(No Model.) 2 Sheets—Sheet 1.

H. S. MAXIM.

HOT AIR OR GAS ENGINE.

No. 293,185. Patented Feb. 5, 1884.

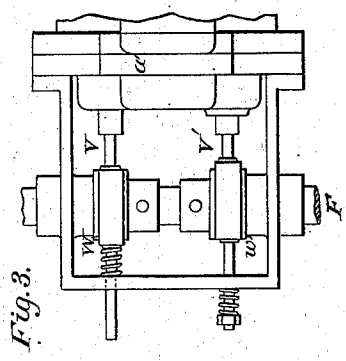


Fig. 3.

Fig. 1.

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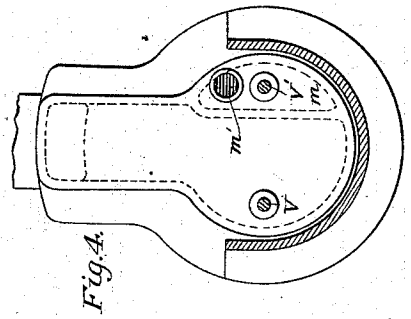


Fig. 4.

Fig. 2.

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UNITED STATES PATENT OFFICE.

HIRAM S. MAXIM, OF PARIS, FRANCE.

HOT-AIR OR GAS ENGINE.

SPECIFICATION forming part of Letters Patent No. 293,185, dated February 5, 1884.

Application filed January 31, 1883. (No model.)

To all whom it may concern:

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

The main object of my invention is to utilize in an engine driven by heated air a single cylinder for compressing or pumping the air that is used in working the piston, or, in other words, to so construct the cylinder that one end may be employed as an air-compressor for compressing or pumping the air to be used in the other or working end.

My invention consists in a method and means of regulating the engine by automatically shunting all or a portion of the air compressed by the pumping end of the cylinder entirely around the flame or fire chamber in its passage to the working end of the cylinder, and also in a method of increasing the efficiency of an air or gas engine by adding a small portion of cool air to the gases issuing from the fire before they act upon the piston, all as hereinafter described.

In the accompanying drawings I have illustrated an engine constructed in accordance with my invention as above stated, and I will now proceed to describe the same in detail.

Figure 1 is a view of the engine complete in side elevation; Fig. 2, a vertical sectional view of the same. Fig. 3 is an enlarged plan view of the valve mechanism located at the working end of the cylinder. Fig. 4 is an end view, partly in section, of the working end of the cylinder.

Similar letters of reference indicate corresponding parts.

Letters A A designate a horizontal cylinder secured to or forming part of a metal casting that constitutes the frame or body of the engine.

B is a piston of the kind ordinarily employed in air or gas engines; C, the piston-rod working through a suitable stuffing-box in the cylinder-head *a*.

D is the cross-head; E, the connecting-rod, and F the crank-shaft carrying a heavy fly-wheel, F′.

The supporting-base A′ of the engine is hollow, and a chamber or similar passage, G, extends from the base along the under side of the cylinder A to the end, where is located in the cylinder-head *a*, a valve, *b*, opening inward. In the wall of the base A′ or the chamber G is an air-inlet, T. Above the cylinder A is also a chamber, G′, which extends around the end of the cylinder, as shown, communication between the chamber and interior of the cylinder being established by a valve, *b*′, opening outward. Both valves *b b*′ are closed by springs *s*. A fire-box, H, with perforated bottom, is mounted above the cylinder A. Below the fire-box is a perforated pan, H′, which is located in a chamber or air-space, K′. The fire-box is contained within a cylindrical casing, K, of such diameter as to leave an annular space around the box. L is a coyer for the casing, which may be removed for adding fuel when necessary, and which is at other times clamped down by a screw, *l*, passing through a yoke, L′.

M is a chamber or air-space communicating with the space between the fire-box and the casing K, and extending along the top of the cylinder A, and partly around the end of the same.

N is a slide-valve working in the bottom of the space K′. It opens communication between the chamber G′ and the space K′ below the fire, or between the chambers G′ and M, or between chamber G′ and both chambers K′ and M, according to its position.

A lever, O, is pivoted to the cylinder-head *a*. To one end is connected a rod, *o*, that operates the slide-valve N. To the other end is connected a rod, *o*′, hinged to one arm of a bell-crank lever, P, within a hollow base, A′. A flexible diaphragm, R, is placed near the bottom of the base A′, and a pin, *r*, attached to it, bears against the lower arm of lever P.

In the head *a*′ of the cylinder A are set two valves, V V′, the first of which is closed by a spring, and opened by a cam, W, on the crank-shaft. The valve V′ opens into a chamber, *m*, separated from the chamber M and open to the air by a suitable passage, *m*′, Fig. 4.

The operation of an engine constructed in the manner described is as follows: The engine is started by hand, the piston being moved by this means toward the cylinder-head *a'*, drawing in air through the hole T and valve *b*. Then as the piston is started forward the air contained in the cylinder A is forced out through the valve *b'* into the chamber G' and up through the slide-valve N. The charge of heated and expanded air that is by this means forced down the annular space between the fire-box and casing K out into the chamber M enters the cylinder A by the valve V and assists in forcing the piston forward. The cam W closes valve V at the proper moment, so that the piston, by the momentum of the fly-wheel, may come back again, the heated air escaping from the cylinder through the exhaust-valve V', which is opened by cam W at the moment when valve V is closed. When valve V is again opened, the expanded air enters the cylinder and propels the piston P forward, thus causing a fresh charge of air to be forced through the fire, and storing in the chamber G' a charge of air under compression, to be used on the next stroke. The diaphragm R, slide-valve N, and intermediate connections operate as a regulator. When the engine is started, or when running slow, the diaphragm is in its normal position and the slide-valve pushed over to the left, opening the port *n* and causing all the air pumped into the chamber G' to be forced through the fire. When the engine runs too fast, or when the air drawn in through the valve *b* is increased beyond a point, which may be determined by adjusting a slide, *t'*, over the opening T, a partial vacuum is formed in the chamber G. This raises the diaphragm and shifts the slide-valve to the right, whereby a part only of the air will be forced through the fire, the remainder being forced up through the port *n* and down through port *n'*, being in this way shunted around the fire. If the speed of the engine continues to increase, the slide-valve will be moved to the right until all the air is diverted or shunted from the fire.

In practice the valve N and its appurtenances should be so adjusted that in the normal operation of the engine a small portion of the air will be forced through the valve into the chamber M, so that it may combine with the air that is forced from the fire-box. By this means oxygen is added to the flaming products driven into the chamber M, forming CO^2 of the CO from the fire and producing a flame which extends into the chamber M, thus causing a greater degree of expansion than would be the case were all the air to pass through the fire.

It is evident that the engine which I have described may be used as a gas as well as an air engine without material changes in its mechanical construction; for, supposing the fire to be replaced by a suitable gas-flame, and a mixture of air and gas to be introduced to the box H, it is ignited and forced down into the chamber M and through valve V, exerting the same effect upon the piston B as the heated air or burning gaseous products from a charcoal fire.

In the drawings I have shown an annular space around the fire-box, down which the products of cumbustion are forced. For many reasons the reverse of this construction is desirable, viz: that the air should be forced up through the space and down through the fire, as by this means the exterior of the engine would be kept cooler. I regard this construction as within the scope of my invention.

Many details of construction herein shown in part or entire I have not described at length, as they are well known in the art and employed in mechanisms of this kind—for instance, the materials used in the construction of the engine, the means of maintaining a draft through the fire when the engine is not in operation, and the like; but,

Having described and specifically pointed out what I regard as my invention, what I claim is—

1. In an air or gas engine, the combination of a cylinder and piston, a flame or fire chamber, passages or chambers of communication from said flame or fire chamber to opposite ends of the cylinder, valves located at opposite ends of the cylinder, those at one end operating, in conjunction with the piston, as a compressor, and those at the other end for admitting and exhausting air to and from the working end of the cylinder, passages and a valve arranged to connect said passages of communication independently of the fire or flame chamber, and automatic means for operating said valve to shunt all or a portion of the air entirely from said flame or fire chamber in its route from the pumping to the working end of the cylinder, substantially as described.

2. In an air or gas engine having a fire-chamber in communication with the opposite ends of its cylinder by means of suitable passages and valves, and suitable shunt-passages arranged to connect the opposite ends of the cylinder independently of the fire-chamber, a valve arranged to control the flow of air through said shunt-passages, an air space or chamber connected with the pumping end of the cylinder, a flexible diaphragm, forming one of the walls of said space or chamber, and devices connecting said diaphragm with the valve controlling the shunt-passages, and arranged to move said valve in proportion to the pressure on the diaphragm, substantially as and for the purpose set forth.

3. The method herein described of regulating the speed of an air or gas engine, which consists in shunting, through a route distinct from and independent of the fire-chamber, a portion or the whole of the air or gas forced

into the engine, as and for the purpose set forth.

4. The method herein described of increasing the efficiency of an air or gas engine, the same consisting in adding a small portion of cool air to the gases issuing from the fire on their way to the cylinder, essentially as set forth.

In testimony whereof I have hereunto set my hand this 4th day of January, 1883.

HIRAM S. MAXIM.

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