No. 880,704. PATENTED MAR. 3, 1908.

M. L. WOOD.

GAS ENGINE.

APPLICATION FILED FEB. 5, 1907.

2 SHEETS—SHEET 1.

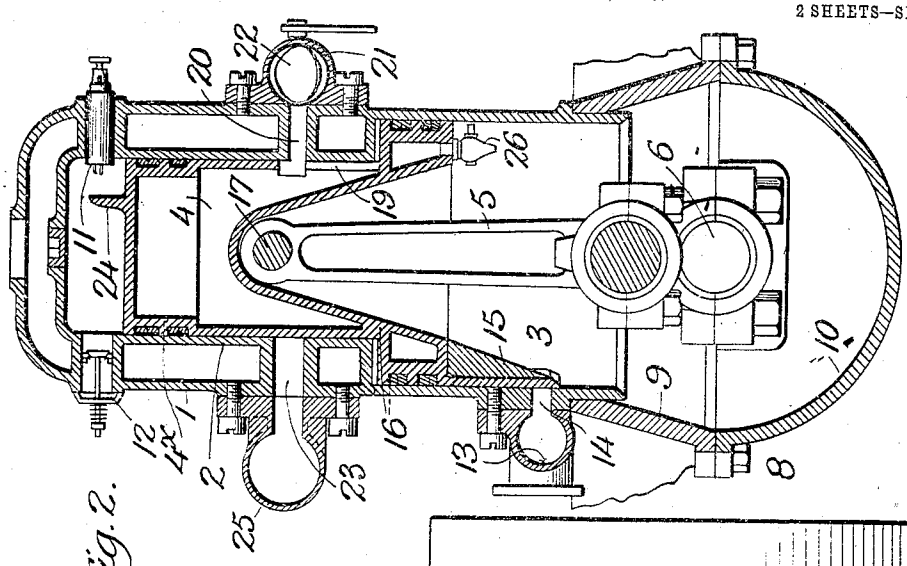


Fig. 2.

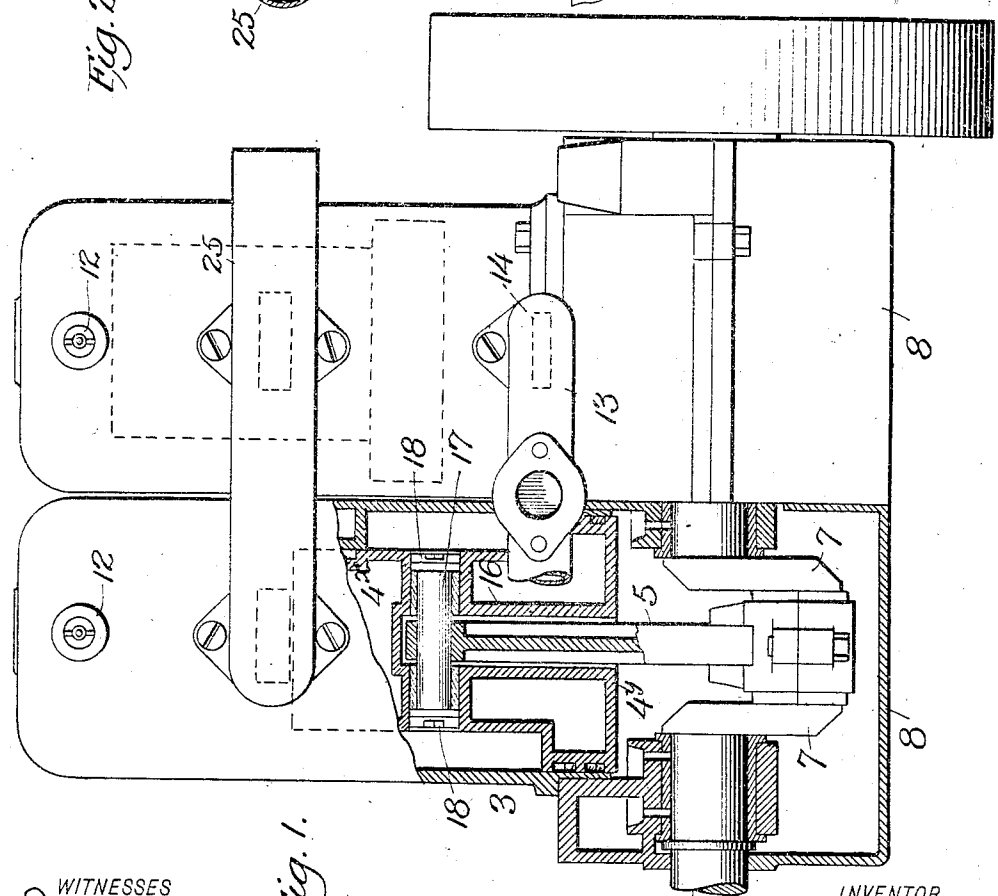


Fig. 1.

WITNESSES

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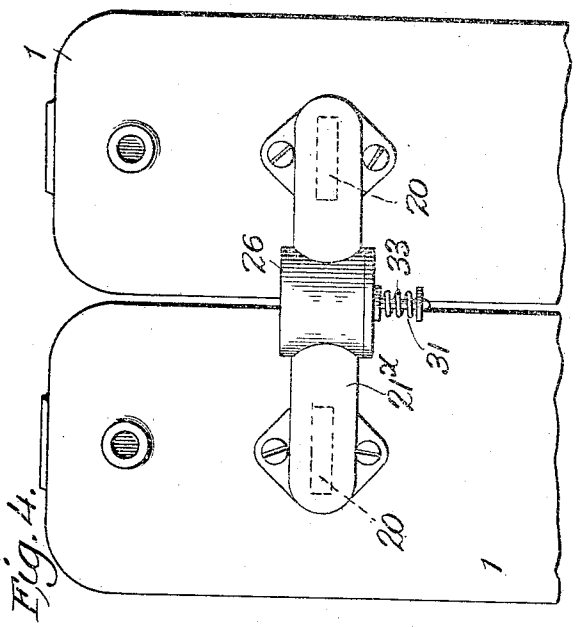


Fig. 4.

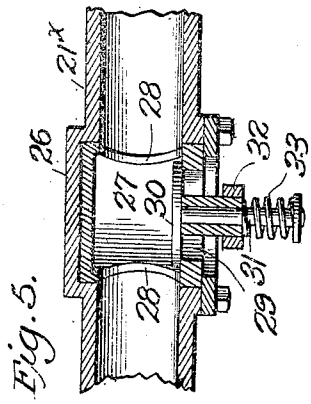


Fig. 5.

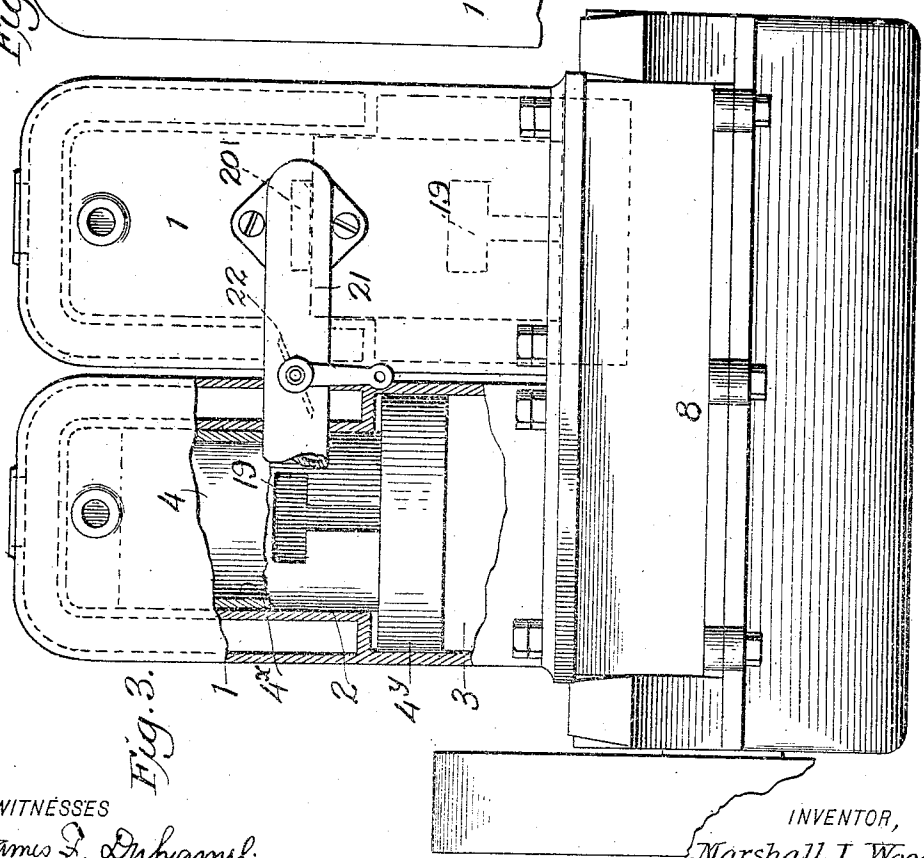


Fig. 3.

WITNESSES

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GAS-ENGINE.

No. 880,704. Specification of Letters Patent. Patented March 3, 1908.

Application filed February 5, 1907. Serial No. 355,782.

To all whom it may concern:

Be it known that I, MARSHALL L. WOOD, a citizen of the United States of America, and a resident of Montpelier, Washington county, Vermont, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification.

This invention relates to internal combustion or explosive engines.

One object of the invention is to provide such an engine embodying improved means for compressing the charge of explosive vapor and air which constitutes the fuel and introducing the same in such condition into the combustion-cylinder.

A further object of the invention is to provide a multi-cylinder engine in which the piston in each cylinder is factitive in introducing the fuel-charge into another cylinder.

The invention also aims to provide a construction in which the fuel, which may consist of gas of various kinds and air, or the vapor of some hydrocarbon and air, or any other suitable explosive mixture or compound, and which arrives in cool condition from the carbureter, is introduced within each piston, each piston being constructed of hollow form for the purpose, whereby a cooling of the piston and adjacent parts, and gasification of the fuel-charge, are produced.

It is also an object of the invention to furnish an engine embodying improved mechanism whereby a relatively small body of air may be introduced into the cylinder, after the explosion, in advance of the fresh charge of fuel, so that the cylinder may be thoroughly scavenged or purged of the burned gases, without pollution of the incoming fuel charge and without loss of fuel; also to prevent "back firing" by thus separating the burning gases from the fuel charge.

It is also an object of the invention to furnish a multi-cylinder engine in which the fuel-charge is supplied in exactly the same amount to all the cylinders, this amount being very readily regulated.

The invention further purposes the reduction of the number of valves and valve-operating devices, the admission of fuel to the pump-section and combustion-section of each cylinder being controlled automatically by the movement of the pistons, which directly cover and uncover at the proper time the various admission ports and also the exhaust ports.

In the accompanying drawings, in which the same parts are denoted by the same reference characters throughout the several views, Figure 1 is a side elevation, partly in section, of an explosive engine constructed in accordance with the invention. Fig. 2 is a vertical transverse section through one cylinder. Fig. 3 is a side elevation from the side opposite to that shown in Fig. 1, certain parts being broken away for the sake of clearness. Fig. 4 is a detail elevation showing a modified form of the transfer-pipe governing valve, and Fig. 5 is a vertical longitudinal section through the transfer-pipe and valve shown in Fig. 4.

The drawing illustrates a two-cylinder engine embodying the invention. The invention is not applicable to an engine having a less number of cylinders, but, on the other hand, the number of cylinders may be as great as desired.

1 denotes the cylinders of the engine. Said cylinders are of similar construction, each being divided into an upper combustion section 2, and a lower pump-section 3 of greater inner diameter than the combustion section. These sections are preferably formed of a single casting. The upper section 2 is water-jacketed, as shown, the water-jacket extending over the upper closed end of said section being there provided with a suitable outlet.

4 denotes the pistons, which are constructed in a manner to be presently described.

5 denotes the connecting rods; 6 the crank shaft; and 7 the crank-arms, which are arranged at an angle of 180 degrees. A crank-case 8 incloses the cranks and serves as a container or reservoir for the lubricant, in which the crank-arms dip at every revolution, in the usual manner. Said crank-case is preferably constructed in two superposed parts 9, 10, which are bolted together, as shown. The upper part 9 is secured about the lower open ends of the pump sections of the cylinders, as shown in Figs. 1 and 2, and forms the main frame.

11 indicates the spark plug of each cylinder which may be of any approved type and is arranged at one side of the cylinder near the upper end of the combustion-section of such cylinder; and opposite each spark-plug there is arranged a suitable relief-valve 12; or relief cock of the usual type.

The engine is supplied with a combustible charge, such as a mixture of air and any suitable hydrocarbon, from a carbureter or

mixing device (not shown). This carbureter or mixing device is connected to the intermediate portion of a supply-pipe 13 which connects ports 14 in the pump-sections 3 of the cylinders at the same side of the engine and near the bottom edges of said pump-sections. The charge of suitable fuel, such as combustible vapor and air, after entering the pipe 13 at its intermediate portion, passes into the pump-sections 3 through the ports 14 as the ports are alternately opened to receive same. Ports 14 may be changed in position if desired, and a check-valve used to admit directly into the pump cylinder.

The pistons 4 are similarly constructed and each is formed in two sections or parts: a working piston 4^x, and a pump-piston 4^y. These two piston-sections are preferably cast integrally and the upper working-section fits within the combustion-section of its cylinder, while the lower pump-section fits within the pump-section of said cylinder. The working-section of each piston is of less diameter than the pump-section, but is somewhat longer, as shown. A thrust shoe 15 is formed integral with each piston 4 at its lower edge, and slides over the inlet-port 14 of the corresponding pump-cylinder in order to prevent loss of fuel into the crank-case through said port. Said port is only open when the piston is at the end of its downward stroke, the pump-piston having passed downwardly beyond said port.

One essential feature of the invention consists in forming the pistons 4, comprising the working and pump-pistons 4^x and 4^y, of hollow form. Each piston is covered at the top by an integral plate and at the bottom by an integral plate with conical reëntrance hood which extends well up into the working-piston and in which the connecting rod 5 is journaled. Said connecting rod is journaled in the piston by means of a wrist-pin 17 extending laterally through said hood and journaled in bearings at its upper inner end, and in order to make the piston tight against the ingress of air or egress of fuel at this point the piston is plugged at the ends of said wrist-pin, as shown at 18.

Communication with the interior of each hollow piston 4 is afforded by a T-shaped port 19 in the side-wall of the working piston or section, as shown in Figs. 2 and 3. When the piston is in its lowermost position, said port 19 is within the corresponding pump-cylinder and hence permits the fuel-charge which has entered said cylinder to enter the piston 4. When said piston reaches its uppermost position, said port is brought into register with a rectangular port 20 in the side-wall of the corresponding combustion-section of the cylinder. This port is connected by means of a transfer-pipe 21 with the corresponding port 20 of the adjacent cylinder, of which the piston is oppositely arranged. As shown in Fig. 3, a valve 22 of the butterfly type is arranged within the transfer-pipe 21 intermediately of its connection with the ports 20, and said valve may be adjusted in any desired manner to regulate the communication between said ports.

23 denotes the exhaust port of each cylinder. This is arranged approximately opposite the port 20, which may be termed the transfer-port, and in order to prevent the incoming fuel-charge from passing out of the exhaust-port, a baffle or deflector 24 is fixed to the working piston 4^x at its upper end, being preferably cast integral therewith, as shown. The fuel-charge after entering the combustion-cylinder through its port 20 is deflected in upward direction, and away from the exhaust ports, by said baffle.

The exhaust-ports 23 are controlled directly by the working-pistons, said ports being closed thereby except when said pistons are at the end of their downward stroke. In this position each working piston 4^x has passed entirely below and uncovered the corresponding exhaust-port, as indicated by the dotted lines at the left of Fig. 1. The exhaust-ports lead into an exhaust-pipe 25. A draw-off cock 26 is preferably provided in the bottom of each piston in order that oil or other liquid which may accumulate within such piston may be drawn off when desirable.

The operation of this form of engine is as follows: When one piston is near the end of its downward stroke and the other near the end of its upward stroke, the pump-section of the former uncovers at its upper edge the inlet-port 14, thus permitting the charge from the carbureter to enter the pump-cylinder 3, by reason of the vacuum caused therein. In this position of the piston the port 19 thereof is down in the pump-cylinder, and accordingly the charge enters the piston through said port. Upon the upward movement of the piston the charge is driven out of the pump-cylinder by the pump-section of the hollow piston and compressed within said piston, the port 19 remaining in communication with the pump-cylinder until the piston reaches the upper limit of its movement, as shown in Fig. 2. The fuel-charge in being driven out of the pump-cylinder and confined within the comparatively smaller space within the hollow piston 4 is subjected to considerable compression. When the piston approaches the upward limit of its movement the port 19 comes into register with the port 20, and this permits the charge to rush out of the hollow piston and through the transfer-pipe 21. The amount of charge which passes through said transfer-pipe is regulated by means of the throttle valve 22. After passing through the transfer-pipe the charge is admitted into the combustion-section of the next cylinder,

the piston of this cylinder being at the end of its down-stroke so that the port 20 is uncovered by the upper edge of said piston. The charge in entering the combustion-cylinder strikes against the baffle 24 carried by the piston and is deflected in upward direction in order to prevent its outward passage through the exhaust-port 23. Upon the upstroke of this last-named piston the charge is compressed by the working-section of said piston in the upper part of the combustion-cylinder and ignited by the spark-plug 11 when the piston approaches the upward limit of its movement. During this upward movement of the piston, a fresh charge of fuel is being compressed within said piston in the manner before described, and the fuel charge passes into the combustion-section of the first-mentioned cylinder, when the piston reaches the end of its upstroke. When the piston reaches the end of its downward stroke, caused by the explosion, the exhaust-port is uncovered by the piston, then permitting the escape of the gases of combustion, which are assisted in their exit by the inrushing charge of fresh combustible charge which enters through the port 20 in the manner before described. The exhaust ports are uncovered slightly before the uncovering of the transfer-ports 20 so that the burned gases escape, for the most part, from the cylinder before the admission of the fresh charge, which drives out the remainder of such gases without being discharged in part itself through the exhaust port, from which it is deflected by the baffle or deflecting plate 24. The pump displacement is so proportioned to the combustion-cylinder that all or practically all of the burned gases are expelled from the combustion-cylinder and without loss of fuel.

It will thus be manifest that in the improved engine the piston of one cylinder is factitive in compressing the fuel-charge and supplying the same to the next cylinder. The fuel-charge arrives in comparatively cool condition from the carbureter, and hence in being conducted against the walls of the piston and stored within the piston, said charge has a considerable cooling effect upon the piston and adjacent parts, which is evidently a desideratum. Further, the fuel charge in absorbing the heat from the piston is vaporized to a maximum degree, whereby it may be compressed to a very high pressure without liability of premature ignition. This increased vaporization and compression causes a general increase in the efficiency and economy of the engine.

The admission of the fuel-charge to the combustion-cylinders may be very readily regulated by the valve 22, and said charge passes to said cylinders in equal amounts, whereby uniformity of action of the engine is obtained. It will be seen that the admission ports 14 of the pump-cylinders, the transfer-ports 20, and the exhaust-ports 23, are all directly controlled by the pistons, which cover and uncover these ports at the proper time. By this construction the provision of numerous valves and valve-operating devices is avoided and the engine considerably simplified. An engine constructed in this manner will run in either direction. It will also be observed that each cylinder provides an impulse for each revolution.

In Figs. 4 and 5 there is illustrated a form of engine constructed in accordance with the invention in which means are provided for separating the incoming charge of fuel from the burned or burning gases by a layer or body of atmospheric air. This result is effected by slightly modifying the form of the transfer-pipe valve. This improved valve is shown as comprising a cylindrical casing 26 formed on the intermediate portion of the transfer-pipe $21^{\times}$. 27 denotes a hollow cylindrical valve-body mounted to rotate in said casing and provided at diametrically opposite points in its side-wall with apertures 28 designed to register more or less with the bore of the transfer-pipe according as said valve-body is moved on its vertical axis. The bottom portion of said valve-body is provided at its bottom with an air-admission opening 29, and said opening is designed to be normally closed by a check-valve comprising a disk 30 arranged within the body 27 and provided with an exteriorly-extending stem 31 movable through a bridge 32 which extends across the valve-casing at its lower portion. The stem 31 is surrounded by a helical spring 33 which normally holds the valve-disk 30 against the bottom of the valve-casing and thereby prevents the passage of the fuel from the transfer-pipe to the atmosphere.

The passage of the fuel-charge is regulated by adjusting the valve-body 27 so that its apertures 28 register more or less with the bore of the transfer-pipe, as will be understood. The downward movement of the pistons causes a vacuum to be formed in said pipe, while the port 19 is open to port 20, and consequently before the fuel-charge reaches said valve-body the valve-disk 30 is moved inwardly, the action of the vacuum overcoming that of the spring 33. Hence a relatively small body of air is introduced into the valve-body and transfer-pipe and is introduced to the cylinder that is to be supplied with fuel, in advance of the fuel-charge. This body of air acts efficiently to prevent the incoming charge of fuel from mixing with the burned or burning gases of combustion, and to prevent loss of fuel through the exhaust port. Said body of air also has a cooling effect upon the interior parts. This means of introducing air into the cylinders is very simple and the admission of air and fuel to the cylinders is effected by what is

practically a single valve. It is apparent that if it is not desired to permit the atmospheric air to enter the cylinders, the spring of the valve-disk is tightened or the valve-disk otherwise locked against inward movement.

Having thus described my invention, I claim:

1. In an internal combustion or explosive engine, the combination of a plurality of cylinders, and a piston in each cylinder which supplies the fuel-charge to another of said cylinders, said piston having a hollow interior in which the fuel-charge is received and compressed.

2. In an internal combustion or explosive engine, the combination of a plurality of cylinders, means for supplying the fuel-charge to each cylinder, and a piston in each cylinder which forces such charge from such cylinder into the adjacent cylinder, said piston having a hollow interior in which the fuel-charge is received and compressed.

3. In an internal combustion or explosive engine, the combination of a plurality of cylinders, and a piston in each cylinder which supplies the fuel-charge to another cylinder, said piston comprising a working-section and a pump-section, and having a hollow interior in which the fuel-charge is received and compressed.

4. In an internal combustion or explosive engine, in combination, a plurality of cylinders each comprising a pump-section and a combustion-section, means for supplying the fuel-charge to each pump-section, and a piston in each cylinder which transfers such charge from the pump-section of such cylinder into the combustion-section of another, said piston having a hollow interior in which the fuel-charge is received and compressed.

5. In an internal combustion or explosive engine, in combination, a plurality of cylinders, and a hollow piston in each cylinder, which piston receives and compresses therein the fuel-charge and transfers the same to the adjacent cylinder.

6. In an internal combustion or explosive engine, in combination, a plurality of cylinders, means for supplying the fuel-charge to each cylinder, and a hollow piston in each cylinder in which the fuel-charge is received and compressed and from which such charge passes into the adjacent cylinder.

7. In an internal combustion or explosive engine, in combination, a plurality of cylinders each comprising a pump-section and a combustion-section, means for supplying the fuel-charge to the pump-section of each cylinder, and a hollow piston in each cylinder which receives the charge from the corresponding pump-section and transfers the same to the combustion-section of the adjacent cylinder.

8. In an internal combustion or explosive engine, in combination, the cylinders each comprising a pump-section and a combustion-section, means for supplying the fuel-charge to each pump-section, and a hollow piston in each cylinder comprising a pump-section and a working-section, said piston being provided with an opening through which the charge passes into said piston under the action of said pump-section of the piston, and means for delivering the charge from said piston through said opening into the combustion-section of another cylinder.

9. In an internal combustion or explosive engine, the combination of the cylinders, hollow pistons therein which receive the charge of fuel, and means for conducting the charge from the interior of each piston to another cylinder.

10. In an internal combustion or explosive engine, the combination of the cylinders, hollow pistons in said cylinders which receive the fuel-charge, and a transfer-pipe through which such charge is conducted from the interior of each piston to another cylinder.

11. In an internal combustion or explosive engine, the combination of the cylinders, hollow pistons in said cylinders which receive the fuel-charge and compress the same, a transfer-pipe into which such charge issues and which conducts the same from the interior of each piston to another cylinder, and a valve controlling said transfer-pipe.

12. In an internal combustion or explosive engine, in combination, a plurality of cylinders each comprising a pump-section and a combustion-section, means for supplying combustible vapor and air to each pump-section, a hollow piston in each cylinder comprising a pump-section and a working-section and having an opening in the latter through which the fuel-charge is forced by the former into the interior of said piston, and a transfer-pipe connecting ports in the combustion-sections of the cylinders with which said openings of the pistons come into register.

13. In an internal combustion or explosive engine, in combination, a plurality of cylinders each comprising a pump-section and a combustion-section, the former provided with an inlet-port for the fuel-charge, a hollow piston in each cylinder which receives and compresses the fuel-charge and then transfers the fuel-charge from the pump-section of such cylinder to the combustion-section of the adjacent cylinder, said piston directly controlling said inlet-port.

14. In an internal combustion or explosive engine, in combination, a plurality of cylinders each comprising a pump-section and a combustion-section, the former being provided with an inlet-port for the fuel-charge and the latter with a transfer-port, a transfer-pipe connecting said transfer-ports, and a hollow piston in each cylinder directly con-

trolling said inlet-port and provided with a single opening, said opening adapted to register with said transfer-port.

15. The combination, with a plurality of cylinders, each comprising a pump-section and a combustion-section, of means for supplying a combustible vapor and air to each pump-section, a hollow piston in each cylinder which receives the fuel-charge from the corresponding pump-section and introduces the same into the combustion-section of the adjacent cylinder, and means for regulating the passage of the charge between said cylinders.

16. The combination, with cylinders, each comprising a pump-section and a combustion-section, of means for supplying a combustible vapor and air to each pump-section, a hollow piston in each cylinder which receives the fuel-charge from the corresponding pump-section and compresses the same, a transfer-pipe to receive the charge from the piston and transfer it to the combustion-section of the adjacent cylinder, and a valve in said transfer-pipe.

17. In an internal combustion or explosive engine, in combination, cylinders each comprising a pump-section and a combustion-section, the former being provided with an inlet-port for the fuel-charge and the latter with a transfer-port, a hollow piston comprising a pump-section and a working-section, the former uncovering said inlet-port on the downstroke of the piston and the latter having a port which communicates with the pump-section on the downstroke of the piston and registers with said transfer-port on the upstroke, and means for connecting the transfer-ports of said cylinders.

18. In an internal combustion or explosive engine, in combination, cylinders each of which is divided into a pump-section and a combustion-section, the former being provided with an inlet-port for the fuel-charge and the latter with a transfer-port and an exhaust-port, a transfer-pipe connecting the transfer-ports of said cylinders, and a hollow charge-receiving piston in each cylinder which covers and uncovers said inlet-port and said exhaust-port and is provided with a port to register with and control said transfer-port.

19. The combination of a plurality of cylinders each comprising an upper combustion-section 2 and a lower pump-section 3, the former being provided in its side-wall with a transfer-port 20 and an exhaust-port 23, and the latter provided in its side-wall with an inlet-port 14 for the fuel-charge, a hollow piston 4 in each cylinder controlling said inlet-port and exhaust-port and provided in its side-wall with a port 19 movable downwardly into said pump-section of the cylinder and upwardly into register with said transfer-port 20, and means for connecting the transfer ports of said cylinders.

20. In an internal combustion or explosive engine, the combination of a plurality of cylinders, a hollow piston in each cylinder which receives the fuel-charge and then transfers it to the adjacent cylinder, and means for introducing a body of air into each cylinder in advance of the fuel-charge.

21. In an internal combustion or explosive engine, in combination, a plurality of cylinders, a transfer-pipe connecting said cylinders, a hollow piston in each cylinder which receives and compresses the fuel-charge and then transfers it to the adjacent cylinder by way of said transfer-pipe, and means for admitting air into said transfer-pipe in front of the fuel-charge.

22. In an internal combustion or explosive engine, in combination, a plurality of cylinders, a transfer-pipe connecting said cylinders, a piston in each cylinder which supplies the fuel-charge to the adjacent cylinder via said transfer-pipe, and a check-valve opening into said transfer-pipe from the atmosphere.

23. In combination, the cylinders, a transfer-pipe or pipes connecting the same, a piston in each cylinder which supplies the fuel-charge to the adjacent cylinder through said transfer-pipe, and a valve in said pipe which controls the passage of the charge and also permits the entrance of atmosphere air into said pipe.

24. The combination of cylinders, a transfer-pipe or pipes connecting the same, a piston in each cylinder which supplies the fuel-charge to the adjacent cylinder, and a valve in said transfer-pipe operative to close the same more or less and embodying an air-admitting check-valve.

25. The combination with a transfer-pipe, of the valve casing, the valve-body movable in said casing and provided with apertures to register with the bore of said pipe, said valve-body having an air-inlet opening, and the spring-actuated check-valve to control said opening.

Signed at Montpelier Vt this 1st day of Feby 1901.

MARSHALL L. WOOD.

Witnesses:
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