(No Model.) 5 Sheets—Sheet 1.

# C. F. HIRSCH.

## GAS ENGINE.

No. 526,837. Patented Oct. 2, 1894.

Fig. 1.

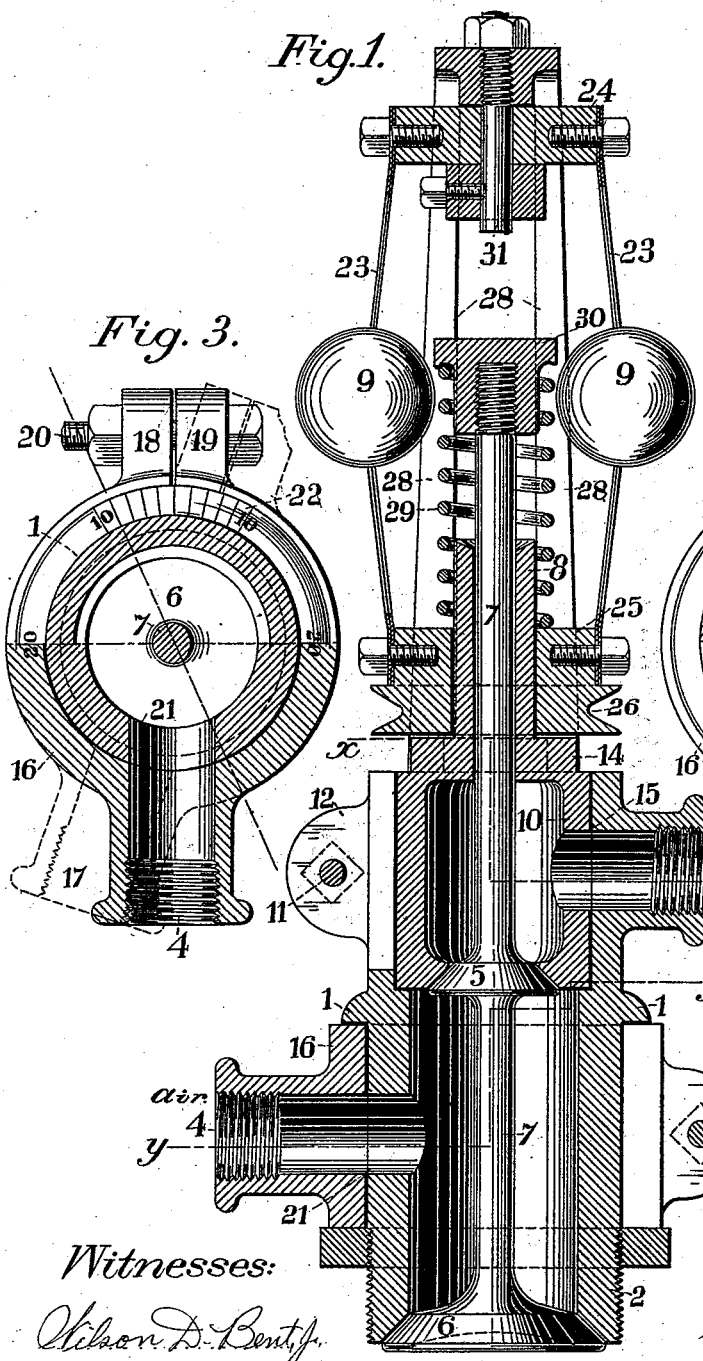
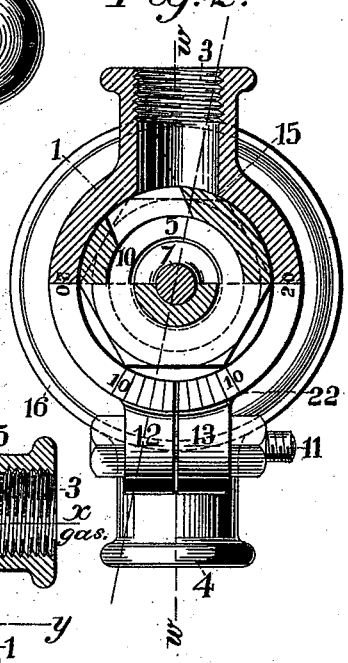



Fig. 3.




Fig. 2.




Witnesses:

Nelson D. Bent Jr.

Carlton M. Cornwell

Inventor:

Carl F. Hirsch

by

John Richards

Atty

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# C. F. HIRSCH.

## GAS ENGINE.

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*Fig. 4.*

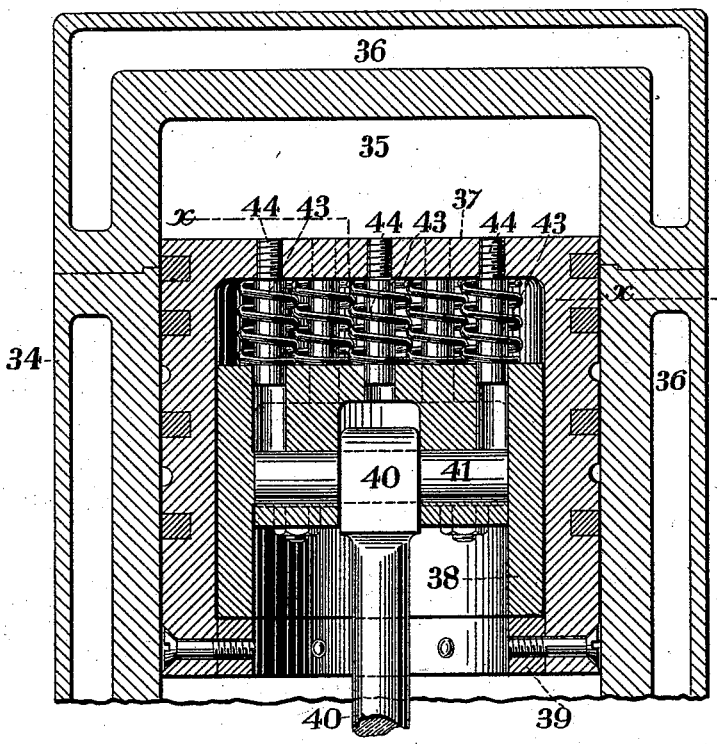
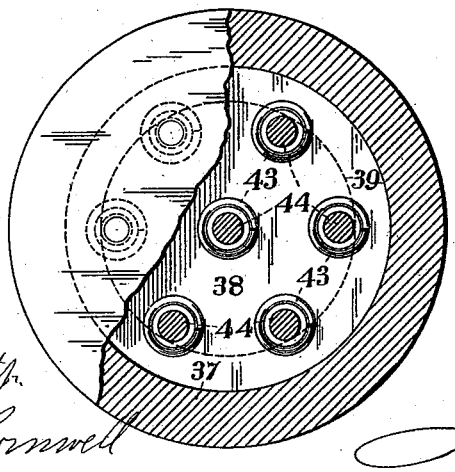



*Fig. 5.*




*Witnesses:*

Nelson D. Bentley

Carlton M. Connell

*Inventor:*

Carl F. Hirsch

by

John Richards

Atty

(No Model.) 5 Sheets—Sheet 3.

# C. F. HIRSCH.

## GAS ENGINE.

No. 526,837. Patented Oct. 2, 1894.

*Fig. 6.*

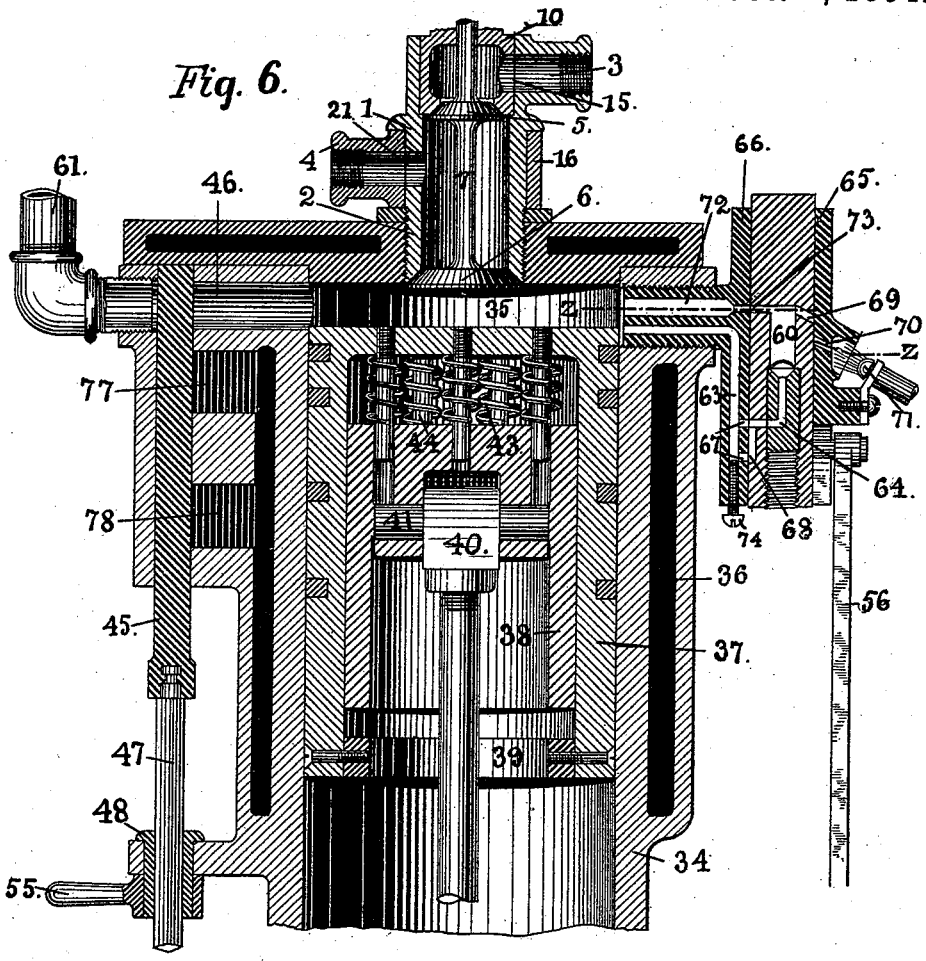
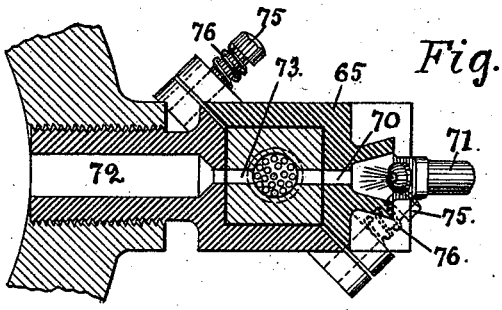



*Fig. 7.*




*Witnesses:*

Wilson D. Bent, Jr.

Carlton M. Cornwell

*Inventor:*

Carl F. Hirsch

by

John Richards

Atty

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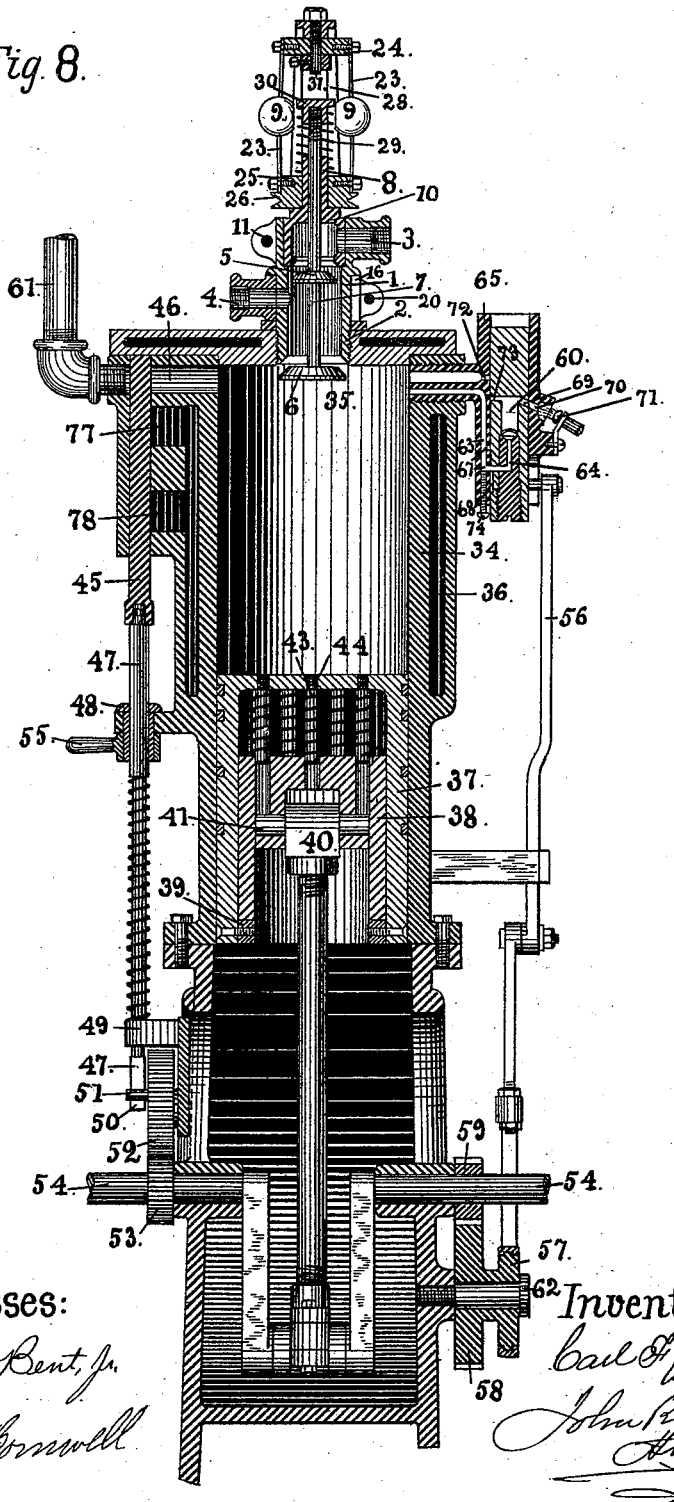
# C. F. HIRSCH.

## GAS ENGINE.

No. 526,837. Patented Oct. 2, 1894.

*Fig. 8.*




Witnesses:

Wilson D. Bent, Jr.

Carlton M. Cornwell

Inventor.

Carl F. Hirsch

by

John Richards

Atty

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# C. F. HIRSCH.

## GAS ENGINE.

No. 526,837. Patented Oct. 2, 1894.

*Fig. 9.*

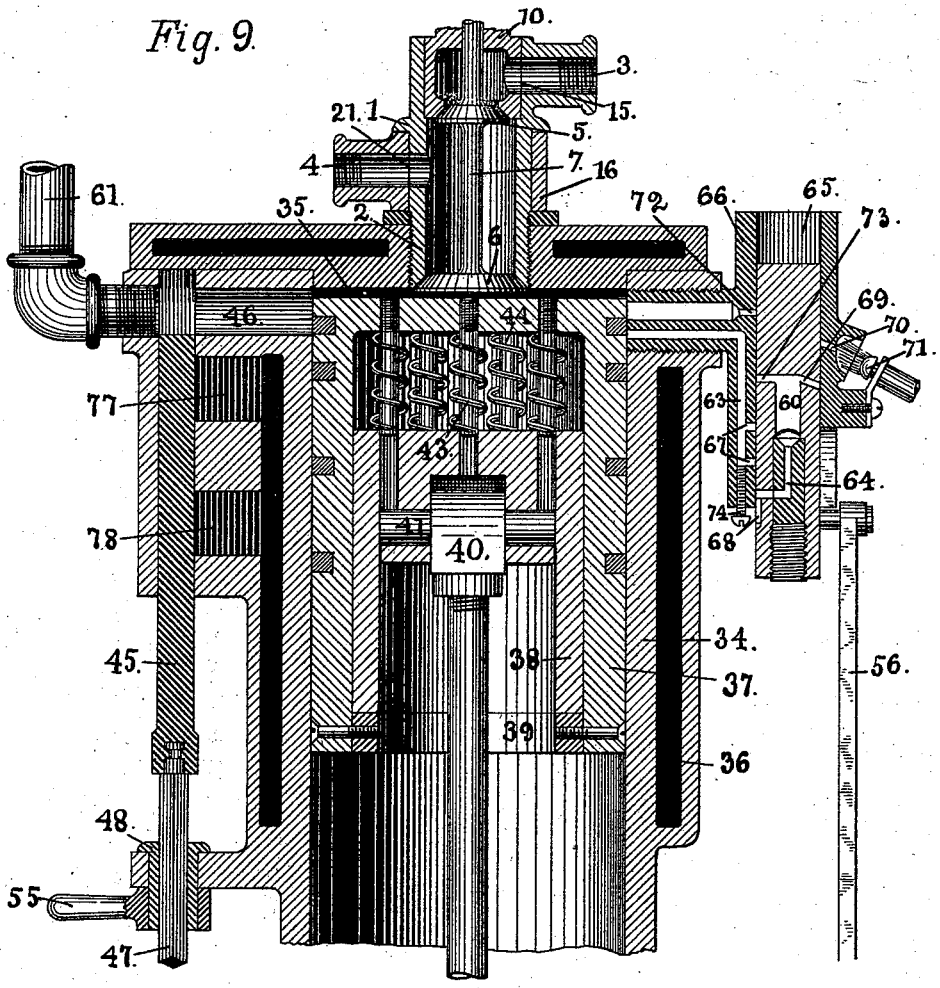
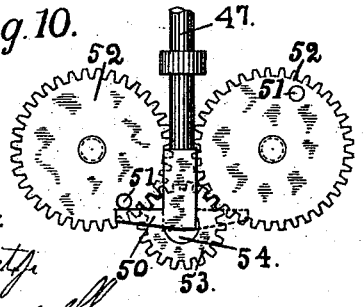



*Fig. 10.*




Witnesses:
Wilson D. Beatty Jr.
Carlton M. Conwell

Inventor:
Carl F. Hirsch
By
John Richards
Atty

# UNITED STATES PATENT OFFICE.

CARL FERDINAND HIRSCH, OF SAN FRANCISCO, CALIFORNIA.

## GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 526,837, dated October 2, 1894.

Application filed February 20, 1893. Serial No. 463,102. (No model.)

*To all whom it may concern:*

Be it known that I, CARL FERDINAND HIRSCH, a subject of the Emperor of Germany, residing in the city and county of San Francisco, State of California, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification.

My invention relates to motive engines impelled by gas or explosive vapor, and consists in various devices that contribute to the convenience and better performance of such engines, as will be set forth in the drawings herewith and forming a part of this specification.

Figure 1 shows a vertical section through the valves for admitting gas and air to the cylinder, also the regulating apparatus to govern the supply of these and consequent speed and power of the engine. Fig. 2 is a plan view, partially in section, on the line *x x* of Fig. 1, showing the gas inlet valve and the method of regulating the supply of gas thereto. Fig. 3 is a similar plan view on the line *y y* of Fig. 1, partially in section, showing the air inlet valve and means of regulating the supply of air thereto. Fig. 4 is a section through the longitudinal axis of the engine piston, and a part of the cylinder, showing the method of arranging the piston to produce more uniform compression irrespective of the volume of the charge, and to avoid violent thrust on the parts. Fig. 5 is a plan view, partially in section, on the line *x x* of Fig. 4. Fig. 6 is a vertical section through the cylinder of a gas engine, arranged according to my invention, showing the devices in position for igniting the charge, also showing the piston in the position of compressing a charge of gas and air. Fig. 7 is a plan view in section of the igniting apparatus on line *z z* of Fig. 6. Fig. 8 is a vertical section through a complete engine, showing the construction of the various parts when the piston is at its extreme outward stroke, and especially the actuating mechanism for the igniting devices and for the exhaust valve. Fig. 9 is a partial view in section through the piston-igniting apparatus, and a portion of the main cylinder, the piston being extended on its inward or upward stroke, and the igniting slide on its extreme downward or outward stroke. Fig. 10 is a front view of the mechanism for reversing the motion of the engine.

Similar numerals for reference are applied in the different figures to corresponding parts of the engine.

Referring first to Figs. 1, 2, and 3, the main supporting shell or body (1), containing the gas and air induction valves, also supporting the regulating mechanism, is screwed into the cylinder by the nipple or extension (2). This shell has a fixed nipple (3) for the inlet of gas, and a movable nipple (4) for the inlet of air.

The gas inlet valve (5) and air inlet valve (6) are made integrally with or attached firmly to a stem (7), extending up through a nipple (8) to a centrifugal governor, as shown in Fig. 1. The gas inlet valve (5) has its seat formed in a shell (10) that fits loosely in the main body (1) and is nipped or held by the bolt (11) passing through the two lugs (12) (13), the outer shell being split for that purpose.

On the top of the shell (10) is a hexagonal extension (14) to which a spanner or wrench can be applied to revolve the shell and thus partially close the inlet orifice at (15), as shown in Fig. 2, so as to regulate the amount of gas admitted each time the valve (5) is opened.

The same arrangement is made for throttling the air admitted at the inlet (4), the shell (16) fitting loosely around the main barrel (1), so the air inlet nozzle (4) can be turned to an angle as indicated by dotted lines at (17) as shown in Fig. 3, and is clamped as in the former case by means of the lugs (18) (19), and screw-bolt (20), so the air inlet orifice at (21) can be closed and regulated, as the amount of air required may demand.

In both the case of the air and gas inlets, there are external figured scales (22) by which the position of the members (16) and (10), and the amount of air and gas being admitted, are indicated.

The regulating apparatus consists of the centrifugal balls (9) attached to flexible springs (23), connected at the top to the member (24), and at the bottom to a similar member (25), the latter and the driving pulley (26) being fastened together, and the two running loosely on the nipple, or sleeve (8), formed integrally with the shell (10).

The upper bearing and support of the gov-

ernor consists of a stem (31) fastened in the bracket (28) that extends down to, and is made integrally with the main member (1) or is attached thereto.

The stem (7) and the valves (5) and (6) are supported by a coil spring (29) resting on the member (25), and pressing upward on the collar (30) as shown in Fig. 1. The tension of this spring is such that when the exhaust valve of the engine is closed the partial vacuum formed in the cylinder, on the outward stroke of the piston, compresses the spring (29), permitting the valves (5) and (6) to open, admitting a proper charge of gas and air, but if the speed of the engine is increased beyond its predetermined rate the balls (9) are thrown out by centrifugal force, and the upper cross member (24) being sustained on the stem (31), fastened in the bracket (28), the lower cross bar (25) is drawn up by shortening of the spring (23), and the coil spring (29) is thus compressed, and the valves (5) and (6) are held closed so that no gas or air is admitted until the speed is reduced and the vacuum formed in the cylinder will overcome the tension of the coil spring (29), opening the valves (5) and (6) to admit a new charge to the cylinder.

The valves (5) and (6), for gas and air, have their respective areas proportioned as nearly as possible to the amounts of gas and air required to produce an explosive mixture of greatest effect, but, as will be seen, the quantity of either admitted can be accurately regulated and observed by the devices that have just been described.

Having thus explained the method of admitting the charges to my improved gas engine, and the means to regulate the same, I will now refer to the method of constructing the piston so as to attain a uniform or nearly uniform compression of the charges, and by the same means avoid violent shocks being communicated to the crank shaft and connections by the explosion of the charges.

Referring now to Figs. 4 and 5 of the drawings, (34) is the engine cylinder, and (35) the combustion chamber; (36), an annular space to be filled with cooling water in the usual manner. (37) is the engine piston, and (38) a follower sliding loosely therein, resting on the fixed collar (39) on the downward or outward stroke of the piston. The connecting rod (40) is attached to the follower (38) by means of a strong cross pin (41) in the usual manner. Between the piston (37) and follower (38) are interposed coil springs (43), held in position and guided by the studs (44) screwed into the top of the piston as shown. When the piston approaches the end of the cylinder on the compressing stroke, and the gas and air have reached a certain tension, the springs (43) yield, and permit the follower (38) to slide downward until the engine reaches the center. Then when explosion takes place the springs (44) are further compressed, and the impulse delivered to the connecting rod (40), and the crank of the engine is elastic and without the usual violent shock. The power is also more equally distributed, because the force stored up in the compressed springs (44) is given back at a later period of the working stroke, and violent strain on the crank and crank shaft is avoided. Another important function gained by this construction of the engine piston is that on the alternate inward strokes to expel the gases of combustion, the springs (43) being extended, the piston fills the combustion chamber, thus sweeping out completely the spent gases, so the incoming charge of gas and air is not mingled therewith. This greatly increases the purity of the working charge, and adds to the efficiency of a given volume of gas and improves the working qualities of the engine.

Referring now to Figs. 8, 9 and 10, these illustrate the method of reversing my improved gas engine, also in part, the igniting apparatus for firing the charges, which will be further explained hereinafter.

Figs. 8 and 9 are so drawn as to represent the working parts of the engine in different positions of their stroke or movement, the piston (37) being in Fig. 8 on its extreme outward or downward stroke, and at its extreme upward or inward stroke in Fig. 9.

Referring first to the reversing elements of the engine, this operation depends mainly on the control of the exhaust valve that permits the escape of the spent charge. This function is performed in my improved engine by means of a slide or cut-off valve (45) that opens and closes the passage (46) leading from the engine cylinder (34) to the exhaust pipe (61). This slide or valve is shown open in Fig. 9, and closed in Figs. 6 and 8. It is operated by means of a rod or connection (47), square in its upper section, sliding through a shell or bush (48), and having also a bearing (49) at the bottom, as shown in Fig. 8. On the lower end of this rod (47) is a toe or extension (50) that is engaged by the pins (51) inserted in the wheels (52). These wheels (52) are driven by a pinion (53) on the crank shaft (54) of the engine, as shown in Fig. 8, and revolve at one half the speed of the crank shaft, so the exhaust slide (45) is opened by one wheel or the other as the toe (50) is turned to the right or left at alternate strokes of the piston (38), the engine running in either direction accordingly.

To reverse the engine the rod or connection (47), by reason of its square section in the shell (48), can be turned around by means of the handle (55), so the toe (50) will engage the pins (51) on either of the wheels (52), these pins being set in such relation to the engine's stroke that the slide (45) will be drawn down at the proper position of the piston, and open the exhaust passage when the crank shaft is revolving in either direction. To keep the slide valve (45) cool, chambers (77) and (78) are provided, communicating

with the water cooling chamber (36) as shown in Figs. 6, 8, and 9. In this manner the engine can run either way, and can be reversed by turning the handle (55) to the right or left, the igniting apparatus on the right not interfering with this change of motion, because of the charge being fired at the extreme of the piston's inward stroke, the engine running either way.

The igniting apparatus to fire the charges of gas and air is shown on the right in Figs. 6, 8, and 9, and consists of a reciprocating slide (45), operated by means of a link or connection (56), extending down to an eccentric (57), formed integrally with or connected to a wheel (58), mounted on the stud (62), and driven by a pinion (59) on the crank shaft (54). This wheel (58) being twice the size of the pinion (59) makes one revolution to two of the engine shaft, so the igniting slide (55) makes its stroke at alternate revolutions of the engine.

The slide (55) moves up and down in the rectangular seat (65) formed in the supporting bracket (66), and has, within it, a chamber (60), which, at a certain point of its up stroke, as shown in Figs. 8 and 9, communicates with the main cylinder (38) by means of the passages (63) and (64), so arranged that by means of the double inlets (67), and a groove (68) in the slide (55) that the chamber (60) will remain for a considerable part of the upward stroke in communication with the combustion chamber (35). During this time the charge of gas and air in the cylinder is being compressed and is forced into the chamber (60) of the slide (55). When the slide (55) has moved up a certain distance, connection is cut off between the passages (63) and (64) and the apertures or ports (69) and (70) coincide, so the gas contained in the chamber (60) is ignited by a burning jet (71). The slide (55) then moves on to the position shown in Fig. 6, opening communication between the combustion chamber (35) and the chamber (60) in the slide (55) by means of the passages (72) (73) firing the charge in the chamber (35). In this manner the gas required for firing the charge is drawn from the engine cylinder and is subjected to the required pressure for producing forcible explosion and preventing back flow from the combustion chamber when the parts (72) and (73) coincide.

The quantity of gas and air admitted through the passage (63) and the lower inlet passage (67) is regulated by a screw (74), which can be forced in to cover in part, or close, this inlet, and thus regulate the time or position in which the chamber (60) is filled with gas up to the pressure in the main cylinder.

The supporting bracket or frame (65) is split diagonally as shown in Fig. 7, and is clamped by means of screws (75) having beneath the heads thereof, coiled springs (76), so as to exert an elastic pressure on the slide (55), and thus provide for its expansion and contraction by heating and cooling.

Having thus explained the nature and objects of my invention and the manner of constructing and applying the same, what I claim as new, and desire to secure by Letters Patent, is—

1. In a gas engine, the combination of the gas inlet valve and the air inlet valve, both carried by a common stem and moving simultaneously therewith, a valve-supporting shell or chamber for each of these valves and split collars or shells embracing the aforesaid valve-supporting shells and having openings to coincide to a greater or less degree with corresponding openings in the valve-supporting shells accordingly as the embracing collars are adjusted, together with adjusting bolts engaging lugs in the ends of the split shells, substantially as described.

2. In a gas engine, the combination with the cylinder and its piston, of a valve-supporting shell thereon, an air inlet valve having a seat in said shell, an adjustable split collar embracing said shell and capable of revolution around it, said embracing collar having a port or opening which coincides to a greater or less degree with a corresponding port or opening in the valve-shell so that the amount of air admitted to the valve at each charge can be regulated by the adjustment of the collar and means for adjusting and tightening said collar, consisting of lugs at each end thereof engaged by a bolt together with a scale for measuring the adjustment, substantially as described.

3. In a gas engine, the combination of a gas inlet valve and an air inlet valve, both of which are connected to a common stem and move simultaneously therewith, valve-supporting shells for the two valves, split collars which embrace the said shells and have their ends provided with connecting bolts and ports in the shells and the embracing collars that can be opened or closed by adjustment of the collars so as to regulate the amount of air and gas admitted at each charge, substantially as described.

4. In a gas engine, the combination of the gas inlet valve and the air inlet valve, both connected to a common stem and moving simultaneously therewith, valve-supporting shells for the two valves, split collars which embrace and are adjustable around the valve shells, said collars having ports or openings adapted to coincide to a greater or less degree with corresponding ports or openings in the shells, means for adjusting the collars and securing them when adjusted and a governor mechanism applied to the upper end of the valve stem and operating substantially as described.

5. In a gas engine, the combination of a gas inlet valve and an air inlet valve, both connected to a common stem and moving simultaneously therewith, valve-supporting shells for said valves, divided collars surrounding

the shells and adjustable thereon, said collars being provided with ports or openings that coincide with corresponding ports or openings in the shells which ports or openings are graduated in size in consequence of the adjustment of the collars, and a governor mechanism applied to the upper end of the valve-stem and consisting essentially of centrifugal balls carried by flexible springs secured to pieces at top and bottom, together with a nut on the end of the valve-stem and a coiled spring encircling the same.

6. In a gas engine, the combination of the gas inlet valve, an air inlet valve, both connected to a common stem and moving simultaneously therewith, a valve-supporting shell for each valve, an adjustable collar on each shell having an inlet opening which coincides with corresponding openings in the shell and is graduated in size by the adjustment of the collar, said collars being split at one point and provided with lugs which are engaged by bolts and being also provided with indicating scales so that the amount of gas and air admitted through the inlet openings may be observable from the scales, together with a governing or regulating mechanism applied to the end of the valve-stem, substantially as described.

7. In a gas engine, the combination of a cylinder, a piston moving therein, inlet valves for gas and air, an exhaust valve, the main crank shaft and two independent cams or lifting cranks, arranged in connection with the exhaust-valve so that the latter may be opened at the proper point of the piston's stroke when the engine is running either way and thus permit the crank shaft to be reversed, substantially as described.

8. In a gas engine, an exhaust valve and its rod, in combination with the main crank shaft and dual actuating mechanism for the exhaust valve arranged between it and the crank shaft so that the valve may be opened at the proper point in the piston's stroke when the engine is running in either direction and hand mechanism to change the valve-actuating devices so that the engine can be reversed at will, substantially as described.

9. In a gas engine, the combination of an exhaust valve, a pair of wheels for actuating it, a revoluble valve-rod, a tappet thereon capable of being turned to the right or to the left and actuating mechanism that will open the valve at the proper position of the engine's stroke when the engine shaft is running in either direction, substantially as described.

10. In a gas engine, the combination with the cylinder and a piston therein, of an exhaust-valve opening and closing the escape passage to the combustion chamber within the cylinder, the adjustable engine gearing as herein described to open said valve at the proper point of the engine's stroke when running either way, a squared revoluble valve-rod and an adjustable handle to turn the same, actuating wheels geared to and revolving positively in respect to the engine shaft, substantially as described.

11. In a gas engine, the combination with the cylinder and a piston moving therein, of an exhaust valve, a revoluble valve-rod having a lifting toe or extension on its lower end, the main crank shaft having a pinion thereon, gear wheels driven by said pinion and provided with pins adapted to engage the toe on the valve-rod and a handle for rotating the revoluble valve-rod so as to fix it in the proper position, substantially as described.

12. In a gas engine, the combination with the cylinder and a piston moving therein, of an exhaust valve, a revoluble valve-rod square in its upper section and sliding through a shell or bushing and provided on its lower end with a toe or extension, the main crank shaft having a pinion thereon, gear wheels engaged by said pinion and provided with pins adapted to engage the toe on the lower end of the valve-rod, a spring enveloping the lower section of the valve-rod and a handle for rotating the valve-rod so as to place its toe in proper position relatively to the pins on the gearing, all substantially as specified.

13. In a gas engine, the combination with the main cylinder having an annular cooling chamber to be filled with water, of a piston moving within said cylinder, a sliding exhaust-valve for opening and closing the escape passage to the cylinder, the face or sides of said valve connecting with the annular cooling chamber so that the valve may be exposed to the cooling water, the revoluble valve-rod with its adjustable handle and the actuating wheels geared to and revolving positively in respect to the engine shaft and engaging the valve-rod substantially in the manner and for the purpose set forth.

14. In a gas engine, an igniting slide driven from an eccentric on the main crank shaft, having an elongated groove on one side communicating with two ports open to the engine cylinder, the lower one of said ports regulated by a screw-valve to control the inflow and pressure in the chamber of the igniting slide up to the point of ignition, the apertures or ports at the top of the igniting slide communicating with a jet burner and the interior of the main cylinder in such relation as to close the igniting port before the charge in the cylinder is exploded, substantially as described.

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

CARL FERDINAND HIRSCH.

Witnesses:
ALFRED A. ENQUIST,
WILSON D. BENT, Jr.