(No Model.) 2 Sheets—Sheet 1.

# J. LEDENT.

## GAS ENGINE.

No. 575,720. Patented Jan. 26, 1897.

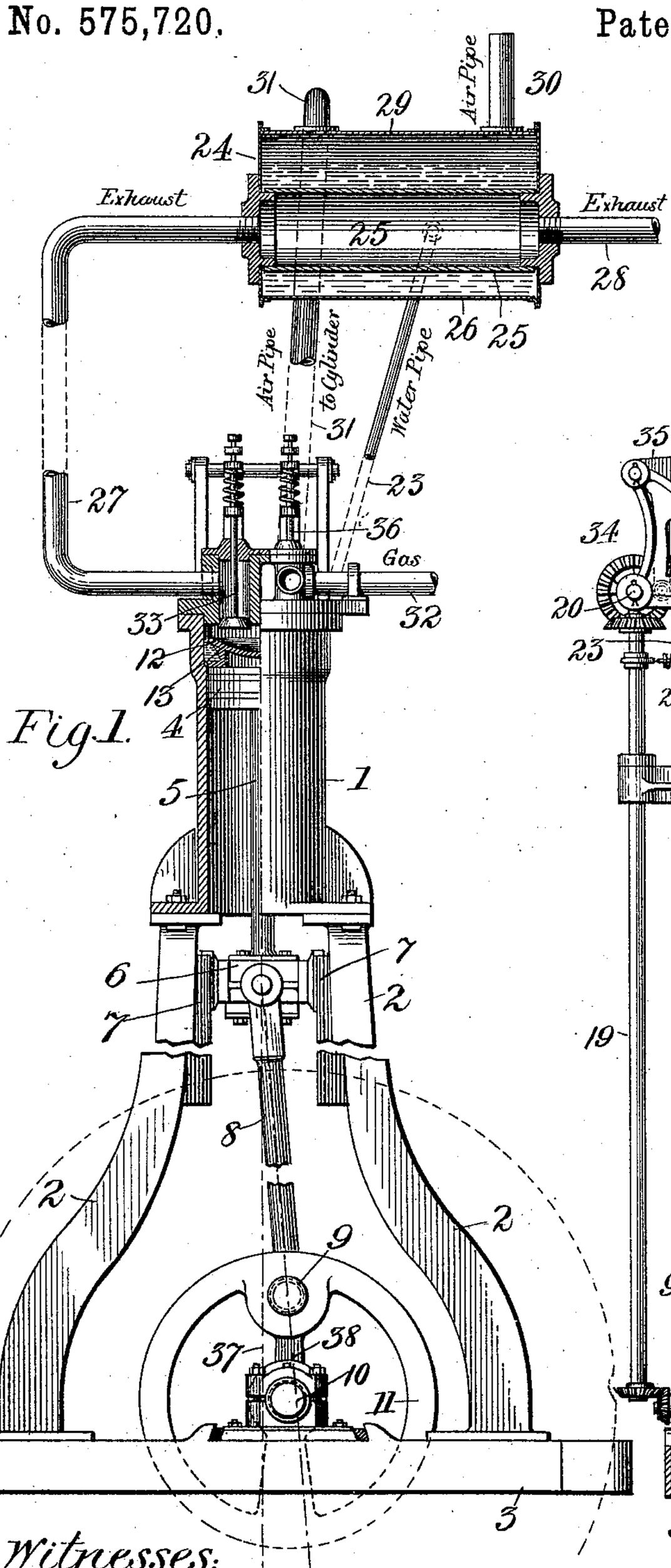


Fig. 1.

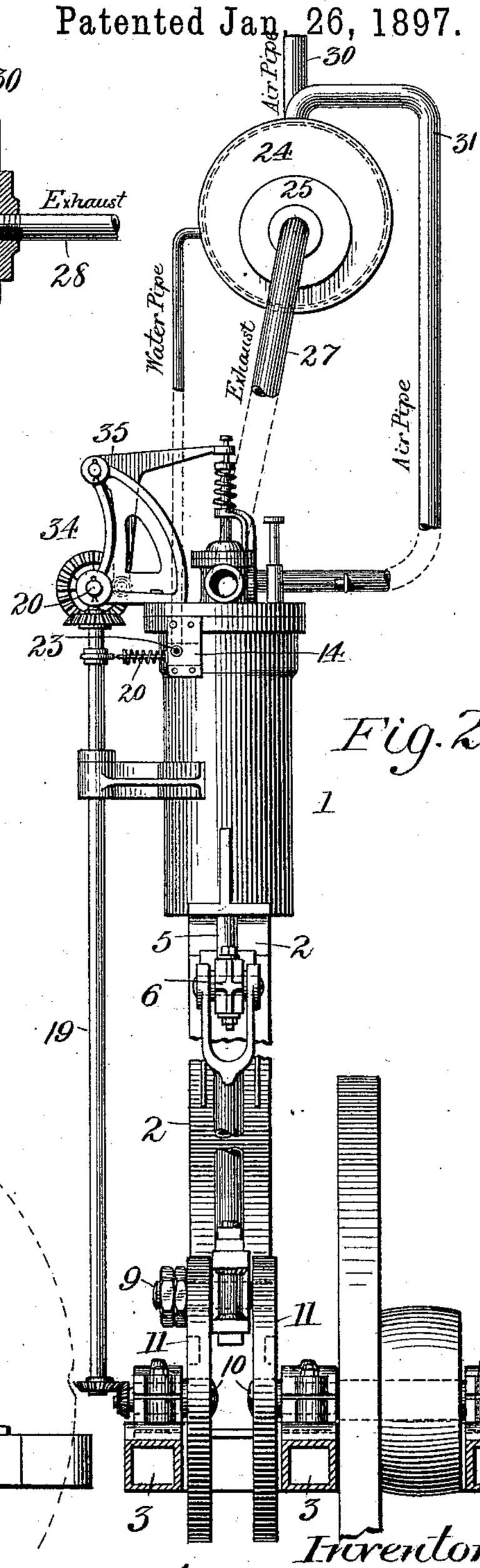


Fig. 2.

Witnesses:
F. O'McCleary,
A. M. Parkins.

Inventor:
Joseph Ledent,
by Lemuel Goldsborough,
Attys

(No Model.) 2 Sheets—Sheet 2.

# J. LEDENT.

## GAS ENGINE.

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Fig. 3.

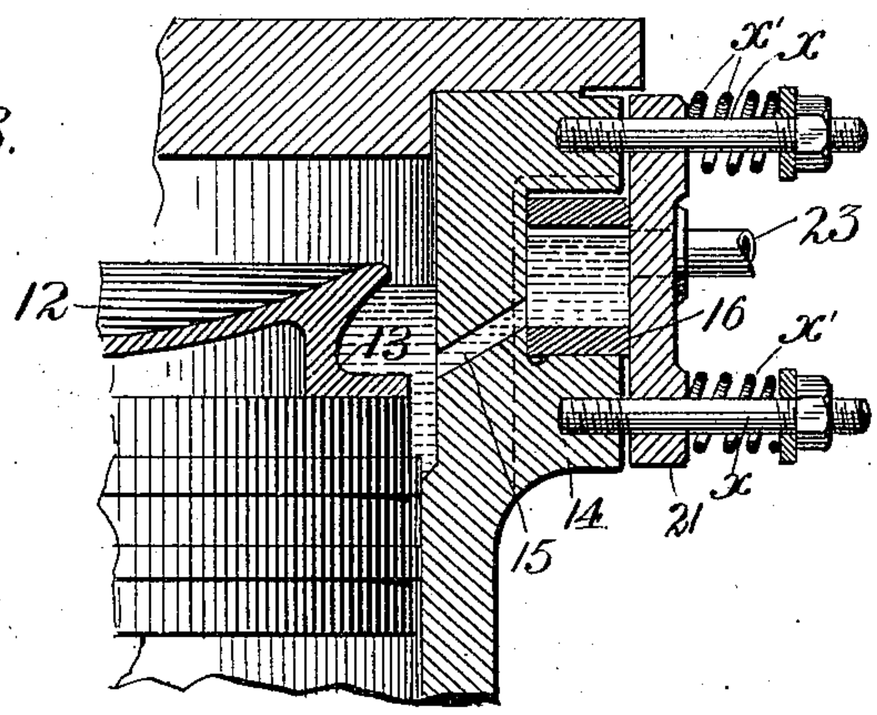



Fig. 4.

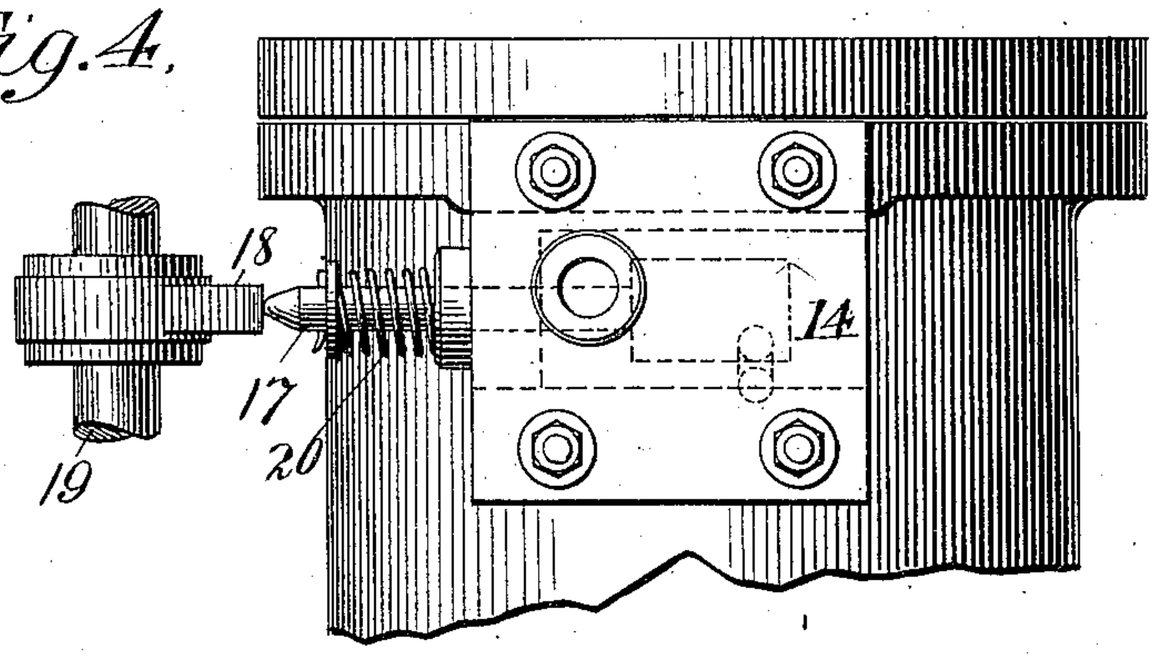
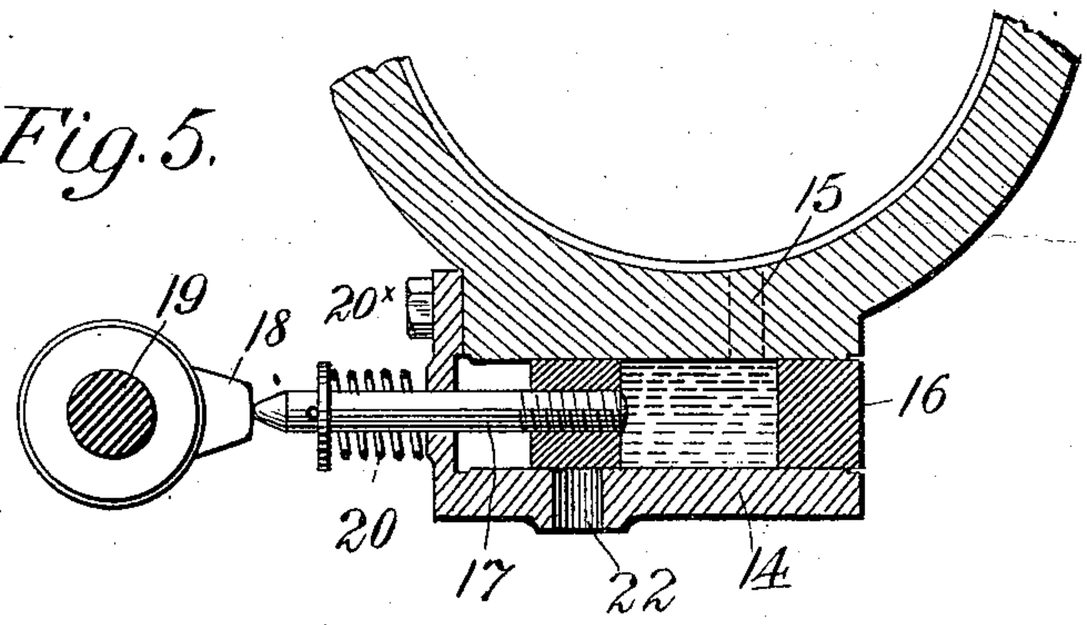



Fig. 5.




Witnesses:
F. O. McCleary,
A. H. Parkins

Inventor:
Joseph Ledent,
by Lemuel Goldsborough
Atty.

# UNITED STATES PATENT OFFICE.

JOSEPH LEDENT, OF BALTIMORE, MARYLAND.

## GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 575,720, dated January 26, 1897.

Application filed July 1, 1896. Serial No. 597,660. (No model.)

*To all whom it may concern:*

Be it known that I, JOSEPH LEDENT, a Belgian subject, residing at Baltimore, in the State of Maryland, have invented certain new and useful Improvements in Gas-Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to gas-engines, and especially to means for cooling the piston and cylinder so as to maintain them at a sufficiently low temperature to counteract the excessive heat developed by the ignition and explosion of the compressed gases within the cylinder.

The primary object of my invention is to effect the cooling of the engine cylinder and piston without undue waste or consumption of the heat required for the most effective combustion of the gases, and I accomplish this by the means hereinafter described, and illustrated in the accompanying drawings, which enable me to apply the water employed as the cooling agent directly to the inner surface of the cylinder.

Further features of the invention will be disclosed in the following description and defined in the appended claims.

In the drawings, Figure 1 is a side elevation, partly in section, of an explosive-engine embodying my invention. Fig. 2 is an end elevation of the same. Fig. 3 is a detail vertical sectional view illustrating a portion of the upper end of the cylinder, the piston and its cover, and the valve for controlling the supply of water thereto. Fig. 4 is an elevation of the upper end of the cylinder, with devices applied thereto for controlling the supply of cooling-water to the cylinder and piston; and Fig. 5 is a detail horizontal section showing the means for operating the valve controlling the supply of cooling-water.

The reference-numeral 1 indicates the engine-cylinder, supported by a suitable framing 2, resting upon base-sills 3.

4 indicates the piston, provided with the usual piston-rod 5, carrying a cross-head 6, traveling in guideway 7 and connected to the upper end of the pitman 8, the lower end of said pitman being secured to the wrist-pin 9 of the crank-shaft 10 11.

To the upper side of the piston 4 is secured a cap or cover 12, the peripheral edge of which is grooved or depressed to form an annular water-space 13 between the piston and the inner surface of the cylinder 1.

A valve chest or casing 14 is arranged on the outer side of the cylinder 1, near its upper end, and communicates with the interior of the cylinder by means of a duct or passage 15. Within this valve-chest 14 is arranged a hollow slide-valve 16, provided with a stem 17, the outer end of which is adapted to be struck by a lug 18, projecting from a collar fixed upon a shaft 19, geared to the crank-shaft 10. The valve-stem 17 is provided with a retracting-spring 20, coiled around the stem and bearing at one end against the casing 14 and at its opposite end against a disk or collar $20^{\times}$, secured upon the valve-stem.

The valve-casing 14 is provided with a cover-plate 21, having an opening 22 to receive a water-supply pipe 23, leading from a water-heater 24, adjacent to the engine. The cover-plate 21 is preferably secured by bolts $x$, provided with cushioning-springs $x'$, as shown in Fig. 3. The heater 24 comprises an inner cylinder 25 and an outer cylinder or casing 26. The cylinder 25 receives the exhaust heat and products of combustion from the engine through the exhaust-pipe 27 and discharges them after their passage through the cylinder through the pipe 28. The cylinder 26, surrounding the cylinder 25, constitutes the water-chamber of the heater, and the space 29 above the water-level in said cylinder 26 constitues an air-space having an inlet-pipe 30 and an outlet-pipe 31, the latter leading to the cylinder 1, as indicated in Figs. 1 and 2.

An inlet-pipe 32 supplies the gas required for admixture with the air to form the explosive compound, and an exhaust-valve 33 controls the discharge of the spent gases and other products of combustion.

Any suitable form of igniter may be used with the engine.

The operation of the construction thus described is as follows: When the piston is at its highest position, and just before the igni-

tion of the explosive mixture of air and gas, the space 13, between the piston-cover 12 and the inner surface of the cylinder 1, will be filled with water, as shown in Figs. 1 and 3, supplied from the heater 24, the temperature of the water being sufficiently low to protect the cylinder and piston from the excessive heat of the exploded mixture. As soon as the piston begins its downward movement after the explosion a portion of the water contained within the space 13 will adhere to the inner surface of the cylinder in a thin layer and evaporate, thus absorbing a portion of the heat imparted to the cylinder, and at the same time protecting the hot gases from contact with the cooler surfaces of the cylinder, thereby insuring a thorough expansion of said gases. When the piston reaches the limit of its downward movement, the exhaust-valve 33 is opened by means of the shaft 20 and valve-gear 34 and 35 and the spent gases pass through the pipe 27 to the cylinder 25 of the heater. The further upward movement of the piston operates to expel the products of combustion, and during such further upward movement of the piston a further evaporation of the water contained in the space 13 takes place, due partly to the reduced pressure in the cylinder and partly to the contact of the water with the inner surface of the cylinder, and thus insures the complete exhaust of the products of combustion. The relation of the valve-stem 17 and contact-lug 18 is such that just before the piston reaches the limit of its upstroke the slide-valve 16 will be forced to the position shown in Fig. 5, that is to say, communication with the water-duct 15 is opened and the water-inlet 22 is closed. Thus the water-space 13 is again supplied with a quantity of water equal to the quantity evaporated. After the delivery of the water to the space 13 from the valve 16 the latter is retracted by its spring 20 to its normal position in communication with the water-inlet 22 from the heater. On the next downward stroke of the piston it will draw into the cylinder by suction through the valve 36 the air and gas required for the next explosion.

It will be observed that the air supplied to the cylinder passes through the air-space 29 of the water-heater, and during such passage it admixes with the steam generated from the water in the cylinder 26 by the products of combustions passing through the cylinder 25, and when the piston is again at the limit of its downstroke the cylinder is filled with a mixture of gas, air, and steam. The return upward movement of the piston compresses the mixture, and such compression operates to partially condense the steam, which imparts its latent heat to the mixture, and the uncondensed portions of the steam contribute to facilitate the combustion of the explosive mixture.

Inasmuch as the combustion of air and gas is never instantaneous, it is important that the piston should be at rest while the combustion proceeds, in order to obtain the highest expansive force of the gases and to avoid, as far as possible, the loss of heat through the walls of the cylinder. To effect this, I arrange the vertical center of the crank-shaft 10 slightly eccentric to either side of the vertical center of the cylinder 1, and thus when the wrist-pin 9 of the crank-shaft is between the points indicated by the lines 37 and 38 the piston will be almost at rest and a more nearly instantaneous explosion results. Moreover, the position of the pitman 8 at the moment of explosion being as illustrated in Fig. 1 the force of the explosion is transmitted directly to the crank-shaft with an increase of leverage represented by the distance between the lines 37 and 38.

Having thus described my invention, what I claim is—

1. In a gas-engine, the combination of a vertical piston provided with an annular peripheral water-chamber at its upper end, a cylinder having a water-inlet at its corresponding end, or at any other convenient place, and valve or similar mechanism for controlling the admission of water to the cylinder.

2. In a gas-engine, the combination of a vertical cylinder having a water-inlet, a piston provided with a peripheral water groove or channel at its upper end, and a valve or similar mechanism operated to admit water into the cylinder when the piston is at the convenient position of its throw.

3. In a gas-engine, the combination of a vertical piston having an annular water-chamber at its upper end, a cylinder provided with an inlet for delivering water into said cylinder, a valve-casing on the cylinder, a slide-valve or similar mechanism controlling the supply of water to the cylinder, and a water-supply communicating with the valve-casing.

4. In a gas-engine, the combination of a vertical piston provided at its upper end with an annular water-chamber, of means for automatically admitting water to said chamber when the piston is at the convenient point of its stroke, whereby the water follows the piston in its downward movement and is distributed in a thin sheet or layer upon the inner surface of the cylinder.

5. In a gas-engine, the combination of a cylinder, provided with a water-inlet near its upper end, a piston having an annular water-chamber, a valve-casing arranged proximate to the cylinder and communicating with said inlet, a hollow slide-valve or similar mechanism working in said casing, a water-supply communicating with the inlet of the casing, and means for throwing said valve into communication alternately with the inlet into the cylinder from the casing and the water-inlet from the source of supply to the casing.

6. In a gas-engine, the combination with a cylinder provided with an air-inlet, and an exhaust for spent gases, of a water-heater comprising an inner cylinder communicating

with the exhaust and receiving the heated products of combustion therefrom, while the outer cylinder serves as a water-chamber and communicates above its water-level with the air-inlet of the engine-cylinder.

7. In a gas-engine, the combination with a cylinder provided with an air-inlet and an exhaust-opening, of a water-heater, through which the products of combustion pass, and provided with a water-chamber, and inlet and outlet connections, whereby the air enters the water-chamber and commingles with the heated water therein, and then escapes through the air-outlet to the engine-cylinder.

8. In a gas-engine, the combination of the cylinder, the air-inlet, the exhaust for the spent charge, and a water-heater provided with a water-chamber, the exhaust-pipe passing through the heater so as to form steam from the water therein, and the pipe supplying air to the engine-cylinder leading from the steam-space of said heater.

In testimony whereof I affix my signature in presence of two witnesses.

JOS. LEDENT.

Witnesses:

HUBERT KREKEL,

OTTO REIMERS.