(No Model.) 3 Sheets—Sheet 1.

J. B. FENNER.

GAS ENGINE.

No. 596,239. Patented Dec. 28, 1897.

Fig. 1.

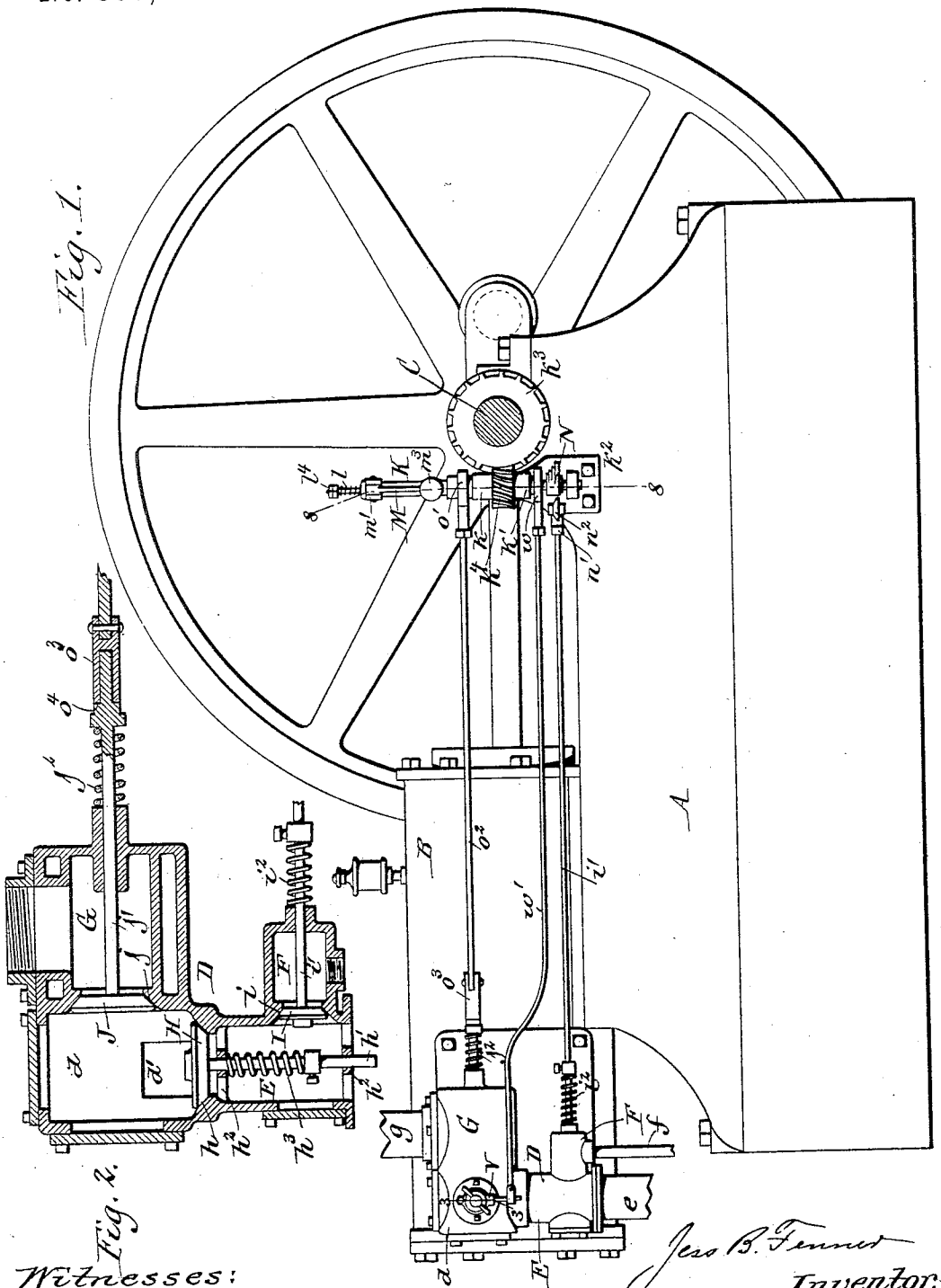

Fig. 2.

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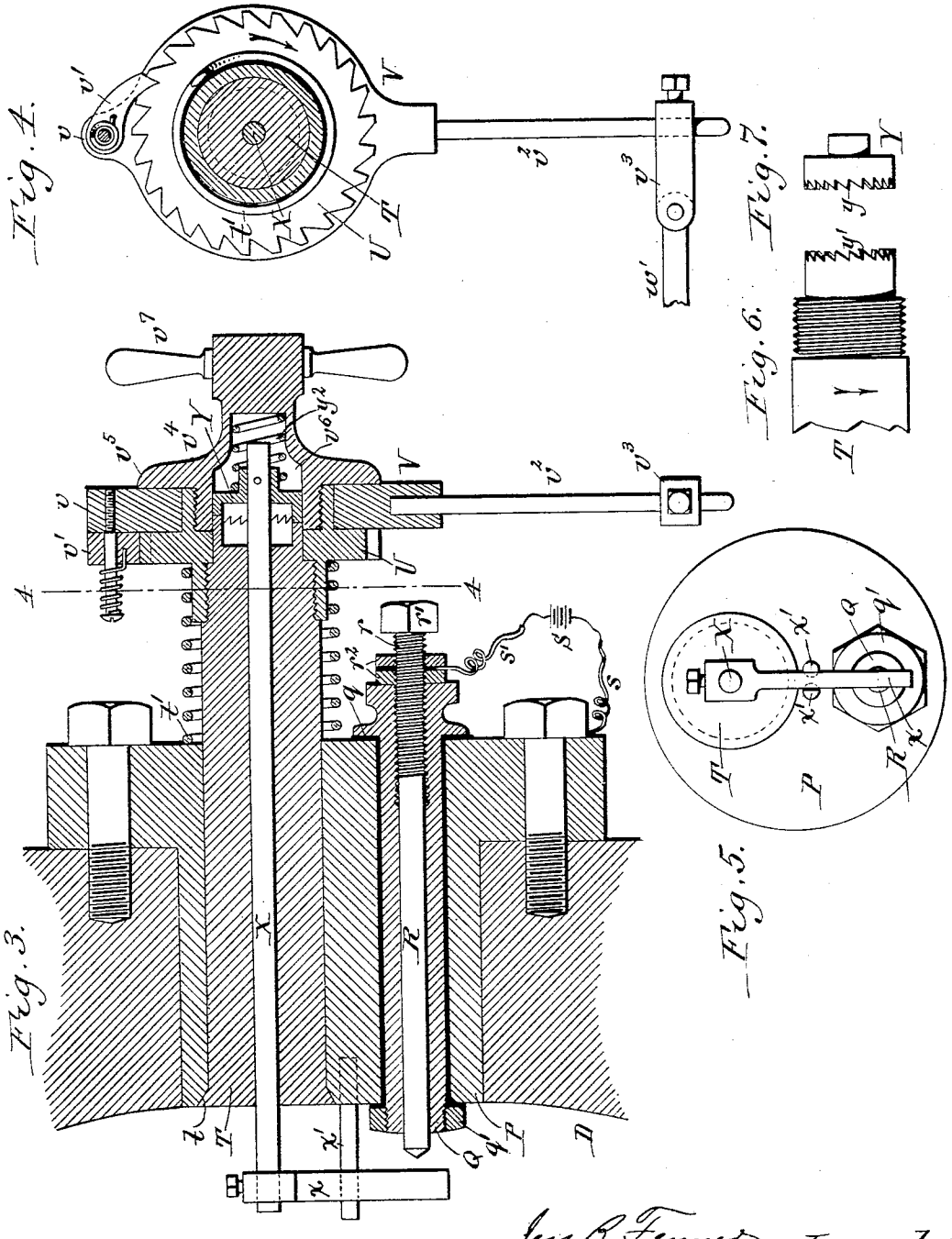

Fig. 4.

Fig. 7.

Fig. 6.

Fig. 5.

Fig. 3.

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(No Model.) 3 Sheets—Sheet 3.

J. B. FENNER.

GAS ENGINE.

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Fig. 8.

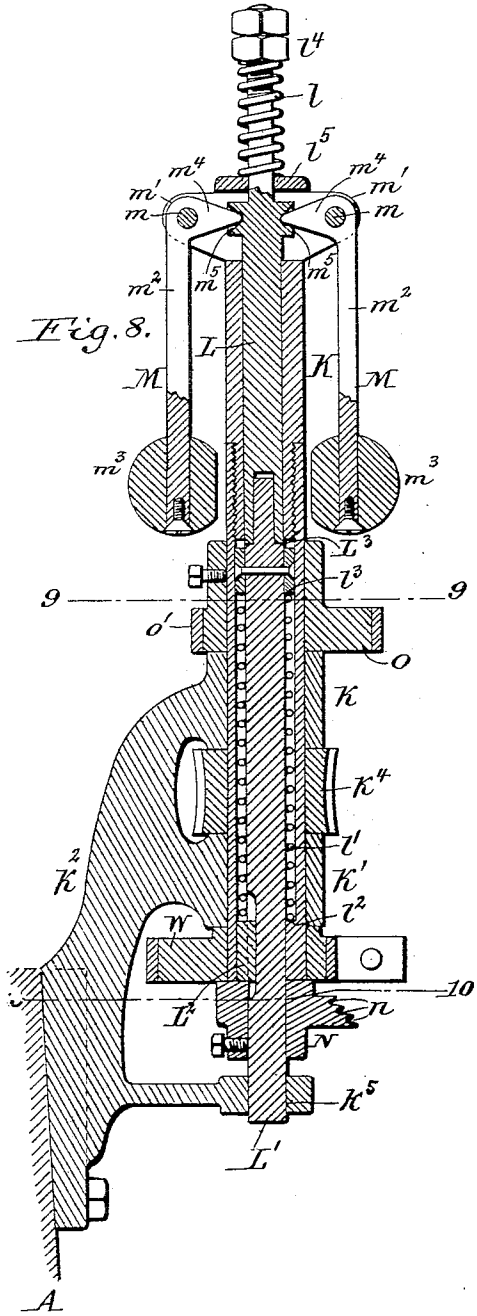
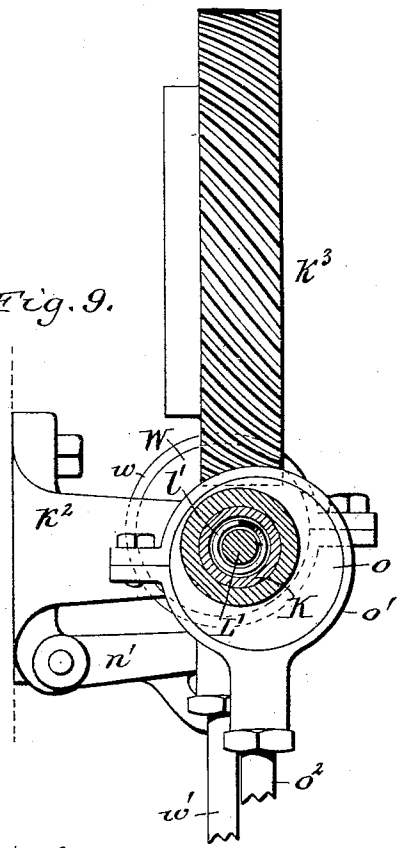


Fig. 9.



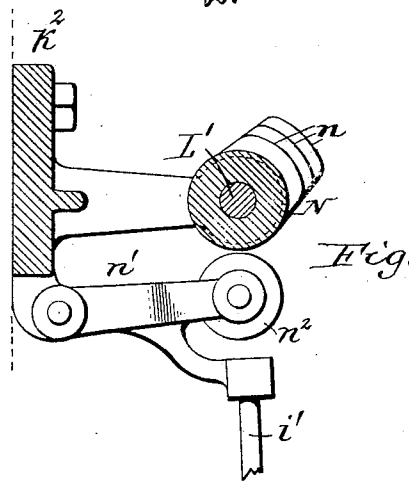


Fig. 10.

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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

JESS B. FENNER, OF BUFFALO, NEW YORK, ASSIGNOR TO THE J. W. RUGER MANUFACTURING COMPANY, OF SAME PLACE.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 596,239, dated December 28, 1897.

Application filed January 27, 1897. Serial No. 620,857. (No model.)

To all whom it may concern:

Be it known that I, JESS B. FENNER, a citizen of the United States, residing at Buffalo, in the county of Erie and State of New York, have invented a new and useful Improvement in Gas-Engines, of which the following is a specification.

This invention relates to gas and similar engines, and has for its objects to simplify the mechanism for operating the fuel and exhaust valves and to provide an electric igniter which is durable and reliable.

In the accompanying drawings, consisting of three sheets, Figure 1 is a side elevation, partly in section, of a gas-engine embodying my improvements. Fig. 2 is a longitudinal sectional elevation, on an enlarged scale, of the valve-chest. Fig. 3 is a vertical transverse section, on an enlarged scale, of the igniter mechanism, taken in line 3 3, Fig. 1. Fig. 4 is a vertical section of the igniter in line 4 4, Fig. 3. Fig. 5 is an inner end view of the igniter. Fig. 6 is a fragmentary side elevation of the rotary sleeve or cam-shaft whereby the movable contact is actuated. Fig. 7 is a side elevation of the cam-head connected with the movable contact. Fig. 8 is a vertical section, on an enlarged scale, of the governor and connecting parts, taken in line 8 8, Fig. 1. Figs. 9 and 10 are horizontal sections in lines 9 9 and 10 10, Fig. 8, respectively.

Like letters of reference refer to like parts in the several figures.

The engine shown in the drawings is of that class in which a working impulse may be obtained during every other forward movement of the piston; and it consists, essentially, of a bed A, a working cylinder B, containing a piston, and a transverse crank-shaft C, connected by a pitman with the piston, all of which parts may be of any usual construction.

D represents a valve-chest which is provided with a valve-chamber *d*, communicating with the working cylinder by a passage *d'*, a fuel-chamber E, connected at one end with the valve-chamber and at its opposite end with an air-supply pipe *e*, a gas-chamber F, connected with the fuel-chamber and with a gas-supply pipe *f*, and an exhaust-chamber G, connected with the valve-chamber and with the exhaust-pipe *g*.

H represents an inwardly-opening fuel-valve arranged in the valve-chamber and adapted to bear against a valve-seat *h*, which is formed around the inner end of the passage connecting the fuel and valve chambers. This valve is provided with a depending stem *h'*, which is guided in cross-bars or bridges h^2, and the valve is yieldingly held in a closed position by a spring h^3, surrounding the valve-stem and bearing with its ends against one of said bridges and a collar or shoulder on the stem.

I represents an inwardly-opening gas-valve arranged in the fuel-chamber and adapted to bear against a valve-seat *i*, which is formed around the inner end of the passage connecting the gas-chamber with the fuel-chamber. This valve is arranged on the front end of a longitudinal valve stem or rod *i'*, which passes through an opening in the rear end of the gas-chamber and is guided therein. The gas-valve is yieldingly moved rearwardly and held in a closed position by a spring i^2, which surrounds the valve-rod and bears with its ends against the rear side of the gas-chamber and a collar or shoulder on said rod.

J represents an inwardly-opening exhaust-valve arranged in the valve-chamber and adapted to bear against a valve-seat *j*, which surrounds the inner end of the passage connecting the valve and exhaust chambers. This valve is arranged on a longitudinally-movable valve-stem *j'*, which passes through an opening in the rear end of the exhaust-chamber and is guided therein. The exhaust-valve is yieldingly held in a closed position by a spring j^2, which surrounds the valve-stem and bears with its ends against the rear end of the exhaust-chamber and a collar or shoulder on the exhaust-valve stem.

K represents a hollow counter-shaft which is driven from the crank-shaft and from which the electric igniter and the valves in the valve-chest are operated. This shaft is arranged vertically in front of the crank-shaft and is composed of two sections which are connected by a screw-joint. The lower section is journaled in bearings *k k'*, formed on a bracket k^2,

which is secured to the base. Motion is transmitted from the crank-shaft to the counter-shaft at the rate of two rotations of the former to one rotation of the latter by means of a large spiral gear-wheel k^3, secured to the crank-shaft and meshing with a small spiral gear-wheel k^4, secured to the vertical shaft between its bearings.

L L′ represent the upper and lower sections of a spindle which is arranged in the hollow counter-shaft and which is capable of a rotary movement with the hollow shaft and of a longitudinal movement independent of the hollow shaft by means of a spline L^2, connecting the lower counter-shaft and spindle sections. The lower section of the spindle is provided at its upper end with a contracted portion which fits into an opening in the lower end of the upper section and forms a shoulder L^3 on the lower section, which bears against the lower end of the upper section. The spindle-sections are yieldingly held in an elevated position by means of upper and lower lifting-springs l l', which surround the upper and lower spindle-sections, respectively. The lower spring l' bears with its lower end against an internal shoulder l^2 on the lower section of the counter-shaft and with its upper end against a collar or shoulder l^3 on the lower spindle. The upper lifting-spring bears with its upper end against a screw-nut l^4 on the upper screw-threaded end of the upper spindle-section and with its lower end against a washer l^5, which surrounds the upper spindle-section and rests on the upper end of the upper counter-shaft section. M M represents two weight-levers which are pivoted by horizontal pivots m to lugs m', arranged on diametrically opposite sides of the upper counter-shaft section at the upper end thereof. The outer depending arms m^2 of the weight-levers are provided with governor-weights m^3, and the inner horizontal arms m^4 engage with recesses m^5, formed in diametrically opposite sides of an enlargement or collar on the upper spindle-section below the washer l^5. Upon rotating the counter-shaft and spindle the depending arms of the weight-levers are moved outwardly by centrifugal force in a well-known manner, and the inner arms of the levers move the spindle longitudinally downward, the extent of this longitudinal movement varying according to the speed of the counter-shaft and spindle.

The lower portion of the lower spindle-section is journaled and guided in a bearing k^5, which is formed on the bracket k^2, and is provided below the counter-shaft with a cam N, whereby the fuel-valve is opened. This cam is provided with a number of steps n, which are arranged in a vertical series and different distances from the axis of the cam, the uppermost step being nearest the axis and the lowermost step farthest from the axis.

n' is a horizontal rock-arm which is pivoted with its inner end to the bracket k^2 and connected at its outer end to the rear end of the rod i' of the fuel-valve. This arm is provided with a roller n^2, which is adapted to be engaged by one of the steps of the cam for opening the fuel-valve. When the engine is running comparatively slow, the spindle is raised by the governor-springs, so that the lower step of the cam having the longest throw engages with the roller of the rock-arm, whereby the fuel-valve is opened considerably and a large quantity of gas is permitted to pass from the gas-chamber through the fuel and valve chambers and into the working cylinder, thereby increasing the explosive force of the charge of fuel and the speed of the engine. When the engine is running at a normal speed, the cam is shifted by the governor-weights, so as to present the intermediate step of the cam to the roller of the rock-arm, whereby the gas-valve is only opened sufficiently to permit of a medium charge of gas entering the cylinder. When the engine is running faster than the normal speed, the governor-weights depress the cam, so that the uppermost step engages with the roller n^2 and reduces the charge of gas accordingly, or the cam clears the roller of the rock-arm altogether, in which event the gas-valve is not opened and the engine passes through one cycle of movements without a working impulse.

O represents a rotary eccentric whereby the exhaust-valve is operated, and which is mounted on the vertical shaft above its upper bearing k. This eccentric is surrounded by a strap o', which is connected with the rear end of a reciprocating eccentric-rod o^2. The front end of the latter is connected with a sleeve o^3, which is capable of a limited sliding movement on the rear end of the exhaust-valve stem and adapted to engage with a shoulder o^4 on said stem. During the first portion of the backward movement of the eccentric-rod the latter moves idly without affecting the exhaust-valve; but during the last portion of the backward movement of this rod the sleeve on the latter engages with the shoulder on the exhaust-valve stem, whereby the latter is compelled to move with the eccentric-rod and the exhaust-valve is opened. The exhaust-valve and its stem move forward with the eccentric-rod until the valve is seated, after which the sleeve on the eccentric-rod leaves the shoulder on the exhaust-valve stem and the eccentric-rod completes its forward movement without affecting the exhaust-valve.

The electric igniter, whereby the charge of fuel is ignited in the cylinder, is constructed as follows:

P represents a supporting-head which is fitted into an opening in the outer wall of the valve-chamber, as shown in the drawings; but the same may be fitted in an opening in the cylinder or any other chamber which is in communication with the cylinder.

Q is a guide-sleeve which is arranged horizontally in a longitudinal opening formed in

the supporting-head and which is provided at its outer end with a shoulder q, bearing against the outer side of the head, and at its inner screw-threaded end with a screw-nut q', bearing against the inner side of the head, whereby these parts are connected. An insulating material, such as mica or vulcanite, is interposed between the guide-sleeve, its shoulder and screw-nut, and the supporting-head to prevent electrical communication between these parts.

R is a contact-rod which is arranged in the guide-sleeve and projects with its inner and outer ends beyond the inner and outer ends of the guide-sleeve, respectively. The inner end of the contact-rod is pointed and forms one terminal of an electric circuit, and the outer portion of the same is provided with an external screw-thread r, which engages with an internal screw-thread on the outer portion of the guide-sleeve, so that upon turning the rod by applying a wrench to the flat-sided head r' on the outer end of the rod the latter is shifted lengthwise for adjusting the position of its inner or terminal end.

S is an electric generator, one pole of which is connected by a wire s with the supporting-head or a part in electrical communication therewith and the other pole of which is connected by a wire s' with the contact-rod R, the latter being provided with two jam-nuts r^2, between which the wire s' is clamped.

T represents an intermittently-rotating ratchet or cam shaft which is journaled lengthwise in the supporting-head parallel with the guide-sleeve Q and which is provided at its inner end with a conical shoulder t, which bears against a corresponding shoulder on the inner end of the supporting-head.

U is a ratchet-wheel which is secured to the outer end of the cam-shaft, preferably by internally screw-threading the inner portion of its hub and engaging the same with an external screw-thread on the outer portion of the cam-shaft. The conical shoulder of the latter is constantly pressed against the shoulder of the supporting-head for producing a gas-tight joint between these parts by means of a spring t', which surrounds the cam-shaft and bears with its ends against the outer side of the supporting-head and the inner side of the ratchet-wheel.

V represents a ratchet or rock lever journaled on the outer portion of the hub of the ratchet-wheel and provided on its upper arm v with a spring-pawl v', which engages with the annular row of teeth on the ratchet-wheel, while its lower arm v^2 is provided with a radially-adjustable block v^3. An oscillating movement is imparted to the ratchet-lever from the counter-shaft K by means of an eccentric W, mounted on said shaft below its lower bearing k', a strap w, surrounding said eccentric, and an eccentric-rod w', connecting the strap w with the adjustable block v^3 on the lower arm of the ratchet-lever. The ratchet-lever is confined on the outer hub of the ratchet-wheel by a cap v^4, which is provided with an annular flange v^5, bearing against the outer side of the ratchet-lever, and which is secured to the ratchet-wheel by means of an external screw-thread formed on its inner portion and engaging with an internal screw-thread on the outer portion of the hub of the ratchet-wheel.

X represents a longitudinally-movable trip-rod whereby the electric circuit is opened and closed and which is arranged lengthwise in the center of the cam-shaft. The rod is provided at its inner end with a laterally-projecting contact-arm x, which forms the opposite terminal of the electric circuit and which is arranged in line with the stationary contact, so that upon moving the trip-rod outwardly the movable contact will engage the stationary contact and close the circuit, while upon moving the trip-rod inwardly the contacts are separated and a spark is produced for igniting the charge of fuel. The trip-rod is held against turning in the cam-shaft and its contact-arm is retained in line with the contact-rod R by two longitudinal pins x' x', which are secured to the supporting-head on opposite sides of the contact-arm and form a guide for the latter. The outer end of the trip-rod projects into a cavity v^6, formed in the inner side of the cap v^4.

Y represents a cam head or disk which is secured to the outer end of the trip-rod and which is provided on its inner side with an annular row of cam-teeth y, which are adapted to engage with a similar row of cam-teeth y' on the outer end of the cam-shaft. Each tooth of the cam-shaft is inclined on its front side and abrupt on its rear side, and the teeth of the cam-disk are reversely inclined and fit into the spaces between the teeth of the cam-shaft. The trip-rod is yieldingly held in its innermost position by a spring y^2, which bears with its ends against the front side of the cam-disk and the bottom of the cavity in the cap v^4. During each forward movement of the ratchet-lever the inclined sides of the teeth of the cam-shaft while rotating in engagement with the corresponding faces of the teeth on the cam-disk move the latter forward or outward, together with the trip-rod and contact-arm, until the latter bears against the contact-rod and completes the electric circuit. Shortly after this takes place the inclined sides of the cam-shaft teeth clear the inclined sides of the respective teeth on the cam-disk, and the latter is then moved inwardly by the spring y^2, with its teeth, into the spaces between the teeth of the cam-shaft, thereby separating the terminals of the electric circuit and forming a spark. This formation of the teeth on the cam-shaft and cam-disk causes the terminals to be brought together slowly but separated very quickly, thereby producing an intense spark. The number of teeth on the cam-shaft and cam-disk correspond to the number of teeth on the ratchet-wheel, and the throw of the ratchet-

lever is so regulated that only one tooth on the cam-shaft and one on the ratchet-wheel are taken during each stroke of the ratchet-lever.

The timing of the various parts when the engine is in normal operation is such that during each cycle of movements the piston first moves forward and draws a charge of air and gas into the cylinder, during which time the fuel-valve is opened by suction of the piston, the gas-valve is opened, and the exhaust-valve is closed. During the following backward movement of the piston the fuel and gas valves are closed, whereby the charge of fuel is compressed in the cylinder. At the end of the backward or compressing movement of the piston the igniter forms a spark which ignites the charge of fuel and the piston is propelled forward with a working stroke, during which time all of the valves are closed. During the next following backward stroke the exhaust-valve is opened and the products of the spent gas are expelled, this valve being again closed at the end of the exhaust stroke of the piston and a new charge of fuel being drawn into the cylinder during the subsequent forward movement of the piston. In order to enable a spark to be produced while the engine is not running for the purpose of starting the same, the outer side of the cap v^4 is provided with a handle v^7, whereby the cam-shaft may be turned by hand.

I claim as my invention—

1. In a gas-engine, the combination with the cylinder, the gas and exhaust valves and the horizontal main shaft, of a vertical counter-shaft, intermeshing gear-wheels mounted on the main and counter shafts, an eccentric mounted on the counter-shaft and operating the exhaust-valve, a spindle arranged in the counter-shaft and capable of sliding vertically therein but compelled to turn therewith, a governor mounted on the counter-shaft and engaging with the spindle, a cam arranged on the spindle, and a rock-arm connected with the gas-valve and adapted to be operated by said cam, substantially as set forth.

2. In an electric igniter for gas-engines, the combination with the stationary and movable contacts, of a sliding rod carrying the movable contact and a rotary cam whereby said rod is shifted for engaging the movable contact with the stationary contact and which is journaled concentric with said rod, substantially as set forth.

3. In an electric igniter for gas-engines, the combination with the stationary and movable contacts, of a sliding rod carrying the movable contact, a cam-disk arranged on said rod and provided with an annular row of cam-teeth and a rotary cam-shaft provided with an annular row of cam-teeth engaging with the teeth of said disk, substantially as set forth.

4. In an electric igniter for gas-engines, the combination with the stationary and movable contacts, of a cam-shaft provided with an annular row of cam-teeth, a rod carrying the movable contact and capable of sliding lengthwise in said shaft but held against turning therewith, and a cam-disk secured to the said rod and provided with an annular row of cam-teeth which engage with the teeth of the cam-shaft, substantially as set forth.

5. In an electric igniter for gas-engines, the combination with the stationary and movable contacts, of a cam-shaft provided with an annular row of cam-teeth, a rod carrying the movable contact and capable of sliding lengthwise in said shaft but held against turning therewith, a cam-disk secured to said rod and provided with an annular row of cam-teeth and a spring whereby the teeth of said cam-disk are yieldingly held in engagement with the teeth of the cam-shaft, substantially as set forth.

6. In an electric igniter for gas-engines, the combination with the stationary and movable contacts, of a cam-shaft provided with an annular row of cam-teeth, a rod carrying the movable contact and capable of sliding lengthwise in said shaft but held against turning therewith, a cam-disk secured to said rod and provided with cam-teeth which are yieldingly held in engagement with the teeth of the cam-shaft, a ratchet-wheel secured to said shaft and a rock-lever provided with a pawl engaging with said ratchet-wheel, substantially as set forth.

7. In an electric igniter for gas-engines, the combination with the supporting-head and the stationary and movable contacts, of a cam-shaft journaled in said head and provided at its outer end with an annular row of cam-teeth and at its inner end with a shoulder which bears against a shoulder on the supporting-head, a rod carrying the movable contact at its inner end and capable of sliding lengthwise in said shaft but held against turning therewith, a cam-disk secured to the outer end of the sliding rod and provided with an annular row of cam-teeth engaging with the teeth of the cam-shaft, and a spring whereby the shoulder of the cam-shaft is pressed against the shoulder of the supporting-head, substantially as set forth.

Witness my hand this 21st day of January, 1897.

JESS B. FENNER.

Witnesses:
THEO. L. POPP,
ELLA R. DEAN.