge the pure air therein with explosive gases, which are mixed with the air and compressed during the remainder of the upstroke of the piston. These gases therefore cushion the upstroke of piston and by reaction would impart an initial downward movement thereto. Furthermore, during the upstroke of the pis-

tons air in the lower cylinder is compressed into chamber *e*. After the pistons have completed their upstroke the charge of combustible gases is ignited in any suitable way, as by an electric lighting device.

I have described the operation as if the engine was single, for obviously the invention is readily applicable to single engines; but where duplex engines are used, as shown in the drawings, the driven stroke of one piston serves to positively lift the other without depending upon the momentum of the main shaft to do this.

The working cylinders are cleared of burned nitrogenous gases after each explosion, the compressed air being introduced suddenly and in sufficient volume to force out the inert gases and fill the cylinder with pure air, and the gases are forced into the cylinder under greater compression than the air therein.

Where it is not desired to use hydrocarbons, gas may be pumped into the cylinder by pump *K* instead of air.

By pumping air on the upstroke of the cylinders into an air-chamber exterior to the cylinders I keep the air clear of lubricating-oil, which, if introduced into an air-chamber, particularly where it is mechanically stirred in such chamber, will gradually be worked into the valves and firing-cylinders, greatly impairing the efficiency of the engine and forming an explosive or combustible gas which is liable to and frequently does fire when admitted into the working cylinder and thus back-fire into the air-chamber, destroying the utility and reliability of the engine. This fault has been the great practical objection to engines using the bases as air-reservoirs and the pistons as main valves.

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

1. In a gas-engine the combination of a working cylinder having an exhaust-port, and an air-inlet port near one end; and a piston therein adapted to cover and uncover said ports; with a pump-cylinder of greater diameter than the working cylinder, the pump-piston connected to the working piston; and an air-chamber connected to said pump-cylinder, and to said air-inlet port, substantially as described.

2. In a gas-engine the combination of a working cylinder and a pump-cylinder of greater diameter than the working cylinder, connected pistons in said cylinders, and an air-reservoir chamber connected with said pump-cylinder, and a valve for closing communication between the pump-cylinder and air-chamber when the air-inlet port to working cylinder is open, all substantially as and for the purpose described.

3. The combination of a working and pump cylinder, and pistons therein, an air-chamber, and air-passages respectively communicating with said pump-cylinder, and air-chamber; with a valve and its operating mechanism

adapted to successively establish communication between the pump-cylinder passage and atmosphere, then between the pump-cylinder and air-chamber passages, and a ported passage connecting the air-chamber to the working cylinder, substantially as and for the purpose described.

4. The combination of a pair of working and pump cylinders and pistons, and an air-chamber; and separate air-passages communicating respectively with the air-chamber, and the working cylinders, and with a common valve-chamber; with a valve in said chamber and mechanism for operating said valve, whereby the passages to the pump-cylinders are alternately and successively put into communication with the atmosphere and with the air-chamber passage, and the ports leading from said air-chamber passage into the cylinder, all substantially as and for the purpose set forth.

5. The combination of a working and pump cylinder, and pistons therein, an air-chamber, and air-passages respectively communicating with said pump-cylinder, and air-chamber, with a valve and its operating mechanism adapted to successively establish communication between the pump-cylinder, passage and atmosphere, then between the pump-cylinder and air-receiver passages, and a ported passage connecting the air-chamber to the working cylinder; and a pump operated from said valve for ejecting compressed gases into said working cylinder, substantially as described.

6. The combination of a pair of working and pump cylinders and pistons, an air-chamber; and separate air-passages communicating respectively with the air-chamber, and the working cylinders, and with a common valve-chamber; with a valve in said chamber, and mechanism for operating said valve whereby the passages to the pump-cylinders are alternately and successively put into communication with the atmosphere and with the air-chamber passage, and the ports leading from said air-chamber passage into the cylinders; and a double-acting gas-pump adapted to force compressed gases into the working cylinders alternately, substantially as and for the purpose set forth.

7. The combination of the cylinder having inlet-ports at both ends, and intermediate outlet-ports; with the piston therein having a central partition, and opposite ports in its sides, respectively opening above and below the partition, adapted to respectively alternately register with outlet-ports of the cylinder when the piston is at opposite ends of its stroke, substantially as and for the purpose set forth.

8. In an explosive-engine, the combination, with the cylinder having a pumping-chamber and a combustion-chamber, a piston having an enlarged annular pumping portion and the reduced working portion and a supplemental air-chamber surrounding said cylinder, hav-

ing air-passages connecting it with the pumping-chamber and combustion-chamber of the cylinder; and a valve having a link connection to a lever actuated by a common eccentric placed upon the crank-shaft, said valve adapted to control the flow of air, both to and from the compression-cylinder and supplemental air-chamber, all substantially as set forth and shown.

9. In an explosive-engine, the combination with the cylinder having a pump-chamber and a combustion-chamber, a piston having an enlarged annular pumping portion and the reduced working portion, a supplemental air-chamber surrounding said cylinder, air-passages connecting the air-chamber and combustion-chamber of the cylinder, a valve adapted to control the admission of air to the air-chamber from the pump and to the combustion-chamber from the air-chamber, and a pump arranged to supply gas to the combustion-chamber, all substantially as set forth and shown.

10. In an explosive-engine, the combination of a cylinder having the pump-chamber and working chamber and a supplemental compressed-air chamber; of a cylindrical valve connected thereto by suitable ports or passages, and constructed and arranged to control the flow of air to and from the pump-chamber of the cylinder, all substantially as set forth and shown.

11. In an explosive-engine, and in combination, a cylinder having a compression-chamber and a combustion-chamber, an air-valve and a gas-pump arranged to reciprocate in unison, suitable passages and ports connecting said cylinder with said air-valve and gas-pump, and the link, pivoted lever, eccentric and power-shaft whereby the said valve and said pump are actuated, substantially as set forth and shown.

12. The combination of the tandem working and pump cylinders and connected pistons therein, an air-receiver exterior to the cylinders and air-passages in the walls of the cylinder-casting, respectively communicating with said pump-cylinder, and air-chamber; with a valve and its operating mechanism adapted to successively establish communication between the pump-cylinder, passage and atmosphere; then between the pump-cylinder and air-chamber passages; a ported passage connecting the air-chamber to the working cylinder, and a pump operated from said valve for ejecting compressed gases into said working cylinder after the exhaust-ports and main air-inlet ports are closed, substantially as described.

13. The combination of a pair of tandem working and pump cylinders and pistons, an air-receiver connected with both pump-cylinders; and separate air-passages communicating respectively with the air-chamber, and the working cylinders, and with a common valve-chamber; with a valve in said chamber and mechanism for operating said valve,

whereby the passages to the pump-cylinders are alternately and successively put into communication with the atmosphere and with the air-chamber passage, the ports leading from said air-chamber passage into the working cylinders closed and opened by the working pistons, and a double-acting gas-pump adapted to force compressed gases into the working cylinders alternately after the main air-supply is cut off, and connections between said pump and valve, substantially as and for the purpose set forth.

14. The combination of a pair of working cylinders and pistons, and a compressed-air receiver, communicating with the cylinders with a pump-cylinder having inlet-ports at both ends, and two intermediate outlet-ports respectively connected to the working cylinders, the pump-piston having a central partition, and opposite ports in its sides respectively opening above and below the partition, and adapted to respectively register with the outlet-ports of the pump-cylinder when the piston is at the ends of its stroke, substantially as and for the purpose set forth.

15. In an explosive-engine, the combination, with the cylinder having a pumping-chamber and a combustion-chamber, a piston having an enlarged annular pumping portion and the reduced working portion and a supplemental air-chamber surrounding said cylinder, having air-passages connecting it with the pumping-chamber and combustion-chamber of the cylinder; and a valve having a link connection to a lever actuated by a common eccentric placed upon the crank-shaft, said valve adapted to control the flow of air, both to and from the compression-cylinder and supplemental air-chamber, and means for injecting oils into the air entering the working cylinders, substantially as described.

16. The combination of a working cylinder having air inlet and exhaust ports, the piston therein forming the main air inlet and exhaust valve, the pump-cylinder and piston, an air-chamber, and air-passages respectively communicating with said pump-cylinder, and air-chamber; with a valve and its operating mechanism adapted to successively establish communication between the pump-cylinder passage and atmosphere, then between the pump-cylinder and air-chamber passages, and a passage connecting the air-chamber to the inlet-port of the working cylinder, a secondary auxiliary air or gas pump operated by said valve, and valved connection between said secondary pump and working cylinder, all substantially as and for the purpose set forth.

In testimony that I claim the foregoing as my own I affix my signature in presence of two witnesses.

WILLIAM O. WORTH.

Witnesses:

ARTHUR E. DOWELL,
JAMES R. MANSFIELD.