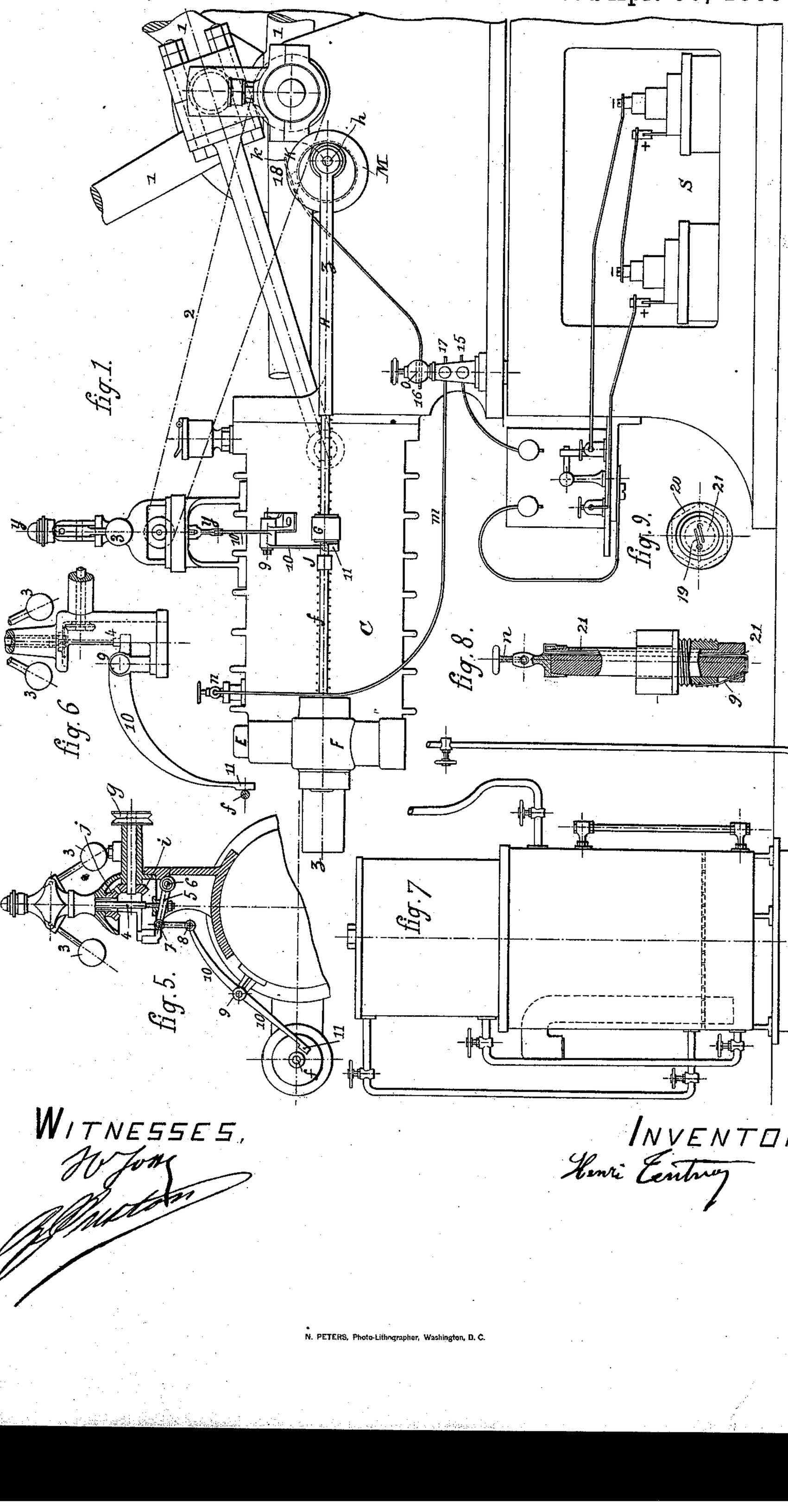
(No Model.) 2 Sheets—Sheet 1.

H. TENTING.

GAS ENGINE.

No. 402,363. Patented Apr. 30, 1889.



WITNESSES.

H. W. Jones

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INVENTOR.

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(No Model.)

2 Sheets—Sheet 2.

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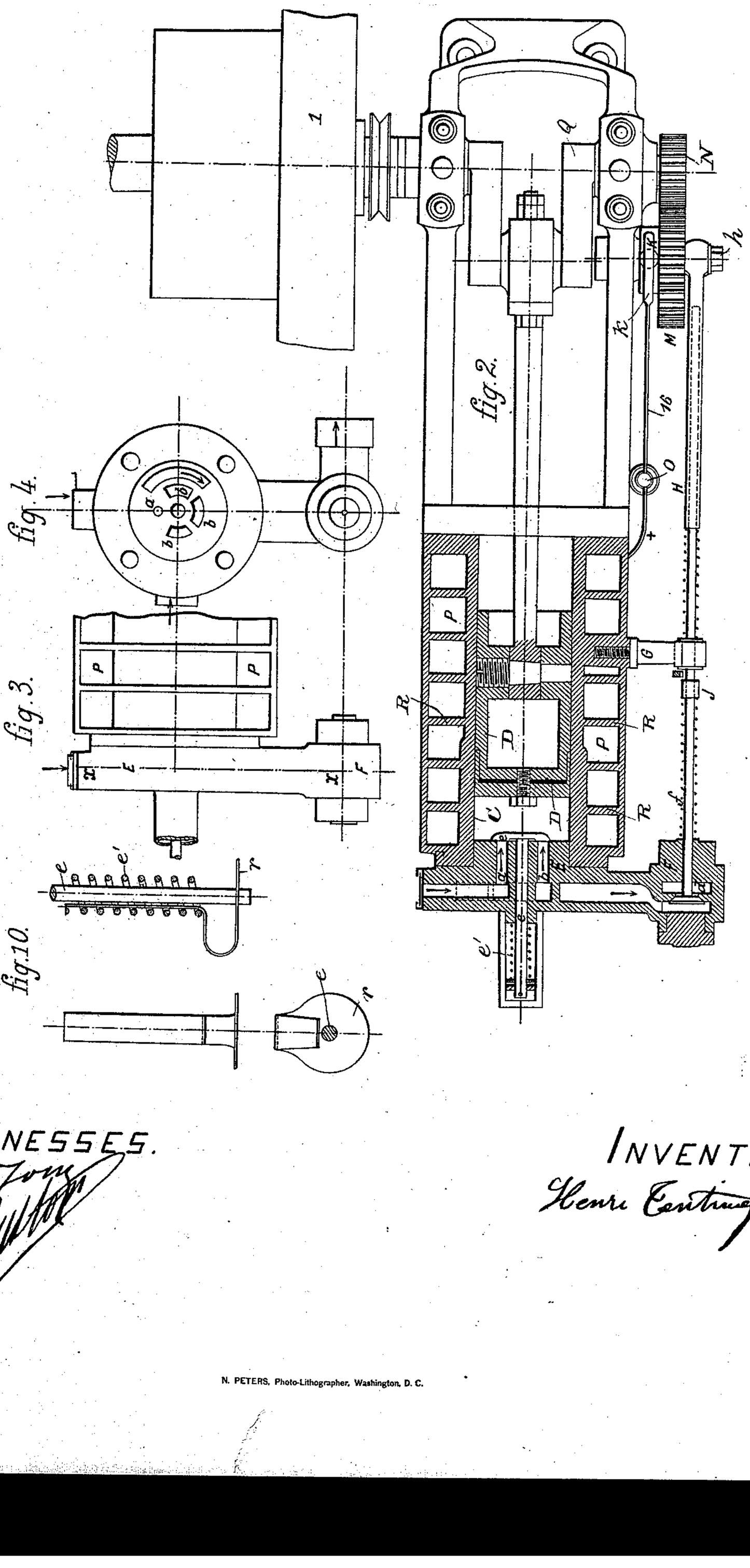

fig. 2.

fig. 4.

fig. 3.

fig. 10.

WITNESSES.

INVENTOR.

Henri Tenting

UNITED STATES PATENT OFFICE.

HENRI TENTING, OF PARIS, FRANCE.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 402,363, dated April 30, 1889.

Application filed January 16, 1889. Serial No. 296,505. (No model.) Patented in France July 7, 1887, No. 184,466; in Belgium February 13, 1888, No. 80,639, and in England February 24, 1888, No. 2,804.

To all whom it may concern:

Be it known that I, HENRI TENTING, a citizen of France, residing at Paris, in the Department of the Seine, have invented new and useful Improvements in Gas-Engines, (for which I have obtained patents in France, No. 184,466, dated July 7, 1887; in Belgium, No. 80,639, dated February 13, 1888, and in Great Britain, No. 2,804, dated February 24, 1888,) of which the following is a specification.

This invention relates to gas-engines; and it consists in the improvements in the construction and arrangement of the parts, as hereinafter described. The said improvements relate to the arrangement of the admission and exhaust valves, the gear for working the exhaust-valve, arrangements for cooling the cylinder, and other features hereinafter specified. The motive power is produced by the explosion of a mixture of air and common lighting-gas, hydrocarbon vapor, or any other suitable gaseous compound.

In order that the said invention may be fully understood, I shall now proceed more particularly to describe the same with reference to the accompanying drawings.

Figure 1 is a side elevation constructed in accordance with the invention, and Fig. 2 a plan view of the same, partly in horizontal section, on line *z z* of Fig. 1. Fig. 3 illustrates the valve-box in plan, and Fig. 4 is a sectional elevation of the same on line *x x* of Fig. 3. Fig. 5 is a section on line *y y*, Fig. 1, illustrating the regulator. Fig. 6 illustrates the regulator somewhat simplified. Fig. 7 represents a carburetor of well known or of any suitable construction; and Figs. 8, 9, and 10 are details.

The engine is of the type working by compression and making four strokes of the piston (two in and two out) to each explosion. The action is divided into four periods for operation, as follows:

First. During the first stroke or half-revolution the piston moves forward and draws in air and gas or vapor in proper proportions through orifices *a* and *b*, communicating with the admission-valve. The arrangement of these orifices is clearly shown in section in Fig. 2 and in elevation in Fig. 4. During this first period the engine simply acts as a suction-pump.

Second. On the return-stroke of the piston the mixture previously drawn into the cylinder is compressed.

Third. During the next or second forward stroke of the piston the explosion takes place.

Fourth. During the following or second return-stroke of the piston it drives out the burned gases from the cylinder, after which this series of operations is repeated.

The gas and air are admitted through a valve, *e*, in a box or chest, E, which is cast in one piece with a chamber, F, containing the exhaust-valve *d*. The positions of these valves will be readily understood by reference to Figs. 2, 3, and 4. The air enters the cylinder through a series of orifices, *b*, and the gas, conveyed by means of a suitable pipe, enters through an orifice, *a*. The relative area of the orifices *a* and *b* is determined in such manner as to cause the air and gas to be mixed in suitable proportions for producing the explosion under the most favorable conditions at the proper time.

During the first period of the cycle of operations hereinbefore described a vacuum is produced on one side of the admission-valve, and the pressure of the atmosphere acting on the other (the exhaust-valve *d* being closed) causes the valve *e* to open, thereby compressing its spring *e'*. At the moment when the piston D completes its forward stroke and begins to return the valve *e* yields to the pressure of spring *e'* and returns to its seat. The valve is forced against its seat with a force increasing in proportion to the compression of the gas in the cylinder by the action of piston D. After reaching the end of its return-stroke the piston again moves forward, and at this moment the electric spark is produced, which explodes the gaseous mixture, as hereinafter explained. At the beginning of the next return of the piston a rod, H, pushes against the end of rod *f* of exhaust-valve *d* and holds it open during the whole time the piston is making its return-stroke, thus driving out the burned gases. Rod H is connected at one end with a crank-pin, *h*, on a toothed wheel, M, driven by a gear, N,

on the crank-shaft Q. Wheel M has twice the number of teeth as wheel N, and therefore makes one revolution to two of the crank-shaft. A certain amount of play is allowed between the adjacent ends of rods H and *f*, in order that the former may not operate the latter except at the proper time during the second return-stroke.

The peculiar construction of valve-box E is illustrated in Figs. 3 and 4. It is cast in one piece and bolted to the cylinder C, so as to admit of being readily removed for access to the cylinder, inspection of the valves, or for any other purpose.

When coal-gas is used, a carburetor of known or of any suitable construction—such as represented in Fig. 7—may be joined to the engine, and which is fed with carbureted air. As such device is well known and forms no part of the invention, a description thereof is not necessary.

The engine may be regulated or controlled by any suitable means. It is preferred to employ the Tangye system, illustrated in Figs. 1, 5, and 6. An ordinary centrifugal or ball governor, 3, is driven, by means of a belt, 2, pulley *g*, and bevel-gears *i j*, from a pulley on the crank-shaft Q. When the speed of fly-wheel 1 increases beyond the desired limit, the balls 3 spread, causing rod 4 to descend. Rod 4 depresses lever 5, which is fulcrumed at 6, thereby tilting lever 10, which is connected with lever 5 by a rod, 8, the latter being jointed to lever 5 at 7. Lever 10 is fulcrumed at 9, and the downward motion of rod 8 causes its lower end to be thrown forward, interposing a stop, 11, between a stationary arm, G, bolted to cylinder C, and a collar, J, on valve-rod *f*. When this occurs, the exhaust-valve *d* is held open and piston D by its forward motion can no longer lift valve *e*. The explosions are thus prevented and another supply of air and gas does not enter the cylinder until by reduction of the speed the governor-balls approach, lifting rod 4, and consequently withdrawing stop 11, so that it no longer opposes the movement of rod *f*.

Fig. 6 shows a more simple arrangement of the devices for operating lever 10. As shown in this figure, the rod 4 is connected directly to the end of lever 10. The intermediate devices are omitted. The operation is the same as just described with reference to Fig. 5.

The cylinder C is cast or formed with hollow sides, forming vertical flues or passages P, surrounding the cylinder, as shown in Figs. 2 and 3. The passages are separated by vertical webs or partitions R. They are essentially different from the ribs or projections which are sometimes formed on the cylinder of a gas-engine, and which simply increase the area of the radiating-surface. This arrangement of vertical passages or flues produces a current of air which circulates rapidly, the heated air being continuously replaced by fresh air, which absorbs a great amount of heat from the metal in the sides of the cylinder. The arrangement also increases largely the radiating-surface, and further has the important advantage of supporting and strengthening the sides of the cylinder. The action of the currents of air may be increased by inclosing the upper ends of the passages P and combining them with a discharge pipe or chimney, in order to produce a stronger draft.

The electric spark for producing the explosion of the gaseous mixture is preferably obtained by momentarily interrupting a current which is continuously flowing from a generator, instead of intermittently transmitting a current for the same purpose.

The electricity is distributed by means of a ring, K, mounted upon the same axis as the toothed wheel M. A spring-contact, *k*, rests upon this ring and connects the same electrically through wire 16 with the binding-post *o*. The current passes to this post from the positive pole of a generator, S, by wire 15. Thus the current normally passes to ring K, which is in electrical contact with the metal frame of the machine. The negative pole of generator S is grounded in any suitable way. Another wire, *m*, leads from the binding-post *o* at the point 17 to the ignitor *n*. Ring K is provided at one point with an insulating piece or projection, 18, which momentarily interrupts the circuit when it passes under contact-spring *k*, and this projection 18 is so placed that it lifts spring *k* just as the piston begins its second forward stroke and the gaseous mixture is ready for explosion. When this occurs, the full strength of the current is for an instant directed by branch wire *m* to the ignitor *n*. The construction of the latter is shown in Figs. 8 and 9. Wire 21 constitutes a continuation of wire *m*, while wire 19 is in electrical contact through nut 20 with the metal of the frame. The terminals of wires 19 and 21 are slightly separated, as shown in Fig. 9. Consequently the current in bridging this space causes a spark, which ignites the gaseous mixture.

When the engine is running at high speed and the cylinder has become highly heated in consequence, the use of electrical agency to ignite the explosive mixture will not be necessary; but the mixture will be ignited and exploded at each stroke by the compression caused by the piston D.

Another improvement in the motor is illustrated in Fig. 10. It consists in a brake formed by a small spring or blade, *r*, which is applied to the valve-rod *e* and its retracting-spring *e'*. The blade *r* extends lengthwise of the valve-rod inside the coils of spring *e'*, with which it is in contact, and is curved into a loop at its lower end, as shown. By its location and contact with the coils of spring *e'* it checks or retards the recoil of the latter and prevents closing the valve suddenly against its seat, thus avoiding concussion.

As shown in Fig. 2, the head D' of the piston is separated from the body D thereof by

an insulating-washer, *s*, which prevents the piston (which is less cooled by radiation than the cylinder) expanding beyond a certain limit when a high temperature is developed, appliances for cooling by a circulation of water not being used.

When a motor of great power is constructed, it is desirable to employ a circulation of water to cool the parts, instead of the air-flues herein described.

I claim—

1. In a gas-engine, the combination, with a cylinder and piston, of the ports for admission of air and gas, a single valve opening by operation of the piston at each alternate forward stroke thereof while the exhaust-port is closed, an exhaust-valve, a valve-rod therefor provided with a collar or boss, an actuating-rod connected with the main shaft by suitable gearing, so as to make one reciprocation for two revolutions of the main shaft, a governor, and a movable stop operated thereby and adapted, when excessive speed is developed, to be thrown into the path of the collar or boss on said valve-rod and prevent the complete closing of the valve, substantially as described.

2. The combination, with the cylinder and piston, of the valve-box cast in one piece and bolted to the end of the cylinder, said valve-box containing passages for supplying air and gas, a single valve controlling the same, an exhaust passage or outlet, and a valve controlling the same, substantially as described.

3. The combination, with the valve, valve-rod, and spiral retracting-spring encircling the same, of a spring-blade arranged in contact with the coils of said spring for preventing concussion of the valve against its seat, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

HENRI TENTING.

Witnesses:
W. TONY,
R. J. PRESTON.