S. LAKE.

INTERNAL COMBUSTION ENGINE.

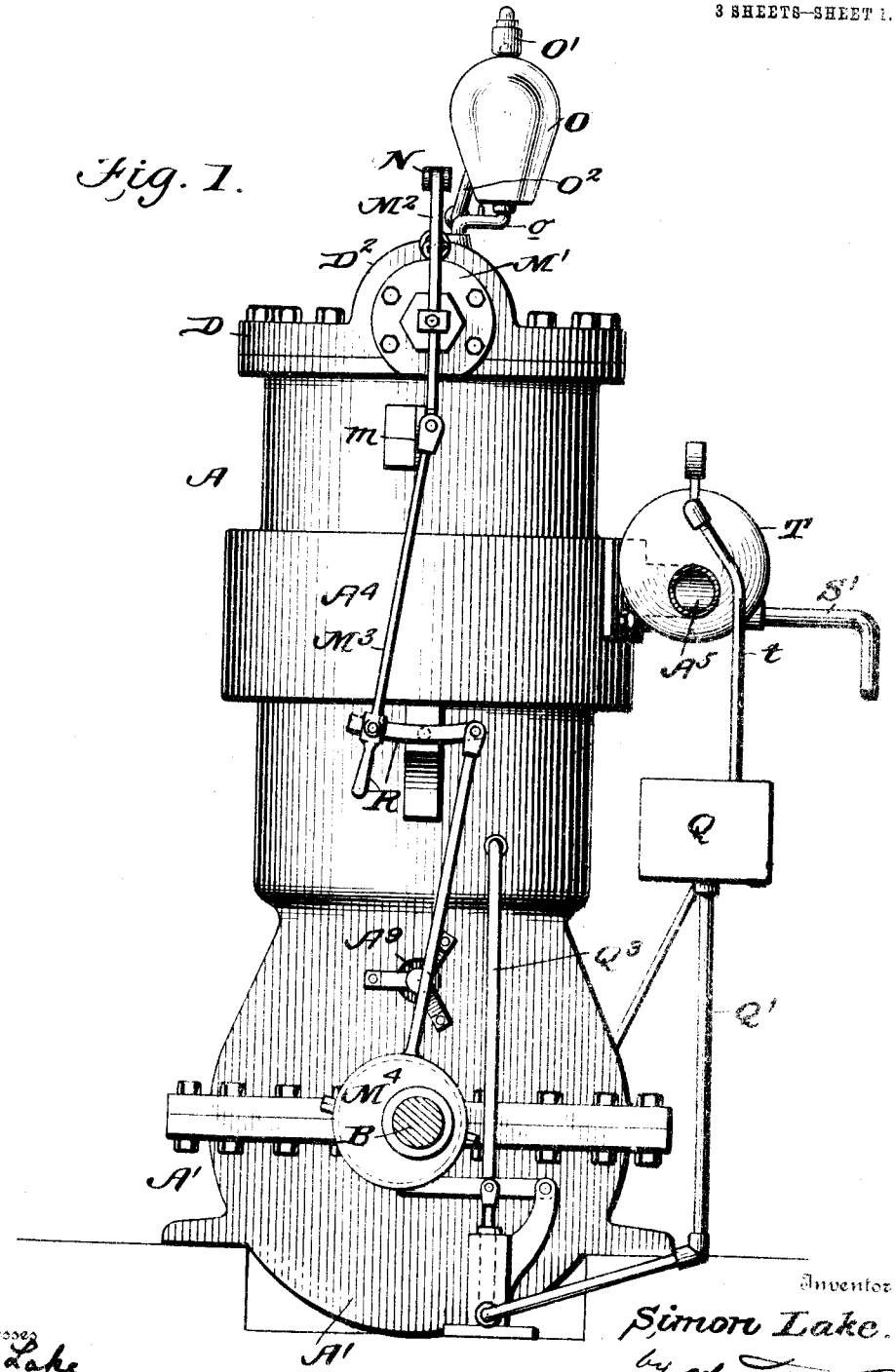
APPLICATION FILED MAR. 21, 1911.

1,067,258.

Patented July 15, 1913.

3 SHEETS—SHEET 1.

Fig. 1.



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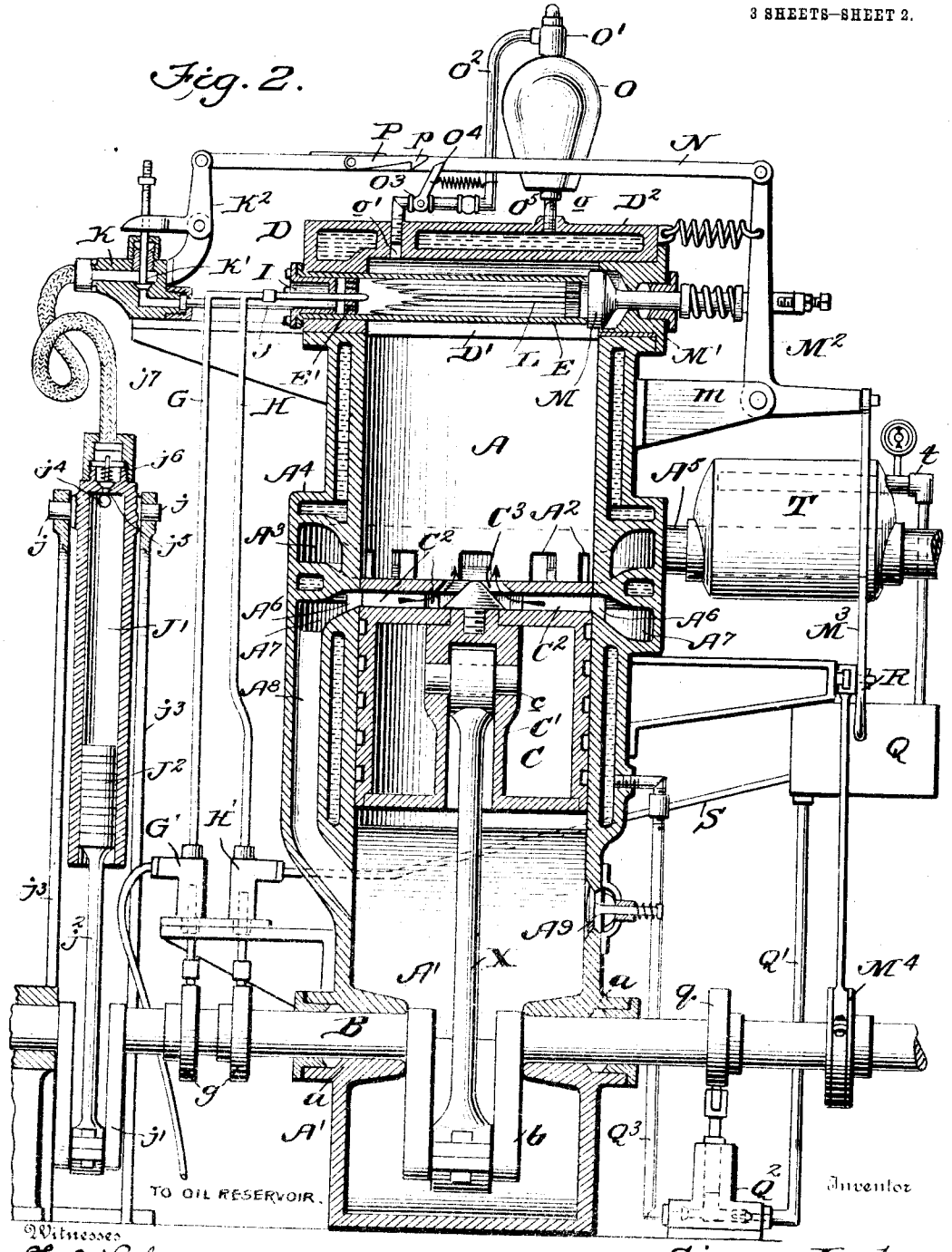
APPLICATION FILED MAR. 21, 1911.

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Patented July 15, 1913.

3 SHEETS—SHEET 2.

Fig. 2.



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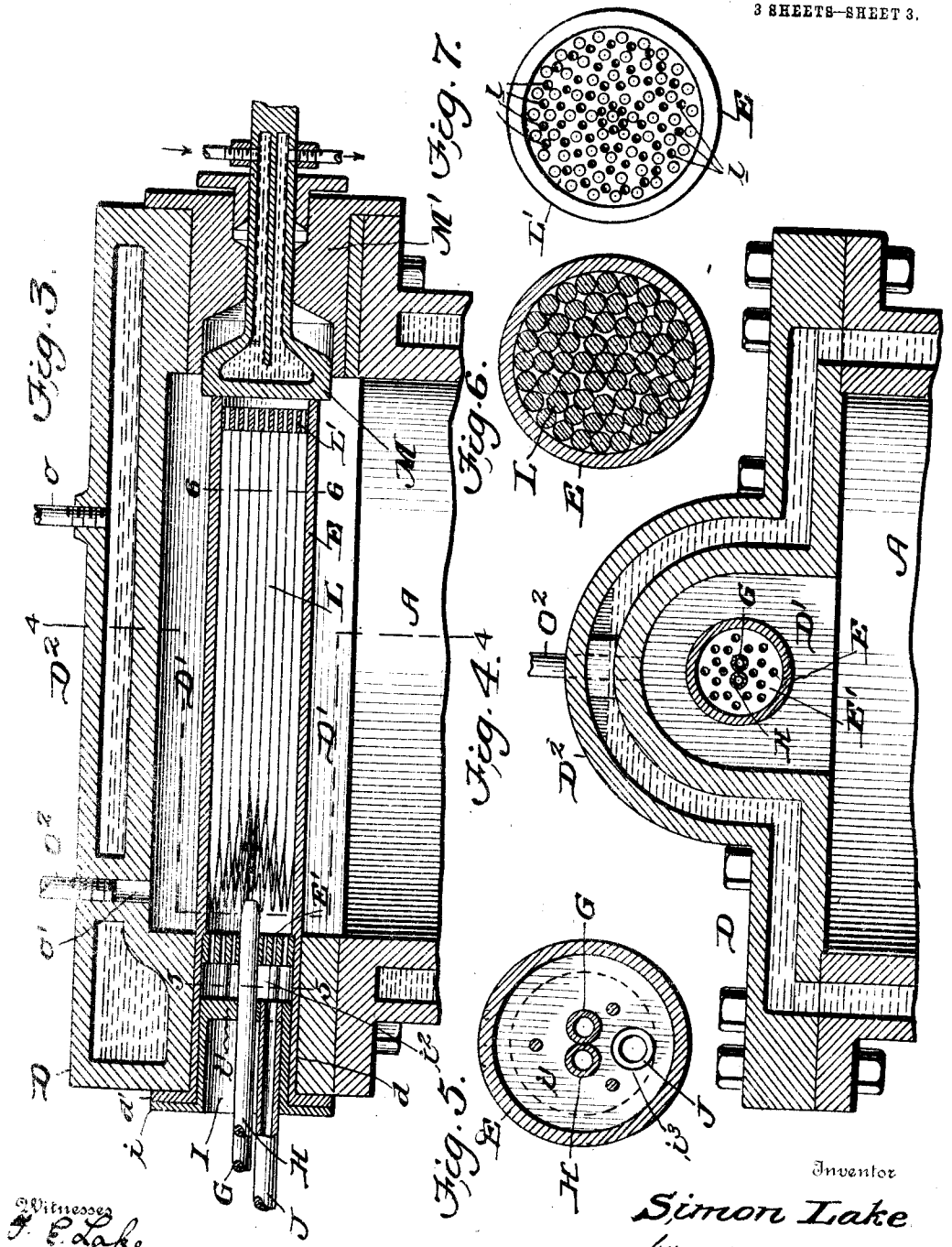
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3 SHEETS—SHEET 3.



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SIMON LAKE, OF MILFORD, CONNECTICUT.

INTERNAL-COMBUSTION ENGINE.

1,067,258. Specification of Letters Patent. Patented July 15, 1913.

Application filed March 21, 1911. Serial No. 615,991.

To all whom it may concern:

Be it known that I, SIMON LAKE, a citizen of the United States, residing at Milford, in the county of New Haven and State of Connecticut, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

This invention relates to certain improvements in internal combustion engines and particularly to that class of engines shown and described in Letters Patent granted to me March 3, 1908, and September 13, 1910, Nos. 880,744, and 970,063, respectively, and in my co-pending applications filed March 22, 1910, Serial No. 551,018, and November 21, 1910, Serial No. 593,562.

The object of the invention is to provide a cheap, simple and highly efficient heavy oil engine that is particularly adapted for marine uses and wherein fuel oil and water or steam are injected into a retort or furnace and there converted into a combustible gas which, at the proper time, is forced into the combustion chamber of the working cylinder and there ignited to drive the piston on its power stroke.

Another object of the invention is to provide an arrangement in which the heat generated by the engine is effectively utilized in the operation of the engine and a condenser for condensing salt water into fresh water that is utilized for cooling the cylinder and various working parts of the engine, and for the supply that is led into the retort or furnace for use as fuel thus particularly adapting the engine for marine uses especially for that class of vessels in which it is impracticable to carry a large quantity of fresh water for use in the engine.

With these stated objects in view the invention comprises certain parts and combinations and arrangements of parts as will now be described and then pointed out in the claims.

In the accompanying drawings, illustrating the invention, in the several figures of which like parts are similarly designated, Figure 1 is a side elevation of the engine. Fig. 2 is a vertical longitudinal section of same. Fig. 3 is a vertical section on a larger scale of the upper end of the power cylinder and the cylinder head. Fig. 4 is a transverse section drawn on the line 4—4 of Fig. 3. Figs. 5 and 6 are transverse sections on a larger scale drawn through the retort or furnace on the lines 5—5 and 6—6, respectively. Fig. 7 is an end view of the retort or furnace.

The cylinder A is mounted upon a suitably closed crank-case A′ which is provided with bearings *a* for the main crank-shaft B of the engine. The cylinder A is water jacketed and in its side walls are arranged a plurality of exhaust ports A^2 which open into an annular exhaust passage A^3 formed in a water jacketed casing A^4 which is cast upon the outer walls of the cylinder. An exhaust pipe A^5 is connected to the casing to carry off the exhaust gases to any desired point. Arranged in the cylinder walls below the exhaust ports and out of vertical alinement therewith, are a plurality of air inlet ports A^6 which communicate with an annular passage A^7 formed in the casing A^4 below the exhaust passage A^3 and this passage A^7 communicates with the closed crank-case A′ through a by-pass A^8. The crank-case is provided with an air inlet that is controlled by an inwardly opening spring seated valve A^9.

Operating in the cylinder A is a hollow piston C which is connected to the crank *b* of the main crank-shaft B by a connecting rod X, the upper end of the rod being journaled upon a pin *c* that is held in the side walls C′ of a well formed in the piston and in which the connecting rod works. The upper end of the piston immediately below the top is formed with a plurality of passages C^2 which are designed to register with the air inlet ports A^6 in the walls of the cylinder A and these passages C^2 merge into a central opening C^3 formed in the end of the piston whereby when the piston reaches the end of its power stroke the air that has been compressed in the crank case by the power stroke will escape into the upper end of the power cylinder and drive out the products of combustion remaining after the exhaust ports have been first opened. By this arrangement it will be seen that both the exhaust ports and the air inlet ports are controlled by the power piston.

The upper end of the cylinder A is closed by a water jacketed cylinder head D which is provided with a transverse recess D′ in its lower side that extends entirely across the bore of the cylinder and which is formed by an upwardly extending semicircular arch D² that is cast integral with the said head. In

one side of the head is a bore d that leads into the recess D′ and in this bore is held the outer end of a retort or furnace E of smaller diameter than the recess and which extends entirely across the upper end of the cylinder and has its inner end terminated a short distance from the adjacent end of the recess D′. The outer end of the retort or furnace is formed with a flange d' which is bolted to the side of the head D to hold the retort securely in place. Within the retort or furnace adjacent to its outer end is held a perforated disk E′ which is also provided with a central opening in which is held an oil feed pipe G and a water feed pipe H whose inner ends extend into the retort or furnace and whose outer ends connect with suitable feed pumps G′ and H′ respectively, Fig. 2. The pistons (shown in dotted lines) of the pumps are operated by cams g carried by the main crank shaft of the engine. Fitted within the extreme outer end of the retort or furnace is a short tubular sleeve I whose outer end is formed with a flange i that is bolted to the flange d' of the retort or furnace and whose inner end is closed by a disk i' which is spaced a short distance from the disk E′ to provide an air chamber i^2. The disk i' is formed with a central opening through which the pipes G and H pass and below this opening is an opening i^3 in which is held the outer end of a compressed air feed pipe J extending from an air compression pump J′ having a piston J^2 which is operated by a crank j' on the main crankshaft of the engine through the connecting rod j^2.

The cylinder of the pump J′ is provided adjacent to its upper end with trunnions j which are journaled in bearings in a frame j^3 so as to permit an oscillating movement of the cylinder that is caused through the rotation of the crank j'.

The upper end of the cylinder is provided with a valve controlled inlet port j^4 and an outlet port j^5 which latter is controlled by an outwardly opening valve j^6 carried in a valve casing secured to the upper end of the cylinder. Extending from the valve casing is a flexible pipe section j^7 whose opposite end is connected to the inlet port of a valve casing K to the outlet port of which is connected the inner end of the compressed air supply pipe J. The valve K′ of the casing K is operated by a crank arm K^2 as will be later described.

Within the retort or furnace E is held a nest of heat conducting wires L against and between which the fuel oil and the water are forced when injected into the retort through the pipes G and H. These wires have their ends adjacent to the disk E′ arranged so as to form a funnel-shape mouth or entrance which serves to catch and scatter the oil and the water throughout the whole group or nest of wires when forced through the pipes G and H. The wires L are closely assembled within the retort or furnace with the outer layer held against the walls of the retort and with the remaining layers or members of the group contacting with each other so as to form a compact mass to take up the heat from the walls of the retort as the latter becomes hot from the explosions in the power cylinder and thereby transfer the heat to all the wires of the nest. The outer ends of the wires are held in a disk L′ which is securely held in the inner end of the retort and this disk is formed with a plurality of perforations l that register with the spaces or channels between the wires L so that the fuel may escape from the retort or furnace as will be best understood from the general description of the operation of the engine.

A water jacketed valve M controls the outlet from the retort or furnace and this valve is held in a plug or casing M′ fitted within an opening formed in the side of the cylinder head D opposite the end of the retort. The valve M is spring seated and is opened by a crank arm M^2 which engages its stem and is pivoted to a bracket m extending from the side of the cylinder A. To one end of the crank arm is connected an operating rod M^3 extending from a reversing lever R of well known construction, which in turn is connected to a strap carried by an eccentric cam M^4 on the main shaft B. Pivoted to the opposite end of the crank arm M^2 is a connecting rod N whose opposite end is connected to the free end of the valve operating lever K^2 whereby both valves K′ and M are operated by the one eccentric M^4.

To reverse the engine, the rod M^3 is shifted from one side of the pivot of lever R to the other. The engine is slowed down, and as the piston nears the end of its return stroke, the rod is thrown over, thereby cutting off the supply to the retort and power cylinder and causing the engine to miss fire once. On the next stroke of the piston, the fuel is admitted and the charge ignited just before the piston reaches the end of its return stroke and just before the crank b reaches a vertical position, or is on the dead center, so that as the charge is ignited to drive the piston on its next power stroke the shaft will be turned in the opposite direction.

O designates a steam dome that is connected to the water jacket of the cylinder head D through a pipe o and connected to the upper end of the steam dome is a safety valve casing O′ to which is connected one end of a pipe O^2 whose opposite end is held in a port o' in the cylinder head and leads into the recess D′. A spring closed valve O^3 controls the passage through the pipe O^2 and the stem of the valve carries an upwardly extending lever arm O^4 that is en-

gaged by a pawl P pivoted at one end to the rod N and having its free end formed with a hook p so that as the levers K^2 and M^2 are rocked to open the valves K′ and M and the bar N is correspondingly moved the pawl will ride up over the end of the lever arm O^3 and hook into engagement therewith and when the levers K^2 and M^2 are released to allow the valves to seat themselves the bar N will be moved in the opposite direction when the pawl P will engage and rock the lever O^4 to open the valve O^3 to permit a quantity of steam to escape into the working end of the power cylinder A and thus be utilized as a power medium in the operation of the engine. The pipe O^2 is provided with a hand operated valve O^5 for positively cutting off the communication between the steam dome and the power cylinder and when closed excess pressure of steam escapes through the safety valve casing.

Q designates a water supply tank which is connected by a pipe Q′ that extends to a suitable pump Q^2 from which extends a supply pipe Q^3 that is connected to the water jacket of the cylinder A. The piston of the pump is operated by an eccentric q carried by the main shaft B. A second pipe S is also connected to the supply tank Q for supplying water to the pump H′.

As before stated the engine is especially designed for marine uses and in order to avoid the necessity of carrying large quantities of fresh water for its use I propose to utilize the heat from the exhaust to condense salt water into fresh water and to this end I extend the exhaust pipe A^5 through a suitable evaporator T from which the vapor is drawn off through a pipe t that empties into the supply tank Q which then forms a condenser. Salt water is fed into the evaporator through a pipe S′ which extends from a pump (not shown) which in turn communicates with the sea.

The operation of the engine is as follows: Let it be assumed that the engine is running and that the retort or furnace and the nest of wires therein have become hot from the explosions of the previous charges injected into the working end of the power cylinder, and also that a charge has just been ignited to drive the power piston on its power stroke. As the piston begins its power stroke a charge of fuel oil and of water is forced into the retort or furnace through the pipes G and H, respectively, against the nest of hot wires and converted into a gaseous mixture. This mixture remains in the retort or furnace during nearly the complete stroke of the piston Now as the piston nears the end of its power stroke, the valves K′ and M are simultaneously opened, the valve K admitting the compressed air in the compression pump I that has been compressed in the compression cylinder during the up-stroke of the piston J^2, to escape into the retort or furnace and drive the gaseous mixture out through the openings between the nest of wires L, through the perforated disk L′ and into the upper end of the power cylinder and the space surrounding the retort or furnace where the gas and the compressed air are thoroughly mixed and compressed by the piston into a combustible mixture. The piston by this time having reached the end of its up stroke the mixture instantly ignites to drive the piston on its next down or power stroke. As the piston nears the end of its power stroke the exhaust ports A^2 are first uncovered to permit the escape of the products of combustion and then the air inlet ports are uncovered to permit the air that has been compressed in the base of the engine, to escape into the cylinder through the central opening in the head of the piston and thereby thoroughly scavenge the cylinder of all the remaining products of combustion and supply the cylinder with a charge of fresh clean air. After the engine has been running for some time steam is generated in the upper end of the water jacket of the cylinder and in the water jacket of the head D. The valve O^5 may then be opened and when the pressure in the steam dome O exceeds that in the power cylinder, the steam will be automatically admitted through the pipe O^2 into the cylinder thus increasing the power of the engine and converting into effective work the heat which is usually lost in this class of engines.

The oil may be admitted to the retort or furnace at any point in the down stroke of the piston, by adjustment on the shaft B of the cam q of the oil pump G′, and hence it is possible to have the oil exposed to the heat of the retort or furnace a length of time sufficient to insure its being thoroughly vaporized by the heat thereof. Consequently oils of different grade and volatility may be used.

From the foregoing it will be seen that I provide an exceedingly simple and highly efficient engine.

I desire it understood that I do not limit myself to the details of construction shown and described as various changes may be made without departing from the scope of the invention, and while I have shown the principle applied to a single acting engine it is obvious that with but slight alterations in the construction the same principle may be carried out in double acting engine in a somewhat similar manner to that shown and described in my co-pending application, Serial No. 593,562, filed Nov. 21, 1910.

What I claim is:—

1. In an internal combustion engine, the combination with a power cylinder, a piston working therein, a power shaft, and a

connecting rod connecting the piston and shaft, of a retort communicating with said power cylinder, means for conducting fuel oil to said retort wherein the oil is converted into a gas, means for retaining the gas within the retort and for opening and closing communication with the power cylinder, and means for thereafter conducting air under pressure to said retort simultaneously with the opening of communication between the retort and power cylinder to force the gas formed in the retort into the power cylinder wherein the gas and air are compressed by the operation of the piston and converted into a combustible mixture.

2. In an internal combustion engine, the combination with a power cylinder, a power piston working therein, a power shaft, and a connecting rod connecting the piston and shaft, of a retort arranged in and communicating with the power cylinder, a valve controlling the communication between the cylinder and retort, means for conducting fuel oil to said retort wherein the oil is converted into a gas and retained therein until the opening of said valve, means for thereafter conducting air under pressure to said retort simultaneously with the opening of said valve to drive the gas into the power cylinder wherein the gas and air are compressed by the operation of the piston and converted into a combustible mixture, and means for controlling the admission of air to said retort.

3. An internal combustion engine, comprising a power cylinder, a piston working therein, a power shaft, a connecting rod connecting the piston and shaft, a retort arranged in and communicating with the power cylinder, a valve for controlling the communication between the retort and cylinder, means for conducting oil, and means for conducting water to said retort wherein the oil and water are converted into a gas and retained therein until the opening of said valve, means for thereafter conducting air under pressure to said retort simultaneously with the opening of said valve to drive the gas into the power cylinder wherein the gas and air are compressed by the operation of the piston and converted into a combustible mixture, and means for controlling the admission of air to said retort.

4. An internal combustion engine, comprising a power cylinder, a power piston working therein, a power shaft, a connecting rod connecting the piston and shaft, a retort arranged in said power cylinder and communicating therewith, a valve for controlling the communication between the cylinder and retort, means for conducting fuel oil to said retort, an air compressing pump operated by the power shaft, means for conducting the air that is compressed in said pump to said retort, a valve for controlling the passage of air to the retort, and a common means for operating both of the said valves.

5. An internal combustion engine, comprising a power cylinder, a power piston working therein, a power shaft, a connecting rod connecting the piston and shaft, a retort arranged in said cylinder and communicating therewith, heat conducting wires arranged in the retort, means for forcing fuel oil into said retort and into contact with said heat conducting wires, means for conducting air under pressure to said retort, and means for controlling the admission of air to said retort, all for the purpose specified.

6. An internal combustion engine, comprising a power cylinder, a power piston working therein, a power shaft, a connecting rod connecting the piston and shaft, a retort arranged in said cylinder and communicating therewith, a nest of heat conducting wires arranged in said retort, independent means for forcing fuel oil and water into the retort and into contact with said heat conducting wires wherein the oil and water are converted into a gas, means for conducting compressed air to said retort for forcing the gas therein into the power cylinder wherein the gas and air are converted into a combustible mixture, and means for controlling the admission of the compressed air to the retort.

7. An internal combustion engine, comprising a power cylinder, a power piston working therein, a power shaft, a connecting rod connecting the piston and shaft, a retort arranged in and communicating with the power cylinder, a valve controlling the communication between the power cylinder and the retort, a nest of heat conducting wires arranged in the retort, an oil conducting pipe extending into the retort, a water conducting pipe extending into the retort, force pumps for forcing the oil and water through said pipes into contact with the said heat conducting wires, an air compressing pump, a pipe extending from said pump to said retort, a valve for controlling the passage of air through said pipe, and means for operating both of said valves, as and for the purposes specified.

8. An internal combustion engine, comprising a power cylinder, having a head closing one end thereof and provided with a recess opening into the power end of said power cylinder, a retort arranged in the recess and communicating at one end with said power cylinder, means for controlling said communication, a power piston working in said cylinder, a power shaft, a connecting rod connecting the piston and shaft, means for conducting fuel oil and means for conducting water into said retort wherein the oil and water are converted into a gas,

means for conducting air under pressure into said retort for forcing the gas therein into said power cylinder wherein the gas and air are converted into a combustible mixture, and means for controlling the admission of the compressed air into said retort.

9. An internal combustion engine, comprising a power cylinder having exhaust ports in the walls thereof, a passage into which the exhaust ports discharge and a pipe for carrying off the exhausts let into the passage, a power piston working in said power cylinder, a power shaft, a connecting rod connecting the piston and shaft, a retort arranged in and communicating with the power cylinder, means for conducting fuel oil into said retort wherein the oil is converted into a gas, means for retaining the gas within the retort and for opening and closing communication with the power cylinder, means for thereafter conducting air under pressure to said retort for driving the gas therein into the power cylinder wherein the gas and air are compressed by the operation of the piston and converted into a combustible mixture, and means for controlling the admission of air to said retort simultaneously with the opening of communication between the retort and power cylinder.

10. An internal combustion engine, comprising a power cylinder having exhaust ports in the side walls thereof, a power piston working in said cylinder and controlling said exhaust ports, a power shaft, a connecting rod connecting the piston and shaft, a retort arranged in said cylinder and communicating therewith, a fuel oil supply and a water supply for said retort, means for forcing the water and the oil into said retort wherein the oil and the water are converted into a gas, means for retaining the gas within the retort and for opening and closing communication between the retort and power cylinder, a compressed air supply for said retort, means for controlling the admission of air to said retort after the production of the gas therein.

11. An internal combustion engine, comprising a power cylinder having exhaust ports and air inlet ports in the side walls thereof, a closed base upon which the cylinder is mounted, a power piston working in said power cylinder having air passages adjacent to one end thereof and a centrally arranged opening that communicates with said passages and with the power cylinder, said cylinder having a by-pass that establishes communication between the said base and said air inlet ports, whereby when the power piston reaches the end of its power stroke the air that has been compressed in said base on said power stroke will escape into said cylinder, for the purpose specified, a retort communicating with the power end of the cylinder, means for admitting fuel oil to said retort wherein the oil is converted into a gas, a valve for retaining the gas within the retort and for opening and closing communication between the retort and power cylinder, means for supplying air under pressure to said retort after the gas is produced to drive the gas formed therein into said power cylinder wherein the gas and air are compressed by the operation of the piston and converted into a combustible mixture, and means for controlling the admission of compressed air to said retort simultaneously with the opening of said valve.

12. An internal combustion engine, comprising a power cylinder having exhaust ports and air inlet ports in the walls thereof, a normally closed base upon which the cylinder is mounted, a valve controlled opening in the base, a power shaft journaled in the base, a power piston working in said cylinder having air passages adjacent to one end that communicate with air inlet ports in said cylinder and a centrally arranged opening in its end that opens into the power cylinder and which communicates with said air passages, a connecting rod connecting the piston and power shaft, said cylinder having a by-pass leading from the said base to the air inlet ports of the cylinder, a retort arranged in and communicating with the power end of the cylinder, heat conducting wires arranged in said retort, a valve controlling the communication between the cylinder and retort, means for supplying fuel oil under pressure to the retort, and means for supplying water under pressure to the retort wherein the oil and water are converted into a gas, an air compression pump, a pipe connecting the retort with the pump, a valve controlling the admission of the compressed air to the retort, and a common means for operating the last mentioned valve and the valve controlling the communication between the retort and the cylinder.

13. An internal combustion engine, comprising a water jacketed cylinder having exhaust ports in the side walls thereof and a passage communicating with said ports, air inlet ports also arranged in the walls of the cylinder and a passage communicating with said inlet ports, a normally closed base upon which the cylinder is mounted having an opening therein, an inwardly opening valve controlling said opening, said cylinder having a by-pass establishing communication between the base and the air passage, a piston working in the power cylinder having air passages arranged adjacent to one end that are adapted for register with said air inlet ports and a centrally arranged opening leading into the power end of the cylinder which communicates with said air passages, a retort ar-

ranged in said power cylinder and communicating therewith, means for controlling the communication, separate means for conducting fuel oil and water to said retort wherein the oil and water are converted into a gas, and retained therein until the opening of communication between the retort and power cylinder, a tank for supplying water to said water conducting means, a source of water supply for the tank, means for conducting water from said tank to the water jacket of the power cylinder, and means for conducting air under pressure to said retort for forcing the gas therein into the power end of the cylinder wherein the gas and air are converted into a combustible mixture.

14. An internal combustion engine, comprising a water jacketed power cylinder, having exhaust ports in the side walls thereof, and a passage into which the exhaust ports enter, air inlet ports also arranged in the side walls of the cylinder and a passage communicating with said air inlet ports, a pipe for carrying off the exhaust from the exhaust passage, a normally closed base upon which the cylinder is mounted having a valve controlled opening, said cylinder having a by-pass connecting the said base and the air passage which communicates with said air inlet ports, a piston working in the power cylinder having air passages arranged therein adjacent to one end that are adapted to register with said air inlet ports and a centrally arranged opening leading into the power cylinder which also communicates with said passages, a retort arranged in and communicating with said power cylinder, means for controlling said communication, separate means for conducting fuel oil and water to said retort wherein the water and oil are converted into a gas and retained therein until the opening of communication with the cylinder, a tank for supplying water to said water conducting means, an evaporator operated by the exhaust from the engine and supplying water vapor to the tank, a pipe connecting said tank with the water jacket of the power cylinder, means interposed in the pipe for forcing the water into the water jacket, means for conducting air under pressure to said retort for driving the gas therein into the power cylinder wherein the gas and air are compressed by the operation of the piston and converted into a combustible mixture, and means for controlling the passage of air through said air conducting means operative simultaneously with the means for controlling communication between the retort and power cylinder.

15. An internal combustion engine, comprising a water jacketed power cylinder having an exhaust port, a pipe for carrying off the exhaust gases escaping through said port, a power piston working in said power cylinder, a power shaft, a connecting rod connecting the piston and shaft, a fuel supply for said cylinder, an evaporator through which the exhaust pipe passes arranged adjacent to and independent of said cylinder, a tank arranged below said evaporator, a pipe connecting said evaporator and tank, means for supplying water to said evaporator, and connections between said tank and the water jacket of the power cylinder including a pump for forcing water of condensation into said water jacket.

16. An internal combustion engine, comprising a water jacketed power cylinder having an exhaust port, a pipe for carrying off the exhaust escaping through said port, a power piston operating in the power cylinder, a power shaft, a connecting rod connecting the piston and shaft, a retort arranged in and communicating with the power cylinder, means for conducting fuel oil to said retort, means for conducting water to said retort, heating wires in the retort for converting the oil and water into a gas, a pipe for conducting water to the water jacket of said power cylinder, a water supply tank for said water conducting means and said water pipe, an evaporator operated by the exhaust from the engine and supplying water vapor to the tank, and means for conducting air under pressure to said retort, all for the purposes specified.

17. An internal combustion engine, comprising a water jacketed power cylinder and a piston therein, a retort in said cylinder and a fuel supply therefor, a power shaft, a connecting rod connecting said piston and shaft, an exhaust port in said cylinder, a pipe connecting said exhaust port with the atmosphere, an evaporator through which said exhaust pipe passes arranged adjacent to and independent of said cylinder, a tank arranged below said evaporator, a pipe connecting said evaporator and tank, means for supplying water to the evaporator, connections between said tank and the water jacket of the power cylinder including a pump for forcing the water of condensation into said water jacket and connections between said tank and retort including a pump for forcing water from said tank into the retort.

In testimony whereof I have hereunto set my hand this 18th day of March, A. D. 1911.

SIMON LAKE.

Witnesses:
THOS. E. LAKE,
M. D. BLONDEL.