No. 780,556. PATENTED JAN. 24, 1905.

A. E. DOMAN.

GAS ENGINE.

APPLICATION FILED APR. 20, 1903.

Fig. 1.

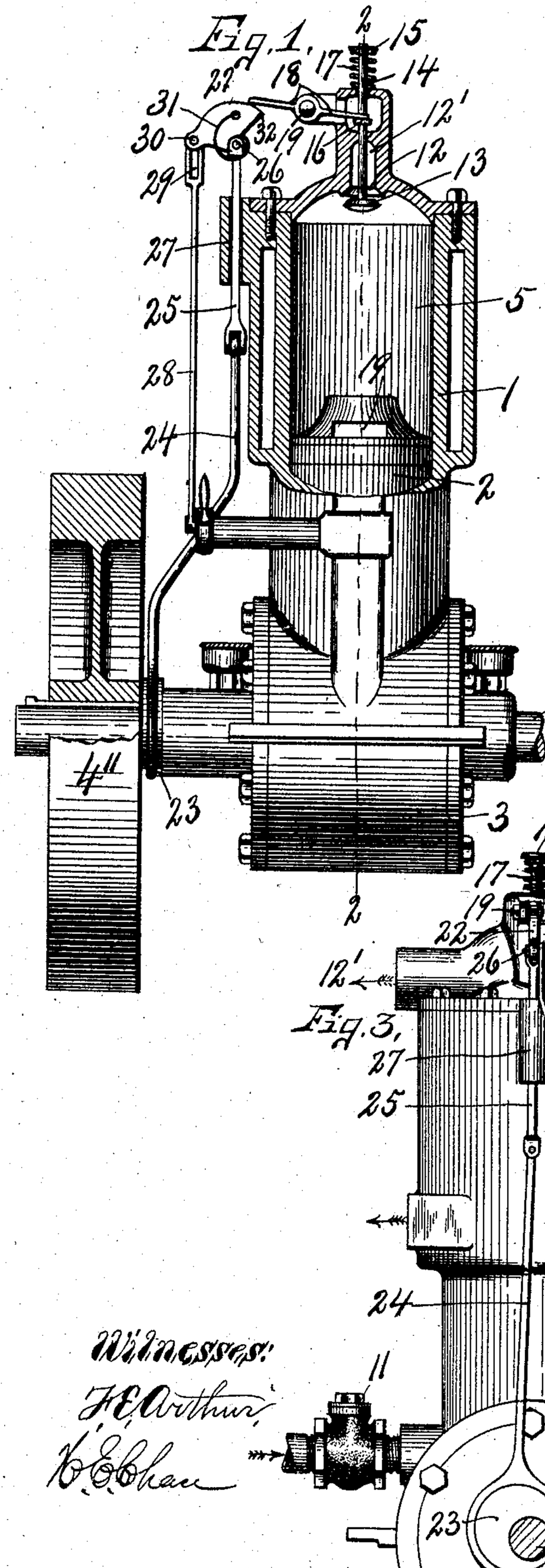

Fig. 2.

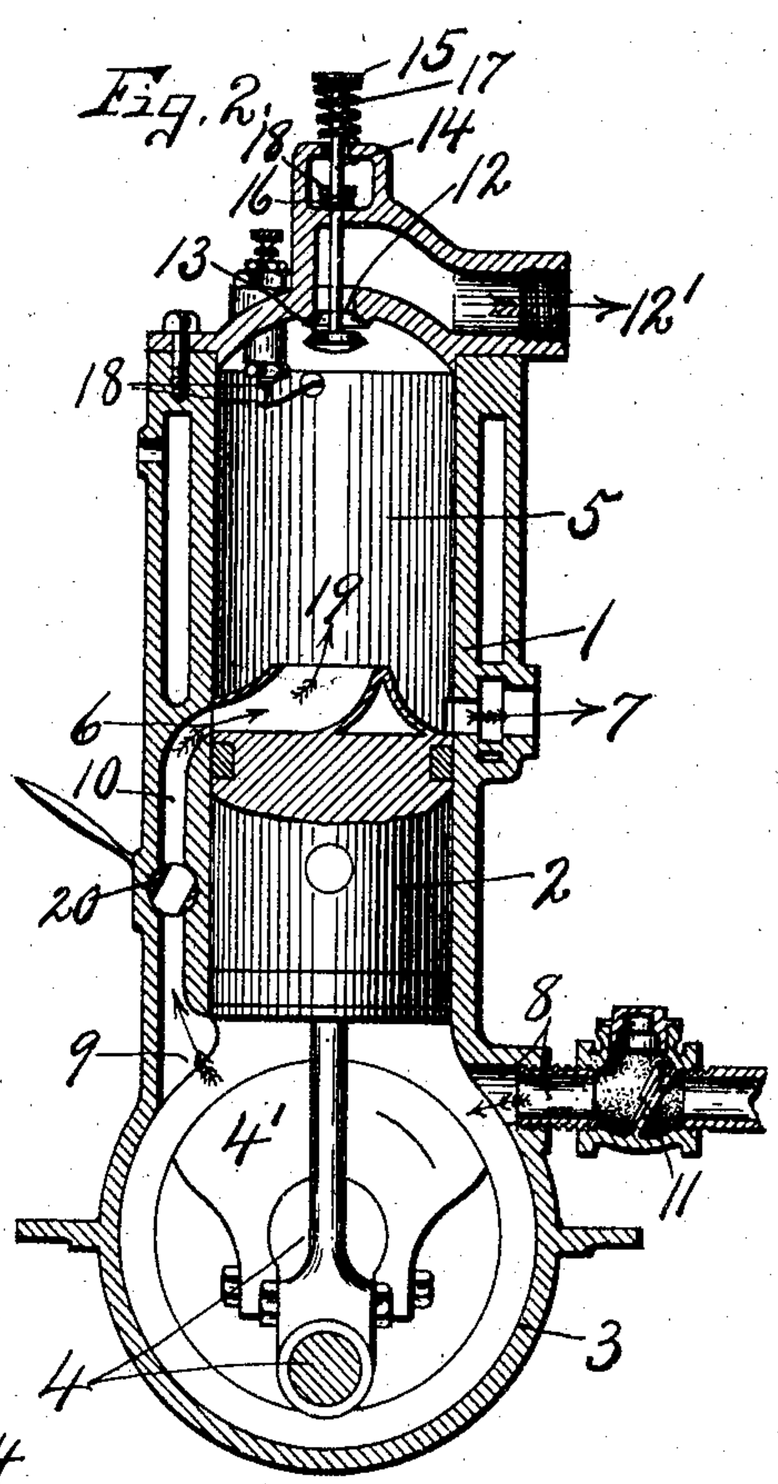

Fig. 3.

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No. 780,556. Patented January 24, 1905.

UNITED STATES PATENT OFFICE.

ALBERT E. DOMAN, OF ELBRIDGE, NEW YORK.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 780,556, dated January 24, 1905.

Application filed April 20, 1903. Serial No. 153,462.

To all whom it may concern:

Be it known that I, ALBERT E. DOMAN, of Elbridge, in the county of Onondaga, in the State of New York, have invented new and useful Improvements in Gas-Engines, of which the following, taken in connection with the accompanying drawings, is a full, clear, and exact description.

This invention relates to certain improvements in gas-engines, and refers more particularly to the two-cycle type in which the explosive mixture is first drawn into the crank-chamber by the inward stroke of the piston and is then compressed by the outward stroke and forced into the explosion-chamber through a suitable passage connecting the crank-chamber with the explosion-chamber. Now when the piston returns on its instroke the fresh explosive mixture is compressed in the inner end of the explosion-chamber and at the proper time is ignited, whereupon the expanded gases force the piston outwardly and are finally discharged under considerable pressure through an exhaust-port, which is usually provided in the side wall of the cylinder at or near the limit of the outstroke of the piston.

I have thus briefly described the operation of an ordinary two-cycle engine for the purpose of more clearly pointing out its mechanical and economical defects and disadvantages, which I have sought to overcome in the improvements hereinafter described. In this class of gas-engines the inlet and exhaust ports are located at the extreme outer end of the explosion-chamber, or rather at or near the limit of the outward stroke of the piston, and the piston is generally provided with a deflector-plate on its inner end to deflect the inflowing mixture inwardly along one side of the explosion-chamber, while the spent gases are supposed to pass in a reverse direction along the opposite side of said chamber and out through the exhaust-port when the latter is uncovered. The inflowing mixture enters the explosion-chamber at a much lower temperature than that of the burned gases, and this, together with the fact that the inlet and exhaust ports are located at the same end of the cylinder, prevents a thorough expulsion of the spent gases, and thus prevents a thorough cleansing of the explosion-chamber, as will be readily seen. It is now apparent that more or less of the expended gases are mixed and compressed with each fresh charge of live gases, thereby reducing the volume of the live gases in the compression-space of the cylinder and also reducing the possible efficiency and power of the engine. It is also obvious that when a single exhaust-port is located as described the heated gases acting expansively upon the piston to impel it outwardly are discharged to atmosphere under high pressure, and therefore with a loud report or noise, which of course is a serious objection and represents a considerable loss of energy. The intensity of this noise may be materially reduced by the use of mufflers; but under such conditions a degree of back pressure is produced upon the piston which materially reduces the working efficiency of the engine. In some instances a throttle-valve may be employed to reduce the quantity of the mixture admitted to the explosion-chamber for the purpose of reducing the pressure and diminishing the intensity of the report at the exhaust; but this not only reduces the working power of the exploded charge, but the inflow of the reduced amount of fresh mixture is insufficient either in force or quantity to expel the burned gases at the exhaust.

The objects of my present invention may be summarized as follows: first, to introduce the explosive mixture into the explosion-chamber in quantities proportionate to the work required of the engine—*i. e.*, a light charge for light work and a heavier charge for heavier work—so that only the live gases are compressed free from burned gases; second, to compress the fresh mixture during only a portion of the compression-stroke of the piston, but permitting the exploded charge to exert its full expansive force upon the piston through its entire outward stroke, so that when a small charge is ignited and expanded to the full limit of the outward stroke it is exhausted at a very low pressure and with little noise; third, to thoroughly and automatically cleanse the cylinder from spent gases after each impulse, whereby only the fresh gases are compressed and expanded; fourth, to not only avoid any back pressure

upon the piston, but to permit the expanded gases to exhaust more freely at or near atmospheric pressure after exerting its full expansive force upon the piston; fifth, to regulate the speed and power of a two-cycle gas-engine by the operation of a single controlling member, such as a hand-lever. It will thus be seen that my aim is to utilize the expansive force of a minimum quantity of fresh gas in the development of a greater degree of power and speed than has heretofore been practiced and to exhaust the burned gases at a low pressure without the use of mufflers.

In the drawings, Figure 1 is a side elevation, partly in section, of a two-cycle gas-engine embodying the features of my invention. Fig. 2 is a sectional view taken on line 2 2, Fig. 1. Fig. 3 is an end elevation of the parts seen in Fig. 1, showing particularly the valve-controlling mechanism.

Similar reference characters indicate corresponding parts in all the views.

This engine consists, essentially, of a cylinder 1, a piston 2 movable in the cylinder, a crank-case 3, inclosing the open end of the cylinder for forming a suitable compression-chamber, and a crank-shaft 4, which is journaled in the end walls of the crank-case and is provided with an inner counterbalance 4′ and an outer balance-wheel 4″, the purposes of which are well known. The cylinder 1 is provided with the usual explosion-chamber 5 and inlet and exhaust ports 6 and 7, which are formed in the side walls of the cylinder at the base of the explosion-chamber at or near the limit of the outward stroke of the piston, while the crank-case is provided with an inlet 8 and an outlet 9, which is connected to the port 6 by means of a conduit 10. The explosive mixture is drawn into the crank-case by suction due to the instroke of the piston and is there compressed by the outstroke of the piston and forced through the conduit 10, so as to enter the explosion-chamber under pressure when the inlet-port 6 is uncovered, a suitable check-valve 11 being interposed in the inlet 8 to prevent backflow of the mixture. Assuming now that the head of the cylinder is permanently closed, as in the usual type of the two-cycle engines, then the introduction of the fresh mixture, which is necessarily of lower temperature than the previously burned or exploded gases, tends to not only retard the outflow of the latter, but actually compresses a large percentage of the burned gases in the head of the cylinder even when a deflector-plate is employed, so that when the piston moves inwardly these burned gases are mixed and compressed with the live gases. The piston is thus compelled to compress the gases through its full inward stroke, and owing to the fact that a large percentage of these compressed gases have been previously devitalized the power required to compress this vitiated excess is practically wasted, and aside from the loud report of the exhaust the engine is always laboring under great disadvantages and loss of both power and fuel. In order to overcome these several defects and objections and to carry out the objects previously enumerated, I provide the cylinder 1 with an auxiliary exhaust port or opening 12, which is preferably located centrally in the head of the cylinder and discharges to atmosphere through a suitable passage 12′. This auxiliary exhaust-port is provided with an automatically-closing valve 13, which preferably opens inwardly into the upper end of the explosion-chamber and is mounted upon an outwardly-extending stem 14, which is guided in apertures in the cylinder-head and is provided with outer and intermediate shoulders 15 and 16. A spring 17 is interposed between the outer shoulder 15 and adjacent wall of the cylinder-head and serves to automatically close the valve 13, said valve being opened at regular intervals by means of a lever 18, which is fulcrumed at 19 and is engaged with the shoulder 16, whereby when the lever is rocked in the manner hereinafter described the valve is opened inwardly. The movements of this valve 13 are synchronized with the movement of the piston 2 in such manner that the valve begins to open at about the same time that the port 7 at the opposite end of the explosion-chamber is uncovered by the outward movement of the piston and remains open during a portion of the return upstroke of said piston or until the burned gases are entirely expelled from the cylinder partially through the exhaust-port 7, but mainly through the exhaust 12 in the head of the cylinder, whereupon the valve 13 is automatically closed and remains closed during the remainder of the instroke of the piston and also during the full outward stroke. It is thus seen that the live gases only are compressed in the head end of the cylinder during only a portion of the instroke of the piston, where they are ignited by any well-known igniting device, as terminals 18 of an electric circuit, not necessary to herein illustrate or describe, as the igniting device forms no part of my present invention. It will also be apparent that the expansive force of the ignited charge acts upon the piston through its full outward stroke, and owing to the fact that the charge previously admitted was free from burned gases and compressed during only a part of the instroke of the piston the pressure at the exhaust through the port 7 when uncovered by the outward movement of the piston is reduced to a minimum, and therefore obviates the usual loud report or noise which is incidental to the compression of the gases through the full inward stroke of the piston. Furthermore, by providing an exhaust-opening at each end of the explosion-chamber operating in the manner described, the pressure being lowered at the time of the exhaust, the re-

sistance to the inflow of the fresh mixture is reduced, and therefore the burned gases are more easily expelled to thoroughly cleanse the cylinder.

In order to further facilitate the cleansing of the cylinder, I provide the piston with a substantially central discharge-opening 19, which extends inwardly from the periphery of the piston and communicates with the inlet-port 6 when the piston reaches the limit of its outward stroke, so that the gases are discharged centrally into the explosion-chamber and entirely across the head of the cylinder whereby the larger part of the burned gases are forced into the head end of the cylinder to be expelled through the outlet 12, while any portion of the burned gases which may remain in the base of the explosion-chamber can exhaust through the port 7.

It is desirable to regulate the charge of explosive mixture to harmonize with the work required of the engine, so that when only a light work is required a correspondingly light charge may be admitted, compressed, and expanded, while, on the other hand, when a heavier work is required a greater quantity of the explosive mixture is likewise compressed and expanded; but in neither case are the fresh gases compressed during the full inward stroke of the piston, while in all cases the expansive force of the charge is exerted during the full downward stroke of the piston. In order to regulate this supply of explosive mixture, I provide the conduit 10 with a throttle-valve 20, which is adapted to be operated by a suitable hand-lever 21, whereby when the lever is rocked in reverse directions the valve is opened and closed, as may be desired.

The means for operating the lever 18 to open the valve 13 preferably consists of a cam 22, an eccentric 23, and connections 24 and 25, the cam 22 being pivotally mounted at 26 upon one end of the rod 25, which is moved in a guide 27 on the cylinder 1. The eccentric 23 is secured to the crank-shaft 4 and receives one end of the connection 24, the opposite end being connected to the rod 25, whereby the rotation of the eccentric imparts a reciprocating motion to the rod 25 and cam 22, mounted thereon. This cam 22 is connected to the valve 21 at one side of its axis by means of a connecting-rod 28, which is provided with an elongated slot 29 for receiving a pivotal pin 30, the latter being located at one side of the pivot 26 and is normally held against the upper end wall of the slot by means of a spring 31, which operates to rock the cam 22 under the adjacent end of the lever 18. This cam preferably terminates in an abrupt end 32, so that when the eccentric operates to open the valve through the medium of the connections 24 and 25 the cam which bears against the outer end of the lever 18 is rocked upon the pivot 30 out from under the lever, so as to permit the spring 17 to automatically close the valve immediately upon the expulsion of the burned gases from the explosion-chamber.

It may be stated here that the eccentric 23 is adjusted or set so that its maximum upward throw is a little later than the limit of the outward stroke of the piston; but the valve 13 begins to open at about the same time that the port 7 is uncovered by the outward stroke of the piston, and the further movement of the eccentric continues to rock the cam 22 out from under the lever 18 during a part of the upstroke of said piston, the cam being adjusted so that its end 32 leaves the lever 18 at about the same time that the burned gases are entirely expelled from the explosion-chamber, whereupon the spring 17 immediately closes the valve 13, and the mixture is then compressed into the upper end of the chamber and ignited and expanded in the manner previously described. It now becomes apparent that the live gases only are compressed during a portion of the compression-stroke of the piston, and while the expansive force of the exploded gases is exerted through the full outward stroke of the piston the charge admitted and compressed in the explosion-chamber is no more than is necessary to fill the space after the spent gases are exhausted, thus giving an increased efficiency to the engine.

By operating the valve 20 to vary the quantity of mixture admitted to the explosion-chamber according to the work to be done it also becomes necessary to vary the time of movement of the valve 13, so as to allow the escape of all of the burned gases, but to prevent the escape of any part of the new charge. This is accomplished by connecting the cam 22 to the throttle-valve 20 in the manner previously described, so that any movement toward opening the throttle-valve 20 will operate to throw the point of the cam 22 outwardly toward the outer end of the lever 18, thereby causing an earlier closing of the valve 13 when a heavy charge is admitted, and, on the other hand, when the throttle-valve is moved toward its closed position the spring 31 operates to rock the cam inwardly farther under the end of the lever, so that the valve will be closed later in the upward stroke of the piston for a lighter charge.

The operation of my invention is as follows: Assuming the piston to be at the limit of its downward stroke, as seen in the drawings, at which time the inlet-port 6 and exhaust-ports 7 and 12 are open and the fresh explosive mixture is discharged centrally into the base of the explosion-chamber, then the upward stroke of the piston causes the burned gases in the upper end of the chamber to be expelled through the exhaust-port 12, this occurring through only a portion of said upstroke, whereby the valve 13 is immediately closed by forcing the cam 22 from under the lever 18 and permitting the spring 17 to operate.

During the continued upward stroke of the piston the gases are compressed and ignited and then expanded and exert their expansive force through the full outward stroke of the piston, whereupon the operation is repeated. After each impulse of the piston the cylinder is thoroughly cleansed from burned gases by the inflowing mixture and the following upstroke of the piston, as described, so that only the fresh gases are compressed during a part of the upstroke of the piston. By operating the valve 20 the quantity of gas admitted may be proportioned to the work required, and the speed and power are thus controlled by a single operating member. Furthermore, aside from the fact that the exploded charge acts expansively upon the piston through its entire outward stroke the pressure is reduced at the exhaust, so that it is discharged at or near atmospheric pressure, thereby avoiding any objectionable noise.

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

1. In a two-cycle gas-engine, a cylinder, a crank-case inclosing one end of the cylinder, a self-closing valved outlet in the opposite end of the cylinder, a conduit connecting the interiors of the cylinder and crank-case, a piston operatively connected to open the valve, a manually-operated valve in the conduit to control the amount of mixture admitted to the cylinder and connected to the first-named valve to vary the time of its closing to correspond to the amount of mixture present in the cylinder.

2. In a two-cycle gas-engine, a cylinder, a piston, a crank-case inclosing one end of the cylinder and having an inlet, the opposite end of the cylinder having an outlet-opening to atmosphere, an automatically-closing valve for the outlet, automatic means to open the valve when the piston approaches the limit of its outward stroke and to hold it open during part of the instroke of the piston, a conduit connecting the interiors of the crank-case and cylinder, a valve in the conduit, and connections between the latter valve and said means whereby the former valve is caused to close at different positions in the upstroke of the piston according to the position of the latter valve to compress only the fresh gases present in the cylinder.

3. In a gas-engine, a cylinder having an explosion-chamber in one end and a compression-chamber in its other end, the explosion-chamber being provided with an inlet-port and an outlet-passage and the compression-chamber having an inlet for the explosive mixture, the inlet of the explosion-chamber communicating with the compression-chamber and the outlet of said explosion-chamber opening to atmosphere, a normally closed valve in the outlet-opening, a piston, a crank-shaft, an eccentric operatively connected and timed to open the valve when the piston approaches the limit of its outward stroke, and a valve in the connection between the explosion and compression chambers operatively connected to the former valve to change the time of operation relative to the movement of the piston.

4. A gas-engine having an explosion-chamber in one end and a compression-chamber in its opposite end, the compression-chamber having an inlet for the explosive mixture, a check-valve in the inlet opening inwardly when checking the outflow of the gases, a conduit connecting the compression-chamber with the explosion-chamber, said explosion-chamber having its end provided with an outlet opening to atmosphere, a manually-operated valve in the conduit for regulating the quantity of live gases admitted to the explosion-chamber, a second valve in the outlet of the explosion-chamber, means for automatically closing said valve, a lever for opening the valve, a cam for operating the lever, means actuated by one of the moving parts of the engine and connected to operate the cam and connections between the cam and manually-operated valve whereby the position of the cam may be varied irrespective of the lever for permitting the automatic closing of the valve at different positions in the movement of the piston.

5. In a gas-engine, the combination with an explosion-chamber having an inlet-port and an outlet-passage, a compression-chamber connected to the inlet-port and having an intake for the fresh gases, a self-closing valve in the outlet-passage, a second valve in the connection between said chambers to control the supply of fresh gases to the explosion-chamber, a piston and connections between the piston and first-named valve whereby the latter is caused to open at the limit of the outstroke of the piston and to remain open during part of the upstroke of said piston, and connections between said valves whereby the partial closing of the second valve effects a later closing of the first-named valve.

6. In a gas-engine, an explosion-chamber having an intake and an outlet, a manually-operated valve for the intake, a self-closing valve for the outlet remaining closed till the intake is uncovered by the piston, a piston opening and closing the intake and operatively connected to effect the opening of the outlet-valve when it approaches the limit of its outstroke and to hold said valve open during part of the instroke and connections between the valves whereby the position of the intake-valve effects and determines the time of closing the outlet-valve.

In witness whereof I have hereunto set my hand this 13th day of April, 1903.

ALBERT E. DOMAN.

Witnesses:
FRED. DYE,
A. E. BROWN.