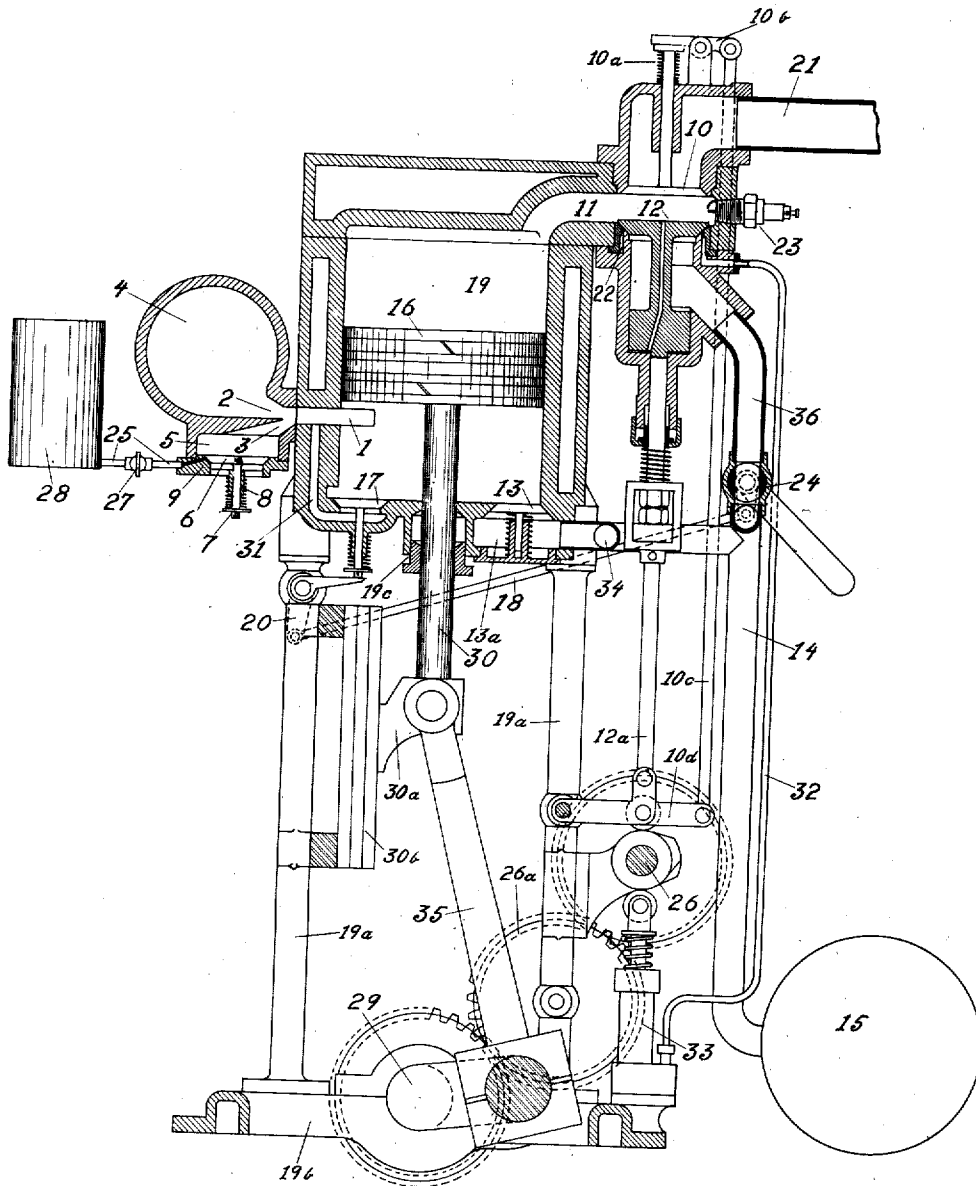


H. E. A. RAABE.
INTERNAL COMBUSTION ENGINE.
APPLICATION FILED APR. 26, 1910.

1,211,231.

Patented Jan. 2, 1917.



WITNESSES

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HENRY E. A. RAABE, OF JERSEY CITY, NEW JERSEY.

INTERNAL-COMBUSTION ENGINE.

1,211,231.

Specification of Letters Patent.

Patented Jan. 2, 1917.

Application filed April 26, 1910. Serial No. 557,649.

To all whom it may concern:

Be it known that I, HENRY E. A. RAABE, of Jersey City, Hudson county, State of New Jersey, have invented certain new and useful
5 Improvements in Internal-Combustion Engines, of which the following is a full, clear, and exact specification, such as will enable others skilled in the art to which it appertains to make and use the same.

10 My invention relates to an internal combustion engine, particularly of the explosive type.

The important object of the invention is to render the use of kerosene and other
15 heavy oils possible, at the same time insuring the formation of a true gas and complete combustion in the working chamber.

It is also an important part of my invention to provide for the scavenging of the
20 working cylinder after each stroke of the piston, filling it with pure air preparatory to the introduction of the charge and in this manner rendering ignition and complete combustion possible.

25 My invention has various other objects and involves various other features of importance, all of which will be fully set forth hereinafter and particularly pointed out in the claims.

30 Reference is now had to the accompanying drawing which represents a vertical section of the engine, illustrating, as an example, merely, the preferred construction.

19 indicates the working cylinder, which
35 is here shown as vertically disposed and sustained by a stanchion-frame 19^a and a base 19^b.

16 indicates the piston, the rod 30 whereof passes through the stuffing box 19^c in the
40 lower head of the cylinder 19. This piston rod 30 is fastened to a cross-head 30^a, which runs in a guide 30^b and is articulated to the crank shaft 29 by the connecting rod 35 in the usual manner.

45 12 indicates the admission valve which opens into a firing chamber 11 communicating with the upper part of cylinder 19. This valve 12 is of a peculiar construction set forth and claimed in my copending application for patent on gas engines, filed May
50 29, 1907, Serial No. 376,437, and will not be described in detail here.

10 indicates the exhaust valve, which operates in the top of the firing chamber 11,
55 and opens into the exhaust pipe 21. The exhaust valve is seated by a spring 10^a on its

stem and is adapted to be mechanically opened through an operating lever 10^b and rod 10^c, the latter being joined to a swinging arm 10^d actuated by a cam on the shaft 26. This shaft is also provided with a cam for
60 actuating the rod 12^a of the inlet valve. The details of these cams will be obvious to skilled mechanics and I will not further describe them. The crank shaft 26 is driven
65 by a train of gearing 26^a from the crank shaft 29.

To the housing or cage of the inlet valve 12 an air pipe 36 leads. This communicates with a pipe 14, such communication, however, being controlled by a valve 24 to the
70 pipe 14 and from it the pipe 36 is supplied with compressed air from a tank 15. Surrounding the seat of the valve 12 is an annular chamber 22 having a narrow outlet
75 on the surface of the seat and this chamber is supplied with oil through the pipe 32 into which the oil is forced by a pump 33 driven by a cam on the shaft 26, this oil constituting the normal fuel of the engine. As the valve
80 12 lifts an annular jet of oil passes from the chamber 22 and is taken up by the air under pressure of the pipe 36, forming an atomized mixture, which impinges against the hot walls of the chamber 11, is transferred into a
85 fixed gas as will more fully appear hereinafter.

In the lower head of the cylinder 19 is an outwardly opening check valve 13 which is spring seated and discharges into a chamber
90 13^a from which leads a pipe 34 to the pipe 14 below the valve 24. On the down-stroke of the piston at a certain period thereof, the valve 13 opens and forces compressed air into the reservoir 15 by way of the chamber
95 13^a and the pipes 34 and 14.

4 indicates a receiver having a throat 2, leading to a port 1 in the walls of the cylinder 19 in such a position that when the piston 16 is at the bottom center, the port 1
100 is uncovered and communicates with the cylinder 19 above the piston. To said port 1 a by-passage 31 leads from the bottom head of the cylinder 19. Communication between the cylinder below the piston and the by-
105 pass 31 is controlled by an inwardly opening check-valve 17. Said valve is spring-seated and its stem is engaged by an elbow-lever 20, by which the valve may be opened. Said elbow-lever 20 has a reach-rod 18,
110 joined thereto and to the valve 24 so that when said valve is moved to closed position

the valve 17 is opened, and when the valve 24 is open, the valve 17 is closed.

28 indicates a storage tank for gasoline or other readily evaporized hydrocarbon, from which a pipe 25 passes to a minute passage in the seat or cage 9 of an inwardly opening check valve 6. The pipe 25 is controlled by a cock 27. The stem 7 of the valve 6 operates in a guide 8 and is furnished with a spring by which the valve is yieldingly seated. The valve 6 discharges into a chamber 5 having a port or passage 3 leading to the throat 2 of the reservoir 4.

The operation of the engine may be traced as follows: The engine is started on gasoline from the tank 28 and such operation is continued until the cylinder walls become sufficiently hot to permit proper application of the kerosene or other heavy or crude oil. Accordingly, to start the engine, the valve 27 is opened and the valve 24 is closed, this latter operation opening the valve 17. The engine is then "turned over" causing the piston 16 to move up in the cylinder 19 above the port 1. This rarefies the air in the chamber 5 and atmospheric pressure opens the valve 6. The in-rush of air gathers the gasoline from the passage in the valve seat 9 and an explosive mixture is thereupon drawn into the cylinder 19 below the piston 16. As the piston reverses its motion this explosive mixture is forced into the reservoir 4, the valve 6 seating, and when the piston covers the port 1 the remainder of the explosive mixture in the cylinder 19 passes the valve 17 and into the port 1 by way of the by-pass 31. When the piston 16 uncovers the port 1 above it the compressed mixture passes through the port into the top of the cylinder and upon the second upward movement of the piston the mixture is compressed and exploded. The engine now operates as a 2-cycle gasoline engine, the exhaust valve 10 opening at the proper period, but the valve 12 remaining seated by reason of the absence of air pressure in the pipe 36 to the closure of the valve 24. This is continued until the walls of the firing chamber 11 are heated sufficiently to fix the heavy hydrocarbon vapor formed from the kerosene or other heavy oil with which the engine normally operates. When the walls of the firing chamber are thus heated, the valve 27 should be closed and the valve 24 opened, which latter operation incidentally seats the valve 17. Meanwhile, oil will have been admitted to the chamber 22 and heated by the walls thereof. The opening of the valve 24 supplies compressed air to the pipe 36 and balanced the valve 12 and when the rod 12^a is lifted the valve 12 opens, by reason of an operation which is set forth and claimed in my above-referred to copending application and which I will not here describe in detail. As the valve 12 opens it

picks up an annular jet of hot oil forming a rich atomized mixture which impinges against the hot walls of the chamber 11 and is transferred into a fixed gas by reason of the cracking of the hydrocarbons due to the heat involved. At this time the exhaust valve 10 is closed. Said valve 10 is never opened at the time the valve 12 is open and in this manner loss of pressure from the receiver 15 into the atmosphere is avoided. Simultaneously with these operates the piston 16 on moving up in the cylinder and draws in atmospheric air past the valve 6 which opens on the suction stroke. This air first passes through the passage 31 and lifts the valve 17 and when the port 1 is uncovered the air is drawn in through this port. On the downward stroke of the piston, the air thus drawn into the cylinder is forced back into the receiver 4, until the port 1 is covered by the piston. Then the valve 13 opens and the remainder of the air is forced into the receiver 15, thus keeping up the requisite pressure in said receiver. As the piston reaches the bottom center the port 1 is uncovered above the piston and the compressed air in the receiver 4 rushes through the throat 2 and port 1 into the cylinder above the piston. By reason of the relative position of the throat 2 and passage 3 the air passing said throat, by an ejector-like action, rarefies the air in the chamber 5, lifting the valve 6 and drawing an additional quantity of air from the surrounding atmosphere which flows through the port 1 and augments the supply delivered from the receiver 4. At this time the valve 10 is open. The supply of air thus introduced sweeps through the cylinder and through the chamber 11 completely scavenging these parts and forcing all of the burnt gases out past the valve 10. When the piston reaches approximately the position shown in the drawings on its upward stroke, the scavenging action will be complete and the valve 10 is then closed by reason of the cam formation. At the same time the rod 12^a is lifted and the admission valve 12 is allowed to open, throwing into the cylinder from the chamber 11 a rich and fixed gas. This mixture, which expands rapidly and therefore combines instantly with the pure air remaining in the cylinder, and the continued upward motion of the piston, compresses such mixture. When the piston reaches the top center, or as near thereto as may be desirable in view of the interval required for the propagation of flame, the compressed charge is exploded by a spark from the plug 23, or otherwise. The burnt gases expanding against the piston force the same outward on its working stroke, the valve 12, of course, having been closed instantly after the admission of the rich mixture into the chamber 11. This completes the cycle of operations, the

engine operating, it will be observed, in a 2-stroke cycle.

Aside from the novelty of the admission valve and which, as I have said, is not herein claimed, it will be observed that my invention embraces two very important features. First, the manner of utilizing the heavy hydrocarbon oil in an internal combustion engine of the explosive type in accordance with which the oil is heated when in a liquid state and then mixed with air below explosive proportions, this heavy atomized mixture being then impinged against a hot surface to form, by the cracking of the hydrocarbons, a fixed gas which is instantly mixed with air in explosive proportions, compressed and fired. In this manner I attain complete combustion of all of the fuel, reaching a maximum efficiency and avoiding carbonaceous and bituminous accumulations in the cylinder and valves. Second, the manner in which the lower end of the cylinder is utilized to keep the reservoir properly charged and to control the operations at the port 1 having to do with the starting of the engine on the gasoline mixture and, during normal operation, the provision of a scavenging blast which sweeps over the explosion face of the piston and through the cylinder completely to cleanse these parts instantly before the mixture of the rich gas with the remaining air to form the explosive charge. Other features of novelty are of course involved and they are mainly ancillary to these two principles.

I have illustrated the engine as of the upright type, but by obvious modifications it could be arranged horizontally or in multiple cylinders, either vertical, horizontal, or at inclinations to each other. Further it is pointed out that in large sizes, to which my invention is particularly adapted, the starting may be effected by compressed air in accordance with the well-known practice, or otherwise, as may be desired. And it is still further pointed out that in starting, the necessary initial heat may be derived from an exterior burner acting on the walls of the chamber 11, thus dispensing with the gasoline attachment. In connection with this application, mention is made of my prior application for patent of the internal combustion engine, filed Jan. 28, 1904, Ser. 214503, allowed July 6, 1908, of which the present application, in so far as there is subject-matter in common, is a continuation.

Having thus described my invention what I claim as new and desire to secure by Letters Patent of the United States is:

1. An oil engine having a working cylinder and a piston, an air-compressor means formed by the lower part of the working cylinder having controlled communication with the compression chamber of the cylinder

to admit air to the same, an exhaust-valve means arranged to open the compression chamber to the atmosphere during the whole or a part of the period of air admission, means for admitting to the compression chamber, after the closure of the exhaust-valve means, an atomized jet of oil and air richer than an explosive mixture, whereby such jet mixes with the air remaining in the compression chamber to form an explosive mixture and means for igniting such mixture, said compressor means serving to compress the air of said fuel before admission to the cylinder.

2. An oil engine having a working cylinder and a piston, an air-compressor means formed by the lower part of the working cylinder having controlled communication with the compression chamber of the cylinder to admit air to the same, an exhaust-valve means arranged to open the compression chamber to the atmosphere during the whole or a part of the period of air admission, means for admitting to the compression chamber, after the closure of the exhaust-valve means, an atomized jet of oil and air richer than an explosive mixture, whereby such jet mixes with the air remaining in the compression chamber to form an explosive mixture and means for igniting such mixture, the engine having a heated part in the path of said atomized jet, the heat of which serves to crack the hydrocarbons of the jet and transform the same into a fixed gas.

3. An oil engine having a working cylinder and a piston, an air-compressor means formed by the lower part of the working cylinder having controlled communication with the compression chamber of the cylinder to admit air to the same when the piston is at the end of its working stroke, an exhaust-valve means arranged to open the compression chamber to the atmosphere during the whole or a part of the period of air admission, means for admitting to the compression chamber, after the closure of the exhaust-valve means, an atomized jet of oil and air richer than an explosive mixture, whereby such jet mixes with the air remaining in the compression chamber to form an explosive mixture and means for igniting such mixture.

4. An oil engine having a working cylinder and a piston, an air-compressor means formed by the lower part of the working cylinder having controlled communication with the compression chamber of the cylinder to admit air to the same, an exhaust-valve means arranged to open the compression chamber to the atmosphere during the whole or a part of the period of air admission, means for admitting to the compression chamber, after the closure of the exhaust-valve means, an atomized jet of

oil and air richer than an explosive mixture and at a higher pressure than the air remaining in the compression chamber, whereby such jet mixes with the air remaining in the compression chamber to form an explosive mixture and means for igniting such mixture.

5. An oil engine having a working cylinder and a piston, an air-compressor means formed by the lower part of the working cylinder having controlled communication with the compression chamber of the cylinder to admit air to the same, an exhaust-valve means arranged to open the compression chamber to the atmosphere during the whole or a part of the period of air admission, means for admitting to the compression chamber, after the closure of the exhaust-valve means, but before the end of the compression stroke, an atomized jet of oil and air richer than an explosive mixture, whereby such jet mixes with the air remaining in the compression chamber to form an explosive mixture and means for igniting such mixture.

6. An oil engine having a working cylinder and piston, an air-compressor means formed by the lower part of the working cylinder having controlled communication with the compression space of the cylinder to throw air thereinto when the piston is at the end of its working stroke, an exhaust-valve means arranged to open when the piston reaches the end of its working stroke, whereby the air flowing through the cylinder scavenges the same, means for admitting to the compression space, after the closure of the exhaust-valve means, an atomized jet of oil and air richer than an explosive mixture, whereby such jet mixes with the air remaining in the compression space to form an explosive mixture and means for igniting such mixture.

7. An oil engine having a working cylinder and piston, an air-compressor means formed by the lower part of the working cylinder having controlled communication with the compression space of the cylinder to throw air thereinto when the piston is at the end of its working stroke, an exhaust-valve means arranged to open when the piston reaches the end of its working stroke, whereby the air flowing through the cylinder scavenges the same, means for admitting to the compression space, after the closure of the exhaust-valve means, an atomized jet of oil and air richer than an explosive mixture, whereby such jet mixes with the air remaining in the compression space to form an explosive mixture and means for igniting such mixture, the engine having a heated part in the path of said jet, the heat of which serves to crack the hydrocarbons of the oil and transform the same into a fixed gas.

8. An oil engine having a working cylinder and piston, an air-compressor means formed by the lower part of the working cylinder having controlled communication with the compression space of the cylinder to throw air thereinto when the piston is at the end of its working stroke, an exhaust-valve means arranged to open when the piston reaches the end of its working stroke, whereby the air flowing through the cylinder scavenges the same, means for admitting to the compression space, after the closure of the exhaust-valve means, an atomized jet of oil and air, whereby such jet mixes with the air remaining in the compression space to form an explosive mixture and means for igniting such mixture.

9. An oil engine having a working cylinder and piston, an air-compressor means formed by the lower part of the working cylinder having controlled communication with the compression space of the cylinder to throw air thereinto when the piston is at the end of its working stroke, an exhaust-valve means arranged to open when the piston reaches the end of its working stroke, whereby the air flowing through the cylinder scavenges the same, means for admitting to the compression space, after the closure of the exhaust-valve means, an atomized jet of oil and air, whereby such jet mixes with the air remaining in the compression space to form an explosive mixture and means for igniting such mixture, the engine having a heated part in the path of the said jet, the heat of which serves to crack the hydrocarbons of the oil and transform the same into a fixed gas.

10. An oil engine having a working cylinder and piston, an air-compressor means formed by the lower part of the working cylinder having controlled communication with the compression space of the cylinder to throw air thereinto when the piston is at the end of its working stroke, an exhaust-valve means arranged to open when the piston reaches the end of its working stroke, whereby the air flowing through the cylinder scavenges the same, means for admitting to the compression space, after the closure of the exhaust-valve means, an atomized jet of oil and air richer than an explosive mixture, whereby such jet mixes with the air remaining in the compression space to form an explosive mixture and means for igniting such mixture, the said exhaust-valve means being located at the head end of the cylinder.

11. A scavenging combustion engine having means to supply air under pressure from a source external to the engine, consisting of a pressure receiving chamber and a passage leading therefrom to the engine cylinder, a valve communicating with the open air and means forming a second pas-

sage between the valve connected with the open air and the first passage, said second passage converging into the first toward the cylinder, whereby an ejector like action is established and air flows into the cylinder from both the source of scavenging air and the atmosphere.

12. An internal combustion engine, having a cylinder, a double-acting piston on one side of which the working fluid acts and on the other side of which air is compressed, the cylinder having an exhaust port and an additional port, the latter at the end of stroke, a reservoir communicating with said latter port, a by-pass means from the extreme end of the compressor side to said port, an inwardly opening valve controlling the by-pass means, a second reservoir communicating with the extreme end of the compressor side and an outwardly opening valve commanding said communication.

13. An internal combustion engine, having a cylinder, a double-acting piston on one side of which the working fluid acts and on the other side of which air is compressed, the cylinder having an exhaust port and an additional port, the latter at the end of stroke, a reservoir communicating with said latter port, a by-pass means from the extreme end of the compressor side to said port, an inwardly opening valve controlling the by-pass means, a second reservoir com-

municating with the extreme end of the compressor side, an outwardly opening valve commanding said communication, and means for unseating the first-named valve at will.

14. An internal combustion engine, having a cylinder, a double-acting piston on one side of which the working fluid acts and on the other side of which air is compressed, the cylinder having an exhaust port and an additional port, the latter at the end of stroke, a reservoir communicating with said latter port, a by-pass means from the extreme end of the compressor side to said port, an inwardly opening valve controlling the by-pass means, a second reservoir communicating with the extreme end of the compressor side, an outwardly opening valve commanding said communication, a fuel supply with which the second reservoir communicates, a valve controlling said communication and means for synchronously operating the first and last-named valves alternately to open and close them.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HENRY E. A. RAABE.

Witnesses:

B. BIGGE,

F. C. MARTIN.