

No. 640,394.

Patented Jan. 2, 1900.

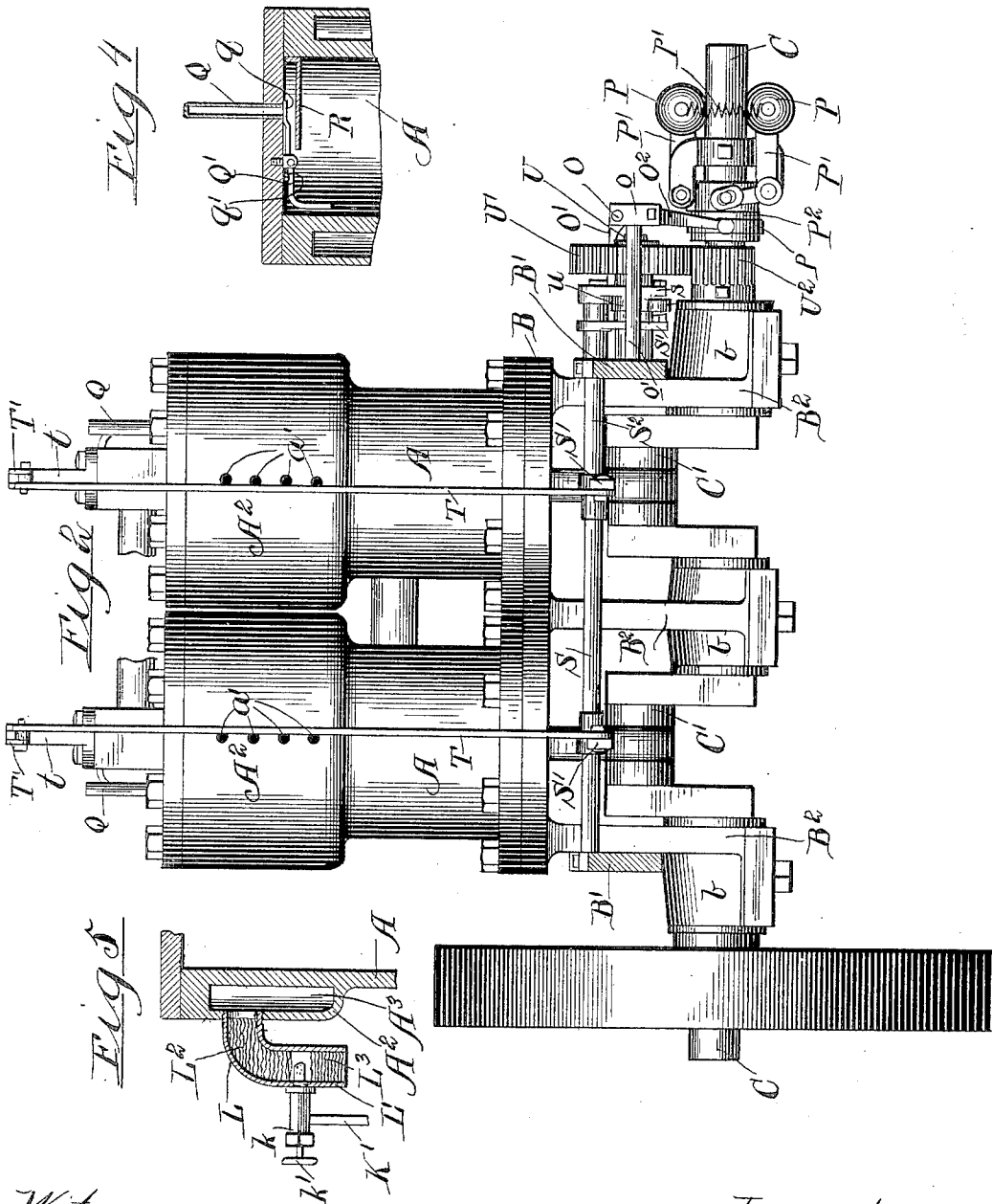
G. W. LEWIS.

GAS ENGINE.

(Application filed June 21, 1899.)

(No Model.)

3 Sheets—Sheet 2.



Witnesses:-
Carl H. Crawford
William H. Hall

Inventor:-
George W. Lewis
by Pole & Brown his Attys

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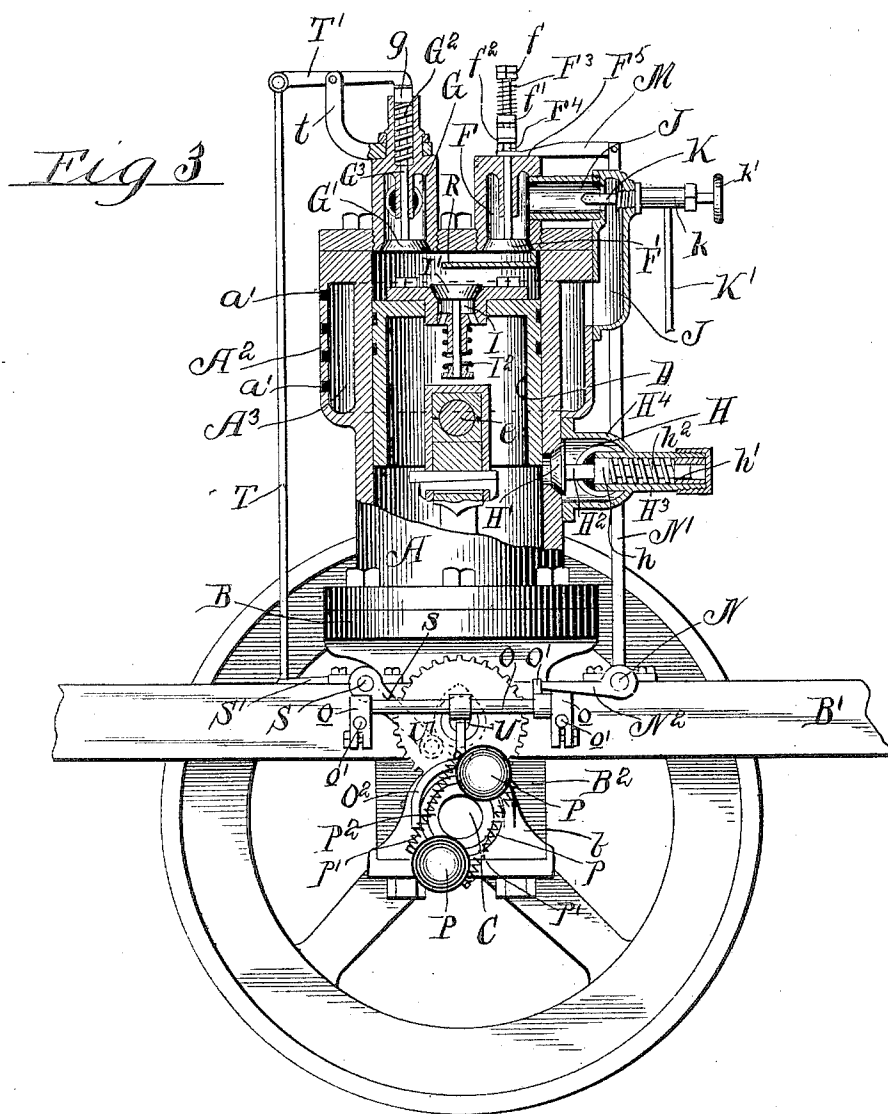
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UNITED STATES PATENT OFFICE.

GEORGE W. LEWIS, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO
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GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 640,394, dated January 2, 1900.

Original application filed November 8, 1894. Renewed September 22, 1898, Serial No. 691,630. Divided and this application
filed June 21, 1899. Serial No. 721,377. (No model.)

To all whom it may concern:

Be it known that I, GEORGE W. LEWIS, of Philadelphia, in the county of Philadelphia and State of Pennsylvania, (formerly of Chicago, in the county of Cook and State of Illinois,) have invented certain new and useful Improvements in Gas-Engines, (Case C;) and I do hereby declare that the following is a full, clear, and exact description thereof, reference
10 being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to improvements in gas-engines of that class known as the "Otto cycle," or those in which the explosion takes place at every second or alternate revolution of the crank-shaft and wherein the waste gases and products of combustion arising from the explosion of the charge are expelled
20 in the back or inward stroke of the piston after each power-stroke and a new supply of the explosive mixture or charge is drawn into the cylinder in the outstroke preceding the power-stroke.

25 The invention embraces improvements in the several features of engines of the character referred to; and it consists in the matters hereinafter described, and pointed out in the appended claims.

30 The invention is herein shown as applied to a double-cylinder engine acting on one crank-shaft and in which the cranks are set at the same side of the shaft, so that the pistons in the two cylinders move inwardly and outwardly together, the parts being so arranged, however, that the power-stroke takes place in alternation in the two cylinders, but the improvements herein described may be
35 applied to single-cylinders engine.

40 In the accompanying drawings, illustrating my invention, Figure 1 is a plan view of an engine embodying the same. Fig. 2 is a view in side elevation of said engine. Fig. 3 is an end elevation thereof with the cylinder and other operative parts in section. Fig. 4 is a detail section of the upper end of the cylinder, showing the ignition-tube. Fig. 5 is a detail section showing a modification.

45 As shown in the drawings, A A indicate power-cylinders, which are in this instance arranged vertically and side by side and at-

tached to a common frame base or casting B, which is bolted to horizontal supporting-bars B', which may represent the frame-bars of a vehicle. Said casting is provided with depending arms B² B², in which are formed bearings b b b for the crank-shaft C. Said crank-shaft is provided with two cranks C' C', which extend at the same side of the shaft and are arranged parallel with each other.

60 The cylinders A are open at their lower and closed at their upper ends and contain pistons D of hollow or trunk form, said pistons being connected with the cranks C' C' by means of transverse bearing-pins e, affixed in the walls of the pistons and extending across the hollow interior of the same in a familiar manner. With respect to their details of construction the two cylinders A A are alike, and in the following description of the parts immediately connected with the cylinders and their mode of operation one cylinder only will be referred to.

Each cylinder A is provided with an inlet port or passage F, through which the explosive mixture of gas or vapor and air enters the cylinder, a main exhaust port or passage G for spent gases, this being located in the head A' of the cylinder, an auxiliary exhaust port or passage H, which is located near the open end of the cylinder and in position to be uncovered by the piston D when the latter reaches the outer limit of its movement in its outward or power stroke, and a supplemental air-inlet port I, which in the instance shown is located in the piston D.

75 The inlet-port F for the explosive mixture is provided with a valve F', having the form of a check-valve and opening inwardly or toward the cylinder. Said valve is held, usually, in its closed position by a spring F³ and is opened by atmospheric pressure acting against the tension of the spring to permit the inflow of air to the cylinder in the outstroke of the piston. An air pipe or passage J leads to the said inlet-port F for the admission of air thereto.

80 The means shown for supplying gas or vapor to the cylinder for making the explosive mixture consists of a supply-nozzle K, which enters the pipe J, preferably at a point near the port F, and which is supplied with liquid

hydrocarbon by means of the supply-pipe K', the quantity of liquid fed to the nozzle K being controlled by means of a valve located within the casing k and operated by means of a hand-wheel k'. Liquid is supplied at a constant pressure through the pipe K' and flows therefrom to the nozzle K at a rate determined by the adjustment of the valve k, the same being vaporized by the air and passing in the form of vapor, with the air, into the cylinder. The rate of flow is also modified, however, by the extent of the vacuum produced in the supply-pipe J in the out-stroke of the piston, as will be hereinafter more fully stated.

Referring now to the inlet-valve F and the governing devices by which the supply of the explosive mixture to the cylinder is regulated, these parts, as herein shown, are constructed as follows: The said valve F' is provided with a stem F⁴. The spring F³, which is applied to hold the valve against its seat, is shown as located between a nut f' on the upper end of the stem and a stationary guide-bracket f', which is attached to the top of the casing and provided with a guide-aperture for the rod. Attached to such rod below the bracket f' is a stop shoulder or collar f², which operates in connection with a sliding wedge M to variably limit the closing of the valve. An automatic governing device acts to move said wedge endwise, and it embraces the following parts: N is a rock-shaft arranged at right angles to the axis of the cylinder and conveniently mounted on bearings on the frame-bars B'B'. Said rock-shaft is provided with a rigid upwardly-extending arm N', to which is attached the outer end of the wedge M. The said wedge is arranged to rest and slide on the casing F⁵, and the end of said wedge adjacent to the valve-stem is slotted or forked, so as to extend at opposite sides of the stem, which thereby forms a guide for the wedge and holds the same from lateral displacement. The rock-shaft N is provided also with a rigid arm N², arranged at right angles with the arm N' and engaging a rigid arm O', attached to a rock-shaft O, Figs. 1 and 2, which latter rock-shaft is arranged adjacent to and transversely of the crank-shaft C. Said rock-shaft O has bearing in blocks o, which are attached to horizontal arms o' o', secured in one of the frame-bars B'. Attached to the crank-shaft is a centrifugal weight-governor consisting of governor-weights P, which are attached to bell-crank levers P', having arms parallel with the crank-shaft, to which the governor-weights are attached, and other arms transverse to the crank-shaft, which latter arms engage an endwise-sliding sleeve P² on the crank-shaft. Said sleeve P² is connected with and gives motion to the rock-shaft O by means of an arm O² on the rock-shaft, which arm is forked at its end adjacent to the sleeve P² and has inwardly-projecting pins engaging a ring p, which is engaged with a groove in said collar. Coiled springs p' p', attached to the oppositely - arranged governor - weights P,

serve to hold the latter normally adjacent to the crank-shank, while allowing outward movement thereof under an increase of speed of the crank-shaft in a familiar manner. The movement of the said governor-weights is transmitted through the two rock-shafts N and O described to the sliding wedge M, which by being moved endwise in a direction transverse to the valve-stem serves as a movable stop to variably limit the opening of the said valve. The governing device described operates in a familiar manner to shorten the movement of the valve and lessen the extent of its possible opening when the usual or desired speed in the engine is exceeded and to afford a greater extent of opening of the valve, and thus admit a greater quantity of the explosive mixture when the speed of the engine is decreased through an increase of load or otherwise.

The main exhaust-port G is controlled by a valve G', which is held usually closed by a spring G² and is opened automatically at proper times by suitable operative connections with the crank-shaft.

Referring in detail to the devices shown for actuating the main exhaust-valve G', said valve is provided with a stem G³, having at its outer end a collar g, between which and an opposing surface of the exhaust-passage is located the spring G², which is made of coiled form to surround said stem and acts to hold the valve normally closed. At the end of the cylinder adjacent to the crank-shaft C is located a rock-shaft S, having a rigid arm S', which is connected by means of a connecting-rod T with a lever T', which is pivoted centrally to a bracket t, secured to the head of the cylinder, and a free end of which acts upon the outer end of the valve-stem. Adjacent to and parallel with the crank-shaft C is located a counter-shaft U, which carries a gear-wheel U', intermeshing with a gear-pinion U² on the crank-shaft, the gear pinion and wheel being of such relative size that the wheel will make one revolution to two revolutions of the crank-shaft. Mounted on said counter-shaft U is a cam u, the periphery of which is engaged by the end of a rigid arm s on the rock-shaft S. Said cam u is provided at one side with a cam projection arranged to oscillate the rock-shaft S, and thereby open the exhaust-valve once at every revolution of the cam, the parts being so arranged that the exhaust-valve is opened once at each second revolution of the crank-shaft and at the time the piston begins its backward or inward stroke following its power-stroke.

The engine herein shown is a double one, or has two cylinders, as before mentioned, and in connection with this kind of an engine I have provided special features of construction in the parts referred to for actuating the exhaust-valves of the two cylinders, as follows: The rock-shaft S, hereinbefore referred to, serves for one of the cylinders only, that being the one remote from the end of the shaft

at which the actuating devices are located, and another separate rock-shaft S^2 , tubular in form and surrounding the shaft S , is employed to give motion to the exhaust-valve of the cylinder nearest said actuating devices. The end of the rock-shaft S adjacent to the actuating devices projects through the tubular shaft S^2 and has upon it the rigid arm s , which engages the cam u , as hereinbefore referred to. Attached to the rock-shaft S^2 is, however, a second crank-arm s' , the free end of which engages a second cam u' , which is like the first one, but which is set upon the shaft with its cam projection diametrically opposite that of the first cam u . The tubular rock-shaft S^2 is shown as having suitable bearing in the frame-piece B' nearest the actuating devices, while the same end of the rock-shaft S is supported by its engagement with the tubular rock-shaft only. At its opposite end, however, said rock-shaft S is engaged with a bearing on the other frame-piece B' , as clearly shown in the drawings, Fig. 1.

As a result of the construction described in the two rock-shafts and cams having oppositely-arranged projections said exhaust-valves of the two cylinders are opened in alternation, with the result that the outer or power stroke of the piston of one cylinder occurs at the time the other cylinder is receiving its charge preparatory to an explosion.

Now referring to the supplementary exhaust-port H said port is supplied with a valve H' , attached to a valve-stem H^2 , which is provided with a collar h , between which and an opposing shoulder h' , formed in a tubular sleeve or projection H^3 , is located a coiled expansion-spring h^2 , which tends to hold the valve against the seat. The said valve is shown as located within a casing H^4 , to one side of which is connected a pipe which leads to a suitable point of delivery for the exhaust or waste gases. In the operation of the engine provided with such a check-valve in its auxiliary exhaust-port the waste gases which are under compression within the cylinder after the explosion escape through the said valve to such extent as is permitted by the tension of the closing-spring of the said valve. In other words, if a pressure of five pounds to the square inch be required to open the said valve the waste gases will pass through the valve as soon as opened to such extent as to reduce the pressure within the cylinder to five pounds per square inch, it being of course understood that the pressure within the cylinder is afterward entirely relieved and the remaining waste gases forced therefrom by the opening of the main exhaust-port in the upstroke of the piston. The auxiliary exhaust-valve, arranged as described, not only serves the purpose of relieving pressure within the cylinder, but it serves as a muffler to deaden the sound produced by the escape of the waste gases, it being found that in engines where no such check-valve is employed the waste gases, being allowed to suddenly escape through the

exhaust-port when the piston uncovers the port, rush out with such force as to make a loud noise, while when the valve is present it checks the escape so as to make the same gradual, and thus comparatively noiseless. Moreover, the presence of the valve, operating as described, insures that all waste gases which have been forced from the cylinder shall remain outside the same instead of being drawn back into the cylinder to fill the space left in the outward movement of the piston after the same has uncovered the exhaust-port sufficiently to permit the pressure to be entirely relieved. This may be better understood by consideration of the fact that in engines having an open exhaust-port arranged to be uncovered by the piston the pressure is entirely relieved as soon as the piston passes the inner edge of the port, so that by the time the piston reaches the extreme edge of the port it has begun to draw the waste gases which fill the exhaust-passage back again into the cylinder to fill the vacuum caused by the continued outward movement of the piston.

The supplemental air-inlet passage I is provided with a spring-actuated check-valve I' , adapted to open inwardly or toward the interior of the cylinder, so that in the outward movement of the piston if the main inlet-port F be not opened sufficiently to fill the cylinder with air as fast as required by the speed of the piston the said check-valve will open and permit the inflow of an additional amount of air through the same. For this purpose the spring I^2 of the said check-valve is made stronger or has greater tension than that of the main inlet-valve F' , so that the latter will open before the pressure is great enough to open the check-valve. The quantity of air admitted through the supplemental air-valve will vary according to the extent to which the main valve is allowed to open by the governing devices, so that the said inlet-valve affords an additional supply of air to the cylinder when the supply through the main admission-valve is partially or wholly cut off through the action of said governing devices. It follows from this construction that the external pressure tending to resist the outward movement of the piston on its charging-stroke will never exceed the pressure required to overcome the force of the closing-spring of the said check-valve I and that such pressure will always be uniform, the check-valve remaining open a longer time and admitting more air when the quantity of air admitted through the main inlet-valve is decreased, and vice versa.

An inwardly-opening check-valve like the valve I may be located at the inner or power end of the cylinder instead of in the piston itself, but I prefer to locate the same in the head of the piston not only because there is more room for it at this point and it may be more easily there placed, but because location of the valve at this point insures the

drawing of the air through the cylinder and the hollow interior of the piston, and thus greatly aids in keeping these parts cool or maintaining them at a suitably low temperature.

The igniting device herein shown consists of an ignition-tube Q, Fig. 4, which extends through the cylinder-head, is open at its inner end, and is closed at its outer end in the usual manner. The inner end of this tube, as shown in Fig. 4, is held normally closed by means of an oscillating valve-plate *q*, attached to a lever Q', which is held by a spring *q'* in position to maintain the valve-plate *q* in contact with the inner end of the ignition-tube. Said lever Q' is provided with an inwardly-projecting end adapted for contact with the piston and arranged in such a position that the lever will be actuated and the valve-plate moved to open the ignition-tube at the inner limit of the movement of the piston.

In connection with the inlet-port F, supplying the explosive mixture, and a separate air-inlet port arranged to afford a supplemental air-supply I propose to employ a plate or partition R, arranged within the cylinder, adjacent to the head thereof, in such manner as to form a partial inclosure or chamber adjacent to the inlet-port and to locate the ignition-tube or other igniting device that may be used within such inclosure or chamber. Said partition serves to confine the explosive mixture which enters the inlet-port in the part of the cylinder adjacent to the igniting devices, and thus insures ignition at the proper time without regard to the quantity of air which may enter the supplemental port. Said plate R is herein shown as being arranged parallel with the cylinder-head and extending about one-half across the width of the cylinder. The advantage of this construction may be better understood by consideration of the fact that in each outstroke of the piston at which a charge is taken into the cylinder the valve F' is opened by atmospheric pressure exerted on its outward face to the extent only permitted by the governing devices, and the mixture is thereby drawn into the cylinder during the outstroke of the piston. The valve I is so adjusted, however, that external air will enter through the same to some extent, depending on the extent of opening of the inlet-valve, it being obvious that when the governing devices act to hold nearly closed said valve, and thus permit the entrance of only the slight quantity of the explosive mixture, the partial vacuum produced in the cylinder in the outstroke of the piston will be so great as to overcome the force of the spring which holds the check-valve closed, and thus permit the entrance of considerable outside air to the cylinder. The plate R serves the purpose of confining or holding adjacent to the igniting device the incoming charge and of preventing the admixture of the same with air which may en-

ter through the check-valve, thereby insuring that the mixture shall be of proper proportions to produce an explosion in the vicinity of the igniting devices and insuring also that an explosion shall take place even though the quantity of gas or vapor admitted in proportion to the whole quantity of air be comparatively small or less than required for producing an explosion if fully mixed with the air within the cylinder. The construction described, therefore, has the important advantage of insuring an explosion at every second stroke of the piston, notwithstanding great variations in the work to be done and the supply of fuel to the engine.

As a further improvement in explosive gas-engines, I have shown as surrounding the upper or power end of the cylinder A a jacket A², forming an annular chamber A³, which chamber is in communication at one side of the cylinder with the open air through suitable inlet-openings, as by holes *a' a'*. At its opposite sides or at a point remote from the inlet-openings said chamber communicates with the inlet or admission port of the cylinder by means of the air pipe or passage J, which is in this case extended to and connected with the jacket A². The said chamber A³, surrounding the cylinder, therefore forms in this construction a part of the air-supply passage leading to the main inlet-port F, so that air drawn into the cylinder for making the explosive mixture or charge is carried around or over the wall of the cylinder, and thus serves the purpose of a water-jacket, heretofore commonly employed for maintaining a suitably-low temperature in the cylinder.

I have shown the jacket A² as arranged to form a single continuous chamber extending around the power or explosive end only of the cylinder, but the jacket may cover a greater or less portion of the cylinder, as may be found desirable, and the jacket may be constructed to form a longer or tortuous passage about the cylinder or a plurality of passages in case it be found desirable to so construct it.

In the operation of the engine the air being drawn rapidly or forcibly into the cylinder by the action of the piston in the outstroke thereof is caused to pass forcibly and quickly through the chamber A³, with the result of rapidly cooling the walls of the cylinder by the extraction of heat therefrom.

In Fig. 5 I have shown, in connection with an air jacket or chamber, a different construction in the devices for supplying the explosive charge to the cylinder, wherein the fuel is mixed with the incoming air before the air passes through the chamber surrounding the cylinder, the advantage of this construction being that the reduction of temperature in the air which arises from the evaporation of the liquid fuel is utilized as a means of cooling the cylinder. In other words, inasmuch as the vaporization of the liquid is accompanied by absorption of heat, the air is greatly cooled at the point where such vaporization takes place,

and the air thus cooled in passing around and over the surface of the cylinder rapidly absorbs the heat therefrom, so that the refrigerating action arising from vaporization is utilized for keeping the cylinder cool. The further advantage gained by locating the vaporizing devices at the entrance of the passage which surrounds the cylinder is that the mixture of air and vapor becomes thoroughly intermingled and to some extent heated while passing through said passage, with the result that explosion more readily takes place and better results are secured in the operation of the engine.

In the construction illustrated in Fig. 5 the pipe L is inserted horizontally into the wall of the chamber A³, and said pipe is provided with a vertical part L', depending from the main or horizontal part and open at its lower end. The oil-supply nozzle is in this instance inserted into the pipe through the vertical portion thereof, the nozzle being provided with the supply-pipe K' and controlling-valve K', as hereinbefore described.

I preferably arrange within the pipe L porous fillings L² L³, located inside and outside of the fuel-nozzle. Such fillings preferably consist of wire-gauze and are for the purpose of holding and retaining a certain quantity of liquid fuel delivered from the nozzle, so that in starting the engine the air drawn inwardly through the pipe in the first outward movement of the piston will be immediately charged with vapor and the cylinder will be supplied with a charge of air and vapor in proper portions for explosion by one stroke only of the piston.

In either of the forms of fuel-supply devices illustrated—namely, that shown in Fig. 3 and the modified form shown in Fig. 5—the quantity of oil or liquid fed to the cylinder at each

outward stroke of the piston will be varied according to the quantity needed by reason of the fact that by the action of the air-inlet valve the suction produced in the outstroke of the piston is greater when a larger supply of fuel is needed and less when the amount required is smaller. It follows that an automatic regulation of the fuel-supply is afforded, it being obvious that inasmuch as the pressure on the oil-supply pipe is constant the variations in the suction or vacuum produced will result in corresponding variations in the quantity of liquid passing through the supply-nozzle to the interior of the air-supply pipes J and L.

I claim as my invention—

1. The combination with an engine-cylinder, an admission-valve provided with a spring acting to hold the same closed, and a governor which variably controls the opening of said valve, of a supplemental air-passage opening into the cylinder and provided with an inwardly-opening check-valve which is held closed by a spring having a greater tension than the spring of the inlet-valve.

2. The combination with an engine-cylinder and piston, of an inwardly-opening admission-valve, a spring to hold the same in its closed position, a governing device which variably limits the opening of said valve, and a spring-actuated check-valve located in the piston and opening inwardly into the cylinder.

In testimony that I claim the foregoing as my invention I affix my signature, in presence of two witnesses, this 1st day of June, A. D. 1899.

GEORGE W. LEWIS.

Witnesses:

H. F. REARDON,
F. E. BECHTOLD.