O. LIETZENMAYER.

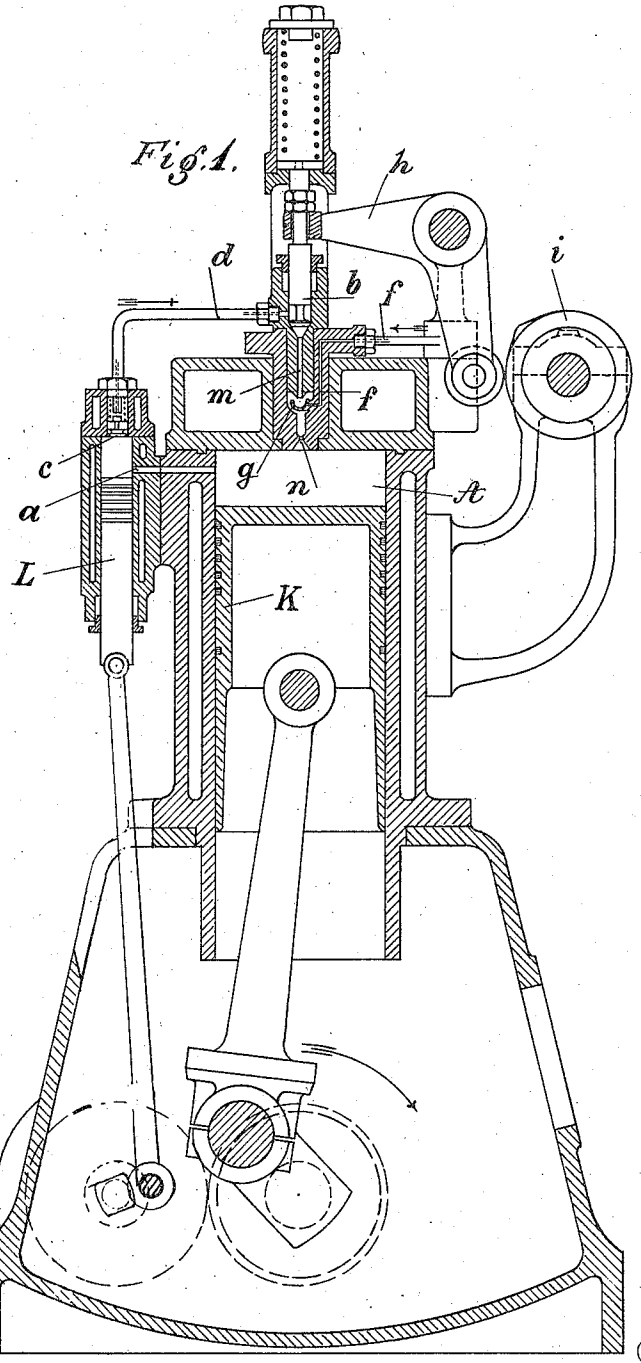
COMBUSTION ENGINE.

APPLICATION FILED DEC. 28, 1905.

923,054. Patented May 25, 1909.

3 SHEETS—SHEET 1.

Fig. 1.



Witnesses:
E. O. Nildebrand
May Taylor.

Inventor:
Otto Lietzenmayer,
by Georgii Massie
attorney

O. LIETZENMAYER.

COMBUSTION ENGINE.

APPLICATION FILED DEC. 28, 1905.

923,054. Patented May 25, 1909.

3 SHEETS—SHEET 2.

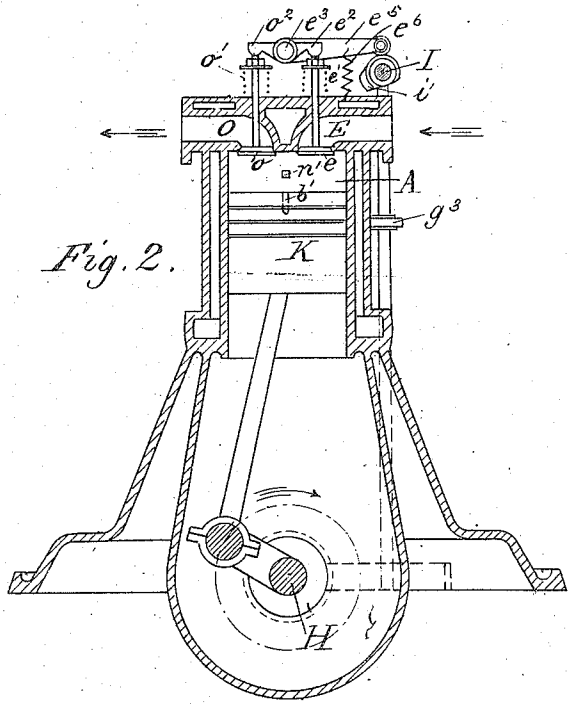


Fig. 2.

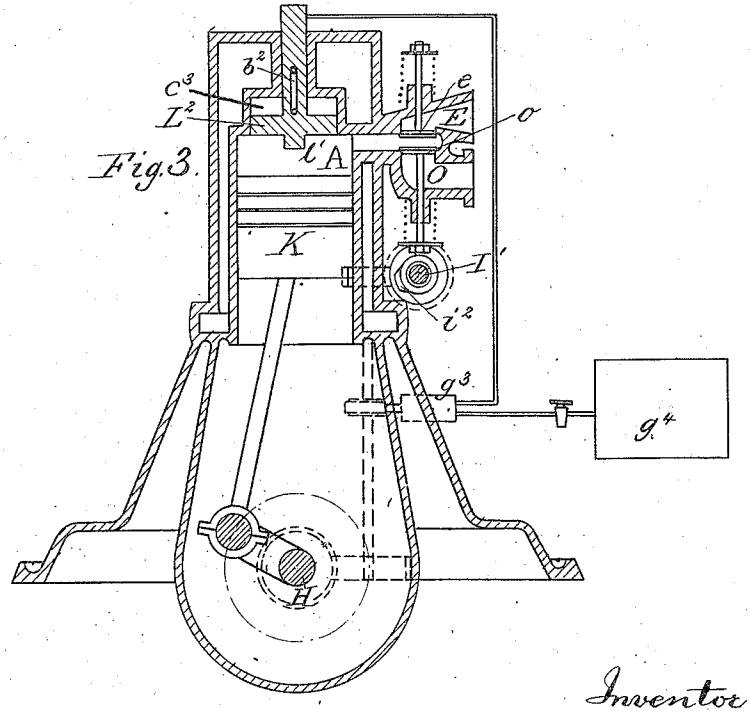


Fig. 3.

Witnesses:

M. B. Taylor.

N. Reynolds.

Inventor:

Otto Lietzenmayer

by Georgii & Massie

attorneys

O. LIETZENMAYER.

COMBUSTION ENGINE.

APPLICATION FILED DEC. 28, 1905.

923,054. Patented May 25, 1909.

3 SHEETS—SHEET 3.

Fig. 5.

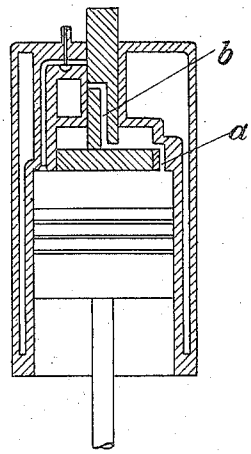


Fig. 4

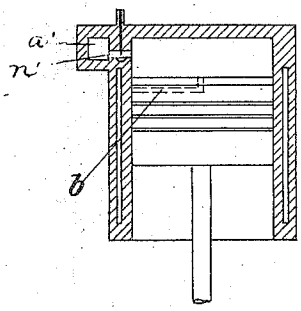
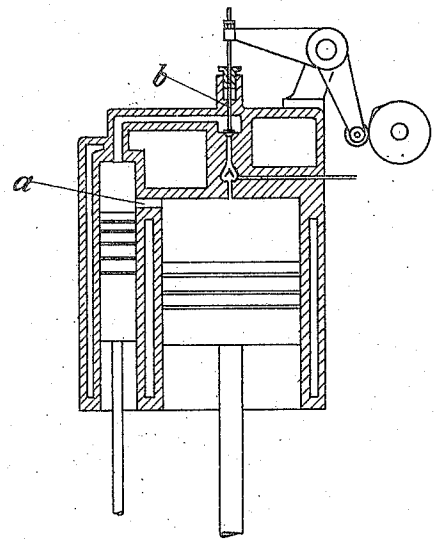


Fig. 6.



Witnesses:
E. O. Nicolebrand
May Taylor.

Inventor:
Otto Lietzenmayer.
by Georgii & Massie
attorneys

UNITED STATES PATENT OFFICE.

OTTO LIETZENMAYER, OF MUNICH, GERMANY, ASSIGNOR TO AUGUST KLUMPP, OF MUNICH, GERMANY.

COMBUSTION-ENGINE.

No. 923,054. Specification of Letters Patent. Patented May 25, 1909.

Application filed December 28, 1905. Serial No. 293,587.

To all whom it may concern:

Be it known that I, OTTO LIETZENMAYER, subject of the King of Würtemberg, residing at Tingstrasse 2, Munich, Bavaria, Germany, have invented certain new and useful Improvements in Combustion-Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to explosive engines, and particularly to the arrangement of means for introducing the explosive charge, whereby is secured an increased efficiency, economy of fuel, and accurate timing and certainty of the explosion.

Gas engines are known in which the fuel is introduced into the explosion chambers under a gradually increasing pressure, through a passage open to the explosion chamber, and also those in which the pressure for forcing in the fuel is a substantially constant one, but, the function of the present invention differs from the one, in that the pressure by which the fuel is introduced is a substantially constant one and takes place through a controlled passage, and is distinguished from the second by the fact that the compressed charge is not a mixture of fuel and air, but air only which is isolated from the fuel, the latter being in the same passage but adjacent to the entrance to the explosion chamber of the cylinder and in open communication therewith, whereby is attained a preheating of the fuel, safety by the avoidance of a compressed explosive mixture exterior of the explosion chamber, an increased efficiency and accurate control of the time of ignition.

Other advantages will be apparent from the following more detailed explanation of the structural features of the invention and from the accompanying drawings, in which:

Figure 1 is a vertical section through a four cycle-engine embodying my invention; Figs. 2 and 3 represent similar views of two modified forms of engines under this invention; Figs. 4 and 5 enlarged detail sectional views, respectively, of these modifications taken on planes at right angles to the sectional planes of Figs. 2 and 3; and Fig. 6 a similar sectional view of still another modification similar in most respects to that of Fig. 1.

Referring to the drawings in detail, and particularly to Figs. 1 and 6, the construction may be advantageously described in terms of the operation. During the downward stroke of the piston K, of the gas engine having the usual working parts, pure air is supplied to the combustion chamber A from the high pressure cylinder *c* through the passage *a* and, during the upward stroke, the air is compressed thereby in the usual manner. Shortly before the piston K reaches its uppermost position, the high pressure piston L closes the passage *a* so that during the remainder of the stroke of the piston K the air is further compressed in the combustion chamber A and the piston L, during its further movement, highly compresses the air trapped in the high pressure cylinder *c*, the pipe *d* and the chamber containing the valve *b*. The fluid fuel, at any suitable time during the working period of the engine, for instance, during the suction stroke, is introduced from the fuel supply through the pipe *f* into the fuel receptacle consisting in the present case of the pan *g* arranged in the channel *m* leading from the chamber containing the valve *b* to the combustion chamber. The fuel receptacle is hence in open communication with the working or explosion chamber of the cylinder and, therefore, it is subjected to the heat from the working cylinder and is prewarmed to facilitate its ignition when later mixed with the proper proportion of air. At the moment when the piston K reaches its uppermost position or at such time as the explosion should occur, the valve *b* is opened through the medium of the control lever *h* by the action of the cam *i* and the highly compressed air in the cylinder *c* and the pipe *d*, rushes through the channel *m* violently dispersing the fuel in the pan *g* and mixing therewith and thence the mixture passes through the opening *n* into the combustion chamber A where it mixes with the highly heated compressed air therein. The ignition follows and the resultant explosion drives the piston, K, downward. During the succeeding upward movement of the piston the burned gases are exhausted in the usual manner of a four cycle engine through the port, *o*, controlled by mechanism such as shown, for example, at i^2 of Fig. 3.

In the form of construction shown in Figs. 2 and 4, the valve *b* is dispensed with, its functions being performed by the passage *b'*

in piston, K, as set forth below. The construction and operation of this embodiment of my invention are as follows: The cylinder A and the piston, K, are of any usual desired form and construction, the cylinder being provided with an air admission port, E, controlled by an inlet valve e, yieldingly closed by a spring e', and adapted to be opened at a predetermined moment by suitable means. These means in the present instance consist in a tappet, e^2, arranged to rock on a shaft, e^3, and rigidly connected to an arm or lever, e^5, which is yieldingly held against a cam i' on shaft I by a spring e^6, the said arm being provided with a friction roller, as shown, at the point of contact with said cam. The said shaft I, is caused to rotate by suitable gearing interposed between it and the main or crank shaft, H, of the engine, as will be readily understood. The cylinder, A, is also provided with an outlet port indicated at O, said port being controlled by an exhaust valve, o, similar to inlet valve, e, also yieldingly held against its seat by a spring o' and also opened against the stress of said spring by a tappet o^2, also adapted to rock on shaft, e^3, and actuated at predetermined intervals by an arm and a cam similar to the arm, e^5, and cam i for operating the inlet valve.

As seen from Fig. 4, there is a combustion or explosion chamber a' arranged at the head of the cylinder A, said explosion chamber communicating with the working space or chamber of the cylinder by an air passage, n', having arranged therein the liquid fuel receptacle, g', to which the liquid fuel is fed at predetermined intervals through a duct, g^2, by means of a fuel pump g^3 of any usual and desired construction, the said duct being controlled for instance by a valve and valve-actuating mechanism such as described in connection with Fig. 1. In order to produce the high compression of the air for spraying the liquid fuel into the explosion chamber and intimately commingling it with the compressed air for such purpose, I arrange the piston K and cylinder A to serve as such high compression means, instead of the cylinder C and piston L in Fig. 1, during the final portion of the compression stroke. These means consist of a duct, b', arranged in the piston K, which duct is so arranged, as shown, that the piston when it reaches the high compression part of its stroke, closes off the upper port of the working chamber of the cylinder until the duct, b, registers with the passage, a, thereby suddenly releasing the highly compressed air. The operation of this modified embodiment of my invention will be obvious from the foregoing. As the piston, K, reaches the final part of its compression stroke, it closes the passage, n', and thereby the communication between the same and the working chamber of the cylinder A. The piston continuing its upward movement then highly compresses the air in said working space which now becomes also a highly compressed air chamber. Still continuing its upward movement the piston reaches a point where the duct, b, comes to register with the passage, n', whereby the highly compressed air is suddenly injected through the passage, n', into the explosion chamber. This highly compressed and thoroughly heated air passes over and through the fuel receptacle g' and converts the liquid fuel into a spray of finely comminuted carbureted air, which is caused to intermingle with the hot compressed air in the explosion chamber, a', thereby causing an explosion, the products of such explosion returning through the passage n', and forcing the piston K downward, as will be readily understood. Since the passage, n', and hence the fuel receptacle, g', is continuously in open communication with the chamber, a', and therefore with the hot air compressed by the compression stroke of the engine, it is maintained in such a preheated condition that it will be immediately vaporized by the jet of highly compressed air as it passes through the passage, a', and the certainty of explosion in the chamber, a, is thereby insured. The preheating of the liquid fuel is also contributed to during the compression stroke of the engine before the high compression of the air commences, and the passage, a', is also practically in continuous open communication with the working chamber of the cylinder A.

In the modification represented in Figs. 3 and 5, the construction, so far as it departs from those previously described, is as follows: The air admission port, E, is controlled by a spring-pressed air-admission valve, e, which in this case is automatically opened by the descent of the piston K after the expulsion of the products of combustion. The exhaust-valve, o, controlling the exhaust or outlet port, O, is, however, operated by means similar to those shown in Fig. 2, namely, by a cam, i^2, mounted on a shaft I', actuated from the main or crank shaft, H, by intermediate gearing, similar to that employed for the modification represented in Fig. 2. In this case the liquid fuel receptacle, g', as clearly indicated in Fig. 5, is in continuous open communication with the working or low-compression chamber of the cylinder by the passage n^2. The high compression chamber or cylinder, c^2, is in this modification arranged above and in line with the working cylinder A, and is combined with a piston L^2 and with means similar to those in Fig. 1 for cutting off the air in the high compression chamber from the working chamber of the cylinder A at the desired moment, and for controlling the communication between the said high compression chamber and the fuel-receptacle g'. The piston L^2 is provided with a rod or shank l which fits air-tight in a suitable socket in

the top of the cylinder, and is provided at its bottom with a stud or projection l' extending into the working chamber of the piston and against which the piston K is adapted to strike toward the end of its upward stroke. A passage a^2, leads through the head of the cylinder from the working chamber to the high compression chamber, c^2, and is so arranged as to be cut off or closed as the piston L^2 ascends. Another passage, b^2, leads from the high compression chamber or compressed air receptacle, c^2, through the shank l, the parts being so arranged that said passage, b^2, will register with the passage, n^2, when the piston, L^2, is at the end of its upward stroke. In this case also, the fuel is fed to the fuel receptacle, g', through the duct g^2, by a fuel pump, g^3, said fuel being supplied from a fuel reservoir, g^4, as usual. The operation of the parts of this modification embodying my invention is obvious from the foregoing. When the piston, K, is toward the end of the compression stroke, it strikes against the stud, l', whereby the piston L^2 is thrust upward, first closing the passage, a^2, and cutting off the air in the high compression chamber whereupon the air is highly compressed therein until the passage, b^2, registers with the passage, n^2, when the highly compressed air will be forcibly ejected through said passage n^2 into the working or explosion chamber of the cylinder A. In doing so it will carry with it the fuel, which, by reason of the continuous open communication with the working chamber of the cylinder, has been preheated, in a highly vaporized and comminuted form, thoroughly mixed with the compressed air. Thereby it will instantly produce the required explosion to start a new cycle of the engine.

From the foregoing it will be noted that in all cases under my invention the fuel receptacle is in continuous open communication with the air compressed by the low compression stroke of the cylinder and more specifically considered in the forms represented in Figs. 1 and 3, it is in continuous open communication with the interior of said cylinder at all times. Thereby the fuel is thoroughly preheated by the heated air in the cylinder whose heat is due to the compression stroke. When, therefore, the highly compressed air is admitted to the passage in which it is arranged, it is in a condition to be thoroughly vaporized and divided by the jet of compressed air which is forced past it from the compressed air receptacle and being thus carried into the combustion or explosion chamber, which may be the interior of the cylinder or a chamber in communication therewith, the explosion takes place with certainty.

The means for controlling the communication between the combustion chamber and the space for highly compressed air may be varied, and for example, consist of a valve, as b in Fig. 1, opened at a predetermined moment, or a duct in the high compression piston as b^2 in Figs. 3 and 5, adapted to register with the passage n^2, or, as shown in Figs. 2 and 4, a duct n' which is adapted to register with the passage, n.

In Fig. 6, instead of a fuel pan, g, a fuel receptacle of a somewhat different form is shown. In other respects this figure shows the same construction as Fig. 1.

My invention is applicable to every kind of combustion engine in which liquid fuel is vaporized, comprising both explosion engines and continuous combustion engines, and depending for this purpose mainly on the rate and time of vapor admission. It works particularly well for a continuous combustion engine, giving an indicator diagram very continuous in form and similar to a steam engine diagram.

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

1. In a combustion engine, the combination, with the working cylinder and its piston, of a high compression space and means for compressing air therein, a combustion chamber, an air passage connecting the said compression space and the interior of the cylinder, and a fuel receptacle arranged in said passage and in continuous open communication with the interior of the working cylinder, and means for controlling the communication between the air-compression space and the said fuel receptacle.

2. In a combustion engine, the combination, with the working cylinder and its piston, of a high compression space, means for compressing air therein operated by the piston, a passage connecting the said high compression space and the interior of the cylinder, a fuel receptacle arranged in said passage and in open communication with the interior of the cylinder, and means for controlling the communication between said high compression space and the fuel receptacle.

3. In a combustion engine, the combination, of a combustion chamber, and a high compression chamber and an air passage connecting the combustion chamber with the air-compression chamber, with a fuel receptacle arranged in said air passage and in open communication with the working chamber of the engine cylinder, and means for controlling the communication between the air compression chamber and the fuel receptacle.

4. In a combustion engine, the combination, of a combustion chamber and a high-compressed air supply, a passage connecting the said combustion chamber and the compressed air supply with a fuel receptacle arranged in the passage and in continuous open communication with the space interior of the cylinder while the low compression of the air

is being effected, and means for controlling the communication between the high-compressed air supply and the fuel receptacle.

5. In a combustion engine, the combination, with the working cylinder and the piston, a compressed air supply and a fuel supply, of a passage connecting the combustion chamber of the working cylinder with the compressed air supply, a fuel receptacle arranged in said passage and in continuous open communication with the said combustion chamber, means for normally cutting off the compressed air supply from the fuel receptacle, and means for establishing communication between the said air supply and the fuel receptacle at a predetermined moment, to charge the fuel into the combustion chamber.

6. In a combustion engine, the combination, with the working cylinder and its piston, a compressed air supply and a fuel supply, of a passage connecting the interior of the working cylinder with the compressed air supply, a fuel receptacle arranged in said passage, adjacent to and in open communication with the interior of the working cylinder, means normally cutting off the compressed air supply from the said fuel receptacle, and means arranged to operate at a predetermined moment to establish communication through said passage to atomize the fuel and charge the same into the interior of the working cylinder.

7. In a combustion engine, the combination, with the working cylinder and its piston, a compressed air supply and a fuel supply, a passage connecting the interior of the working cylinder with the compressed air supply, a passage leading from the fuel supply into the air supply passage, a fuel receptacle arranged substantially at the junction of the said two passages and in open communication with the interior of the working cylinder, of means normally cutting off the air supply from the fuel receptacle, and means operating at a predetermined moment to establish communication through the air passage to atomize the fuel and charge the same into the combustion chamber.

8. In a combustion engine, the combination, with the working cylinder, of a fuel supply, a fuel receptacle supplied by the fuel supply and in open communication with the combustion chamber, a compressed air supply, a normally closed valve therein, and means to establish communication between the air supply and the combustion chamber by way of the fuel receptacle to charge the fuel prewarmed by the heat of compression into the combustion chamber.

In testimony whereof I hereunto affix my signature in the presence of two witnesses.

OTTO LIETZENMAYER.

Witnesses:

ULYSSES J. BYWATER,

ABRAHAM SCHLESINGER.