(No Model.) 3 Sheets—Sheet 1.

G. M. HOPKINS.

GAS ENGINE.

No. 306,254. Patented Oct. 7, 1884.

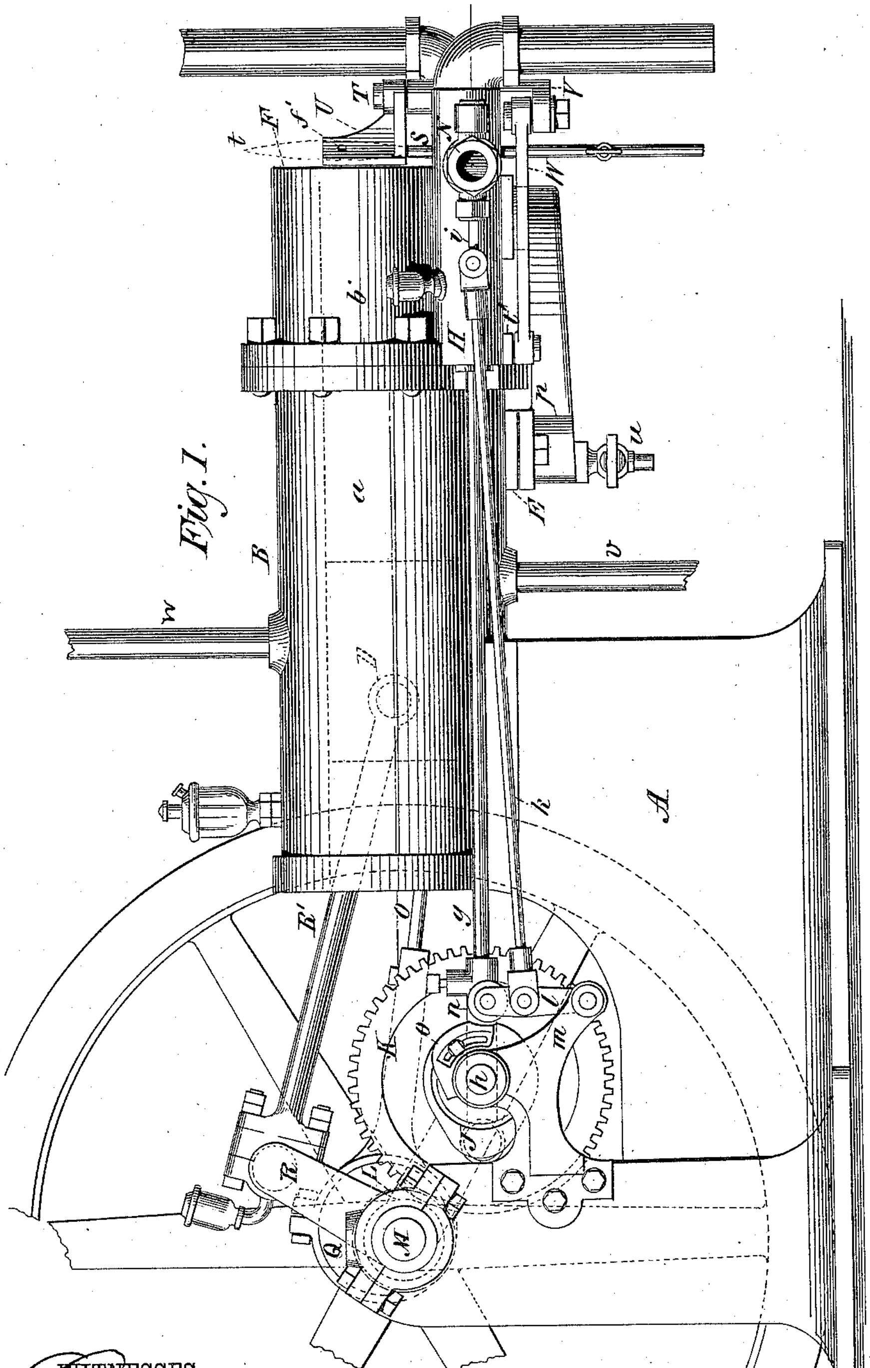


Fig. 1.

WITNESSES:

Gustave Dietrich

Fred Haertwohl

INVENTOR

Geo M. Hopkins

N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.) 3 Sheets—Sheet 2.

G. M. HOPKINS.

GAS ENGINE.

No. 306,254. Patented Oct. 7, 1884.

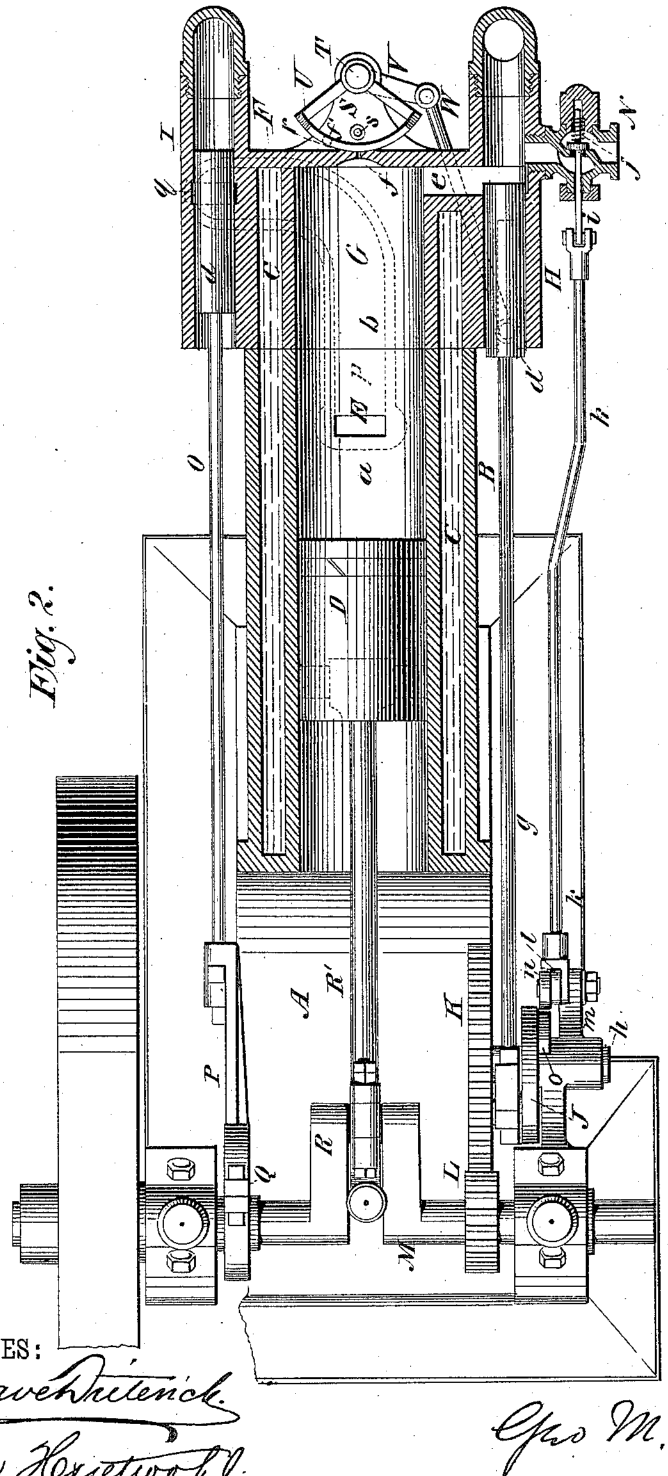


Fig. 2.

WITNESSES:

Gustave Dieterich.

Fred Haintwohl.

INVENTOR

Geo M. Hopkins

N. PETERS. Photo-Lithographer. Washington. D. C.

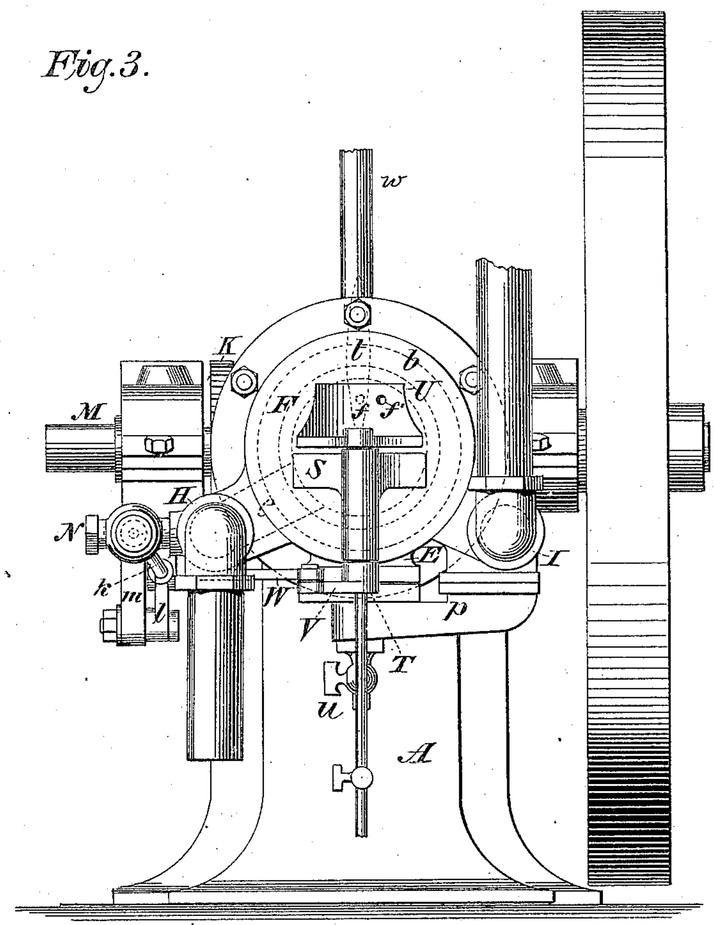
(No Model.) 3 Sheets—Sheet 3.

G. M. HOPKINS.

GAS ENGINE.

No. 306,254. Patented Oct. 7, 1884.

Fig. 3.



WITNESSES:

Gustave Dieterich

Fred Hinterwohl

INVENTOR

Geo. M. Hopkins

UNITED STATES PATENT OFFICE.

GEORGE M. HOPKINS, OF BROOKLYN, NEW YORK.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 306,254, dated October 7, 1884.

Application filed June 20, 1884. (No model.)

To all whom it may concern:

Be it known that I, GEORGE M. HOPKINS, of Brooklyn, in the county of Kings and State of New York, have invented a new and useful Improvement in Gas-Engines, of which the following is a specification, reference being had to the annexed drawings, forming a part thereof.

Figure 1 is a side elevation of my improved gas-engine. Fig. 2 is a horizontal section taken through the cylinder and valves, and Fig. 3 is an end elevation.

Like letters of reference indicate the same parts in all the figures of the drawings.

My invention relates to the class of engines known as "non-compressing gas-engines," in which the explosive mixture is ignited and exploded under atmospheric pressure; and it consists in mechanism for admitting gas and air in proper proportions at alternate revolutions of the main crank, and for exhausting the products of combustion at every instroke of the piston.

It also consists in devices for introducing the explosive or combustible mixture in the direction of the igniting-aperture, so as to insure a prompt ignition of the gas.

It further consists in slide-valves for admitting air and gas and exhausting the products of combustion, arranged parallel with the main cylinder, and formed integral with the water-jacket of the said main cylinder to insure the cooling of the slide-valves.

It further consists in a combined oil-receiver and exhaust-tube communicating between the exhaust-valve and the exhaust-port of the cylinder, for receiving and retaining oil or water that may flow through the exhaust-port.

It also consists in novel mechanism for operating the igniting-valve, all as hereinafter more fully described.

To the top of the base A, at one end, is secured the cylinder B, which is made in two parts, *a b*, and provided with a water-jacket, C. The piston D slides in the part *a* of the cylinder between the open end thereof and the exhaust-port E, and that portion of the cylinder between the said exhaust-port E and the cylinder-head F constitutes a combustion-chamber, G, for containing the mixture of air and gas, which is exploded to propel the piston forward.

Upon opposite sides of the part *b* of the cylinder, arranged parallel with its axis, and formed integrally with the outer wall of the water-jacket C, are the air and exhaust slide-valves H I, each consisting of a cylindrical valve, *d*, sliding in a cylindrical casing formed on the wall of the water-jacket. The air-valve H is provided with an inclined inlet-port, *e*, communicating with the combustion-chamber G, and opening in the direction of the ignition-aperture *f*, so that a portion of the strong mixture of gas and air is sure to fill that part of the chamber G in the vicinity of the ignition-aperture. The air-valve *d* is operated through a rod, *g*, by a crank, J, the said crank being mounted on the shaft *h*, and carrying at its outer end a spur-wheel, K, mounted eccentrically on the crank-pin and axially in line with the shaft *h*. The spur-wheel K is driven by a pinion, L, on the main crank-shaft M, and the said pinion and spur-wheel are so proportioned that the spur-wheel K makes one revolution while the pinion L makes two revolutions, and the port *e*, valve H, and crank J are related to each other, so that the port *e* is opened to admit air during one-quarter of one revolution of the crank J, this period being equal to that of an outstroke of the piston D. By this construction the air-valve H is opened during each alternate outstroke of the piston D, and closed at all other times. A gas-supply valve, N, communicates with the interior of the air-valve and is of the well-known form, arranged to be opened by pushing in its stem *i* against the pressure of a spring, *j*, the said spring being capable of returning the valve to its seat when the pressure on the valve-stem is removed. The valve-stem *i* is connected by a rod, *k*, with an arm, *l*, pivoted in a fixed bracket, *m*, and carrying at its upper end a roller, *n*. The roller *n* lies in the path of a cam, *o*, secured to the back of the crank J, and related to the said crank J so that it will open the gas-valve N after the air-port *e* has been open for about one-half of its period of being open, and will allow gas to enter the combustion-chamber with the air during the remainder of the said period. The gas-valve

cam *o* is equivalent in length to about one-eighth the circle it describes, so that the gas-valve N and air-valve H close simultaneously, and remain closed during the return-stroke of the piston D and the following outstroke and instroke of the said piston. The exhaust-valve I communicates with the exhaust-port E through a tube, *p*, which leads to the port *q* in the casing of the exhaust-valve I. The cylindrical valve *d* of the exhaust-valve I is connected by a rod, O, with a strap, P, of the eccentric Q on the main shaft M, which is adjusted with reference to the main crank R and piston D, connected therewith, so as to open the exhaust-valve and hold it open during every instroke of the piston, and to close the exhaust-valve during every outstroke of the piston.

In a bearing supported by an arm, S, projecting from the head F of the cylinder is journaled a rock-shaft, T, carrying at its upper end an ignition-valve, U, consisting of a segment of a hollow cylinder concentric with the shaft T, and capable of swinging in a concave seat, *r*, formed in the cylinder-head. There is an igniting-aperture, *f*, in the concave seat *r*, and the valve U is provided with an igniting-aperture, *f'*, which will coincide with the aperture *f* in the cylinder-head once in each stroke of the valve. A small burner, *s*, projecting through the arm S, supports an ignition-flame, *t*, opposite and near the ignition-aperture *f*.

The lower end of the shaft T is provided with an arm, V, pivoted to a rod, W, which in turn is pivoted to a lug, *t'*, formed on the slide-valve *d* of the air-valve H, and projecting through a slot in the bottom of the valve-casing. The ignition-valve U is turned in its movement so as to bring the aperture *f'* opposite the aperture *f*, when the piston D completes its instroke after having taken in air and gas. The tube *p*, forming the exhaust-passage, also forms a receptacle for oil or water that may accumulate in the bottom of the cylinder, and a cock, *u*, is provided in the lowest place in the said tube for the removal of oil or water that may flow from the cylinder into the tube. The water-jacket C is supplied with water to carry off the superfluous heat through the tube *v*, and the water flows off through the tube *w*. The piston D is preferably connected directly with the crank R by means of the usual connecting-rod, R'; but a guide may be interposed between the piston and connecting-rod, if desirable.

The operation of my improved gas-engine is as follows: The gas being turned on and the igniting-flame *t* being lighted, the main crank-shaft M is turned by means of the fly-wheel secured thereto, thus drawing forward the piston D, which first draws in air and then air and gas through the air-valve H, in the manner already described. The air-valve then closes and the exhaust-valve I opens, when that portion of the contents of the cylinder lying between the piston D and the exhaust-port E, consisting of some of the products of combustion and some air, is driven out through the exhaust-port by the instroke of the piston, leaving in the combustion-chamber G, behind the port E, a uniform combustible or explosive mixture of gas and air. As the piston completes its instroke the valve U has been moved by virtue of its connection with the air-valve, so as to cause its ignition-aperture *f'* to coincide for an instant with the ignition-aperture *f* in the cylinder-head, and the slight advance of the piston D during the time draws in the flame *t*, and ignites the gas within the combustion-chamber G, which explodes and pushes the piston forward through its outstroke. The momentum of the fly-wheel returns the piston, and the exhaust-valve I being open that portion of the products of combustion lying between the piston and the exhaust-port E is driven out through the exhaust-port. When the exhaust-valve closes and the air-valve H opens, first admitting air to the cylinder and then gas and air, as already described, as the piston moves outward still by the momentum of the fly-wheel, the products of combustion lying in the combustion-chamber G are drawn forward with the piston, the air and then the mixture of gas and air following. When the piston is returning, the products of combustion and the air lying between it and the port E are driven out through the said port, the exhaust-valve I being open and the air-valve H being closed. The removal of the exhaust-tube *p* from the cylinder and water-jacket allows the said tube to be cooled by the surrounding air, and prevents the unequal heating of the sides of the cylinder. When the piston reaches the limit of its instroke, the ignition-flame *t* is again admitted to the cylinder, another explosion follows, and the piston is again pushed forward, and the cycle of operations just described is repeated for every two revolutions of the engine. To reduce the distance through which the flame must pass to enter the cylinder, the inner surface of the cylinder-head F is concaved around the ignition-aperture *f*, rendering the head very thin at that point.

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

1. The combination, with the power-cylinder and exhaust-valve of a gas-engine, of ports in the under side of the said power-cylinder and exhaust-valve, and a tube connecting the said ports and forming a combined exhaust-passage and oil and water receptacle, as herein specified.

2. In a gas-engine wherein the power-cylinder is provided with a water-jacket, the combination, with the outer walls of the water-jacket, of air and exhaust slide-valves arranged parallel with the power-cylinder, and formed integrally with the water-jacket, whereby the said air and exhaust valves are prevented from becoming unduly heated, as described.

3. In a gas-engine, the combination of the air-valve and mechanism for operating the same, the oscillating ignition-valve, and the

connecting-rod for connecting the said air and ignition valves to cause them to move synchronously, as and for the purpose specified.

4. In a gas-engine, the combination, with the air-supply valve, of a gas-supply valve communicating with the interior of the air-valve casing, and mechanism for opening the said gas-supply valve when the air-valve is open, to effect the simultaneous entrance of air and gas to the combustion-chamber G through the port *e*, as specified.

5. In a gas-engine provided with a combustion-chamber, G, behind the part of the cylinder in which the piston moves, the combination, with the cylinder, of an exhaust-tube, *p*, communicating with the forward part of the combustion-chamber and with the exhaust-valve, and made wholly exterior to the cylinder and water-jacket, as herein specified.

6. In a gas-engine having an ignition-valve formed of a segment of a hollow cylinder, and working in a concave seat in the cylinder-head, the combination, with the said ignition-valve, of an igniting-burner supported parallel with the axis of the ignition-valve, and capable of holding a flame parallel with the concave surface of the ignition-valve, as described.

7. In a gas-engine provided with an exhaust-tube connecting the exhaust port of the power-cylinder with the exhaust-valve, the combination, with the said exhaust-tube, of a cock placed in the lowest part thereof for removing the contents of the exhaust-tube, as specified.

8. The combination, in a gas-engine, of a power-cylinder provided with a water-jacket, exhaust and air valves placed on opposite sides of the cylinder, communicating with the interior thereof, and formed integrally with the outer wall of the water-jacket, and mechanism worked by the power-piston for operating the air and exhaust valves, as specified.

GEORGE M. HOPKINS.

Witnesses:
FRANK M. CLUTE,
H. C. HAGEN.