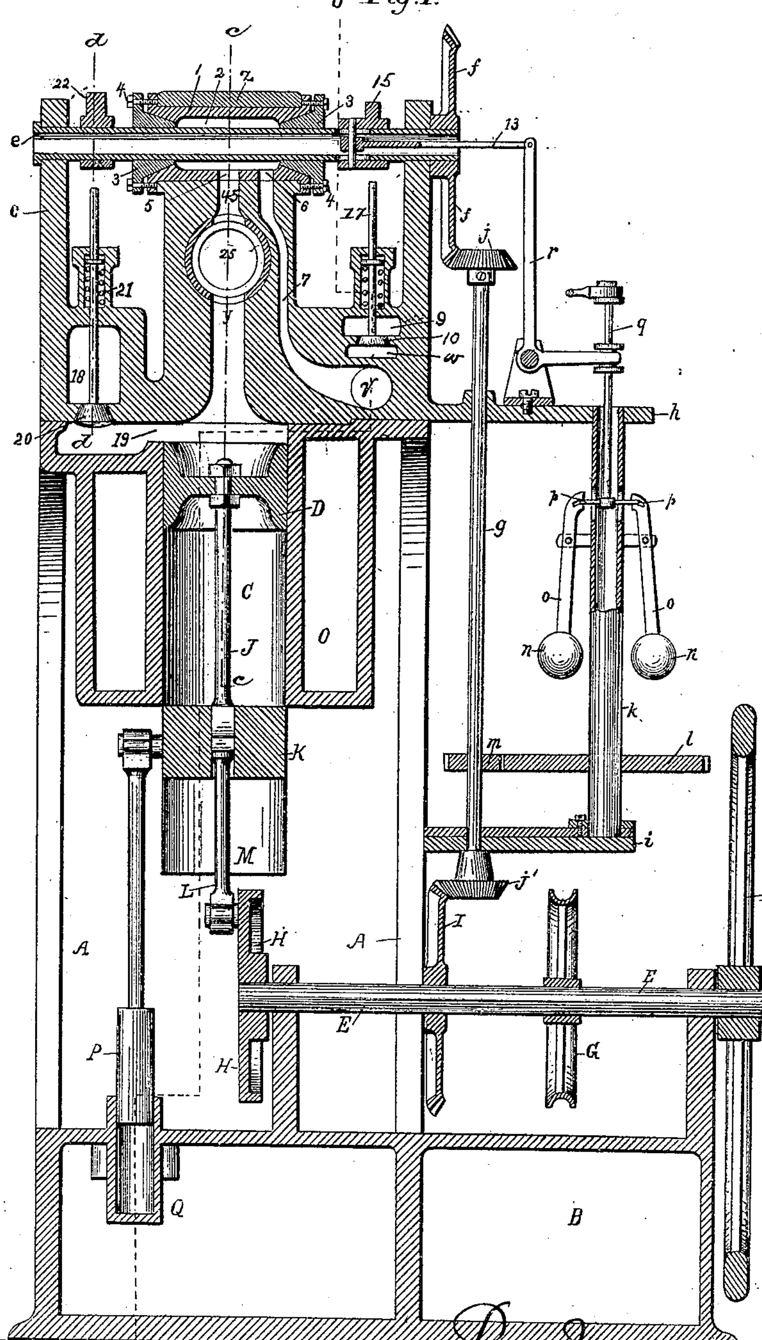
(No Model.) 5 Sheets—Sheet 1.

P. MUNZINGER.

GAS ENGINE.

No. 266,304. Patented Oct. 24, 1882.

"b" Fig. 1.



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(No Model.)

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P. MUNZINGER.

GAS ENGINE.

No. 266,304. Patented Oct. 24, 1882.

Fig. 2.

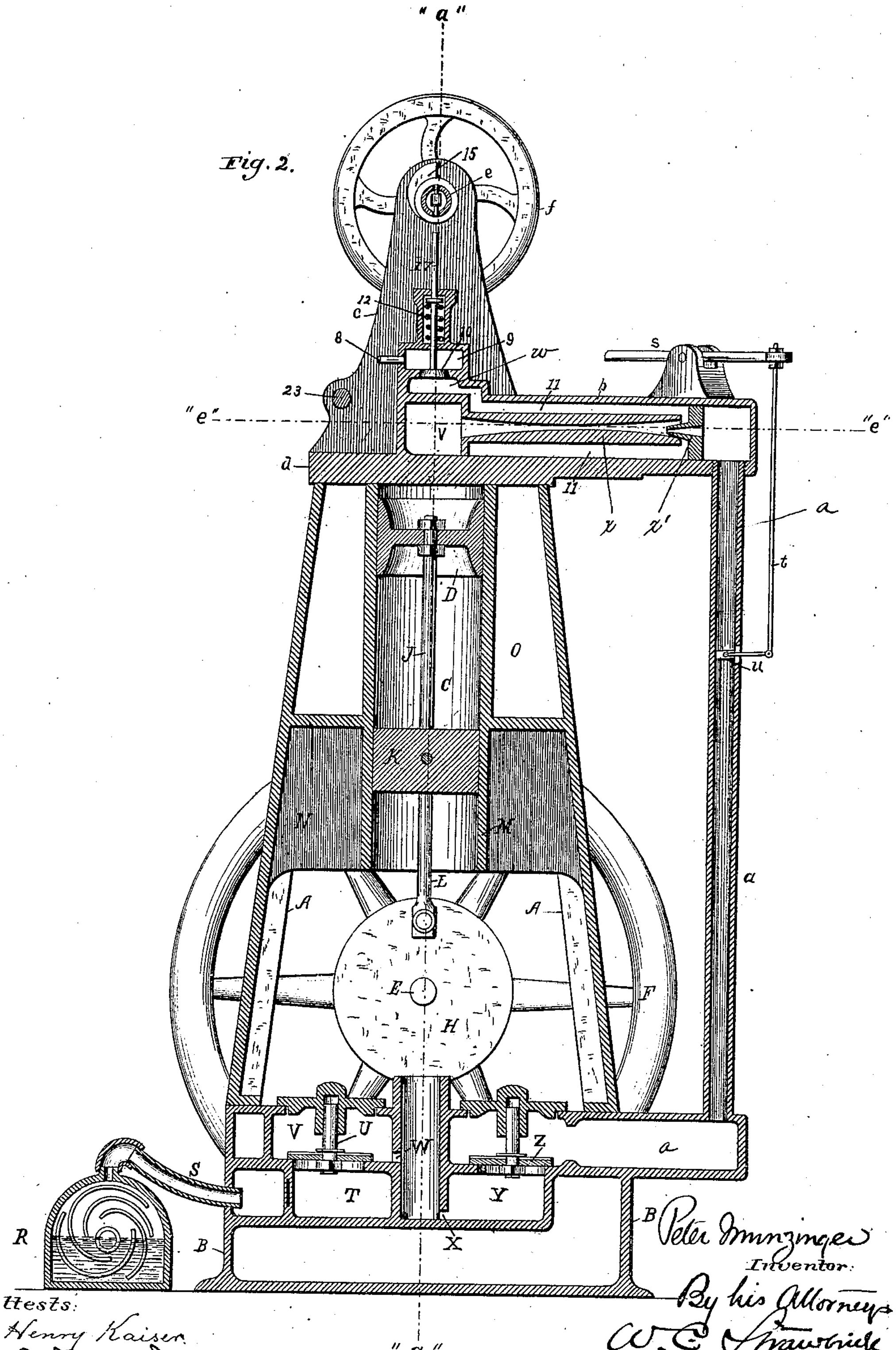

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Fig. 4.

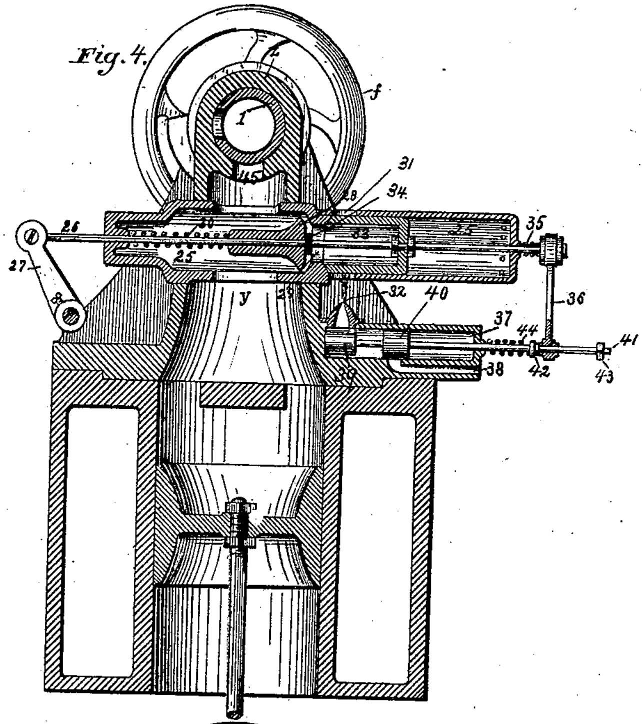
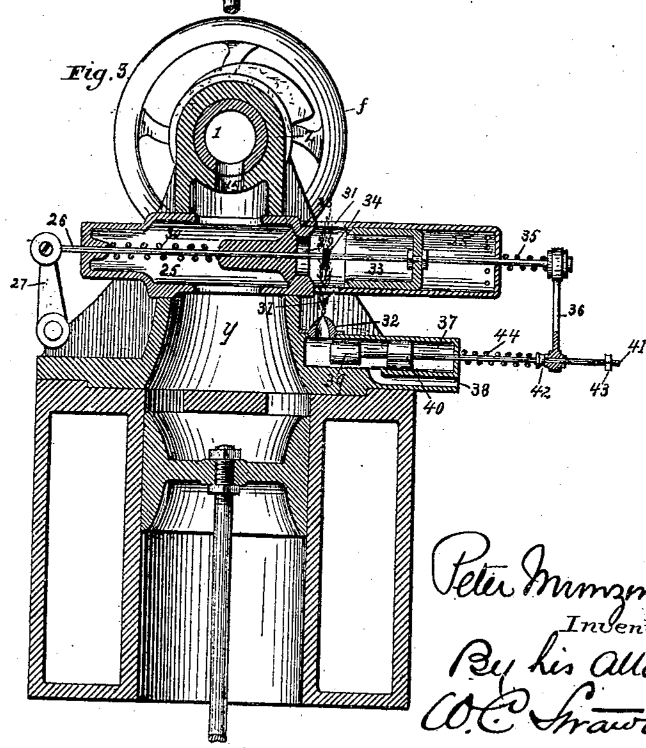


Fig. 3.



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P. MUNZINGER.

GAS ENGINE.

No. 266,304. Patented Oct. 24, 1882.

Fig. 7.

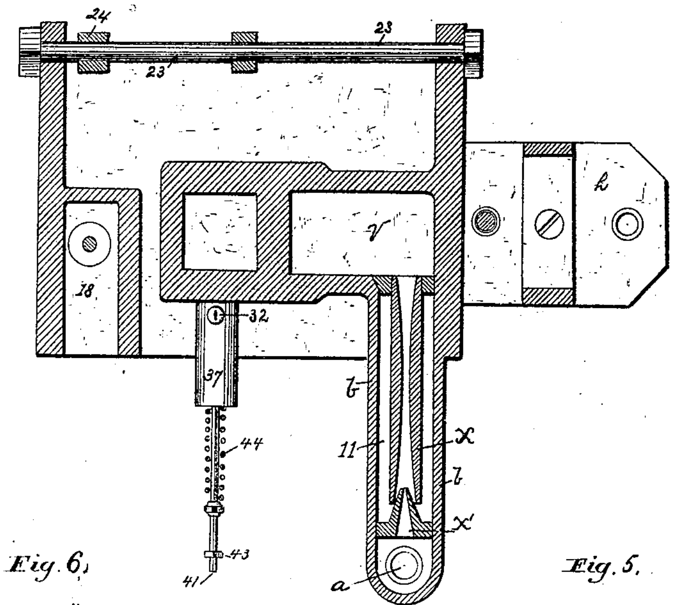


Fig. 6.

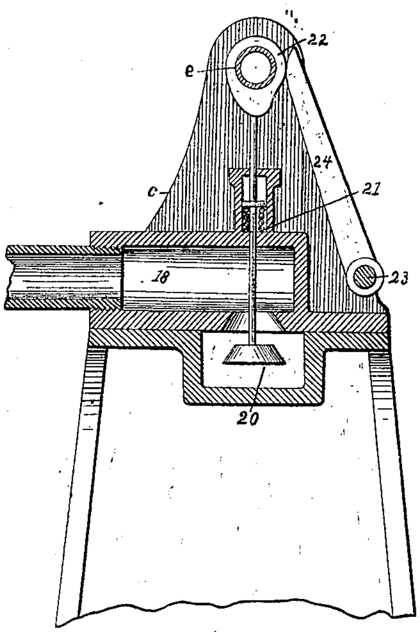
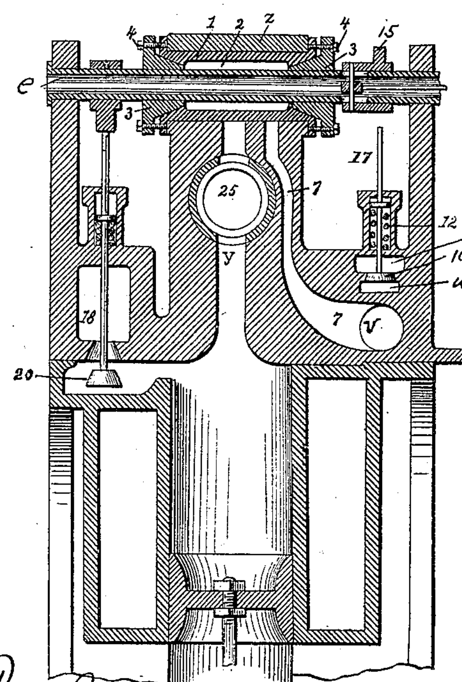


Fig. 5.



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P. MUNZINGER.

GAS ENGINE.

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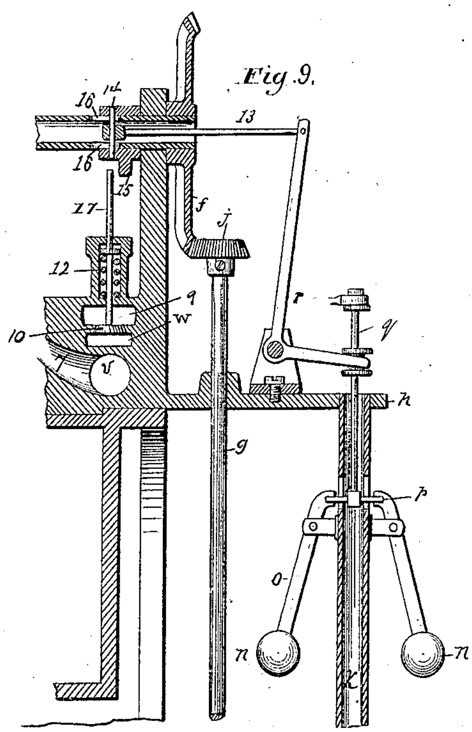

Fig. 9.

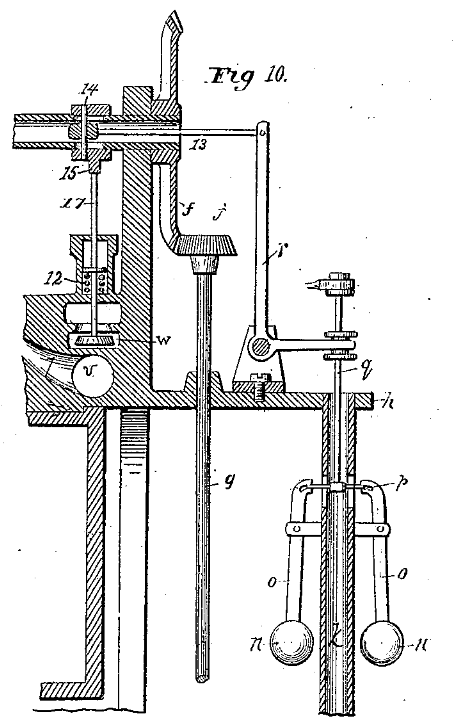

Fig 10.

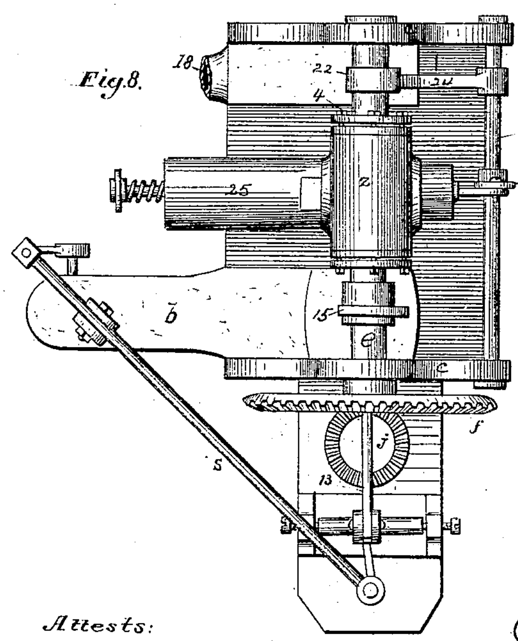

Fig. 8.

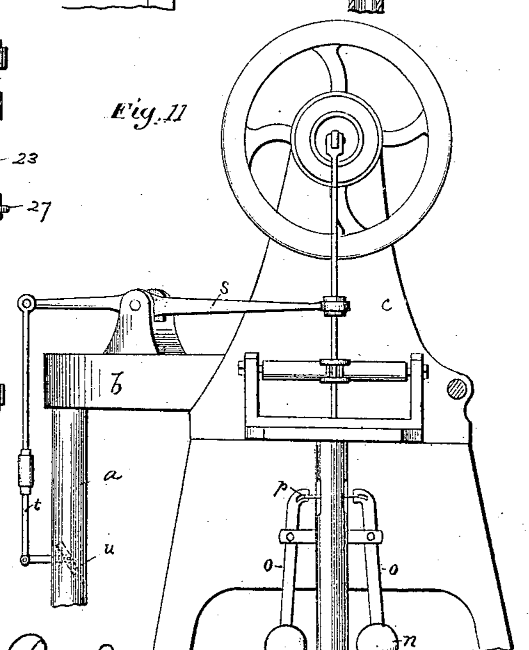

Fig. 11.

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UNITED STATES PATENT OFFICE.

PETER MUNZINGER, OF PHILADELPHIA, PENNSYLVANIA.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 266,304, dated October 24, 1882.

Application filed March 2, 1882. (No model.)

To all whom it may concern:

Be it known that I, PETER MUNZINGER, of the city and county of Philadelphia, in the State of Pennsylvania, have invented an Improvement in Gas-Engines, of which the following is a specification.

The object of my invention is to produce a gas-engine which shall be simple and durable in its construction, and which shall effect the most economical results by insuring the maximum amount of power from the expenditure of a given quantity of gas.

The invention relates to an engine in which the force developed by the ignition of explosive gaseous mixtures is employed as the motive power. Those compounds which result from the mixture of gases obtained from light hydrocarburets with atmospheric air are those best employed. It has for a long time been known that such compounds were capable of developing upon ignition an immense degree of force, and various attempts have been made to employ them as motive agents for working machinery. My engine is provided with a free piston working in an open-ended cylinder, the said piston being connected to the crank through the intervention of a suitable cross-head and connecting-rod. The engine is single-acting, and the impetus of the fly-wheel is designed to return the piston, after the explosion of the charge, in position to receive the impulse of the next explosion. The valve-motion employed places the space on one side of the piston only alternately in connection with the feed and with the exhaust. The gaseous mixture is first introduced into the cylinder, then suddenly ignited by means provided for that purpose, and, becoming thus suddenly and greatly expanded, forces the piston to the end of its stroke, the return of the piston expelling the products of combustion from the cylinder.

The invention consists in certain novel constructions or arrangements of various parts of the engine, whereby numerous specific advantages are obtained and an engine combining increased durability with efficiency is produced.

In the accompanying drawings, Figure 1 represents in vertical front sectional elevation an engine conveniently embodying my improvements, the section being supposed in a vertical plane projected at right angles to the plane of the sectional view of Fig. 2, and on the line *a a* thereof, looking from the right-hand side of said Fig. 2. Fig. 2 is a vertical side sectional elevation taken on planes projected at right angles to the sectional plane of Fig. 1, and on the lines *b b* of said Fig. 1, viewed from the left-hand side of said Fig. 1. Fig. 3 is a side sectional elevational view of the combustion-chamber and contrivances for regulating the supply of burning-gas and controlling its introduction into the combustion-chamber for the purpose of producing an explosion therein. The view is taken on a sectional plane projected on the line *c c* of Fig. 1, and at right angles to the plane of section of said figure. The parts are represented in the positions which they respectively occupy before the ignition of the explosive mixture. Fig. 4 is a view in all respects similar to Fig. 3, with the exception that the parts are represented in the position which they occupy at the moment when the flame or igniting medium has been forced into the combustion-chamber for the purpose of producing the explosion. In other words, the parts are in positions opposite to those which they occupy in said Fig. 3. Fig. 5 is a vertical front sectional elevation of the combustion-chamber, induction and eduction valves, and neighboring parts in the opposite positions to those which the same parts occupy in Fig. 1. Fig. 6 is a side sectional elevation, taken on the line *d d* of Fig. 1 in a plane at right angles to the plane of section of said Fig. 1, representing the position of the eduction-valve when open and viewed from the right hand of said Fig. 1. Fig. 7 is a top sectional plan view taken on a horizontal plane projected on the line *e e* of Fig. 2, or on the line *f f* of Fig. 1, and at right angles to the plane of section of both the above figures. Fig. 8 is a top plan view of the upper portion of my apparatus. Figs. 9 and 10 are respectively front sectional elevational details, taken on planes corresponding to the plane of section of Fig. 1, and designed to represent the governor and its connected appliances and the injector supplemental feed-valve in opposite positions. Fig. 11 is an end elevational view of the upper portion of the apparatus, looking from the right-hand side of Fig. 1 or from behind Fig. 2.

Similar letters of reference indicate corresponding parts.

The following is a description of an apparatus conveniently embodying my invention.

The apparatus consists primarily of a framework, fitly composed of suitable standards erected from and upon a hollow base and carrying across their upper extremities a head-plate and head frame-work, in which the combustion-chamber and the various valves and valve-movements are assembled. In the framework are also placed the cylinder, piston, and gas-feeding and motion-transmitting devices, all as hereinafter set forth.

In the drawings, A A represent two main standards of any preferred shape, but suitably of that shown in the drawings. They are erected upon a hollow base, and support near their upper extremities a vertical cylinder, C, within which plays the piston D.

E is the main shaft, suitably journaled horizontally in the frame-work, preferably above the base. This shaft carries the balance-wheel F, driving-pulley G, crank-wheel H, and a beveled spur-wheel, I. The piston-rod J, which is connected with the piston, is also connected with a reciprocating cross-head, K, to which is also connected the pitman L, which drives the crank-wheel. The reciprocating cross-head plays in guideways M, depending from the cylinder and suitably stayed by webs N, brackets, or supports from the main standards.

O is a water-jacket, surrounding the cylinder, subserving the usual purpose.

P is a pump-plunger, the upper extremity of which is connected with the reciprocating cross-head K, and the lower extremity of which plays within a pump, Q, erected within the base of the frame-work.

R is a differential force-pump of a construction invented by me, application for patent for which was filed in the United States Patent Office January 23, 1882. This pump is employed to supply, in suitable proportions, a combustible mixture of gas and air, forcing the same under pressure through the force-pump inlet-pipe S into a receiving-chamber, T, in the base of the frame-work, and represented in Fig. 2. The accumulation of the explosive mixture in this chamber occasions the elevation of a pump-supply valve, U, and the escape and introduction of the explosive mixture into a pump-vestibule, V, from out of which the mixture flows through the port W into the pump Q. The explosive mixture being supplied to the pump as above stated, in the action of the engine the descent of the pump-plunger P will occasion the expulsion of the mixture from out the pump, *via* the pump exit-port X, into a second vestibule, Y, provided with a pump exit-valve, Z, which is lifted by the pressure of the explosive mixture in the second vestibule so as to permit the escape of the said mixture into a conduit, *a*, leading out from the base of the engine and thence upwardly into the injector-casing *b*, so as to provide a means of passage for the explosive mixture to the injector. The pump's supply and exit valves U and Z are of any such usual construction as adapts them to permit of the passage of the gaseous mixture in one direction only and to prevent the reflux or movement in the opposite direction. It will be understood that the gaseous mixture or explosive medium employed is thus introduced to the engine under the pressure, first, of my rotary differential forcing-pump, and, second, of the pump which is driven by the piston of the engine.

c c are supplemental standards, erected at right angles to the main standards upon either side of a head-plate, *d*, set or rested upon said main standards in a plane horizontal thereto. Horizontally between the upper extremities of these supplemental standards is journaled a cam-shaft, *e*, upon the right-hand extremity of which is keyed a second bevel spur-wheel, *f*, corresponding in dimensions and pitch of thread to the bevel spur-wheel I upon the main shaft.

g is a pinion-shaft, vertically erected and journaled between two brackets, *h i*, laterally projected from the main standards. On each end of this shaft are pinions *j j'*, respectively meshing with the beveled spur-wheels I and *f*. This pinion-shaft and pinion and spur-wheel connection is simply a convenient means of transmitting motion from the main shaft to the cam-shaft, and any other suitable device may be substituted therefor.

k is a governor-shaft, also journaled between the brackets *h i*, and taking its motion of rotation by means of a toothed wheel, *l*, keyed thereon and meshing with a toothed pinion, *m*, on the pinion-shaft. The relative proportions of the toothed wheel and pinion are such as to impart a predetermined revolution of the governor-shaft.

n are the balls of the governor, the arms *o* of which are pivoted to the governor-shaft, and engage above their pivots, in the usual manner, with pins *p*, connected to and projecting laterally from a stem, *q*, through vertical slots in the governor-shaft, which is made hollow to receive said stem. The stem projects from the upper end of the governor-shaft, and is connected with the bell-crank lever *r*, pivoted upon the upper face of the bracket *h*, and with the throttle-lever *s*, Figs. 8 and 11, which connects by means of a link, *t*, with the throttle-valve *u*, applied in the conduit *a*, through which the gaseous mixture is supplied to the injector, as hereinbefore stated. It will now be understood that upon the rapidity of revolution and consequent spread of the balls of the governor will depend the movement of the governor-stem, while upon the movement of the stem will depend the throw of the throttle-lever and the consequent movement of the throttle, and also the deflection of the bell-crank lever, for a purpose hereinafter set forth.

b is, as stated, the injector-casing which incases the injector, and communicates at its receiving end with the conduit *a*, through which the explosive gaseous mixture is supplied from the pump, and at its discharging end communicates, first, with a chamber, v, which I term the "injector-discharge chamber," into which the injector opens, and which leads to the induction-valve; and, second, with another chamber, w, which I term the "injector supplemental supply-chamber," all as shown in Figs. 1, 2, and 7.

$x\ x'$ is an injector inclosed within the injector-casing referred to, and preferably formed of such character as is shown in the drawings—that is to say, as a tube, x, and nozzle x' opening thereinto. The conduit a discharges into this nozzle. Reference to the drawings will show that the injector-tube is concentric with the injector-casing, so that an annular gallery, 11, is formed between them. This gallery communicates with the injector supplemental supply-chamber w, while the injector-tube communicates with the discharge-chamber v. The only communication between the chambers w and v is through the gallery and tube at the point of introduction of the injector-nozzle into the tube. Upon the supply of the gaseous mixture through the conduit past the throttle it finds its passage through the injector into the injector-discharge chamber v.

Between the supplemental standards upon the head-plate are cast, formed, or otherwise erected the combustion-chamber and certain valve-chambers, passage-ways, and structures, which are hereinafter described. First among these is the combustion-chamber y, which is well shown in Figs. 1, 3, 4, and 5. It is a chamber of proper interior configuration, formed in a casting of suitable strength and adapted to receive and contain at the moment of explosion the charge of explosive gaseous mixture. It is, moreover, preferably vertically disposed—that is to say, its greatest dimension is from top to bottom—and at its lower portion it expands and communicates with the upper portion of the cylinder, which, as stated, is set in the frame-work below it. At its upper portion the combustion-chamber is formed into a tubular journal box or sleeve, z, Figs. 1, 3, 4, and 5, which is designed to contain, free for revolution, a tubular induction-valve, 1, through ports in which the gaseous explosive mixture is introduced into the combustion-chamber.

The induction-valve is formed in three parts, the first a hollow cylinder, to which the numeral 1 has been applied, and which is made hollow, so as to surround the cam-shaft and leave an annular interspace, 2, between the exterior of the shaft and the interior of the cylinder. The ends of this cylinder No. 1 are reamed out in conical form, so as to fit them to receive two cones, 3, which are keyed gas-tight upon the cam-shaft by means of a feather or spline or kindred contrivance, which enables them to move endwise upon said shaft, while insuring their revolution with it. These cones are provided with adjusting-screws 4, by which they can be tightened up into the cylinder 1, so as to take up any wear of the parts. The cylinder revolves with the cones. Said cylinder is provided with two ports, 5 and 6, respectively registering in line in their revolution with an opening, 45, into the combustion-chamber, and with the passage-way 7, which leads down to the injector-discharge chamber v. Upon the revolution of the cylinder and cones, together forming the tubular induction-valve, with the shaft, it will be readily understood the ports 5 and 6 come simultaneously as to each other, but intermittently in point of time, into line with the opening into the combustion-chamber and with the passage-way 7, and at the moment when they register in line, as in Fig. 1, they afford means of escape for the explosive gaseous mixture which has been forced through the injector, *via* the injector-discharge chamber and passage-way 7, into the interspace within the tubular valve, and thence into the combustion-chamber. Thus it is seen that this induction-valve not only enables the introduction at predetermined intervals of a sufficient quantity of explosive mixture into the combustion-chamber, but also shuts off the supply, as in Fig. 5, after the requisite amount has been fed into said combustion-chamber. Under favorable conditions it is to be supposed that the explosive mixture of gas and air supplied through the force-pump is of the identical composition requisite to insure the desired explosive standard. Under certain well-known conditions, however, it becomes desirable to enrich the mixture forced through the conduit by the addition of richer and unmixed gas before the mixture reaches the combustion-chamber, and this I accomplish by the following contrivance:

8, Fig. 2, is an inlet for rich gas, which opens into a tight compartment, 9, formed in the head casting of the engine. This tight compartment communicates through a valve-port closed by means of a puppet-valve, 10, called hereinafter the "injector supplemental supply-valve," with a supplemental supply-chamber, w, with which in turn the gallery 11 in the injector-casing b communicates. Through the instrumentality of this contrivance rich gas can be introduced upon the opening of the valve 10, *via* the gallery, to the injector at its nozzle, so as to be sucked in to mingle with the gaseous mixture which is supplied through the injector from the conduit a. The valve referred to as No. 10, or the injector supplemental supply-valve, is operated to open and to permit of this introduction of rich gas, whenever the movement of the engine is so slow that the balls of the governor close in upon the governor-shaft, in the following manner: When the balls close in their arms raise the governor-stem, so that the bell-crank lever is tilted and its vertical arm thrown from the left to the right, or from the position which it is represented as occupying in Fig. 9 to that which it is represented as occupying in Figs. 1 and 10. Connected with the upper end of this bell-crank lever is a rod, 13, which passes into the end of the cam-shaft, which is made hollow to receive it, and within said shaft is connected with a pin, 14, which is secured to a movable cam, 15, surrounding and free to move endwise upon the cam-shaft, and which pin passes through longitudinal slots 16 in cam-shaft. From this construction it will be at once seen that the tilting of the bell-crank lever causes the movement of the sliding cam endwise upon the shaft, so as to bring the cam out of line with the upwardly-projecting valve-stem 17 of the valve 10, or else throw it in line with said stem, so as to cause it to act upon the latter, and upon its every revolution, so long as it remains in alignment with the stem, cause its depression and the consequent opening of the valve and introduction of rich gas into the injector. 12 is a spring for returning the valve-stem 17.

It will be apparent that the supplemental supply-valve is only opened when the engine is running at the slowest speed and when it is desired to accelerate the speed and to such end to supply rich unmixed gas to the explosive mixture.

Referring now to Figs. 1, 6, and 7, 18 represents the eduction-port, which communicates through the passage-way 19 with the combustion-chamber and upper extremity of the cylinder. Through this port escape the smoke and other products of the combustion. The port is controlled by the eduction-valve 20, being a puppet-valve, the stem of which passes through a chamber in which is incased a spiral, 21, which acts in the usual manner to keep the valve seated in its seat.

22 is a fixed cam upon the cam-shaft, which is so set that upon every revolution of the cam-shaft it encounters the stem of the eduction-valve, and opens the latter to give the lead to the exhaust and permit of the escape of the products of combustion. This cam is so timed with respect to the revolution of the tubular induction-valve that it causes the opening of the eduction-valve at the moment when the piston is at the bottom of its stroke and causes its closing at the moment when the piston has reached the top of its stroke, acting oppositely to the induction.

Suitably journaled in the head of the framework, preferably between the supplemental standards, is a rock-shaft, 23, which is provided with a rock-shaft arm, 24, Fig. 8, which bears against the fixed cam 22 on the cam-shaft, and is caused thereby to rock the rock-shaft with a predetermined oscillation dependent upon the pitch of the cam.

Transversely set through the combustion-chamber, and in fixed relation thereto, so as to open as to its interior therein, is a "cylindric" carrier-chamber, 25, as I term it, which projects transversely as to the head of the engine on either side from out the casting forming the combustion-chamber. Throughout this cylinder runs a carrier-stem, 26, which projects beyond both extremities of the chamber, and to the rear of the head of the machine is connected with a rocker, 27, on the rock-shaft. By this contrivance, upon the oscillation of the rock-shaft through its arm, the rocker is caused to intermittently reciprocate the carrier-stem 26 lengthwise of its chamber.

Within that portion of the cylindric carrier-chamber which lies within the combustion-chamber is fitted, free to slide on the carrier-stem, an ignition-valve, 28, which closes what I term the "ignition-port" 29, which latter is a double-faced throat, formed transversely within the cylindric chamber, and to which said ignition-valve is fitted. When this ignition-valve is closed upon the ignition-port the combustion-chamber is tight against the outer air, while the explosion which takes place within it tends to tighten the valve in its seat, an action which a spiral spring, 30, coiled about the carrier-stem 26 and butting against the ignition-valve, supplements.

Exterior to the casting which forms the combustion-chamber the transverse cylindric carrier-chamber 25 is provided with flame-ports 31, in line below which opens the burner 32, from which emanates the flame which is designed to produce the ignition of the gases.

Located, when at rest, to the front of the flame-ports 31 is a flame carrier, 33, which is a cup fitted within the exterior or front portion of the cylindric carrier-chamber and adapted to be reciprocated therein by means of the valve-stem 26, to which it also is connected.

Now assume the parts to be in the positions which they are represented as occupying in Fig. 3, upon the throw of the rocker the carrier-stem is drawn back, and with it the flame-carrier is moved until its open face registers against the outer face of the ignition-port in the position shown in Fig. 4, whereby the flame-ports are closed by the carrier. In this throw of the carrier-stem the stop 34 upon it encounters and unseats the ignition-valve 28 slightly in advance of the time when the flame-carrier is closed against the ignition-port, so that by this contrivance there is provided a means not only for opening the ignition-port, but also for carrying the flame bodily thereinto, so as to bring it into contact with the explosive gaseous mixture already in the combustion-chamber for the purpose of occasioning the explosion of such mixture. The timing of the throw of the flame-carrier as respects the movement of the valve of the ignition-port is such as to enable the closing of the flame-ports subsequent to the opening of said ignition-valve. The stroke of the stop 34 against the ignition-valve is such as to overcome the spiral 30 (whereof hereinafter) and cause the movement of said valve notwithstanding it. Upon the release of the rock-shaft arm from its cam the rocker is of course free to be returned, and the timing of the fixed cam that moves the arm referred to is such as to permit of the counter movement of the carrier-stem and the consequent closing of the ignition-valve prior to the time of the explosion. This return is effected through the instrumentality of a powerful recoil-spring, 35, coiled about the carrier-stem to the front of the cylindric carrier-chamber, and abutting between the front of said chamber and a depending yoke, 36, aided by the expansion of the spiral 30 of the ignition-valve and the force of the explosion. In the return of the flame-carrier an air-cushion is formed between the front of the cylindric carrier-chamber and the head of the flame-carrier.

37 is what I term a "burning-gas valve-chamber," it being a cylindric chamber formed upon the head-plate of the engine, preferably in line beneath the carrier-chamber. Midway below this chamber a burning-gas-inlet pipe, 38, opens, while its upper outlet at the burner 32 is in line below the flame-ports of the cylyndric chamber. Irrespective of other devices, burning-gas admitted through the pipe 38 can be lighted at the burner 32 and kept constantly burning, in which condition, when the carrier is retracted, as in Fig. 3, the flame will pass completely through the flame-ports in the carrier-chamber and be visible above the upper port.

39 is the flame-valve, being a cylindric stopper playing endwise within the burning-gas valve-chamber, and being of an exterior diameter which is not equal to the interior diameter of said chamber, so that the valve is not a tight valve as to said chamber, but one around which gas admitted to the chamber can constantly flow.

40 is a burning-gas valve, which fits tightly within the burning-gas valve-chamber, and which is connected with and moved by a gas-valve rod, 41, which is entered within the burning-gas valve-chamber, and which projects to the front thereof, and is connected with the lower end of the depending yoke 36, said depending yoke sliding thereon between two stops, 42 and 43.

44 is a spiral coiled around said gas-valve rod 41, between the front of its chamber and the stop 42.

Such being a convenient construction of parts, by a reference to Figs. 3 and 4 it will be apparent that when the parts are in the position represented in Fig. 3 the burning-gas valve is off the inlet-pipe and the supply of burning-gas at full head. Upon the throw of the rocker and the movement of the flame-carrier, as hereinbefore described, the carrier-stem 26, through the instrumentality of the depending yoke 36, will occasion the backward throw of the gas-valve rod and the movement of the flame and gas valves from the positions which they occupy in Fig. 3 to those which they occupy in Fig. 4. In this last-named position of parts the fresh supply of burning-gas is of course cut off, and the flame at the burner supported simply by such residuum of burning-gas as remains within the burning-gas valve-chamber around and contiguous to the flame-valve. Upon the return of the flame-carrier through the medium of the yoke and spiral the flame and burning-gas valves are again caused to assume the position which they occupy in Fig. 3, in which position the supply of burning-gas is augmented and the flame at the burner increased in volume, so as to cause it to leap up through the flame-ports in the carrier-chamber, as shown in Fig. 3.

The whole contrivance last described is designed to regulate to a nicety the amount of burning-gas actually required for the explosion of the gaseous mixture, and to avoid the waste occasioned by the unnecessary consumption of burning-gas.

One feature of my invention in this connection is of an especial value—namely, the fact that when the parts are in the position represented in Fig. 3 the large flame from the burner through the flame-ports heats the air within the flame-carrier, so that at the moment when the carrier is driven back against its seat in the ignition-port it is caused not only to close the flame-ports and carry a portion of the flame bodily into the combustion-chamber, but is also caused to supply, together with said flame, heated air to the furtherance of the force of the explosion, as will be well understood by those familiar with the properties of explosive gases.

While I have specified with some particularity of detail the exact constructions which I have represented in the drawings, I desire to state that competent constructors will understand that many of these detailed constructions and contrivances can be modified or altered, or even dispensed with, while the substitution of equivalent contrivances properly embodying the principles of the invention may be made. Thus, for instance, while I have described a rock-shaft, a rock-shaft arm, cam, rocker, yoke, stems, and sundry springs as a means for conveniently operating the flame-valve, flame-carrier, and ignition-valve, it is obvious that the gist of the invention lies in the provision, in the relation stated, of the last-named elements themselves, and that many devices may be resorted to by a skillful mechanic which will take the place of the various movements recited. Thus, for instance, while I have also represented and described a bell-crank lever, a rod, and a sliding cam as a means for securing the transmission of the motion of the governor to the operation of the valve which controls the supply of rich gas, I desire to state that many other mechanical contrivances will effect this transmission of power, the gist of the idea residing in the supply to the injector of rich gas at such time as such gas is needed. I have simply herein recited what I deem a convenient form of an engine embodying my improvements; but

I claim as my invention—

1. In a gas-engine in which the motive power is derived from the ignition of explosive gaseous mixtures, in combination with an injector communicating on the one hand with a source of supply of explosive gaseous mixtures and on the other hand with the combustion-chamber in which the explosion is to take place, a conduit or passage-way communicating on the one hand with the injector at a point within its injecting influence and on the

other hand with a source of supply of rich gas, and means for controlling the influx of said rich gas.

2. In a gas-engine in which the motive power is derived from the ignition of explosive gaseous mixtures, in combination with an injector communicating on the one hand with a source of supply of explosive gaseous mixtures and on the other hand with the combustion-chamber in which the explosion is to take place, a conduit or passage-way communicating on the one hand with the injector at a point within the influence of the injector-nozzle and on the other hand with a source of supply of rich gas, a valve upon said conduit to control the influx of rich gas, a movable cam, and mechanism connecting said cam with a governor operated by the engine, whereby upon the slow movement of the governor the cam is moved to engage against and open the valve, and upon the rapid movement of the governor is moved out of said engagement.

3. In a gas-engine in which the motive power is derived from the ignition of explosive gaseous mixtures, in combination with a combustion-chamber, a jet of burning gas exterior to said chamber and adapted to heat the air in the flame-carrier, a flame-carrier, (preferably within a carrier-chamber communicating with the combustion-chamber,) and means for automatically moving said flame-carrier athwart the burning flame and then against an ignition port or opening in the combustion-chamber, so as to project both flame and heated air into said chamber into contact with the explosive mixture therein.

4. In a gas-engine in which the motive power is derived from the ignition of explosive gaseous mixtures, in combination with a combustion-chamber, a jet of burning gas exterior to said chamber, a flame-carrier within a carrier-chamber communicating with the combustion-chamber, a flame-valve within a burning-gas chamber, and means for moving said flame-valve synchronously with the flame-carrier, so as to regulate and reduce the supply of burning-gas subsequent to the closing of the carrier.

5. In a gas-engine in which the motive power is derived from the ignition of explosive gaseous mixtures, as a tubular rotary induction-valve, the combination of the hollow cylinder provided with ports, the cones, and the shaft, substantially as and for the purpose specified.

6. The method of producing an explosion in a gas-engine herein set forth, which consists in introducing both flame and heated air into the combustion-chamber in which is contained an explosive mixture of gas and air.

7. In a gas-engine in which the motive power is derived from the ignition of explosive gaseous mixtures, in combination with a combustion-chamber, an ignition-valve controlling a port entering thereinto, a reciprocating flame-carrier, a jet of burning gas exterior to the port of the ignition-valve and in the path of said flame-carrier, and means for both advancing said carrier athwart said flame and against the ignition-port, and for unseating said ignition-valve from said port, as and for the purposes set forth.

8. In a gas-engine of the class herein recited, the combination of the following instrumentalities for the purposes set forth: a combustion-chamber, an ignition-port, a flame-carrier, a jet of burning gas, a valve controlling said jet, means for supplying an explosive mixture to the combustion-chamber, and means for operating the carrier, ignition-valve, and burning-gas valve, substantially as described.

In testimony whereof I have hereunto signed my name this 18th day of February, A. D. 1882

PETER MUNZINGER.

In presence of—
JOHN JOLLEY, Jr.,
J. BONSALL TAYLOR.