No. 729,194. PATENTED MAY 26, 1903.

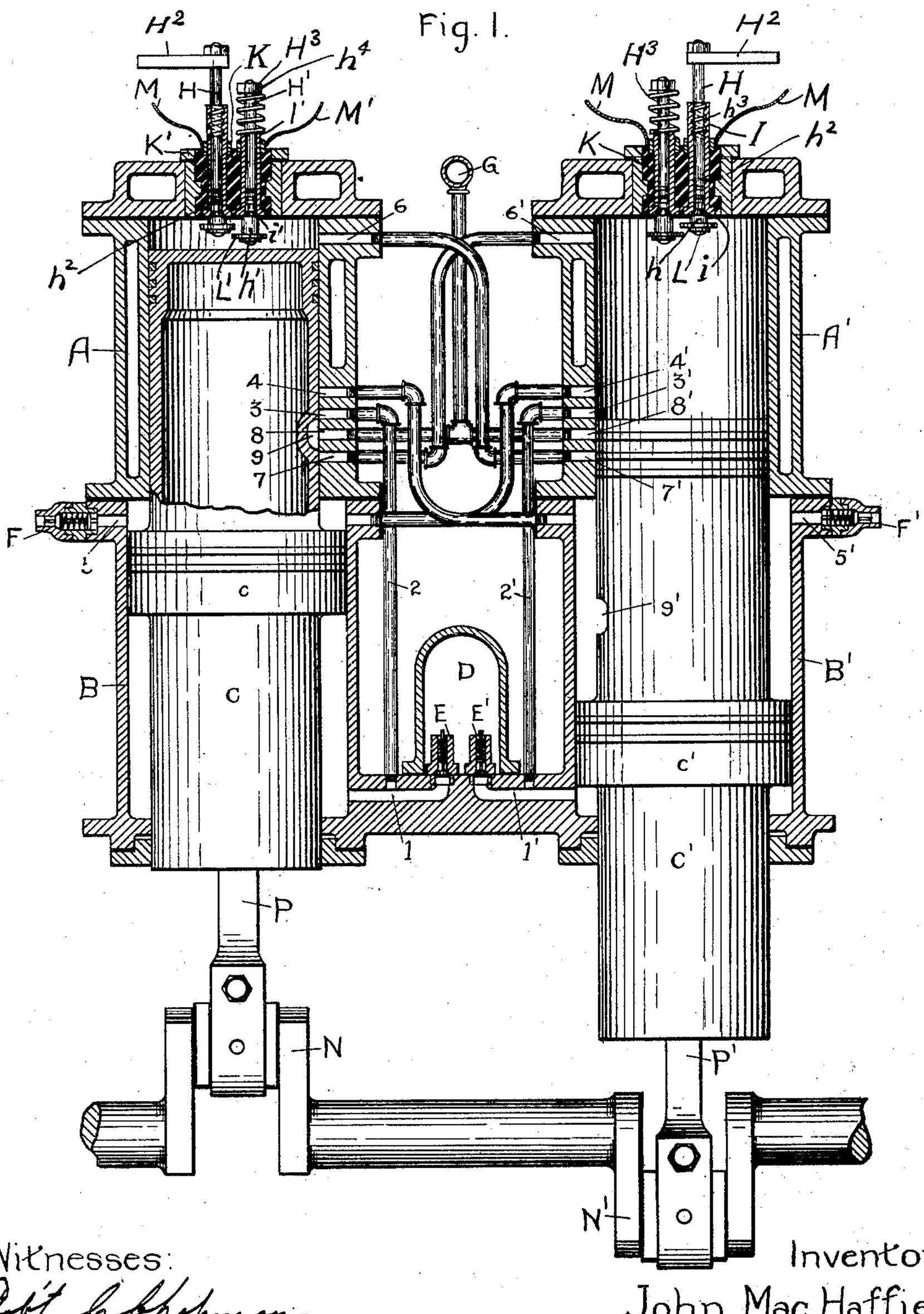
J. MacHAFFIE.

GAS ENGINE.

APPLICATION FILED AUG. 12, 1901.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.



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Benjamin B. Hull.

Inventor
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Atty

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NO MODEL. 2 SHEETS—SHEET 2.

Fig. 2.

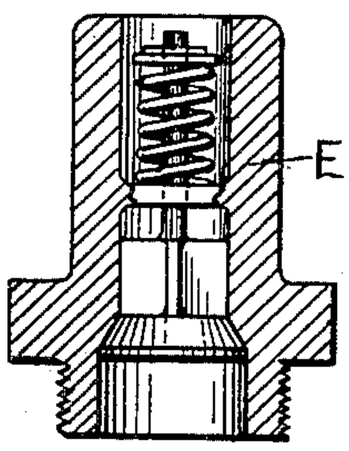


Fig. 3.

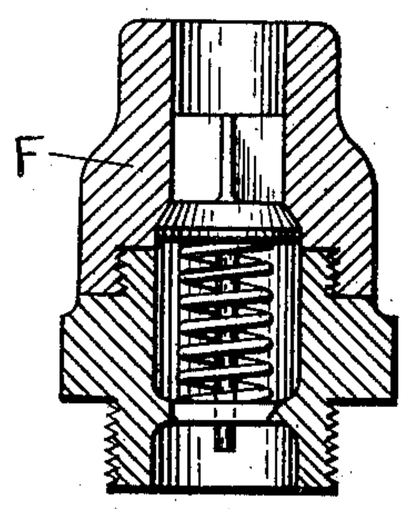


Fig. 4.

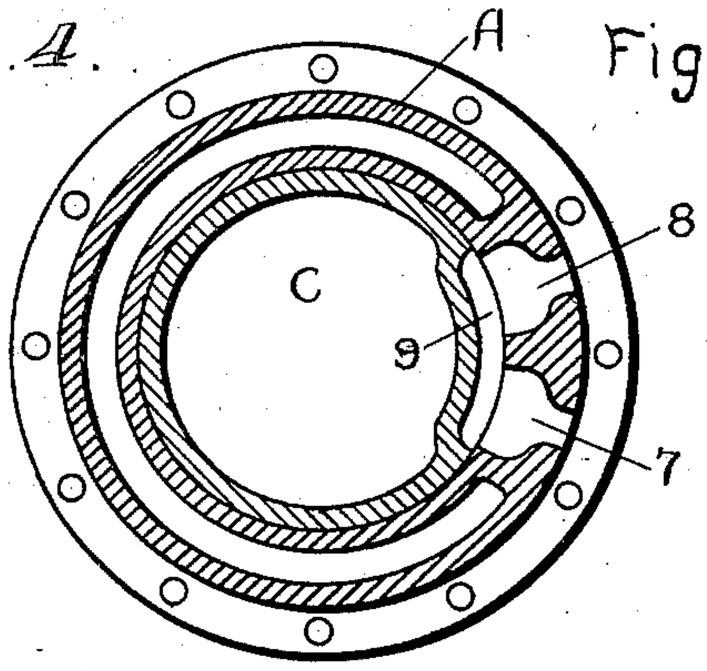
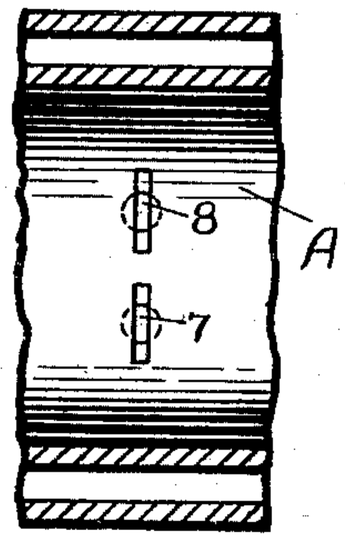


Fig. 5.



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UNITED STATES PATENT OFFICE.

JOHN MACHAFFIE, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 729,194, dated May 26, 1903.

Application filed August 12, 1901. Serial No. 71,676. (No model.)

To all whom it may concern:

Be it known that I, JOHN MACHAFFIE, a subject of the King of Great Britain, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification.

This invention relates to motors driven by an explosive mixture of air and hydrocarbon vapor; and its object is to effect certain improvements in the details of construction whereby the efficiency of the engine is increased, its operation rendered more uniform and reliable, its mechanism simplified, and its cost of construction and maintenance lessened. To accomplish these ends, the usual valve-gearing is dispensed with, and by means of suitably-arranged ports and passages the pistons are made to govern the admission and exhaust. The engine requires two working cylinders, each containing a single-acting piston, each piston controlling certain passages leading to the other. In connection with the working cylinders, in which the mixture of air and vapor is exploded, there are two air-pump cylinders and two mixture-pump cylinders. These are preferably, though not necessarily, arranged in line with the working cylinders, so that one piston, with three abutments, can be used for each set of working and pump cylinders. I shall describe an engine in which this construction is used, though it is evident that separate pumps may be employed, if desired, suitably piped to the working cylinders.

In the accompanying drawings, Figure 1 is a longitudinal sectional elevation of my engine. Figs. 2 and 3 show the check-valves in enlarged longitudinal section. Fig. 4 is a cross-section of a working cylinder and piston, showing a modified arrangement of the exhaust-ports. Fig. 5 is a plan of a portion of the same cylinder.

The engine shown has two sets of working cylinders A A′ and pump-cylinders B B′, the latter being larger in diameter than the former. A trunk-piston C C′ fits each working cylinder and extends through the pump-cylinder, in which it is provided with a head *c c′*, fitting the bore thereof. The upper end of each piston C C′ forms the abutment against which the exploding gases exert their pressure to drive the engine in the usual manner. The upper side of the heads *c c′* forms a second abutment and the lower side of said heads a third abutment, each coöperating with the adjacent annular heads of the pump-cylinders B B′.

At some convenient point, preferably between the two sets of cylinders, is a mixing-chamber D, in which the hydrocarbon vapor is mixed with atmospheric air to form the explosive mixture. This mixing-chamber may be of any desired construction, the mixer forming no part of my invention. Passages 1 1′ lead from the mixing-chamber D to the mixture pump-cylinder, which in this case is the annular space between the head *c* or *c′* and the lower end of the cylinder B or B′. A check-valve E E′ permits the mixture to enter said passage, but prevents it from being returned to the chamber D. A branch passage 2 2′ leads from the passage 1 1′ to a port 3 3′ in the corresponding working cylinder A A′ at a point distant from the upper end of said cylinder by nearly the stroke of the engine, so that said port will be uncovered by the trunk-piston C C′ at the end of its power or out stroke. Just above the port 3 3′ is a second port 4 4′, which communicates with the space above the head *c c′* in the opposite pump-cylinder—that is, port 4 in cylinder A communicates with pump-cylinder B′, while port 4′ in cylinder A′ communicates with pump-cylinder B. The annular space above the head *c c′* has also a passage 5 5′ opening to the atmosphere and controlled by an inwardly-opening check-valve F F′.

In the upper end of each working cylinder is an exhaust-passage 6 6′, connected with an exhaust-port 7 7′ in the wall of the opposite working cylinder, as shown. Adjacent to each port 7 7′ is an escape-port 8 8′, leading to an escape-pipe G. In the side of each piston C C′ is a recess 9 9′, adapted to connect the ports 7 8 and 7′ 8′ when the piston is near the end of its instroke. For ease of illustration I have shown the ports 7 7′ and 8 8′ in Fig. 1 lying lengthwise of the cylinders; but in practice it would be better to

place them side by side, as shown in Figs. 4 and 5, and make them rather narrow, so that they will be in communication but a short time during the stroke of the piston for a reason hereinafter pointed out.

In the head of each cylinder A A′ is my improved electric igniter, which forms the subject of a separate application. It comprises two longitudinally-movable stems carrying contacts and rotatable in order to effect a rubbing action between the contacts. The stems H H′ are preferably held in sleeves I I′, mounted in a block K of insulation suitably secured in a bushing K′, screwed into a hole in the head of the cylinder. At their lower ends the stems have valve-faced collars *h h′* fitting seats *i i′* in the lower ends of the sleeves to make a gas-tight joint. Above these collars are packing-rings h^2. The inner end of each stem carries a contact-disk L L′, one overlapping the other and normally separated from it, as shown. The stem H is provided with means for imparting to it a combined rotating and axial movement, such as a screw-thread h^3 of coarse pitch meshing with similar threads in the upper part of the sleeve I. By means of an arm H^2 or other suitable device the stem can be connected with a moving part of the engine, so as to receive impulses at regular intervals. The inward twisting motion of the stem H causes the disk L to strike the disk L′ and partially rotate it with a rubbing action. A spring H^3 between the sleeve I′ and a head h^4 on the stem H′ permits the stem to yield inwardly when the disks come in contact. Each sleeve I I′ is connected with a terminal M M′ of an induction-coil or the like, so that when the disks approach each other near enough a spark will pass between them and explode the charge of air and gas in the working cylinder.

The operation of my invention is as follows: The cranks N N′ are one hundred and eighty degrees apart, so that the pistons C C′, connected therewith by the rods P P′, operate alternately. When a piston moves up to the position of C in Fig. 1, the head *c* draws into the lower part of the pump-cylinder B a charge of the mixture from the chamber D, the check-valve E opening outwardly from said chamber. At the same time the upper side of the head *c* is compressing a charge of air in the upper end of cylinder B and head of the piston C is compressing a charge of the explosive mixture in the working cylinder A. Meanwhile the piston C′ has been moving downward under the pressure of the exploded gases above it, the head *c′* compressing in the lower end of the pump-cylinder B′ a charge of the mixture and drawing into the upper end of said cylinder a charge of air through the check-valve F′, which opens inwardly. When the head of the piston C′ passes and uncovers the port 4′, the charge of air compressed in cylinder B suddenly escapes into the cylinder A′, blowing out the burned gases through the exhaust-passage 6′, the exhaust-port 7, the recess 9 in the piston C, escape-port 8, and escape-pipe G. A further movement of the piston C closes the exhaust-port 7, and the corresponding movement of the piston C′ uncovers the port 3′ and permits the charge of mixture compressed in the lower end of the cylinder B′ to expand into the cylinder A′, the volume of the expanded gas being just sufficient to fill said cylinder. The compressed charge of mixture in cylinder A is now exploded, forcing the piston C downward, drawing a charge of air into the upper end of the cylinder B and compressing the charge of mixture in the lower end thereof. At the same time the piston C′ makes its instroke, compressing its charge of mixture a second time, compressing the air in the upper end of the cylinder B′ and drawing a fresh charge of mixture into the lower end thereof. As the recess 9′ passes the ports 7′ 8′ the exploded gases in the cylinder A are allowed to escape simultaneously with the admission into said cylinder of the scavengering blast of air from the upper end of cylinder B′. The cycle in each cylinder is therefore as follows: On the outstroke explosion, exhaust and scavengering admission of mixture; on the instroke, compression of mixture. There is thus an explosion at every half-revolution of the crank-shaft.

The purpose of arranging the ports 7 8 side by side, as shown in Figs. 4 and 5, is to reduce the time of the exhaust, so that these ports may remain open as short a time as possible, and thus lessen any liability of the fresh charge of mixture to escape from either cylinder when the exhaust-ports are reopened during the outward movement of the other piston. When the charge is exploded, the pressure forces the valve-faces *h h′* tightly against their seats, thus preventing any escape of gas around the stems H H′.

It will be noted that the air-compressing chamber is interposed between the mixture-compressing chamber and the explosion-chamber, thus preventing any possibility of exploding the charge of mixture in the pump-cylinder when that in the working cylinder is fired.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a gas-engine, the combination with two working cylinders, of an air-pump and a mixture-pump for each cylinder, air and mixture ports in each cylinder controlled by the piston in that cylinder, and an exhaust-passage from each cylinder controlled by the piston in the other.

2. In a gas-engine, the combination with two working cylinders, of an air-pump and a mixture-pump for each cylinder, air and mixture ports in each cylinder controlled by the piston in that cylinder, an exhaust-passage in each cylinder connected with a port in the other cylinder, an escape-pipe connected with each cylinder near said port, and

a recess in each piston arranged to connect the escape-pipe with said port at a certain point in its movement.

3. In a gas-engine, the combination with two working cylinders, of an air-pump and a mixture-pump for each cylinder, an exhaust-passage opening into one end of the cylinder, an air-port in the side of the cylinder, a mixture-port in the side of the cylinder at a greater distance from its end than the air-port, an exhaust-port in the side of the cylinder still farther from its end and connected with the exhaust-passage of the other cylinder, an escape-pipe entering the cylinder adjacent to the exhaust-port, and a piston adapted to uncover the air and mixture ports in succession on the outstroke, and provided with a recess to connect the exhaust-port and escape-pipe just before it reaches the end of its instroke.

4. In a gas-engine, the combination with two working cylinders, of means for compressing air at each instroke of a piston, means for admitting the compressed air suddenly into the other cylinder, means for compressing the explosive mixture on each outstroke of a piston, means for admitting the compressed mixture suddenly into the cylinder shortly after the admission of the compressed air, and means for igniting the mixture after it has been again compressed by the instroke of the piston.

5. In a gas-engine, the combination with the two working cylinders, of the pump-cylinders in line therewith and of larger diameter, the trunk-pistons having one abutment fitting the working cylinders, and a head fitting the pump-cylinder and affording two abutments therein, an exhaust-passage in the end of each working cylinder connected with an exhaust-port in the other cylinder covered by the piston therein, an escape-pipe connected with each cylinder near said exhaust-port, a recess in each piston controlling said ports, an air-port in each cylinder connected with the inner end of the opposite pump-cylinder, a mixture-port in each cylinder connected with the outer end of its own pump-cylinder, and a mixing-chamber connected with the outer ends of both pump-cylinders.

In witness whereof I have hereunto set my hand this 8th day of August, 1901.

JOHN MACHAFFIE.

Witnesses:
BENJAMIN B. HULL,
CHARLES STEINER.