No. 796,686. PATENTED AUG. 8, 1905.

H. O. WESTENDARP.

EXPLOSION ENGINE.

APPLICATION FILED JAN. 20, 1903.

3 SHEETS—SHEET 1.

Fig. 1.

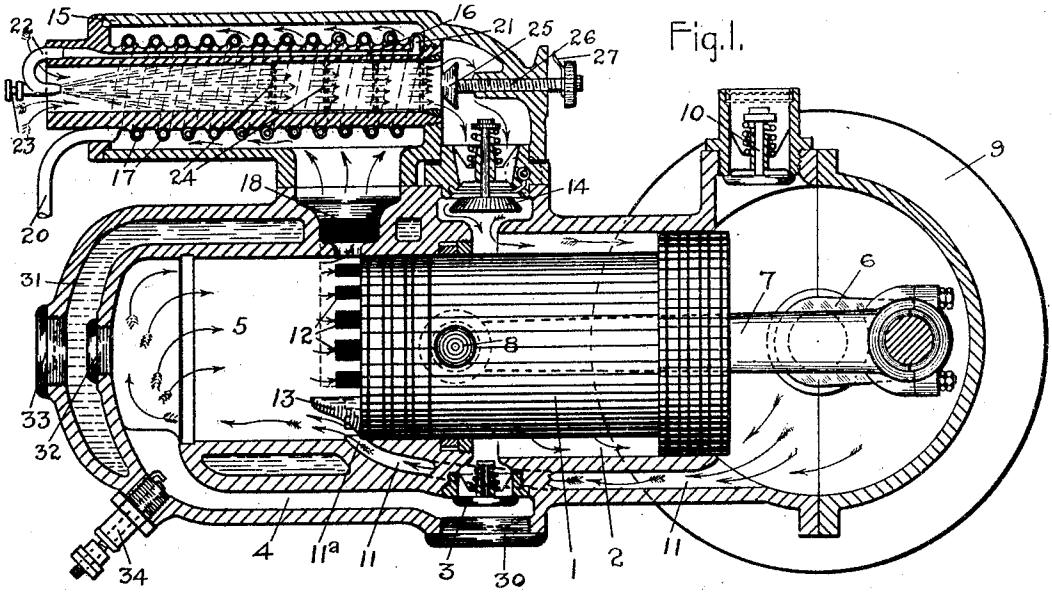
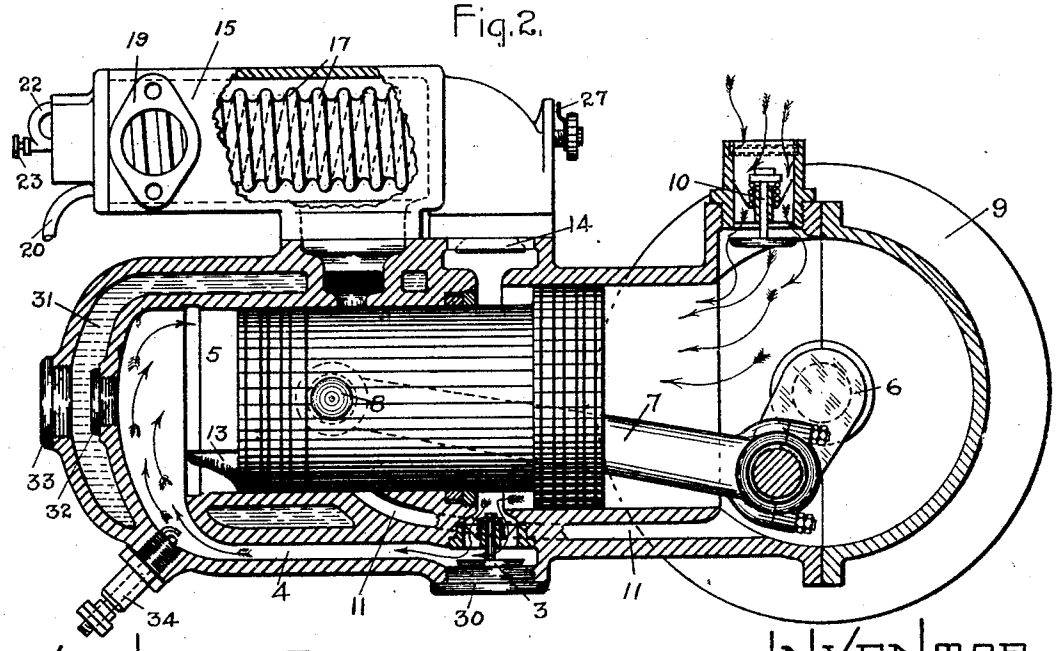


Fig. 2.



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3 SHEETS—SHEET 2.

Fig. 3.

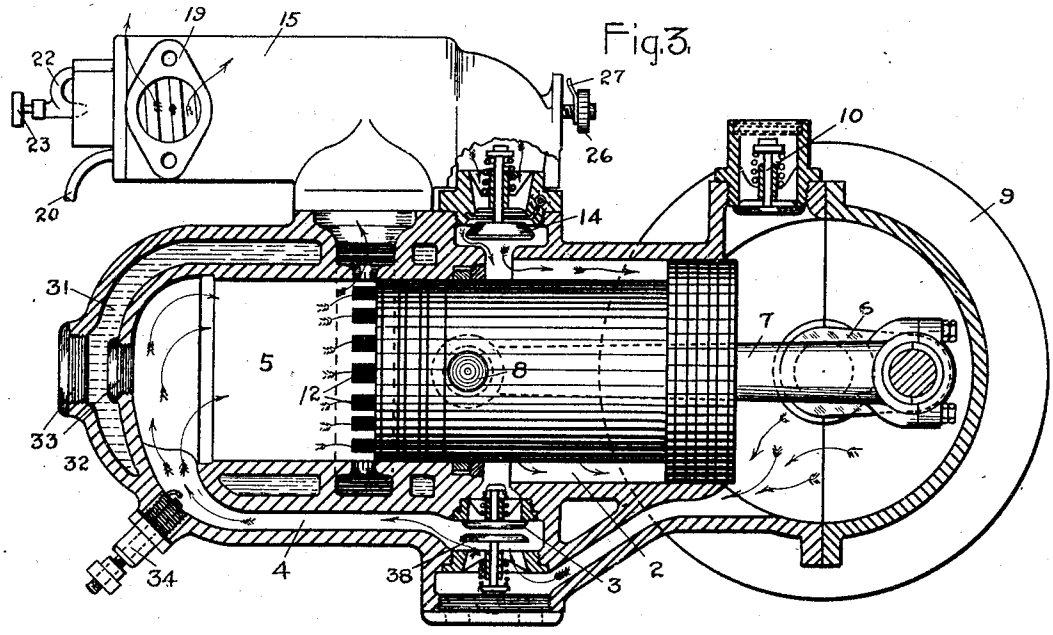
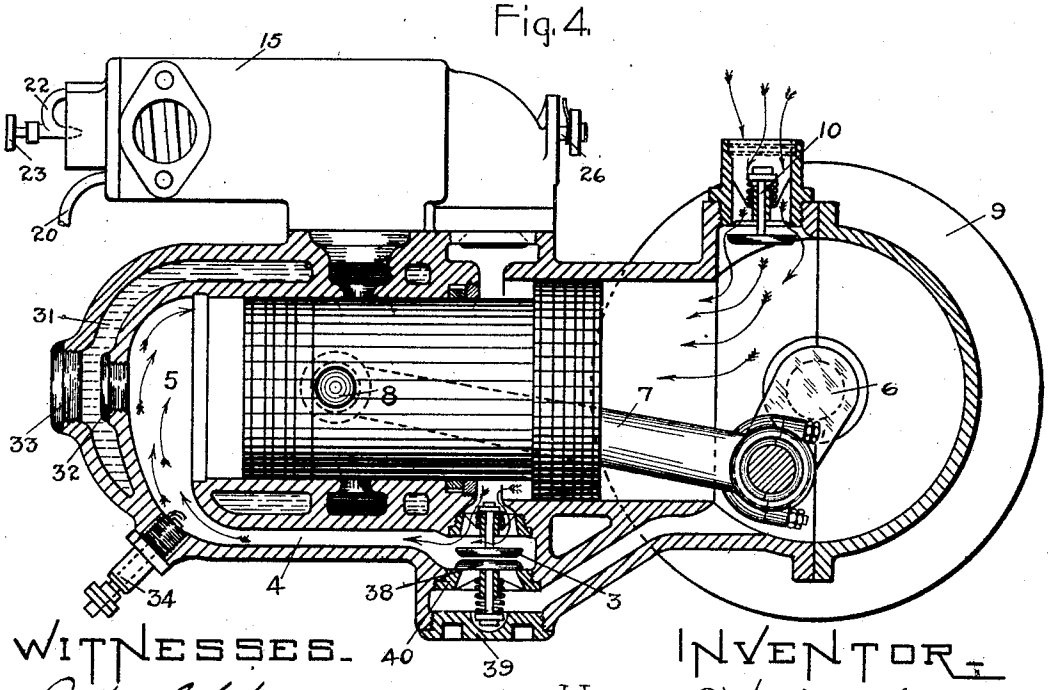


Fig. 4.



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3 SHEETS—SHEET 3.

Fig. 5.

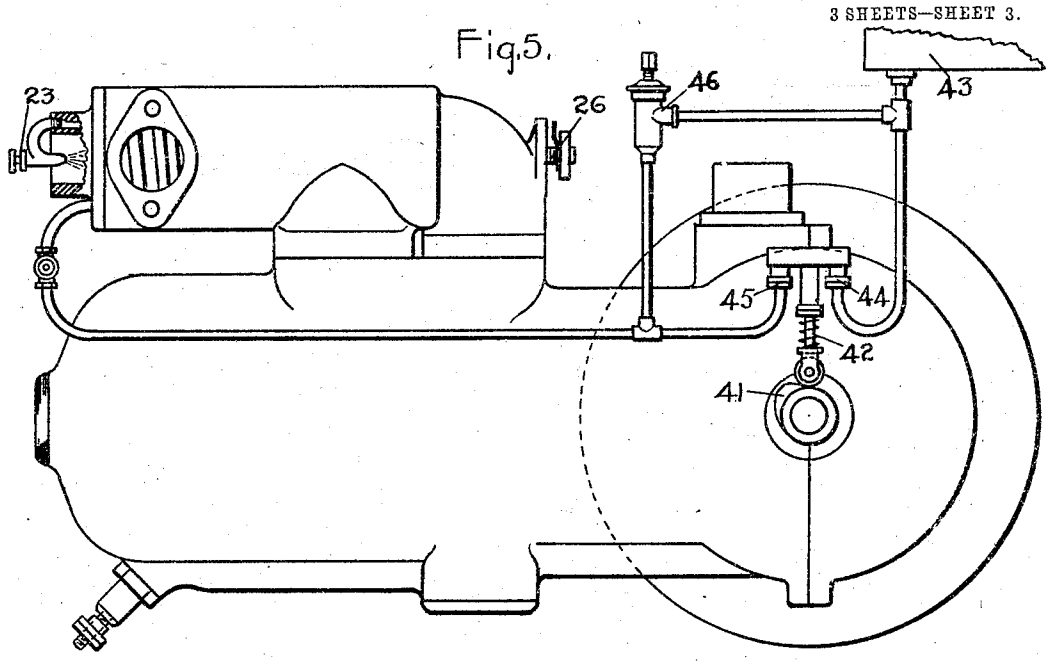
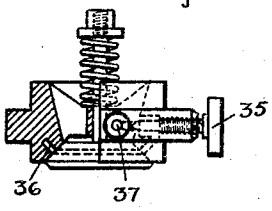


Fig. 7.



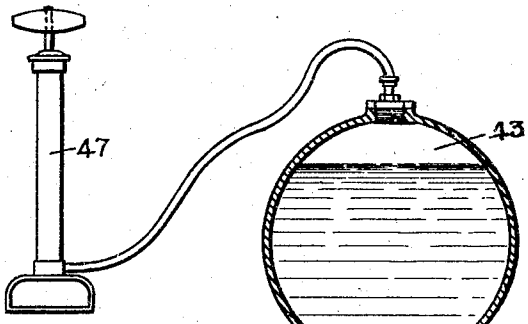
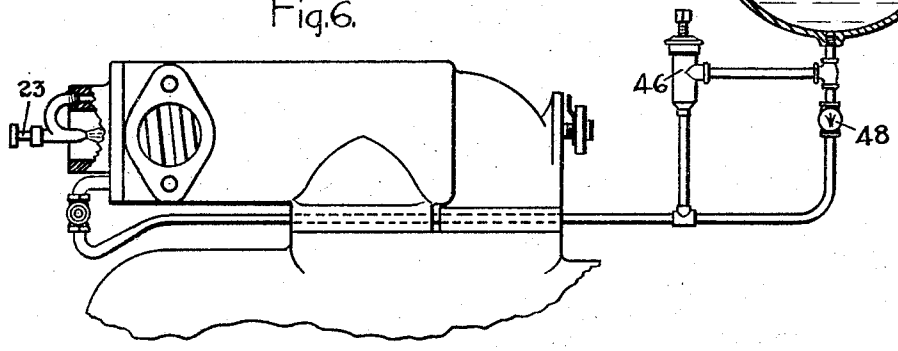


Fig. 6.



WITNESSES

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UNITED STATES PATENT OFFICE.

HENRY O. WESTENDARP, OF SAUGUS, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

EXPLOSION-ENGINE.

No. 796,686. Specification of Letters Patent. Patented Aug. 8, 1905.

Application filed January 20, 1903. Serial No. 139,839.

To all whom it may concern:

Be it known that I, HENRY O. WESTENDARP, a citizen of the United States, residing at Saugus, in the county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Explosion-Engines, of which the following is a specification.

The present invention relates to explosion-engines, and more especially to those adapted for kerosene-vapor; but the invention is not limited thereto, since certain of the novel features can be used with other types of engines.

In order to make an explosion-engine of high efficiency, the mean effective pressure must be high with a wide difference in temperature between the gases at the time of the explosion and at the exhaust.

In the kerosene-engines with which I am familiar it is impossible to get a very high degree of compression, due chiefly to the fact that the entire charge of fuel and air properly mixed to burn and of high temperature is admitted to the cylinder at a time when the piston is at the outer end of its stroke. This means that the entire charge of inflammable vapor is being compressed in the cylinder, and with the cylinder-walls and head hot the temperature attained by compression will be high enough to fire the charge before the end of the compression-stroke, resulting in what is commonly called "preignition."

The present invention has for its object to improve the construction and operation of an explosion-engine, and more especially an engine of the kerosene type. My improvements are directed chiefly to the construction and arrangement of the parts whereby the proper mixture can be supplied to the cylinder under favorable conditions for burning and this without danger of preignition. By reason of these improvements I am enabled to provide an engine the output of which is high for the amount of metal used in its construction. I am also enabled to use a high mean effective pressure which is conducive to good economy.

For a consideration of what I consider to be novel and my invention attention is called to the description and claims appended thereto.

In the accompanying drawings, which represent an embodiment of my invention, Figure 1 is a longitudinal section of an explosion-engine, showing the piston in a scavenging position. Fig. 2 is a longitudinal section of said engine with the piston in the act of forcing an explosive hydrocarbon vapor mixed with a certain amount of air into the cylinder-space. Fig. 3 is a longitudinal section of an explosion-engine of a slightly-modified type wherein the passage carrying the explosive mixture and the cylinder-space are both scavenged. Fig. 4 is a longitudinal section of the same engine, showing the piston in the act of forcing the explosive mixture into the cylinder. Fig. 5 is a side elevation of the engine, showing the fuel-pump for forcing fuel into the vaporizer. Fig. 6 is a detail view showing a fuel-tank working under air-pressure for supplying fuel to the engine-vaporizer, and Fig. 7 illustrates a means for starting the engine by means of gasolene or other light hydrocarbon fuel.

The engine shown is of the two-cycle type and is provided with a double-area piston 1, working in a double-area cylinder. That portion of the piston having the larger area is employed to indraw a charge of fuel mixed with a certain amount of air into the cylinder-space 2 and discharge it through the automatic-acting valve 3 into the passage 4, the latter being in unrestricted communication with the cylinder 5, in which the smaller end of the piston travels. Mounted within a suitable case of the inclosed type is a crank 6, to which the piston-rod 7 is connected. The piston being of the trunk type, no guides are necessary, and the rod is connected thereto by the pivot 8. Mounted on the main shaft of the engine is a fly-wheel 9, which may be employed to impart motion to the apparatus driven by the engine as well as to act as a balance-wheel. The cylinder-space 2 opens directly into the closed crank-case, and as the piston moves inward its right-hand head serves to draw air through the automatic suction-valve 10 and as it moves out to discharge the air through the passage 11 in the cylinder-wall into the cylinder-space 5 to the left of the small end of the piston. It is to be noted that the fuel-carrying passage 4 and the air-carrying passage 11 are entirely distinct. The cylinder 5 is provided with a series of exhaust-ports 12, and to prevent the fresh air from passing directly out through the exhaust-ports a deflector 13 is provided, which is attached to the end of the piston. The passage

of the air during the outward stroke of the piston is as indicated by the arrows, Fig. 1. The air passes through the passage 11, thence around the valve 3, after which it is discharged into the cylinder-space 5, and by reason of the deflector it is discharged toward the cylinder-head instead of passing directly through the exhaust-ports. The end of the passage 11 terminates in a port or ports 11^a, which are covered and uncovered by the movements of the main piston. The ports are so related that in moving outward the piston first uncovers the exhaust-ports and then the air-admitting ports. On moving inward the piston first closes the air-admitting ports and then the exhaust-ports. As the piston moves outward the suction created by the left-hand side of the enlarged head causes the fuel-valve 14 to open to permit a change of hydrocarbon vapor and air to enter the cylinder-space 2. During the inward movement of the piston the mixture in the cylinder-space 2 is compressed and the valve 3 opens and permits the mixture to enter the passage 4, from which it is discharged into the end of the cylinder. The inward movement of the piston also causes the suction-valve 10 in the crank-casing to open and admit air, as is indicated by the arrows, Fig. 2. In order to properly vaporize kerosene or other hydrocarbon before delivering it to the engine, a vaporizer is provided, which is bolted to the upper side of the cylinder. The vaporizer is made detachable for the purpose of cleaning and repairing. It comprises a cylindrical body or heating-chamber 15, having a downwardly-extending hollow projection which is arranged to register with the passage receiving the exhaust-gases. Mounted within the said body is a tubular support or mixing-chamber 16, which is threaded to the said body on the right-hand end, the left-hand end being provided with a shoulder that engages with the cylindrical body 15. This shoulder engaging with the cylindrical body or shell acts to center and support the interior parts of the vaporizer. Surrounding the tube 16 is a coil of pipe 17. The oil enters the pipe at its outer end and flows inwardly in the direction opposite to that of the exhaust-gases, or, in other words, the oil passes from the cold portion of the coil to the relatively hot portion, so as to be gradually heated to the point of vaporization by the exhaust-gases. It is to be noted in connection with this that the exhaust-port 12 communicates with the space 18 and that the latter is in direct communication with the interior of the cylindrical body or support of the vaporizer. The passage of the exhaust products through the vaporizer is as indicated by the arrows. The front side of the casing 15 is provided with a flange 19, to which the exhaust-pipe is connected.

As the oil enters the vaporizer from the pipe 20 it circulates through the coil 17 until it reaches the inner turn 21, from which it is discharged in the form of vapor into a longitudinally-extending passage that delivers the vapor into the mixing-chamber at its outer end by the nozzle 22, the latter being curved, so that it enters the chamber preferably in an axial position. The nozzle is provided with a regulating device 23, by means of which the amount of fuel in the form of spray or vapor delivered can be controlled. A certain amount of air for producing an explosive mixture is drawn into the tube by the action of the vapor issuing from the jet, and the balance is supplied by the atmospheric air from the closed crank-case. The vapor and air enter the tube at the outer end and pass toward the inner end, where they discharge through the throttling device as a uniformly-heated carbureted fuel. In passing through the mixing-tube the air is thoroughly heated while combining with the vapor. In order to insure the mixing of the air and vapor, one or more screens or similar devices 24 are placed inside of the tube 16, so that it or they act on the vapor stream prior to the time the latter passes through the suction-valve 14. In order to regulate the amount of mixture, a throttling device is provided comprising a conical valve 25, which is mounted opposite a suitable seat, the latter being carried by the end of the tube 16. The valve is controlled by a screw-threaded spindle 26, and a pointer 27 is provided, so that the position of the valve can be ascertained from the outside of the casing. When the valve 25 is partially closed, it is evident that a partial vacuum will be created in the cylinder-space 2; but this does not mean a loss of power, because the energy is substantially given back on the return stroke.

It will be seen that the vaporizer as a whole can be detached from the engine, or the tube 16 and the vaporizing-coil 17 can be removed by unscrewing the tube. In removing the tube the seat for the conical valve 25 is also removed.

Situated opposite the discharging-fuel valve 3 is a screw-threaded detachable plug 30, through which the valve and its detachable seat are rendered accessible.

To reduce the temperature of the engine parts, a system of water-cooling may be used comprising one or more water-containing chambers 31, which surround the cylinder and the head. The head is provided with a detachable plug 32 and the outer casing with a somewhat larger detachable plug 33, by means of which the interior of the cylinder can be inspected.

In order to fire the mixture at the proper time, a sparking plug 34 is provided, and suitable electrical means are connected thereto for furnishing a spark. The mixture which passes through the valve 3 is too rich in hydrocarbon to burn explosively until after it mingles with the air within the cylinder left after the scavenging. In this connection it

is to be noted that the inward movement of the piston first covers the port 11ª, connected with the air-carrying passage 11, and then covers the exhaust-ports 12. By means of this arrangement a certain amount of practically pure air is trapped in the cylinder and afterward compressed by the piston. This body of compressed air mingles with the rich mixture from the fuel-valve 3 under compression, and by reason of its being between the piston-head and the fuel a high degree of compression can be obtained without preignition. It is only after the vapor is thoroughly mixed with the air that the explosion can take place, and this mixing is only complete at or about the time the crank is passing the dead-center. The firing takes place by means of a sparking device which operates when the mixture contains the proper amount of air.

It is customary to start a kerosene-engine by using a torch or similar device to heat the vaporizer. This is objectionable for obvious reasons. I have so arranged the engine that it can be started with gasolene without the use of a torch or equivalent device. To accomplish this, a source of gasolene (not shown) is provided which is piped to the fuel-admission valve and is controlled by a valve 35, Fig. 7. The seat of the main fuel-admitting valve is provided with a groove 36, that communicates with the gasolene-carrying pipe 37. When the valve 35 is open, gasolene is freely admitted to the groove 36; but so long as the main valve 14 is closed it cannot escape. As soon, however, as the valve opens, due to the outward movement of the piston, the gasolene entrains with the air and forms an explosive mixture. After the engine is started the kerosene-supply is admitted and that of the gasolene cut off. Under certain conditions it may be found desirable to permit a certain amount of gasolene to mingle with the kerosene-vapor even after the engine is started.

In Figs. 3 and 4 is shown a slight modification of the invention. The former figure shows the piston at the end of its scavenging stroke, while the latter shows it in the act of compressing the fuel charge. The essential difference between this engine and the one previously described is that the fuel-carrying passage 4 also acts as an air-carrying passage. The advantage of this arrangement lies in the fact that no opportunity is afforded for a body of gas to be pocketed.

Using the passage 4 for a double purpose—*i. e.*, conveying combustible and pure air—necessitates an additional valve 38 for controlling the passage of air from the crank-casing. The fuel-valve 3 and the air-valve 38 are oppositely disposed, so that when one is open the other is closed. By removing the plug 39 the valve 38 is rendered accessible, and by removing the valve-seat 40 the fuel-valve is accessible.

As shown in Fig. 3, the valve 38 is open and air is being forced into the cylindrical space 5 to wash out or scavenge the products of combustion from the cylinder and also any gas that may remain in the passage 4.

In Fig. 4 air is being admitted to the crank-case by the valve 10 and a mixture rich in fuel is being forced through the valve 3 into the passage 4 and cyindrical space 5. The mixture mingles with and picks up air enough to burn explosively as soon as it is compressed to the proper degree. When the crank is at or about a dead-center, a spark from the plug 34 fires the mixture and a new cycle begins.

In Fig. 5 is shown a pump for forcing fuel into the vaporizer. Mounted on the end of the main shaft is a cam 41, that imparts an inward movement to the pump-piston 42 once for every revolution, a spring being employed to force the piston outward. 43 represents a fuel-tank, and 44 the suction, and 45 the delivery-valve. When the charge is throttled by the valves 23 and 25, the normal delivery of the pump is too great, and in order to take care of the excess an adjustable by-pass valve 46 is provided in a connection that shunts the pump.

In Fig. 6 is shown a modified form of fuel-supplying means comprising a fuel-tank 43, working under air-pressure due to a pump 47. A check-valve 48 prevents the return of fuel to the tank except through the adjustable by-pass 46.

In accordance with the provisions of the patent statutes I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is merely illustrative and that the invention can be carried out by other means.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a two-cycle explosive-engine, the combination of a power-cylinder having exhaust-ports at its forward end, a piston therein which covers and uncovers the exhaust-ports by its movement, a crank-casing in which air is compressed by the piston, a conduit through which air is discharged from the casing to the cylinder when the exhaust-ports are uncovered, and means for injecting a charge of mixture through said conduit to the cylinder successively to the discharge of air therethrough.

2. In a two-cycle explosive-engine, the combination of a power-cylinder having exhaust-ports at its forward end, a piston therein which covers and uncovers the exhaust-ports by its movement, a crank-casing in which air is compressed by the piston, a conduit extending from the casing to the cylinder, a valve therein which opens to permit air to pass the cylinder when the pressure in the latter is below that in the casing, and means for injecting a charge of mixture through said conduit to

the cylinder after the air charge passes therethrough.

3. In a two-cycle explosive-engine, the combination of a power-cylinder having exhaust-ports at its forward end, a piston therein which controls the exhaust-ports, a conduit which opens into the compression-space of the cylinder, and means for delivering successively a charge of air through said conduit to the cylinder while the exhaust-ports are open and a charge of mixture when said ports are closed.

4. In a two-cycle explosive-engine, the combination of a power-cylinder having exhaust-ports, a piston working in said cylinder, which controls the ports, a conduit which opens into the compression-space of the cylinder, a means for delivering a charge of air through said conduit to the cylinder when the piston uncovers the exhaust-ports, and means for delivering a charge of mixture through said conduit to the cylinder after the piston closes the exhaust-ports.

5. In a two-cycle explosive-engine, the combination of a power-cylinder having exhaust-ports, a piston working therein which controls the ports, a conduit which opens into the cylinder, a valve in said conduit which admits a charge of air to the cylinder at the time the piston uncovers the exhaust-ports, and a second valve in said conduit which admits a charge of mixture after the admission of the air charge.

6. In a two-cycle explosive-engine, the combination of a power-cylinder having exhaust-ports, a piston working therein, a piston and cylinder of larger area at the forward end of the power-piston, a crank-casing in which air is compressed during the forward stroke, an inlet-valve through which a charge of mixture is admitted to the cylinder of larger area during the forward stroke, a conduit between the power-cylinder and crank-casing, and separate valves which permit charges of air and mixture to pass successively through said conduit to the power-cylinder from the crank-casing and the cylinder of larger area respectively.

7. In a two-cycle explosive-engine, the combination of a double-area cylinder forming explosion and mixture chambers, a double-area piston, exhaust-ports in the explosion-chamber, a crank-casing in which air is compressed during the forward stroke of the piston, an automatically-actuated inlet-valve for the mixture-chamber, a conduit cored out in the cylinder which extends from the crank-casing to the explosion-chamber, an automatically-actuated valve in said conduit which opens toward the cylinder, a connection between the mixture-chamber and the conduit at the discharge side of the valve in the latter, and an automatically-actuated valve in said connection from which the mixture is discharged through the conduit to the explosion-chamber.

In witness whereof I have hereunto set my hand this 16th day of January, 1903.

HENRY O. WESTENDARP.

Witnesses:

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DUGALD MCK. MCKILLOP.