

No. 810,565.

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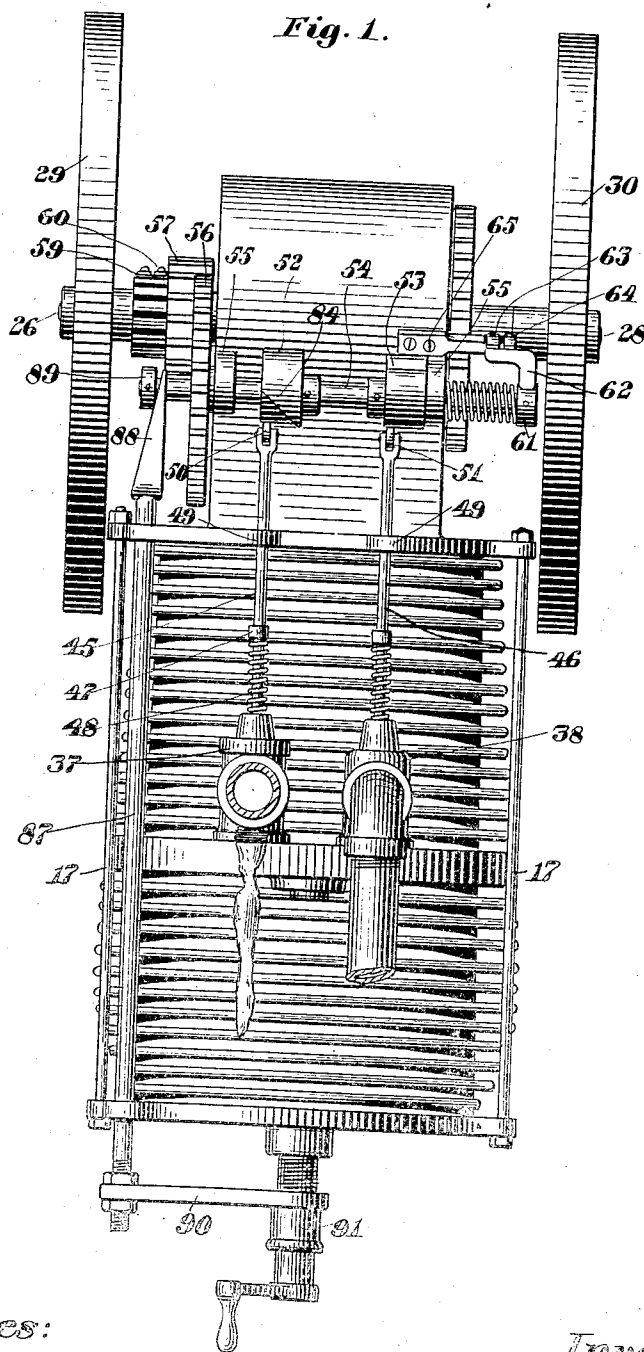
E. F. PORTER & W. R. WHITING.

GAS ENGINE.

APPLICATION FILED NOV. 24, 1900. RENEWED MAR. 16, 1905.

3 SHEETS—SHEET 1.

Fig. 1.



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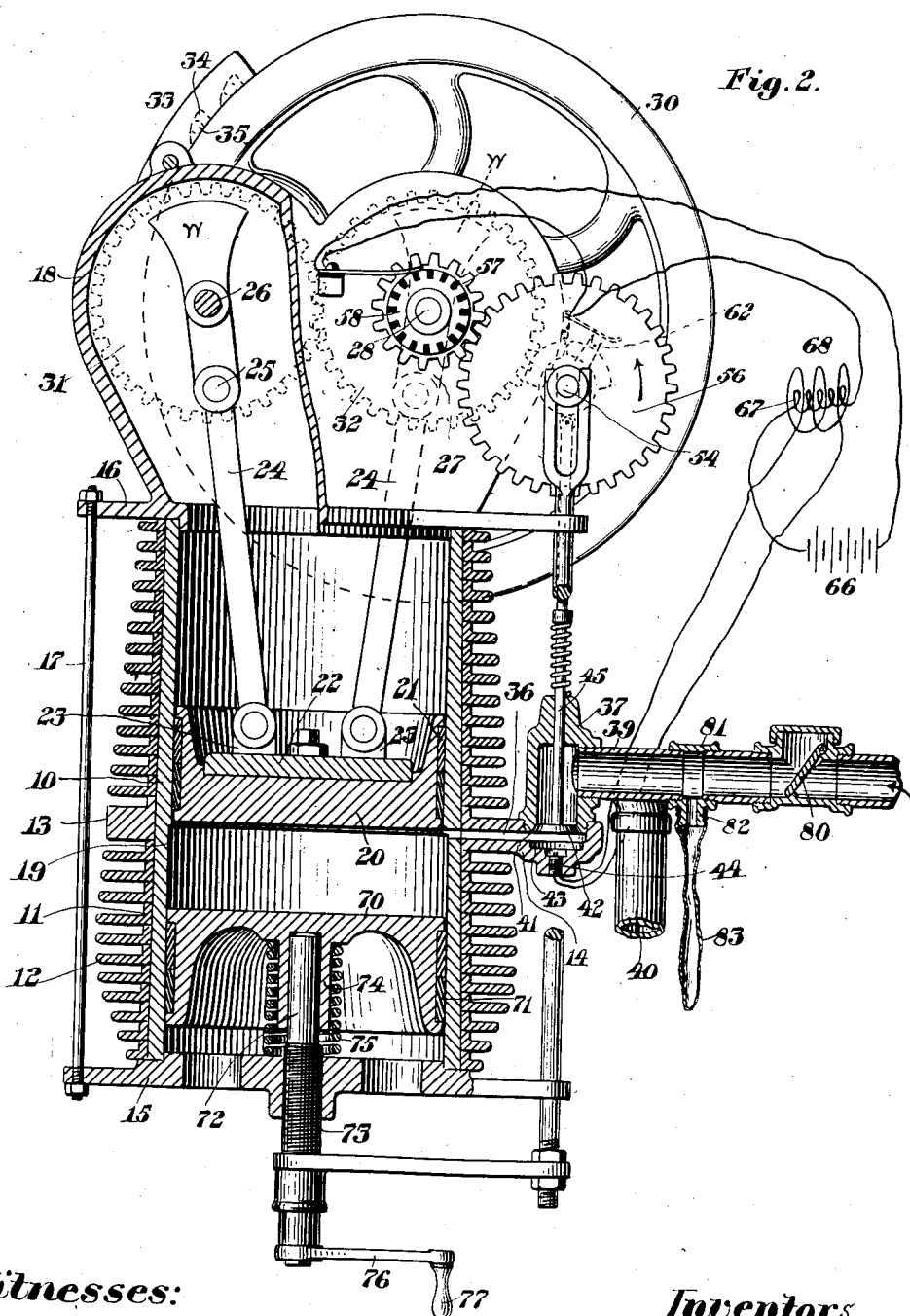
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3 SHEETS—SHEET 2.



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3 SHEETS—SHEET 3.

Fig. 3.

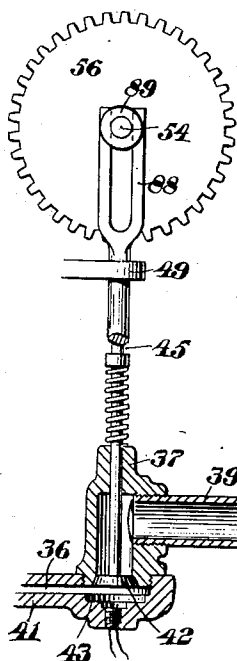
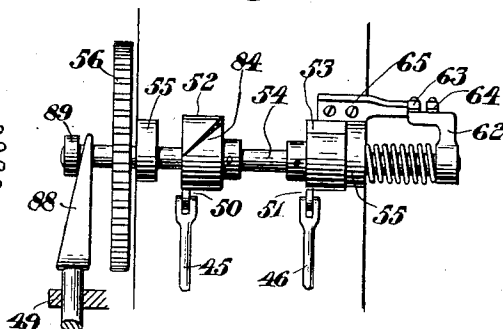


Fig. 4.



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UNITED STATES PATENT OFFICE.

EDWIN F. PORTER AND WALTER R. WHITING, OF BOSTON, MASSACHUSETTS, ASSIGNORS TO AMERICAN ROTARY ENGINE COMPANY, OF BOSTON, MASSACHUSETTS, A CORPORATION OF MAINE.

GAS-ENGINE.

No. 810,565.

Specification of Letters Patent.

Patented Jan. 23, 1906.

Application filed November 24, 1900. Renewed March 16, 1905. Serial No. 250,405.

To all whom it may concern:

Be it known that we, EDWIN F. PORTER and WALTER R. WHITING, of Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification.

This invention has relation to gas-engines of the so-called "four-cycle" type, in which are employed a cylinder, a reciprocatory piston, and valve mechanism for admitting the explosive mixture at the proper time to the explosion-chamber in the cylinder.

The present invention has for its objects, first, to reduce the variable torsional thrust experienced by the piston, the piston-rod, and the cylinder, as the relation between the parts varies during the rotation of the crank-shaft, and the consequent vibration which has hitherto practically unfitted a gas-engine for use on relatively delicate mechanism or machines, as motor-carriages and the like; second, to provide a gas-engine of the type mentioned with means whereby it may be changed to increase or reduce its power without varying the degree of compression of the explosive mixture, and, third, to equip an engine of the character last referred to with means for automatically regulating the operation of the valve in accordance with the power developed by the engine; fourth, to improve gas-engines of the type referred to in numerous other ways, all as hereinafter fully described.

Referring to the accompanying drawings, which illustrate one embodiment of my invention, Figure 1 represents in front elevation a gas-engine embodying our invention. the standard or support for the engine not being shown. Fig. 2 represents a longitudinal section through the engine and illustrates an electrical circuit diagrammatically. Figs. 3 and 4 show a modified valve mechanism which we sometimes employ.

The engine-cylinder consists of an open-ended tube 10, over which are slipped a number of collars 11, each of which abuts against two adjacent collars, so as to completely cover the tube 10. These strengthening bands or collars accordingly increase the resistance of the tube 10, and they are each provided with a flange 12 for dissipating the heat. It will be observed that the flanges

are greater at that part of the cylinder where the explosion occurs, so that the cooling of the cylinder is evened or equalized throughout its length. One of the bands or collars 13 is relatively wide and is formed on one side with the outwardly-projecting shelf 14, which is bored to form the inlet and the outlet for the explosive mixture and the products of combustion, respectively, all as will be subsequently explained. The cylinder-heads are indicated at 15 and 16, respectively, and they are securely clamped against the ends of the cylinder by the elongated bolts 17 17, passed through lugs formed in said heads.

The cylinder-head 16 is open to permit the passage of the piston-rods, and it is cast in the form of a casing 18 to afford bearings for the crank-shafts and to provide a housing for the gears and cranks on said shafts. The cylinder is provided internally with the shoulder 19, so that the internal diameter of one end of the cylinder is slightly greater than that of the other end. In the smaller end of the cylinder is placed the trunk-piston 20, which is provided with the usual packing 21.

Bolted or otherwise secured to the piston is a plate 22, provided with two ears or lugs 23 23, which are exactly similar and which are arranged at equal distances from the axial line of the piston in a plane coinciding with said line. Preferably said ears or lugs 23 occupy a position substantially half-way between the ends of the radii of the piston in which they are located. Pivoted to each of the ears or lugs 23 is a connecting-rod 24, one of said rods being connected to the crank 25 of a crank-shaft 26, while the other of said connecting-rods is connected to a similar crank of a shaft 28. The two connecting-rods of the two cranks are precisely similar or are duplicates of each other, and the two shafts 26 28 are arranged in parallelism, as indicated in Fig. 2. Said shafts are journaled in the sides of the housing 18, and they are each provided with a fly-wheel. The fly-wheel for the shaft 26 is indicated at 29, while that for the shaft 28 is indicated at 30. The two fly-wheels are duplicates of each other and they are arranged on opposite ends of the shafts 26 28, as shown in Fig. 1, and are designed to rotate in opposite directions. To this end the shafts 26 28

are geared together by straight spur-gears 31 32, said gears being duplicates of each other. The crank - shafts are also provided with weights *w*, which aside from any function as counterweights also serve to maintain a relatively even contact between the peripheries of the gears 31 32 and assisting in maintaining uniformity of rotation and evenness of movement throughout the entire system.

By this construction and arrangement it will be seen that when the piston is reciprocated the cranks 25 27 will be revolved in opposite directions, causing the fly-wheels 29 and 30 to be rotated likewise in opposite directions. By the described construction of parts it will be apparent to those skilled in the art to which this invention relates that the hitherto variable torsional strain experienced by the cylinder, the piston, and piston-rod will be entirely obviated and the vibration of the engine reduced to a minimum.

In order to prevent the fly-wheels from rotating in a reverse direction, the housing 18 is provided with an extension 33, having internal cam-shaped sockets 34 to receive rollers 35, which become wedged in said sockets on reverse rotation of the fly-wheel 30. The said rolls 35 normally rest lightly upon the periphery of the fly-wheel 30 and are carried to the larger ends of the cam-shaped sockets 34 when the fly-wheel 30 is rotating in the proper direction, and will therefore offer no impediment to the movement of said wheel.

We shall now proceed to describe the valve-operating mechanism.

In the band or collar 13 are formed two ducts, each leading to the interior of the cylinder in the plane of the shoulder 19. One of the said ducts is indicated in Fig. 2 by the numeral 36, and it serves as the inlet for the explosive mixture, the other (not shown) serving as the outlet for the products of combustion. Secured to the shelf or projection 14 are two valve-casings 37 and 38, respectively, one for the gas-inlet and the other for the outlet of the products of combustion. The two casings and the valves therein are precisely similar, so that we shall describe only one of them. Each casing is externally threaded at its lower end to be screwed into a socket in the shelf or projection 14 of the band or collar 13. The side of the casing is apertured to receive the inlet-pipe 39 for the explosive mixture, or in the case of the exhaust-valve chamber the exhaust-pipe 40 for the products of combustion. The lower end of each casing is beveled, as at 41, to form a seat for the valve 42, and below said seat there is a recess 43 for the valve when the latter is moved to open position. Said recess in the inlet-duct forms the igniting-chamber, and in it are placed two slightly-separated electrodes, between which may be formed the spark. One of the electrodes is indicated at

44, and it is connected with a Ruhmkorff coil, as will be subsequently explained. The valve-casings are mounted upon the ends of valve-stems 45 46, respectively, each of which is equipped with a collar 47, between which and the end of the casing there is a spring 48, which by its pressure against the collar tends to hold the valve normally seated. The valve-spindles pass through the lugs 49 on the cylinder-head 16 and upon their ends are equipped with rollers 50 51, respectively, actuated by cams 52 53 upon a shaft 54, journaled in bearings 55, afforded by the housing 18. The shaft receives its rotative movement from the crank-shaft 28, there being interposed between said shafts a gear-wheel 56 on the shaft 54, intermeshing with and driven by a pinion 57 on the crank-shaft 28. The ratio of the gears 56 57 is as two is to one, so that for each two rotations of the crank-shaft 28 and each two double reciprocations of the piston 20 the gear-wheel 56 will receive one rotation.

The sparking apparatus or apparatus for igniting the explosive mixture after it is introduced into the cylinder consists of an electrical circuit having two independent circuit-closers by means of which a succession of sparks may be caused at the igniting-electrodes.

On the crank-shaft 28 is placed an interrupter consisting of a commutator 58, having a series of conducting and insulating sections arranged alternately. Against this commutator rest two brushes 59 and 60, which are suitably supported upon insulating material, so as to be insulated from each other. When the two brushes rest upon a conducting-section of the commutator, other conditions being proper, the current is caused to flow through the circuit. The other circuit-closing device consists of a collar 61 on a shaft 54 and having a single conducting-section 62. Two brushes 63 and 64 are mounted upon a support 65, attached to the casing, said brushes being insulated from each other and being adapted to rest simultaneously against the section 62 to have the circuit closed between them. The brushes 59 60 and 63 64 are arranged in series in the primary circuit, which includes a generator 66. The primary of the Ruhmkorff coil is indicated at 67, the secondary coil being indicated at 68 and forming a part of the induction-circuit, which includes the igniting-electrodes 44.

Inasmuch as the movement of the shaft 54 is relatively slow, the brushes 63 64 remain in engagement with the section 62 a relatively long period of time, during which a plurality of conducting-sections of the commutator 58 are engaged with the brushes 59 and 60, whereby the circuit will be closed and broken rapidly a number of times to cause a plurality of sparks at the igniting-electrodes to follow one another in rapid succession.

Assuming that the cylinder is provided with a suitable abutment, such as the one which we shall subsequently describe, and that the piston 20 is in the position shown in Fig. 2 with the charge of explosive mixture is a compressed condition, the valves being likewise in their closed positions, the formation of sparks at the igniting-electrodes will cause the mixture to explode and drive the piston toward the other end of the cylinder. The momentum acquired by the fly-wheels during the outward movement of the piston will be sufficient to cause them to make several rotations, so that as the piston moves back to original position after the explosion the exhaust-valve is opened and the products of combustion are forced out through the exhaust-duct. As soon as the piston reaches its original position and begins its outward movement once more the inlet-valve is opened by the cam and a fresh charge of the explosive mixture is drawn into the cylinder. At the instant, however, that the piston reaches the outer extreme of its movement the inlet-valve may be closed, (except as hereinafter explained,) and the following movement of the piston will compress the explosive mixture to the proper extent, ready for its ignition and consequent explosion. The valve-cams are properly timed to effect the opening movement of the valve at the proper time and for the proper period of time.

It being our purpose to render the motor variable as to the power which is developed thereby, we have provided mechanism by means of which the operative volume may be varied and a greater or smaller quantity of the explosive mixture may be exploded within the cylinder without varying the degree of compression thereof. To this end we employ an adjustable abutment 70. Said abutment fills the open lower end of the cylinder and is provided with packing-rings 71. Said abutment is centrally apertured to receive the end of a pin 72; which is threaded, as at 73, and passed through an internally-threaded aperture located centrally in the cylinder-head 15. Said abutment is provided with an annulus 74, around which is placed a coiled spring 75 with its outer end pressing against the cylinder, and it permits the abutment to yield when the explosive mixture is being compressed by the downward or inward movement of the piston 20. The opposite movement of the abutment permits the scavenging of the cylinder after an explosion. The downward and outward movement of the abutment is limited by the end of the pin 72, the said pin likewise acting as a guide to prevent the abutment from twisting on a transverse axis. By adjusting the screw 73 the operative volume of the cylinder may be increased or diminished at will, and to adjust said pin it is equipped on its outer end with a crank 76 and handle 77. Were the abutment adjust-

ed, however, and the same quantity of explosive mixture injected regardless of the operative volume of the cylinder, said mixture would be compressed to a greater or lesser extent inversely, proportional to the volume of the cylinder—that is to say, if the abutment were adjusted to lessen the space between it and the piston when the latter is in the position shown in Fig. 2 the explosive mixture would be compressed very much more than it would if the abutment were adjusted toward the outer or lower end of the cylinder. Consequently the adjustment of the abutment would not serve to economically vary the power or energy developed by the motor. We assume that in order to secure the best results economically the explosive mixture should be compressed to a predetermined degree—say, for instance, three atmospheres—and we provide means controlled by the position of the abutment or the adjusting-pin whereby irrespective of the position of the abutment the compression of the gaseous mixture will be the same in all cases. The amount of gaseous mixture, however, drawn into the cylinder by the outward movement of the piston is unvarying, the abutment at this time occupying a position with its edge engaging the shoulder 19, and consequently in order to vary the volume of said mixture which is retained and compressed in the cylinder we provide means for part of it passing backward into the inlet-pipe, and we are obliged, therefore, to obtain a differential actuation of the inlet-valve spindle. The pipe 39, through which the gaseous mixture is admitted to the valve-chamber 37, is provided with a back check-valve 80, and between said valve and the valve-casing 37 a coupling 81 is inserted in the pipe, said coupling having a nozzle 82, around which is secured the mouth of a gas-bag 83, so that if the valve 42 be held open when the piston begins its compressing action a part of the gaseous mixture will pass backward through the valve-chamber and will partially fill the gas-bag 83. Its escape through the pipe 39 on the other side of the gas-bag is prevented by the check-valve 80. The next time, however, that the explosive mixture is drawn into the cylinder it escapes from the bag first before the check-valve 80 is raised, and consequently the gas which escaped into the bag during the compressing action of the cylinder is used during the following inducing action of the piston.

The differential actuation of the valve-spindle 45 is secured by forming the cam 52 with an elongated graduated dwell having the inclined edge 84, said cam being made relatively wide. Consequently, as the said cam is changed in position axially relatively to the roller 50 on the spindle 45 the duration of time in which the valve is maintained in open position is increased.

The parts are so constructed and timed that when the abutment is adjusted to its extreme of outward movement the valve will be shut at the instant the piston 20 begins its compressing movement. The cam 52 at this time occupies a position to the extreme right, as shown in Fig. 1, and as the abutment is adjusted nearer and nearer the center of the cylinder the cam 52 is gradually slid to the left to lengthen the period of time in which the valve is held in open position. To secure this movement of the cam, said cam is secured rigidly to the shaft 54 and the said shaft is moved bodily lengthwise, the parts all being so constructed as to permit this without varying the operative relation between the several contacting or coacting parts. On the end of a rod 87 is formed a wedge-shaped yoke 88, which operatively engages a collar 89 on the end of the shaft 54. The other end of the rod 87 is secured by nuts to the arm 90, which projects laterally from a sleeve 91 on the pin 72, the said collar being held against axial movement relatively to said pin, although the pin is free to rotate therein. The said rod is passed through apertures in the cylinder-head, whereby it is guided in its movements.

From this description it will be seen that when the abutment-adjusting device—to wit, the pin 72—is adjusted, the shaft 54 and the cam 52 are likewise adjusted.

It is evident that instead of drawing the full charge of explosive mixture into the cylinder and then expelling a portion we may arrange to have drawn into the cylinder only that amount of explosive mixture which is necessary, and we accomplish this by a very slight change in the mechanism which we have described—that is to say, instead of holding the valve open during all the time that the piston continues its upward or outward inducing movement and a portion of the time in which it makes its compressing movement we provide for closing the valve during the inducing movement of the piston just as soon as the proper amount of explosive mixture has entered the cylinder. To do this, it is merely necessary to reverse the dwell upon the cam 52—that is to say, instead of having the dwell increase from left to right the dwell in this case is decreased from left to right, its greatest circumferential portion being at the left end of the cam. Consequently we provide for the valve 42 being closed prior to the completion of the upward gas-inducing stroke of the piston. In either event we secure the differential operation of the valve 42 and provide for the retention in the cylinder of only that amount of explosive mixture which is desirable to secure the constant and unvarying compression of the charge in the cylinder.

In the engine which we have thus described, but to the construction of which it will be un-

derstood that we have in no wise limited ourselves, we achieve several desirable and important results. In the first place we obviate all vibration and secure a smooth and easy action of the crank-shafts by mounting the two fly-wheels on the opposite ends of their respective crank-shafts, for since said shafts are arranged parallel, as we have explained, they balance each other and largely assist in preventing the vibration referred to. Secondly, we are enabled to convert the engine from a high to a low horse-power by merely adjusting the abutment. (We have have spoken of "adjusting the abutment" because although we have shown the abutment as being held normally in inoperative position by a spring, yet if the abutment were connected directly to the pin 72 the result would be no different upon adjusting the screw, although the abutment would not in that case serve to eject the products of combustion after an explosion.) We also attain other results which will be apparent to those skilled in the art to which this invention relates, but to which it is unnecessary here to refer. We do not herein claim the igniting devices.

We claim—

1. An engine comprising a piston and cylinder, a pair of crank-shafts mounted parallel with each other, a pair of connecting-rods extending from said piston to said shafts, a gear mounted on each shaft and intermeshing one with the other, and a fly-wheel keyed to one end of each crank-shaft and located on opposite sides of the engine.

2. An engine comprising a piston and cylinder, a pair of crank-shafts mounted parallel with each other, a pair of connecting-rods extending from said piston to said shafts, a gear mounted on each shaft and intermeshing one with the other, a weight carried by each shaft, and a fly-wheel keyed to one end of each crank-shaft and located on opposite sides of the engine.

3. An engine comprising a piston and cylinder, a pair of crank-shafts mounted parallel with each other, a pair of connecting-rods extending from said piston to said shafts, fly-wheels mounted on each shaft and means for automatically preventing reverse rotation of said fly-wheels.

4. An engine comprising a piston and cylinder, a pair of crank-shafts mounted parallel with each other, a pair of connecting-rods extending from said piston to said shafts, fly-wheels mounted on each shaft, and means normally in engagement with the periphery of each fly-wheel adapted to automatically prevent reverse rotation thereof.

5. A gas-engine comprising a piston and cylinder having means whereby all the explosive mixture is drawn into the cylinder by the piston, an abutment located in said cylinder, a threaded pin arranged to vary the position

of said abutment whereby the operative volume is correspondingly varied, a threaded collar working on said threaded pin, and means operated by said collar for automatically varying the amount of explosive mixture compressed within said cylinder.

6. A gas-engine comprising a piston and cylinder having means whereby all the explosive mixture is drawn into the cylinder by the piston, an abutment located within said cylinder a pin serving as a guide for said abutment, means for adjusting said pin, whereby the position of said abutment is varied, and means automatically operated by said pin for varying the amount of explosive mixture compressed within said cylinder.

7. A gas-engine comprising a piston and cylinder having means whereby all the explosive mixture is drawn into the cylinder by the piston, a cushioned abutment located within said cylinder and means for simultaneously varying the relative position of said abutment and varying the amount of explosive mixture compressed within said cylinder.

8. A gas-engine comprising a piston and cylinder having means whereby all the explosive mixture is drawn into the cylinder by the piston, an abutment located in said cylinder, a threaded pin arranged to vary the position of said abutment whereby the operative volume is correspondingly varied, valve mechanism for admitting explosive mixture to said cylinder, means for operating the same, a threaded collar working on said threaded pin and means operated by said collar for varying the relation between said valve mechanism and its operating means.

9. A gas-engine having a piston and cylinder, means for varying the operative volume in said cylinder, and mechanism automatically controlled by said means, whereby said piston is permitted to draw the explosive mixture into the cylinder and automatically expel a predetermined portion thereof, said mechanism also permitting the entrance of the expelled mixture to the cylinder at the next cycle of operation of the engine.

10. A gas-engine comprising a piston and cylinder, means for varying the operative volume within said cylinder, an inlet-valve, means for operating the same, means automatically controlled by said volume-varying means for controlling said valve, operating

means whereby the piston is permitted to draw the explosive mixture into the cylinder and expel a predetermined portion thereof past said inlet-valve and means for receiving said expelled explosive.

11. A gas-engine comprising a cylinder and piston, an abutment located in said cylinder, a threaded rod for varying the position of said abutment, a collar working on said rod, and mechanism automatically controlled by the movement of said collar, whereby a part of the explosive mixture is permitted to escape from said cylinder.

12. A gas-engine comprising a cylinder and piston, an abutment located in said cylinder, a threaded rod for varying the position of said abutment, a collar working on said rod, an inlet-valve, mechanism for operating the same having means for controlling the movement of said valve whereby a part of the explosive mixture is expelled from said cylinder, and connections between said collar and said valve mechanism, whereby the valve-controlling means is automatically operated.

13. A gas-engine comprising a piston and cylinder, an adjustable abutment located in the latter, an inlet-pipe having a check-valve, an inlet-valve intermediate of said check-valve and said cylinder, valve-operating mechanism for said check-valve arranged to permit the piston to draw the explosive mixture into the cylinder and to expel a part thereof into said inlet-pipe past said inlet-valve, and a gas-bag intermediate of said inlet and check valves adapted to receive the expelled gas whereby the latter is introduced into the cylinder for the next succeeding explosion.

14. A gas-engine having a piston and cylinder, an abutment located in the latter, a threaded rod for adjusting the same, an inlet-valve, differential valve-operating mechanism, a threaded collar working on said rod, and connections between said collar and said valve-operating mechanism.

In testimony whereof we have affixed our signatures in presence of two witnesses.

EDWIN F. PORTER.
WALTER R. WHITING.

Witnesses:

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