(No Model.) 2 Sheets—Sheet 1.

H. S. MAXIM.

GAS MOTOR.

No. 302,271. Patented July 22, 1884.

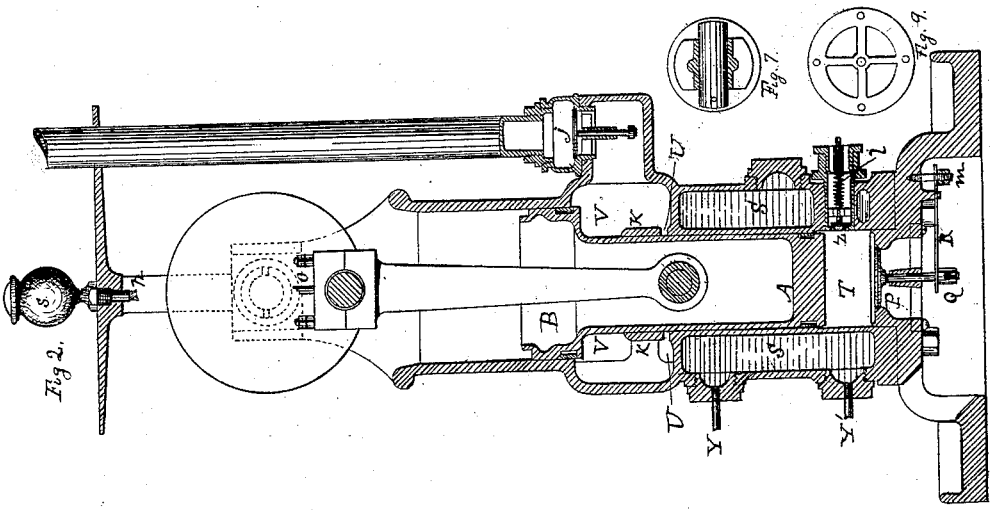


Fig 2.

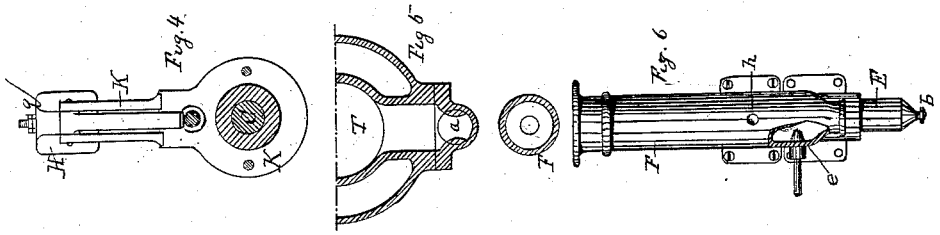


Fig 4. Fig 6. Fig 6.

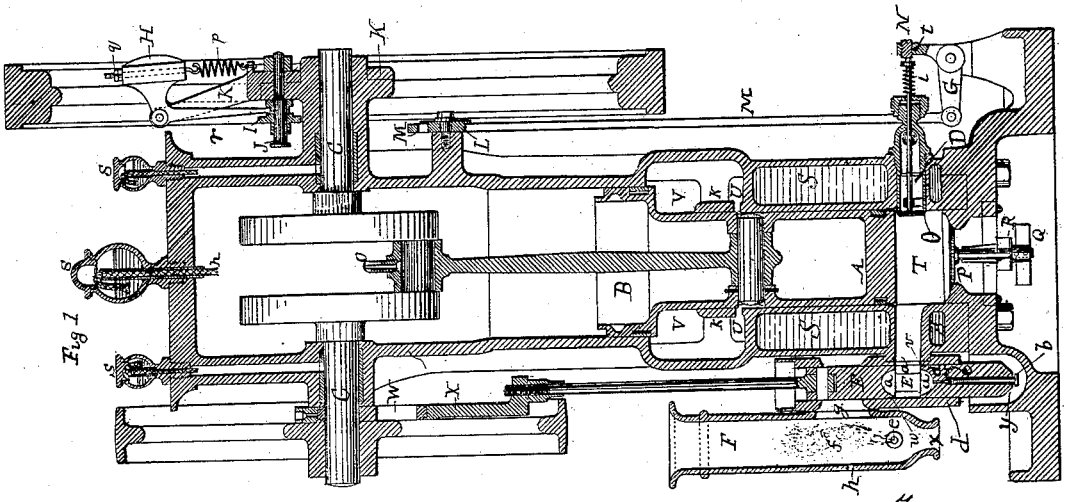


Fig 1

Witnesses:
1. W Frisby
2. Geo. Pierce

Inventor:
Hiram S. Maxim
Parker W. Page
atty

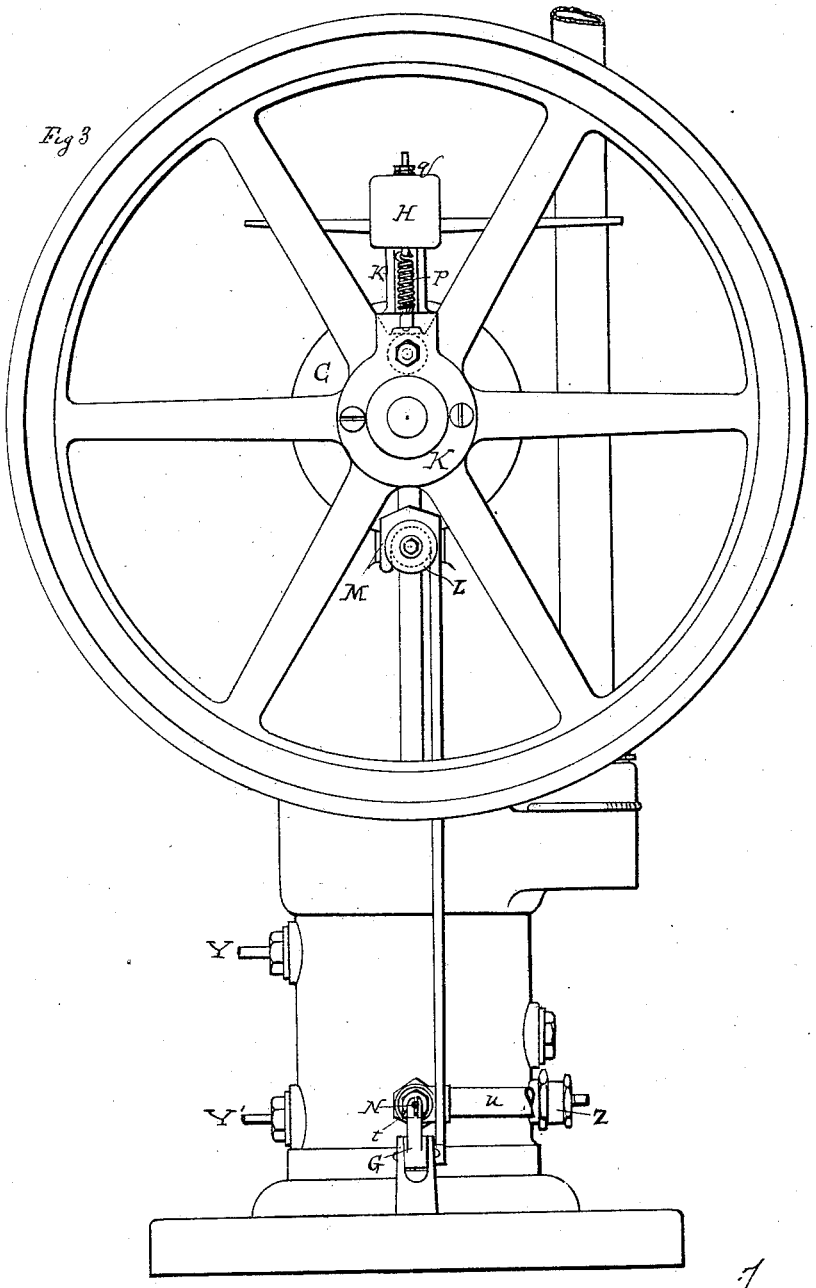
(No Model.) 2 Sheets—Sheet 2.

H. S. MAXIM.

GAS MOTOR.

No. 302,271. Patented July 22, 1884.

Fig 3



Witnesses:
1: W. Frisby
2: Henry Hill

Inventor:
Hiram S. Maxim
Parker W. Page
atty.

UNITED STATES PATENT OFFICE.

HIRAM S. MAXIM, OF PARIS, FRANCE.

GAS-MOTOR.

SPECIFICATION forming part of Letters Patent No. 302,271, dated July 22, 1884.

Application filed January 19, 1883. (No model.) Patented in France January 16, 1883, No. 153,137, and in England February 23, 1883, No. 999.

To all whom it may concern:

Be it known that I, HIRAM S. MAXIM, a citizen of the United States, at present residing in Paris, in the Republic of France, have invented certain new and useful Improvements in Gas-Motors, of which the following is a specification, reference being had to the drawings accompanying and forming a part of the same.

In a previous application I have shown and described a gas motor or engine in which two connected pistons were employed—one of larger diameter than the other—and which operated conjointly, the latter as a working the former as a vacuum-producing piston, the object of this construction being to withdraw from the working-cylinder at the end of each stroke the products of combustion remaining in the cylinder after the explosion.

My present invention consists, mainly, of improvements in the construction of an engine of this character, the said improvements being directed mainly to the attainment of a higher speed, and to the production of an engine which, while capable of a great amount of work, may be more economically produced and more compact and durable. To this end I have constructed a motor in which is employed a vertical cylinder, one part of larger diameter than the other, and fitted with two pistons, one—that occupying the smaller end of the cylinder—being designed as the working-piston, and the other or larger piston being constructed for producing a vacuum for clearing the working-cylinder of the exploded gases. The pistons referred to, in lieu of being mounted on the same rod, are cast in one solid piece. I have also improved the construction of the engine in many particulars, the nature of which improvements will be more fully hereinafter set forth.

In the accompanying drawings, Figure 1 represents a vertical central section of an engine constructed in accordance with my invention, the section being parallel to the axis of the crank-shaft. Fig. 2 is a vertical central section of the same at right angles to the axis of the crank-shaft. Fig. 3 is a side elevation of the engine complete. Fig. 4 is a detail of the governor mechanism. Fig. 5 is a horizontal section of the igniting apparatus; Fig. 6, a side elevation of the same; Fig. 7, a horizontal section of the working-piston; Fig. 8, a reversed plan of the air-inlet valve.

Similar letters refer to corresponding parts in all the figures.

A and B are two pistons, the piston B having an area of rather more than twice that of piston A. These two pistons are cast in one piece, and are connected to a piston-rod which operates a crank-shaft, C C. The pistons work in a vertical cylinder, which is cast in one piece, and has a portion, B′, of sufficient diameter to receive the piston B, and a smaller portion, A′, in which works the piston A.

Below the piston A is a space, T, known as the "explosion-chamber" in engines of this character. This explosion-chamber and a portion of the cylinder A′ are surrounded by the usual water-jackets, S, through which a circulation of water is maintained during the operation of the engine, the water being admitted at the port Y and discharged at Y′.

On the crank-shaft C is placed a pulley-wheel and a fly-wheel. In the latter is a frame, K K, supporting a hinged weight, H, which is held to the hub of the fly-wheel by means of a stout spiral spring, *p*. Through a projection from the hub of the fly-wheel passes a spindle, J, on which is a loose sleeve formed with a rim, I, the whole constituting a shifting roller. An arm, *r*, extending from the weight H, engages with this roller. The tension of the spring *p* is adjusted by means of a set-screw, *q*. These parts constitute the governing mechanism, and their functions will be explained more fully hereinafter.

Entering the space T below the piston A is a passage, D, connected by a pipe, *u*, with a supply of gas, or mixed gas and air. The passage is closed by a valve, O, opening inward. The spindle of valve O extends outward through the tube or casing D, and is provided with a spiral spring, *i*, which keeps the valve O closed.

G is a bell-crank lever pivoted to a portion of the base of the engine, and provided with an adjustable screw, N, that bears upon the end of the valve-spindle, and is used for adjusting the travel of valve O. To lever G is connected a rod, M, the end of which is turned back upon itself, as shown in Fig. 3. A wheel

or pin, L, is placed on the cylinder or other convenient part of the engine, and serves to keep the rod M in place, while permitting it to move freely up and down. In the normal operation of the engine the rounder or beveled end of rod M lies in the path of movement of the roller I.

E is a slide or piston connected with the strap X of an eccentric, W, on the crank-shaft, so as to receive a vertical reciprocatory movement. In the piston E is a chambered space, *a*, which by the movement of piston E is caused to register alternately with an opening, *g*, in its cylinder or casing, and with the space T beneath the piston A.

F is a chimney with a contracted opening, *x*, at the bottom; *e*, a gas-jet in the lower part of the chimney, and *f* a gas-flame, which is kept constantly ignited during the operation of the engine.

h is an opening in the chimney opposite the opening in the casing of piston E. Notches *w v* are cut into piston E from the chamber *a*, in such positions that the notch *w* establishes communication with the flame-chimney and the chamber *a* before the latter has reached the opening *g*, and the notch *v* establishes communication between the chamber *a* and space T before the said chamber *a* has arrived opposite the space T. From the lower portion of chamber *a* a passage, *d*, leads through the piston E to a small chamber, *c*, formed in the side of said piston, with a smaller chamber, *c*, in the piston E, and through this chamber and passage the gas escapes from T whenever the piston E is raised and the pressure at T exceeds that in chamber *a*. A screw-stem, *b*, passes up through the piston E, and is employed to regulate the size of the jet burning at *a*.

Below the piston E in the base of the engine is a receptacle, *y*, for containing oil, into which piston E dips at every stroke, the purpose of this being to keep the piston E lubricated and prevent the dripping of oil. In the lower portion of the space T is a large air-valve, P, opening inward. A thumb-piece, Q, is connected to the spindle of this valve for turning it in its seat for removing any foreign matter which may accumulate there. A spring, R, is connected with the valve-spindle, and provided with an adjusting-screw, *m*, by which the tendency of the valve to rise may be controlled.

Between the two portions A′ and B′ is an enlargement containing an annular space, U. Above this space is a ring, *k*, of the same diameter as the portion A′ of the cylinder. Above this ring is a second annular space, V, from which leads a pipe containing an exhaust check-valve, *j*.

Z is a safety-valve provided with a spiral spring, *l*, the tension of which may be adjusted in any ordinary manner.

The operation of an engine constructed in the manner described is as follows: Upon the proper connections being made with the gas-main, and a circulation of water being started in the jacket S, the gas-flame is ignited at *e*. The pistons A B are then set in motion by revolving the crank-shaft C. As the piston A ascends, it draws in air through the valve P. The spring R, however, is set so as to prevent a full atmosphere entering. A partial vacuum is thus produced in the cylinder A′. The piston B, in its upward movement, also produces a partial vacuum in the chamber or annular space V. When it has reached a point where the piston A is wholly withdrawn from its cylinder, there is a free connection established through the annular space U into the chamber V. The air passes freely, therefore, from one chamber to the other until the same degree of vacuity exists in the chamber T as exists in the space or chamber V. As the crank-shaft is rotated, the piston A descends and closes off the communication between the cylinder A′ and the space U. At this moment the roller I is brought in contact with the end of rod M, which, operating through the bell-crank lever G and the adjusting-screw N, presses the valve O open, thus admitting sufficient gas or gas and air through O to bring the pressure in the exploding-chamber T to one atmosphere. The descent of the piston A compresses the gases in the cylinder A′ until a pressure of about forty pounds is attained. At this moment the piston E has descended sufficiently to bring the chamber *a* into communication with space T, when the explosion takes place and the piston is driven upward with great force. As it passes in its upward stroke beyond the space U, the gas below it will be instantly sucked out into the chamber V, and as there is not gas sufficient to fill this chamber air will be drawn in through P. Then when the piston descends again the space beneath it will be partly filled with pure air until the piston has reached a point where the valve O is opened, as before, when sufficient gas will enter at O to produce one atmosphere of explosive mixture at T. When an explosion occurs at T, the flame in chamber *a*, which ignited the gas at T, is extinguished; but at the next half-stroke of the engine the flame in this chamber is again ignited from the constant flame *f*. As the piston E again descends, a small flame appears at *d*, which may be adjusted by the screw *b*, and which continues to burn until another flame is ignited at the notch *v*. This continues until the chamber *a* is brought into full contact with space T. It will thus be seen that when the explosion occurs the cylinder is completely cleared of its exploded gases, a sufficient charge of air is admitted, and this air is impregnated with gas, ready for another explosion at each stroke of the engine.

The operation of the governor is similar to those described by me in other applications, the principle of operation being to regulate the number of charges, rather than the quality of each individual charge. It will thus be understood that any increase above the normal

speed of the engine will cause the weight H to recede from the hub of the fly-wheel by centrifugal action, in this way shifting the sleeve or roll I out of line with the plate M, so that the latter is not depressed, and the valve O in consequence not opened until the normal speed has been again reached, when the roller I will be brought back into position to operate the rod M. The quantity of gas admitted at each stroke of this engine may be adjusted by the tension of the spring R. If this spring permits the valve P to open freely, then the pressure in the exploding-chamber T will hardly ever be less than a full atmosphere, and but very little gas will be admitted to supply the difference between the pressure at T and the external atmosphere or pressure of gas used. If, however, the tension of the spring R should be so increased that it would require a difference of pressure of one-third of an atmosphere between the external and internal pressures to open it, then at the moment of the opening of the valve O one-third part of the volume of space below the piston A will be supplied through the valve O. It will therefore be seen that the amount of gas entering through O will be adjusted by the tension of spring R, as the degree of the vacuity in the exploded chamber is determined by this spring. Piston B operates as an exhaust-pump, sucking the gas into the space V through U as it ascends, and expelling the gas through the exhaust check-valve J as it descends.

For effecting and maintaining the necessary lubrication I employ oil-cups *s s s*, two of which supply oil to the bearings of the crank-shaft. The other is provided with a wick, *n*, from which a tube, *o*, scrapes a drop of oil at every turn of the crank.

Other details in the construction are not here described at length, for the reason that they are now commonly employed in engines of this kind.

The engine which I have now described is compact and powerful, and is more economically constructed and run than others of its kind.

I do not claim, broadly, herein a vacuum or exhaust and a working piston connected together, or to the same piston-rod, as this I have made the subject of other applications; but

What I claim is—

1. In an engine of the kind described, the combination, with cylinders, of a working and exhaust or vacuum-producing piston formed in one piece, and operating conjointly and without intermediate valves or stuffing-boxes, substantially as specified.

2. In a gas engine or motor, the combination of an exploding-chamber, a working cylinder and piston, a vacuum-producing cylinder and piston, and an intermediate vacuum-chamber, these parts being constructed and arranged for operation without the aid of intermediate valves or stuffing-boxes, in substantially the manner set forth.

3. In a gas engine or motor, the combination of a working cylinder and piston, a vacuum-producing cylinder and piston, an intermediate vacuum-chamber, and a ring within said chamber, and adapted to surround the working-piston, in the manner and for the purpose specified.

4. The combination, with the exploding-chamber, of air-inlet and gas valves, a working piston and cylinder, a vacuum-producing piston and cylinder, an intermediate vacuum-chamber, and an exhaust connected therewith, the working and vacuum-producing cylinders being connected together without intermediate valves, as and for the purpose set forth.

5. The combination, with a working-cylinder, of means for withdrawing therefrom the products of combustion, an adjustable valve for admitting air to fill or partially fill the vacuum produced by the withdrawal of the products of combustion, and an independent gas-inlet valve, these parts being constructed and arranged in such manner that the amount of gas introduced may be controlled by the regulation of the air-valve in substantially the manner set forth.

6. The combination, in a gas-engine, with a working-cylinder and a piston arranged to be carried completely out of the cylinder at each stroke, of a vacuum-chamber which is brought into communication with the working-cylinder by the removal therefrom of the piston, as set forth.

7. In a gas-engine, the combination, with the working cylinder and piston, of an auxiliary cylinder or ring placed in juxtaposition to the working-cylinder, for the purpose of holding the piston in position and preventing the expansion of its ring or rings when withdrawn from the working-cylinder, as set forth.

8. In a gas-engine, the combination, with a reciprocating exploding-piston, of a receptacle for containing oil below the piston and in its path of movement, as and for the purpose set forth.

9. The combination of the piston E E, space *a a*, screw *b*, space *c*, and jet *d*, when constructed and arranged substantially in the manner and for the purpose herein shown and described.

10. The combination of the chimney F, having a contracted bottom, *x*, and provided with an opening, *h*, for causing a deflection in the igniting-flame, when constructed and arranged substantially in the manner and for the purpose herein shown and specified.

11. The combination of the weight H, roller I, spindle J, rod M, bell-crank lever G, adjusting-screw N, and valve O, when constructed and arranged substantially in the manner and for the purpose herein shown and specified.

HIRAM S. MAXIM.

Witnesses:
ROBT. M. HOOPER,
DAVID T. S. FULLER.