No. 673,109. **Patented Apr. 30, 1901.**

G. A. BRONDER.

GAS ENGINE.

(Application filed Feb. 16, 1898.)

(No Model.) **3 Sheets—Sheet 1.**

Fig. 2.

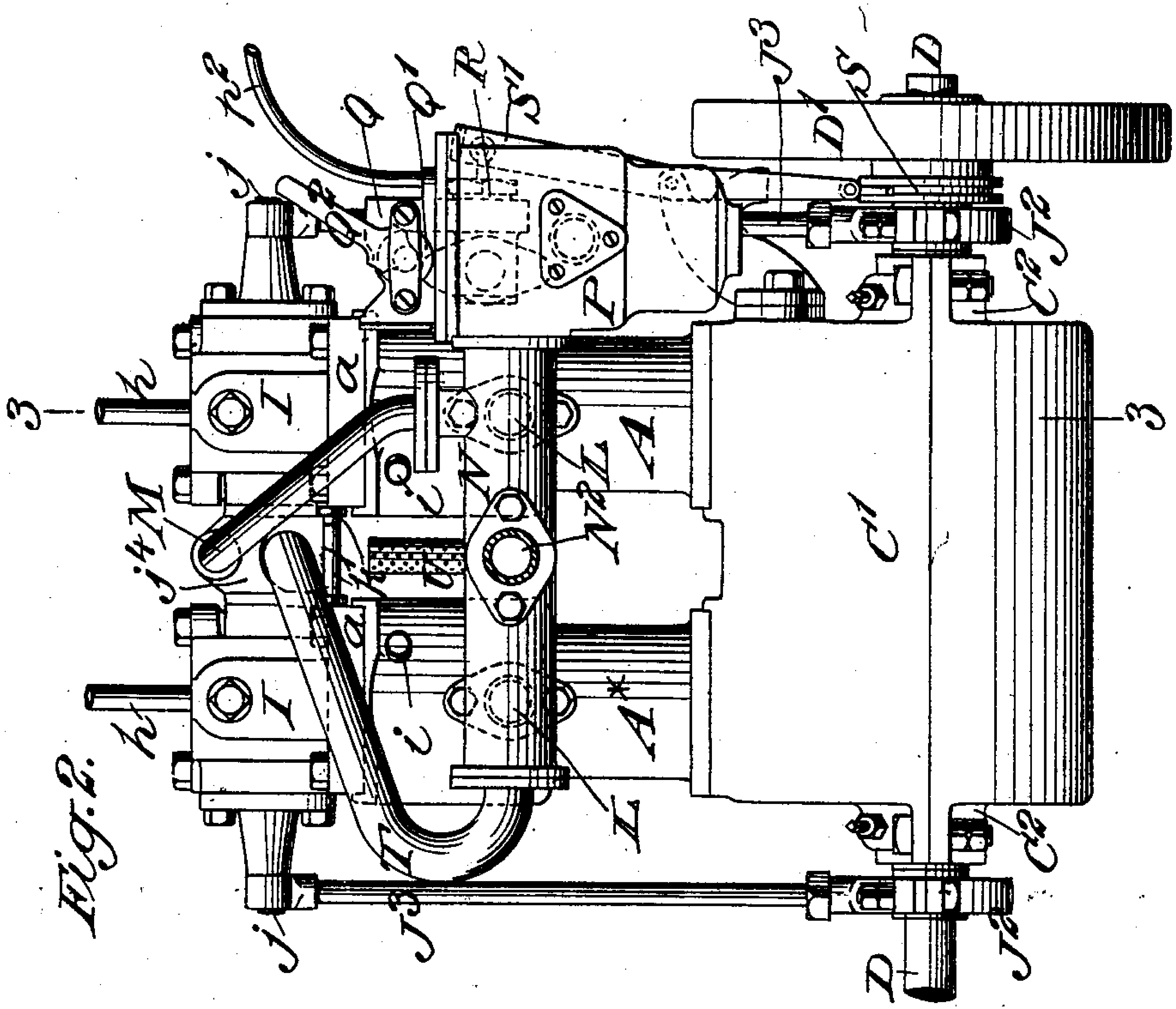
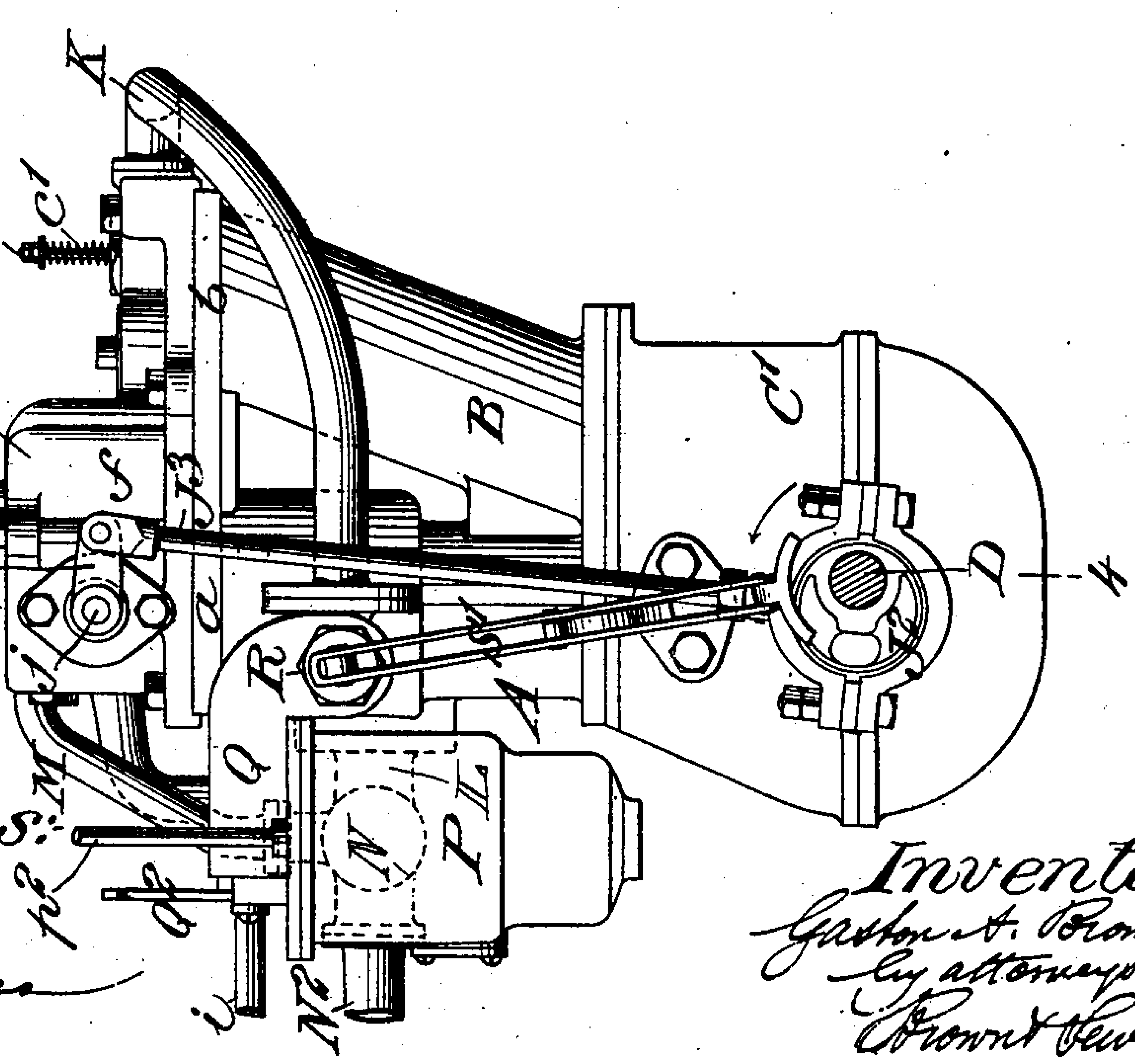


Fig. 1.



Witnesses:-
George Barry Jr.
Fred Haynes

Inventor:-
Gaston A. Bronder
by attorneys
Brown & Seward

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 673,109. Patented Apr. 30, 1901.

G. A. BRONDER.

GAS ENGINE.

(Application filed Feb. 16, 1898.)

(No Model.) 3 Sheets—Sheet 2.

Fig. 4.

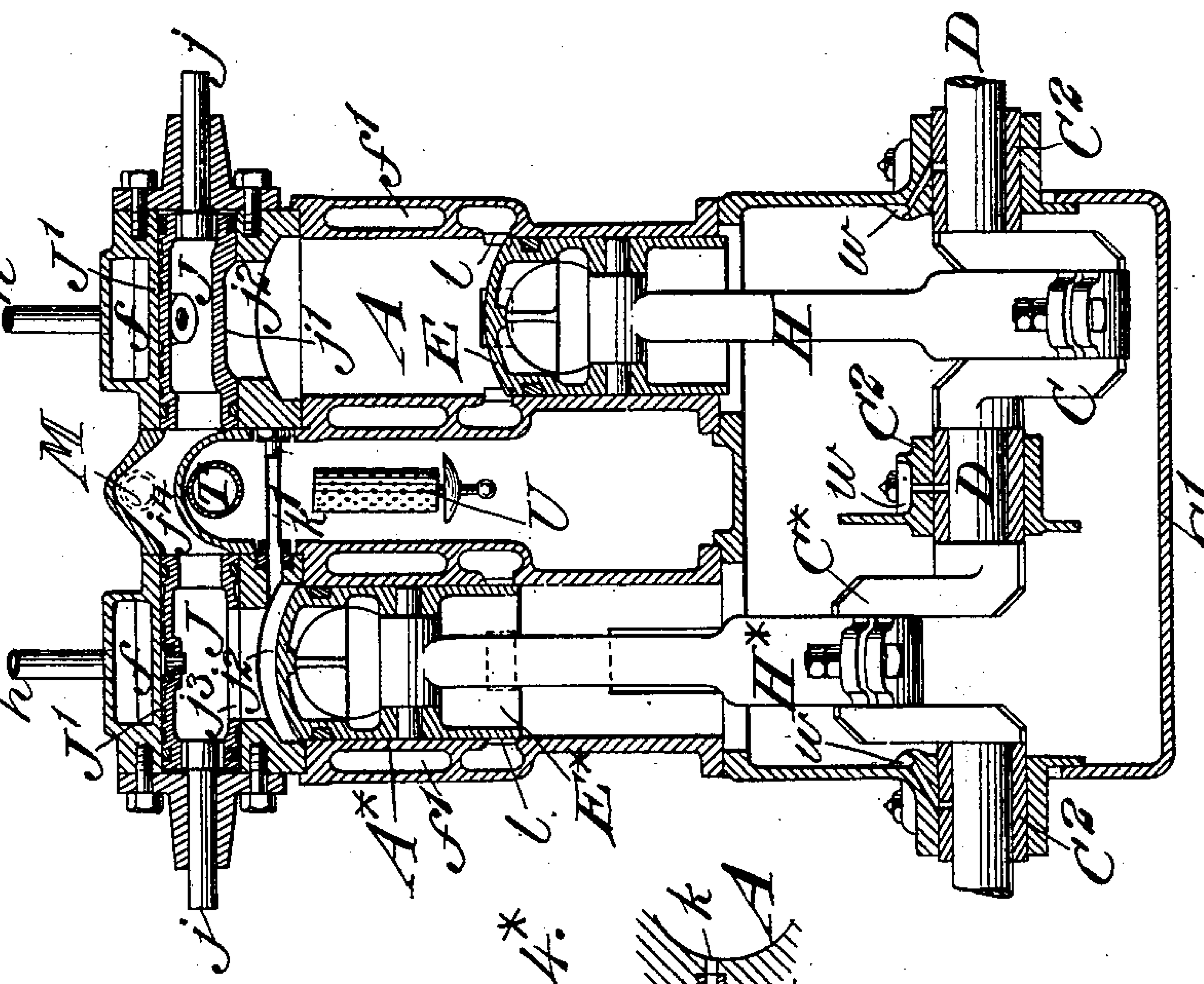


Fig. 4*.

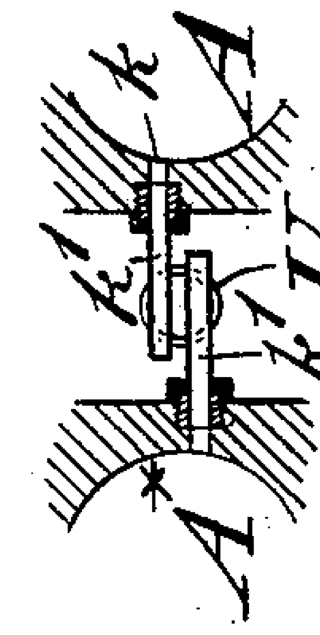
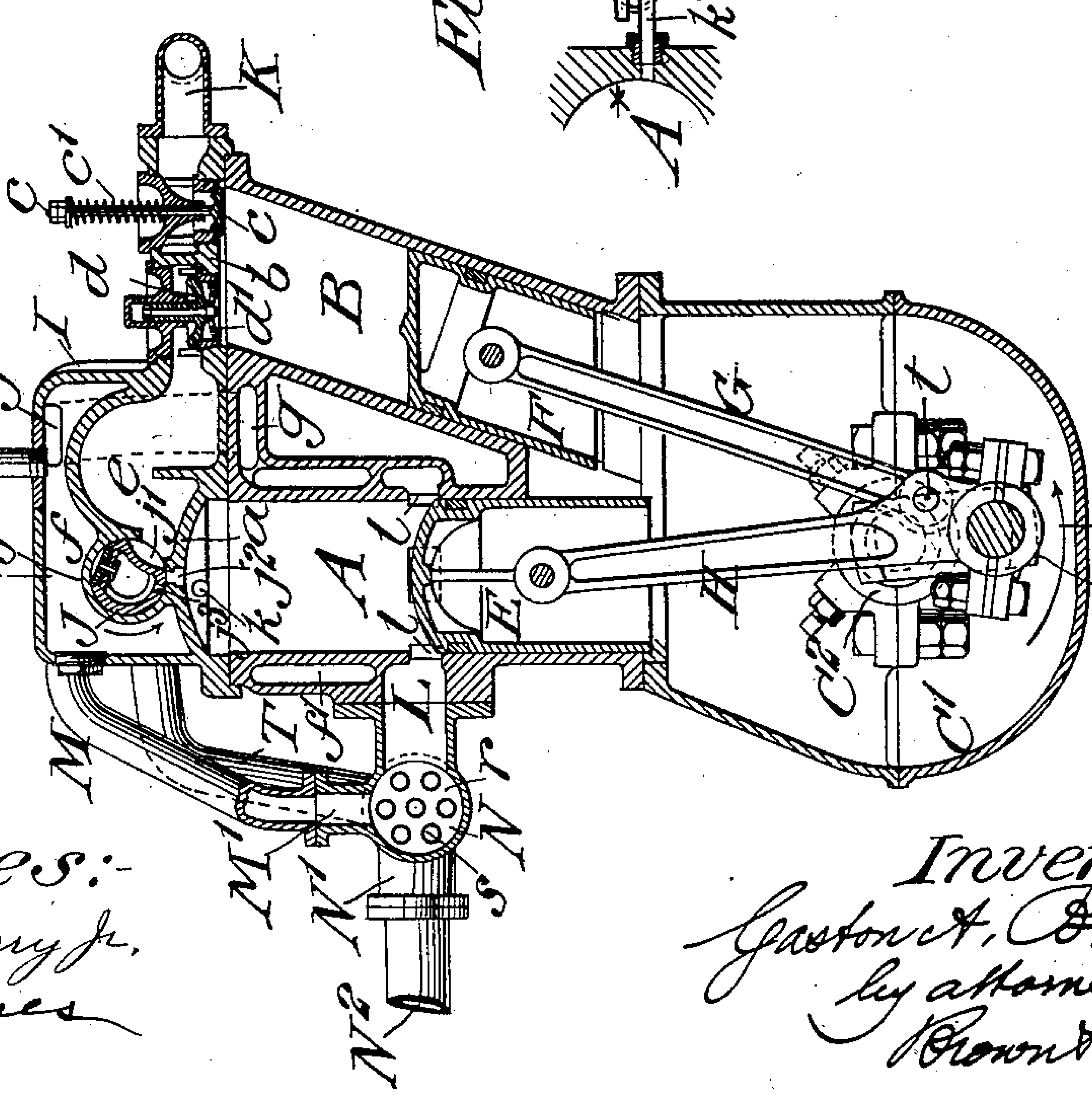


Fig. 3.



Witnesses:-
George Barry Jr.
Fred^k Haynes

Inventor:-
Gaston A. Bronder
by attorneys
Brown & Seward

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

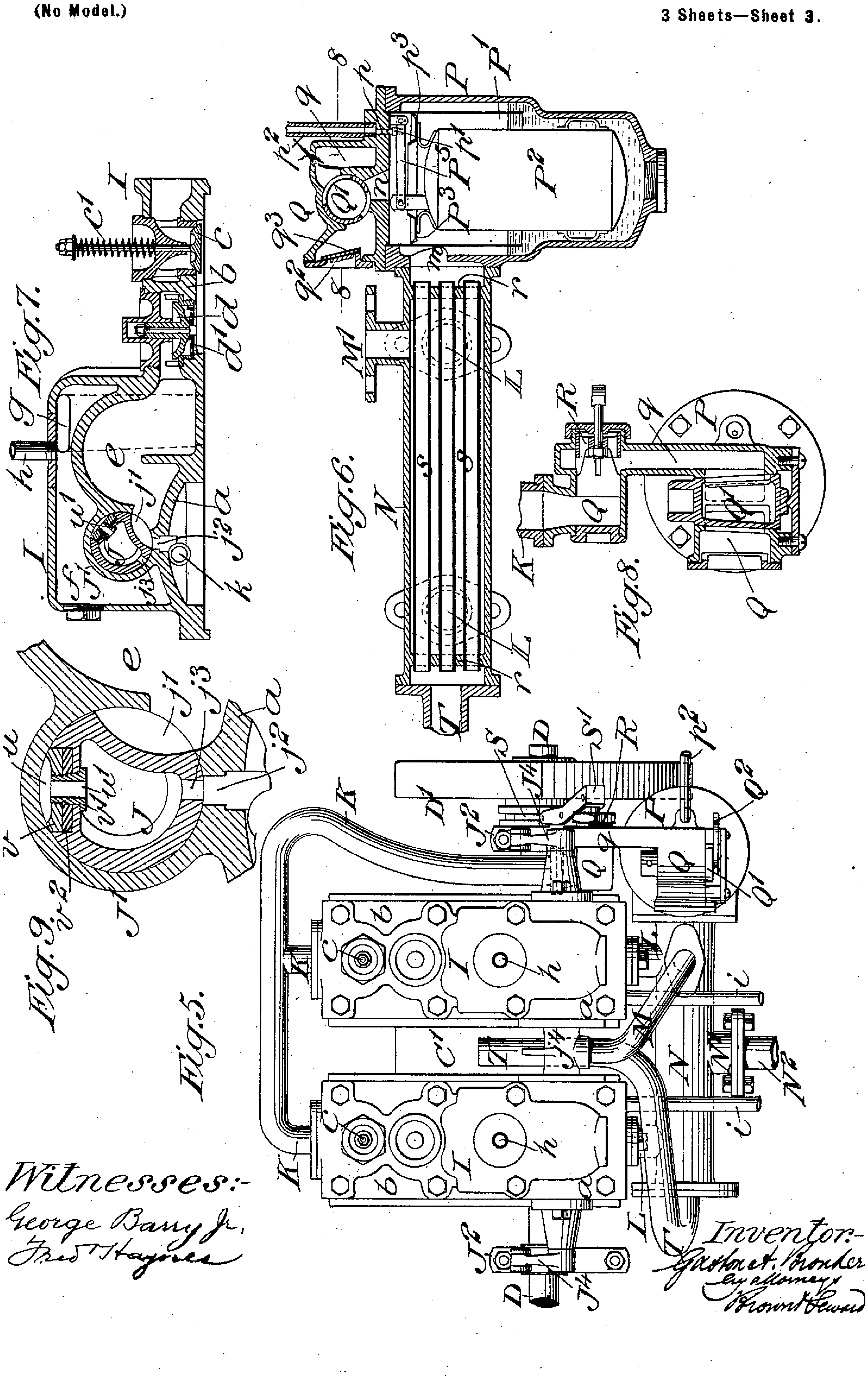
No. 673,109. **Patented Apr. 30, 1901.**

G. A. BRONDER.

GAS ENGINE.

(Application filed Feb. 16, 1898.)

(No Model.) **3 Sheets—Sheet 3.**



THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

GASTON A. BRONDER, OF BROOKLYN, NEW YORK.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 673,109, dated April 30, 1901.

Application filed February 16, 1898. Serial No. 670,464. (No model.)

To all whom it may concern:

Be it known that I, GASTON A. BRONDER, a citizen of the United States, and a resident of the borough of Brooklyn, in the city of New York and State of New York, have invented a new and useful Improvement in Gas-Engines, of which the following is a specification.

This invention relates to that class of gas-engines known as "compression explosive gas-engines," in which pistons are actuated by the pressure produced by the explosive combustion of a mixture of compressed air and a combustible vapor or gas.

A gas-engine embodying my invention in its most complete and desirable form comprises as essential features an air-compression cylinder and an explosion or power cylinder having pistons connected with the same crank, a carbureter in which the air and vapor are mixed, a heater in which the hot spent gases escaping from the power-cylinder are employed for heating the air on its way to the carbureter, an explosion-chamber between the compression and power cylinders, and a valve deriving motion from the engine and serving the two purposes of controlling the admission of the explosive mixture of air and vapor or gas from the explosion-chamber to the power-cylinder and the evacuation of the spent gases from the said cylinder.

My invention also includes certain details to be hereinafter described, and pointed out in claims.

The accompanying drawings represent an engine embodying all the features of my invention.

Figure 1 is a side elevation; Fig. 2, a front elevation. Fig. 3 is a vertical section parallel with Fig. 1 in the line 3 3 of Fig. 2 as viewed from the left of that figure. Fig. 4 is a vertical section parallel with Fig. 2 in the line 4 4 of Figs. 1 and 3 as viewed from the right of those figures, the valve-gear and governor being omitted. Fig. 4* is a detail view, which will be hereinafter explained. Fig. 5 is a plan view; Fig. 6, a vertical section of the carbureter and air-heater; Fig. 7, a vertical section corresponding with Fig. 3 of the explosion-chamber, the valve-box and valves of the compression-cylinder, and the valve for controlling the admission of the explosive mixture of air and gas or vapor from the combustion-chamber to the power-cylinder and the evacuation of the spent gas from the latter cylinder; Fig. 8, a horizontal section of the hand-controlled valve hereinbefore mentioned and of the governor-valve and communicating passages, taken in the line 8 8 of Fig. 6. Fig. 9 is a detail view, which will be hereinafter explained. Figs. 6, 7, and 8 are on a larger scale than Figs. 1 to 5, and Fig. 9 is on a still larger scale.

Similar letters of reference designate corresponding parts in all the figures.

The engine represented is a double one—that is to say, it has two similar power or explosion cylinders A A*, fitted with pistons E E*, and two similar compression-cylinders B, fitted with pistons F, one compression-cylinder for each explosion-cylinder, the piston E of the one explosion-cylinder A and the piston F of the corresponding compression-cylinder B being connected by rods G H with one, C, of two cranks set in opposite directions on the main or power transmitting shaft G of the engine, and the piston E* of the power-cylinder A* and the piston of the corresponding air-compression cylinder being connected by similar rods G H with the other one, C*, of said cranks. These connections will be hereinafter more fully described. The said cylinders and shaft may be supported in any suitable manner. The cylinders are represented as all erected upon a hollow base C′, in which are also provided the bearings C^2 for the crank-shaft D. The lower ends of all the cylinders being open to the cavity of the base C′ may be considered as open to the atmosphere. As the two engines of which this double engine is composed, each comprising one compression-cylinder and piston and one explosion or power cylinder and piston, one crank and its piston connections, and one set of valves, are both alike, it will be sufficient to describe in detail, as follows, one of said engines.

The upper end of the explosion-cylinder A is closed by a head *a* and the upper end of the compression-cylinder is closed by a head *b*, the last-mentioned head being made hollow to constitute a valve-box to contain the inlet-valve *c* for the admission of the explosive mixture to the compression-cylinder and the outlet-valve d for the passage of the compressed mixture to the explosion-chamber e, which is arranged, as shown in Fig. 3, between the compression-cylinder and the explosion-cylinder. Each two corresponding cylinder-heads a and b and their respective explosion-chamber e are represented as formed by a single casting I, as more fully shown in the larger view, Fig. 7. This casting I includes a water-jacket f, which surrounds the greater part of the seat J' of the cylindrical valve J, which controls the admission of the explosive mixture from the explosion-chamber to the explosion-cylinder and also controls the final evacuation of the spent gases from the said cylinder. The said jacket f is supplied with cooling water through a side passage g (see Figs. 3 and 7) from a jacket f', which surrounds the power-cylinder and which is supplied with water through a pipe i, the water passing through both jackets and escaping by a pipe h at the top of the jacket f.

The induction-pipe K, through which the mixture of air and vapor is admitted to the engine, communicates with the inlet-compartment of the valve-box in the compression-cylinder head b. The inlet and discharge valves c d in the said head may be such as are common in air-compressors. They are represented as puppet-valves with closing-springs c' d'. The valve J is of hollow cylindrical form and derives an oscillating motion from one of two separate eccentrics J^2 (see Figs. 1 and 2) on the crank-shaft D, the rod J^3 of said eccentric being connected with an arm J^4 on a part of the valve-spindle j, which projects through one side of the casting I, in which the cylindrical seat of the said valve is formed. The valve J has in its outer circumference a coved port j', which by the oscillation of the valve is caused to open and close communication between the explosion-chamber e and the cylinder A through a port j^2 in the cylinder-head, just below which port there is an inlet k through one side of the cylinder-head from an igniting-tube k'. The said valve also has a second port j^3, which will be hereinafter described as a "supplemental exhaust-port," and through which by the oscillating movement of the valve communication is opened and closed between the cylinder A and the internal cylindrical cavity of the valve. The valves J J of the two engines opposite and in line with each other, as shown in Fig. 4, and their internal cylindrical cavities are both in constant communication, through a cross-passage j^4, (see Figs. 2, 4, and 5,) with a pipe M, which will be hereinafter described as the "supplemental exhaust-pipe," and through which the final evacuation of the hot spent gases from the cylinder A is effected, the greater portion of said gases being intended to escape through ports l in the lower part of the said cylinder, which are opened and closed by the movement of its piston E, and through said ports to an outlet L (see Figs. 1, 2, 3, 5, and 6) to the heater N, wherein the said hot gases are employed to heat the air on its way to the carbureter p.

The body of the carbureter, the location of which is shown in Figs. 1, 2, and 5, but which is shown in section in Fig. 6, consists of a tight vessel P for containing the gasolene or carbureting liquid and in which there is an opening m at one side for the entrance of fresh-heated air from the heater N and an opening n at the top for the exit of the carbureted air. From the top of this vessel P there is dependent a dipping cylinder or petticoat P', extending about half-way down, and within this petticoat there is contained in the said vessel a float P^2. Attached to the top of the float within the petticoat there is an annular tray or trough P^3, over which in the head of the vessel P there is a small opening p, through which a suitable hydrocarbon liquid, as gasolene, drops into said trough or tray by a pipe p^2 from any suitable reservoir under the control of a valve p', fitted to said opening. This valve is attached to a lever P^5, which is so connected with the float as to be closed by the ascent and opened by the descent thereof. The tray P^3 is perforated near its outer edges, as indicated at p^3 in Fig. 6, for the escape of the liquid therefrom in numerous small streams against the internal surface of the petticoat P' in a thinly-distributed condition. The float is so balanced and its lever connection with the valve p' is such that the opening and closing of the said valve p' is so controlled as to keep the liquid in the reservoir at a normal level only slightly above the lower edge of the petticoat. From the outlet n for the carbureted air a communication is provided to the induction-pipe K, which leads to the inlet-compartment of the valve-box of the compression-cylinder through a valve-box Q on the top of the carbureter, the said valve-box having an outlet-passage q, Figs. 1, 2, 5, 6, and 8, which leads to said pipe K. The communication between the outlet n and the passage q is controlled, as shown in Figs. 6 and 8, by a hollow conical valve Q', which is fitted to a corresponding seat in the valve-box Q and adjustable by a hand-lever Q^2, the ports in said seat and valve being so arranged, as shown in Fig. 6, as to be capable of opening and closing communication between n and q while opening or closing communication between the said passage q and an inlet-opening q^2, through which fresh cold air may be admitted to the valve-box from the surrounding atmosphere to mix with the carbureted air when it may be ascertained that the latter is too highly carbureted. The inlet q^2 is fitted with an inwardly-opening check-valve q^3, which is self-closing, to prevent any escape of carbureted air.

The air is drawn through the carbureter by the suction of the compression-cylinder piston during every downstroke of the latter, the said suction causing the air entering at m to the space between the petticoat and the walls of the vessel P to be drawn down in the said space and to depress the level of the liquid therein below the edges of the petticoat under which it passes through the liquid within the latter, thence passing between the float and inner surface of the petticoat and absorbing the vapor from the thinly-distributed liquid on the said surface passing out at n. If the valve Q′ be turned to a proper position to open communication between the fresh-air inlet q^2, the suction of the compression-cylinder piston will also cause the opening of the valve q^3 and the entrance of fresh air to mix with the carbureted air passing out at q.

Between the passage q and the pipe K there is provided in the valve-box Q a governor-valve R, controlled, through a lever S′, by a governor S on the crank-shaft, so that when the highest desired speed is exceeded the said valve cuts off the supply of air and vapor entirely from the engine and causes a vacuum in the compression-cylinder, thereby retarding the engine until it resumes its normal speed.

The heater represented is of multitubular construction, consisting of a cylinder or shell N, across which, near the ends thereof, are tube sheets or diaphragms r, which receive the air-tubes s. The said shell N is connected at one end with the carbureter P at the inlet m of the latter, and its other end is open to the atmosphere and has connected with it the air-suction pipe T, through which the air to be carbureted is supplied. The said shell is connected between the tube-sheets r with the outlets L L of the two power-cylinders, so that the hot spent gases escaping from said cylinders through said outlets into said shell will circulate around and between said tubes and heat the air which is drawn through said tubes in the carbureter by the suction of the compression-cylinder. The said shell has an outlet at N′ to the exhaust-pipe N^2, through which the final escape of the spent gases takes place. The supplemental exhaust-pipe M, hereinbefore mentioned, through which the final exhaust from the power-cylinder through the ports j^2 j^3 and the valve J takes place, is connected with the heater-shell N at M′, so that all of the escaping hot spent gases from the engine are utilized for heating the incoming air.

The arrangement of the power-cylinder A and the compression-cylinder B and their connection with a single crank, which constitute important features of my invention, are best illustrated in Fig. 3. The two cylinders, placed one before the other and as near together as practicable, are set at such inclination to each other and the crank-shaft is arranged in such relation to them that lines coincident with the axes of the two cylinders would meet approximately in the axis of the crank-shaft, and hence that the two connecting-rods G and H of their respective pistons operate in connection with the crank-pin with approximately equal directness, each in lines as nearly as practicable parallel with its respective cylinder. The connecting-rod H of the power-piston E is connected directly with the crank-pin, but the connecting-rod G of the compression-piston instead of being so directly connected is connected with the said rod H as nearly as practicable to the crank-pin by means of a separate pin t, (see Fig. 3,) and by this means, while the connection between the crank-pin and the compression-piston is made in a nearly straight line, a comparatively long crank-pin bearing is obtained for the power-piston rod without a very long crank-pin. The revolution of the crank being in the direction of the arrows shown near it in Figs. 1 and 3, which is such that the crank-pin passes the compression-piston before it passes the power-piston, causes the former piston first to complete its stroke and fill the explosion-chamber e with the fully-compressed gas before the power-piston is required to start on its working stroke. It will be understood that the eccentric J^2 should be so set on the crank-shaft as to so operate the valve J that the said valve will not open the communication between the two cylinders until after the termination of the upward stroke of the compression-piston and the completion of the compression, and that it will leave the power-cylinder port j^2 open to the valve-port j^3 for the final escape of the spent gas from the power-cylinder until the power-piston has made all but a small fraction of its complete stroke. The valve J so operating insures the evacuation of the power-cylinder of all but an exceedingly small portion of the spent gases before the advent of a fresh charge of air and gas or vapor.

To provide for the balancing of the valve J hereinbefore described against the pressure of the gas which is admitted into its interior through its port j^3, I provide in its exterior opposite the said port a cavity u of an area equal to that of the said port j^3 and provide an opening u' to said cavity u from the interior of the valve. In order to prevent any leakage around the valve through the port j^3 and opening u', I have made the special provision fully represented in Fig. 9, which is a transverse section of the valve and its seat on a larger scale than Fig. 7. The said cavity u instead of being formed in the body of the valve is formed in the outer face of a metal packing-ring v, which is fitted to a seat countersunk in the exterior of the valve, and the opening u' is formed in a thimble v', which is screwed into the said ring from the interior of the valve. Under the said ring at the bottom of its seat there is placed around the thimble v' a ring v^2 of a suitable more or less elastic substance, as asbestos packing, of sufficient thickness to form not only a gas-tight packing around the thimble, but a spring by which the margin of the outer face of the metal ring v is held gas-tight against the interior of the valve-seat J′.

The igniting-tubes k' k' of the two power-cylinders are located in the spaces between said cylinders, as shown in Figs. 2 and 4, but more clearly in Fig. 4*, which is a horizontal section of said tubes and parts of the two cylinders and a plan of the single lamp by which both of said tubes are kept heated sufficiently to inflame the mixture of air and vapor or gas which enters them from the explosion-chamber. The said tubes are arranged side by side, and the lamp U is so arranged below them that it will heat them both. A part of the pipe T which supplies the air to be carbureted is arranged over the lamp and above the igniting-tubes and within an arch formed by the cross-passage j^4, as shown in Figs. 2 and 4, so that it may be heated to some extent by the waste heat from the same lamp U, the heat from which is reverberated upon the said pipe T and the igniting-tubes by the said arch.

It has been hereinbefore mentioned that the base C′ of the engine is hollow. Its bottom being closed tightly makes it serve as an oil-reservoir for containing oil for the lubrication of the crank-shaft and crank-pin bearings. The cranks during the lower portions of their revolutions dipping into the oil in this reservoir oil their own crank-pins and pick up a certain portion of said oil, which during the upper portions of their revolutions is thrown by them against and into catchers w, which conduct it to the oil-holes of the shaft-bearings C^2.

The operation of either of the two engines is as follows: First, suppose the parts to be in the relative positions shown in Fig. 1, the crank moving in the direction of the arrow shown near it in Fig. 3. The power-piston has completed its downward stroke and is just commencing to move upward and is exhausting through its ports l. The compression-piston having started on its upward stroke in advance of the power-piston has not yet moved upward far enough to cause the opening of its valve d by the compression of the mixture of air and vapor with which its cylinder was filled by the downward stroke. The oscillating valve J is moving in the direction of the arrow shown near it in Fig. 3, but the port j^2 in the power-cylinder head is closed both to the explosion-chamber and to the valve-port j^3. By the time the power-piston has moved upward far enough to close the exhaust-ports l the valve J will have moved far enough to open its port j^3 to the port j^2, as shown in Fig. 9, and so permit the spent gas remaining in the power-cylinder to be forced out therefrom by the upward movement of its piston through the interior of the valve J, and hence through the heater and carbureter to the exhaust-pipe. In the meantime the compression of the air and vapor which is going on in the compression-cylinder will have caused the opening of the valve d, and the compressed mixture will be forced into the explosion-chamber e, which continues to be closed to the power-cylinder by the valve J until the upward stroke of the compression-cylinder has been completed, when the valve J, the movement of which has been reversed, opens communication through the cove j' between the explosion-chamber and the power-cylinder, as shown in Fig. 7. The explosive mixture entering the power-cylinder is at once ignited at the opening k and the whole charge in the chamber e is exploded into gas, which entering the power-cylinder through the port j^2 produces the downward movement of the piston E and a half-revolution of the crank, the downward movement of the compression-piston B, which takes place at the same time, drawing a new charge of explosive mixture into the compression-cylinder.

A single engine, organized as hereinabove described, having a heavy fly-wheel D′ on the crank-shaft would form an effective motor for light work. In such an engine the upward stroke of the piston would be produced by the momentum of the fly-wheel. In the double engine with the two cranks set in opposite directions the operations of compressing the explosive mixture in the cylinder B and chamber e and of expelling the spent gas from the power-cylinder A of one engine will be performed while the exploded gas is doing its work on the piston E of the power-cylinder and the fresh charge of the explosive mixture is being drawn into the compression-cylinder of the other engine, one explosion taking place in each power-cylinder during every half-revolution or two during each revolution.

In an engine having its compression and power cylinders, explosion-chamber, valves, and piston connections like those of the engine herein described, but intended to be actuated by an explosive mixture of air and a permanent combustible gas, the carbureter will be dispensed with and the induction-pipe K may be connected with the outlet m of the heater, and the gas may be introduced into the induction-pipe in a continuous jet or shean at any suitable distance from the compression-cylinder.

What I claim as my invention is—

1. In an explosive gas-engine, the combination of a compression-cylinder, a power-cylinder, an explosion-chamber between said cylinders, and a hollow oscillating valve the internal cavity of which is in constant communication with an exhaust-outlet and in the exterior of which there is a coved port for forming communication between the power-cylinder and explosive-chamber and through one side of which there is a port for communication between the said power-cylinder and the said internal cavity, substantially as herein described.

2. In a compression explosive gas-engine having two power-cylinders arranged side by side and an arched exhaust-passage between and common to both cylinders, the combination of two igniting-tubes arranged side by side one for each cylinder under the arch of said passage, a heating-lamp arranged under

said tubes and common to both and an air-suction pipe a portion of which passes under said arch above said tubes to be heated both by said lamp and by the gas exhausting through said passage, all substantially as and for the purpose herein described.

3. The combination with the hollow oscillating valve for controlling the admission of the explosive mixture to the power-cylinder and the explosion of spent gases therefrom having a port j^3 through one side and opposite said port an open seat, of a metal packing-ring v fitted to said seat and having in its outer face a cavity of an area equal to said port, an elastic packing-ring v^2 fitted to said seat within said metal packing-ring and a shouldered thimble v' screwed into said metal ring from the interior of the valve, all substantially as herein described.

In testimony that I claim the foregoing as my invention I have signed my name, in presence of two witnesses, this 7th day of February, 1898.

GASTON A. BRONDER.

Witnesses:
FREDK. HAYNES,
L. M. EGBERT.