No. 632,888. Patented Sept. 12, 1899.

S. A. AYRES.

GAS ENGINE.

(Application filed Nov. 5, 1898.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

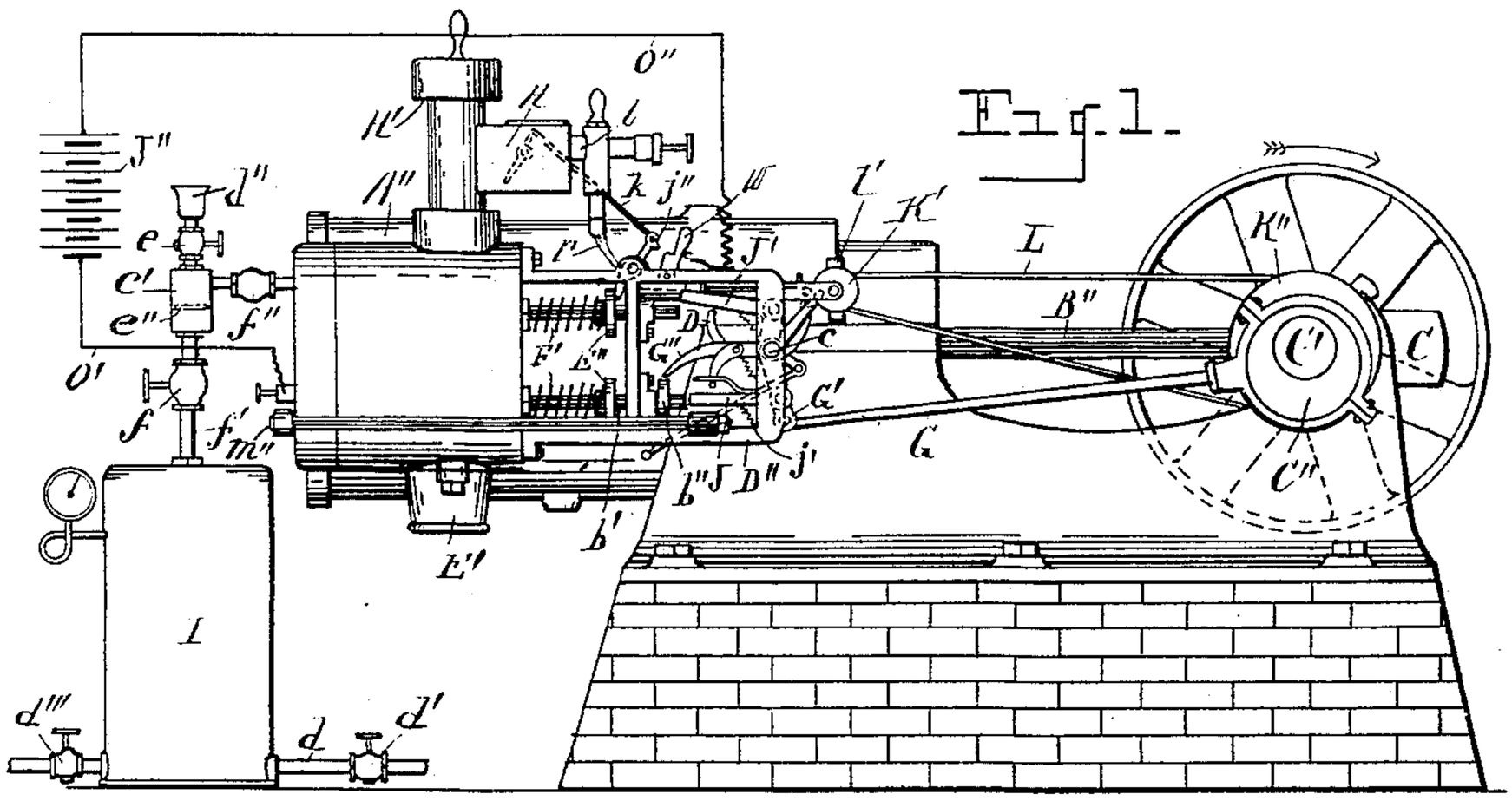

Fig. 3.

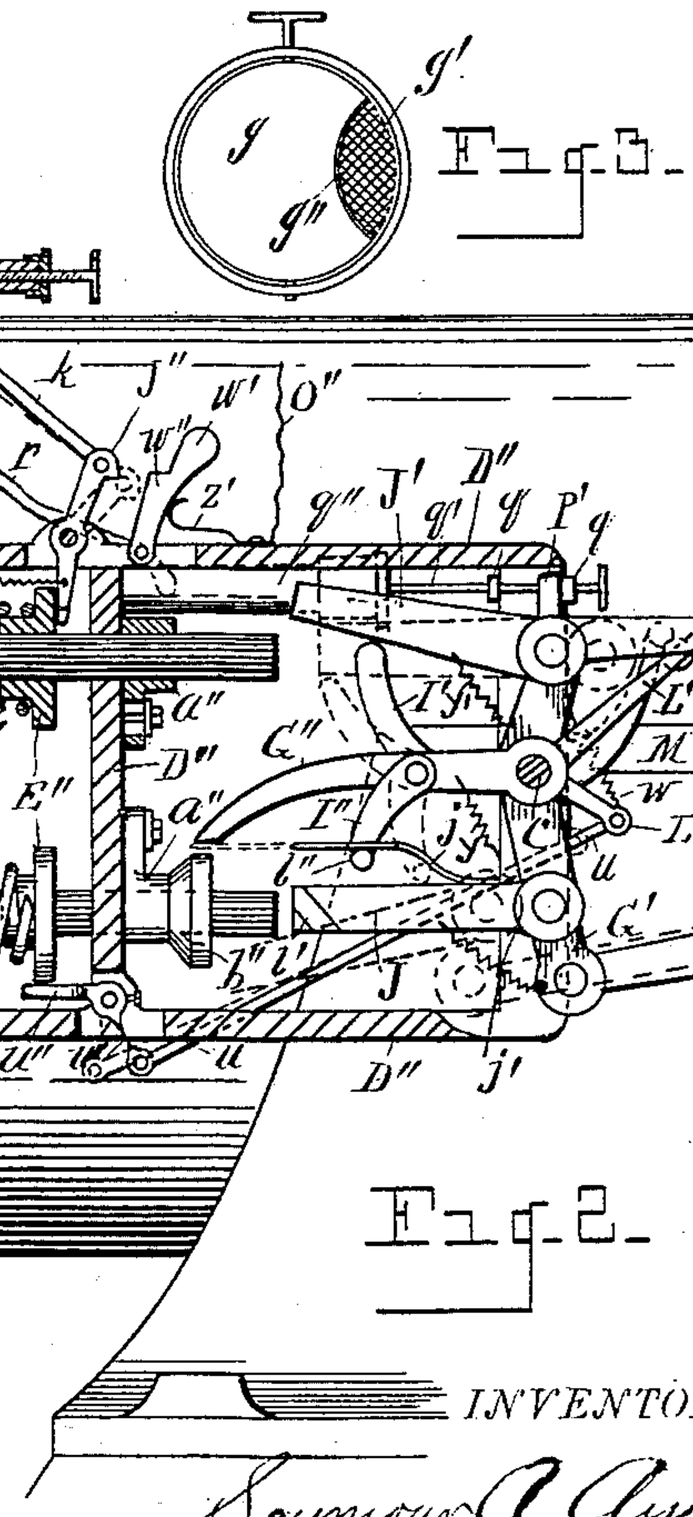

Fig. 2.

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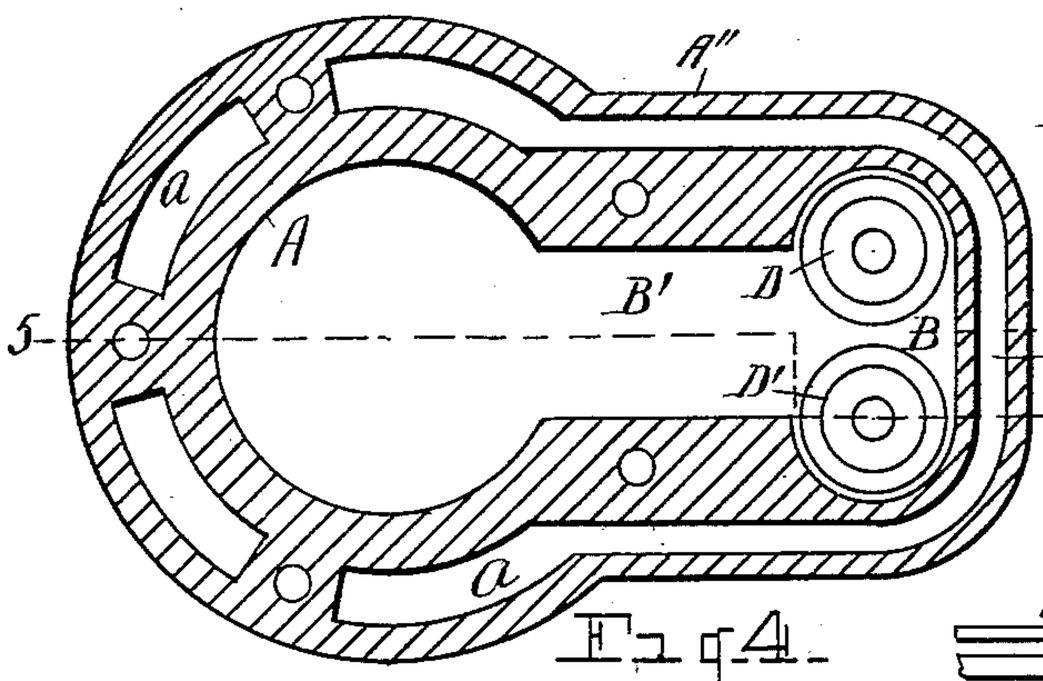

Fig. 4.

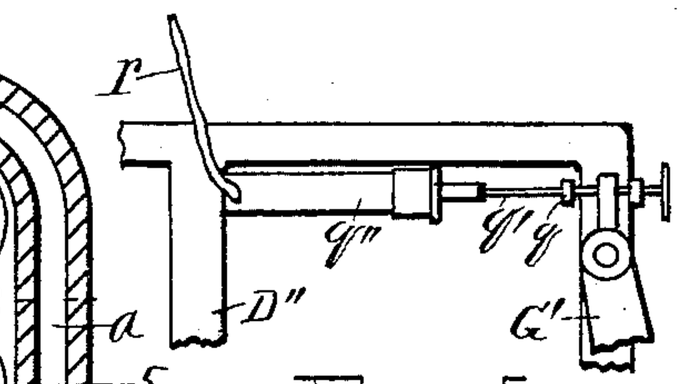

Fig. 6.

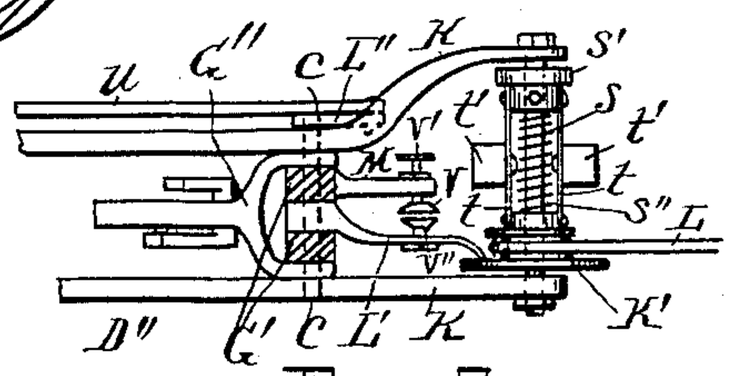

Fig. 7.

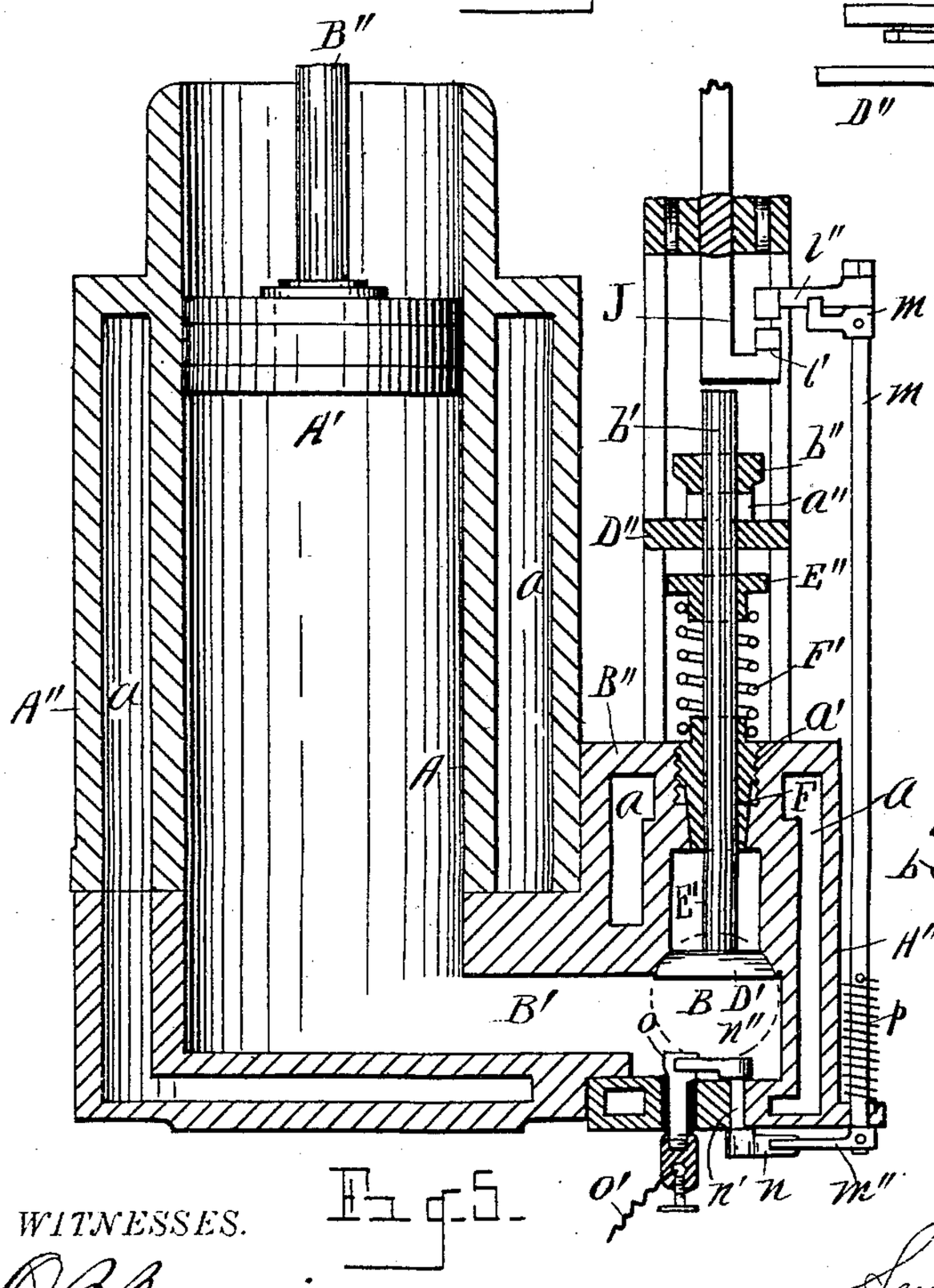

Fig. 5.

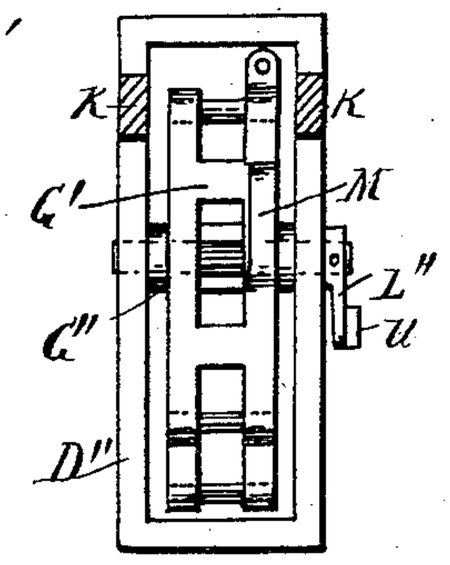

Fig. 8.

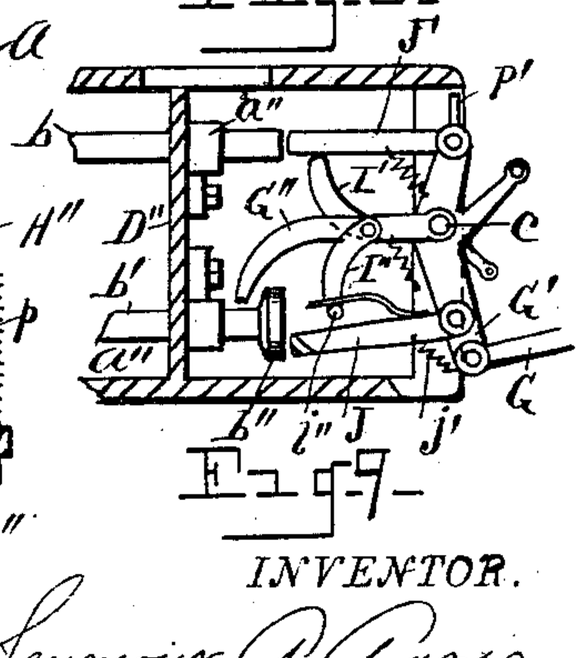

Fig. 9.

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UNITED STATES PATENT OFFICE.

SEYMOUR A. AYRES, OF BAY CITY, MICHIGAN.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 632,888, dated September 12, 1899.

Application filed November 5, 1898. Serial No. 695,529. (No model.)

To all whom it may concern:

Be it known that I, SEYMOUR A. AYRES, a citizen of the United States, residing at Bay City, in the county of Bay, State of Michigan, have invented certain new and useful Improvements in Gas-Engines; and I do 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, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to gas-engines or to engines of the class which are driven by the explosion of a combustible gas or vapor; and it consists in the construction and arrangement of parts hereinafter more fully set forth, and pointed out particularly in the claims.

The objects of the invention are to produce an engine of the class described, of simple and inexpensive construction, in which the arrangement is such as to provide for economy in the use of the propulsive vapor, to regulate the impulses which the engine receives and thereby control the speed thereof, to provide for proper adjustment of the valves to insure a proper seating thereof, and for taking up the wear around the stems of said valves, to provide for a perfect carburization of the air as it passes into the combustion or explosive chamber, and for regulating the supply of the explosive fluid. These objects are attained by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation of an engine involving my improved features. Fig. 2 is a central vertical section through the carbureting-chamber, the combustion-chamber, the inlet and exhaust valves communicating therewith, the exhaust-port, and a portion of the valve-operating mechanism, other parts of the engine appearing in elevation. Fig. 3 is a plan view looking into the top of the passage leading to the inlet-valve through which the carbureted air passes, showing the controlling-damper therein. Fig. 4 is a vertical transverse section through the end of the cylinder and communicating combustion-chamber as taken on dotted line 4 4 of Fig. 2. Fig. 5 is a central horizontal section as on line 5 5 of Fig. 4. Fig. 6 is a detail showing the pump which supplies the explosive fluid to the valve in the carbureting-chamber. Fig. 7 is a detail of the governor mechanism. Fig. 8 is a detail showing a front elevation of the rock-arm as pivoted in the engine-frame and the various parts connected therewith. Fig. 9 is a detail of the valve-actuating arms, showing a change in their position from that shown in Fig. 2 incident to the operation of the engine.

Referring to the letters of reference, A designates the cylinder in which the piston A′ is adapted to reciprocate.

B designates the combustion or explosive chamber communicating with the cylinder through the passage B′. Surrounding the cylinder and combustion-chamber is the exterior jacket A″, between which and the walls of said cylinder is the interposed water-space *a*.

To the piston is attached one end of the connecting-rod B″, the opposite end of which is journaled on the crank C of the main shaft C′ in a manner common and well understood in the art.

The inlet-valve D and the exhaust-valve D′ are located within the combustion-chamber and are arranged approximately parallel, their valve-stems *b* and *b*′, respectively, passing through the exterior wall B″ of the combustion-chamber and being supported in the frame D″ of the engine. The inlet-valve D controls the opening into the passage E, through which the carbureted air or explosive fluid enters the combustion-chamber. The exhaust-valve D′ controls the opening leading from the combustion-chamber and communicating with the exhaust-port E′. The faces of said valves are ground spherical, and their valve-seats are provided with a circular concave coinciding therewith, so as to insure a perfect seating of said valves, even should there be a slight lateral play in their valve-stems. To provide for taking up all wear in the bearings through which said valve-stems reciprocate, said stems are surrounded with conical split sleeves F, which are provided on their parallel faces with a thread *a*, adapted to screw into a threaded aperture in the wall B″, a portion of which aperture is tapering to receive the conical portion of said sleeve, whereby by screwing said sleeves into said apertures a proper bearing may be main-

tained around said valve-stems. Fixed upon each of said valve-stems is a collar E″, and upon each of said stems, between said collars and the wall B″, is an interposed coiled spring F′, the tension of which spring is exerted to maintain the valves upon said stems normally closed. The extreme outer ends of said valve-stems where they pass through the frame D″ of the engine are provided with suitable bearings *a*″, which may be adjusted to insure a perfect seating of the valves on said stems, and the end of the exhaust-valve stem is provided with a sliding collar *b*″, for purposes hereinafter stated.

The valve-actuating mechanism is operated through the medium of the eccentric-rod G, which is strapped at one end to the eccentric C″ upon the main shaft of the engine, the opposite end of said rod being pivoted to the lower end of the rock-arm G′, which is in turn pivoted at *c* to the lower frame of the engine. Mounted upon said rock-arm is a series of pivoted arms and levers adapted to alternately open and close the inlet and exhaust valves.

The carbureting-chamber H is located adjacent to the passage E, which leads to the inlet-valve and communicates with said passage through the opening *c*′, through which the explosive fluid passes from said chamber into the passage-way E and meets the air-current, which enters said passage-way through the air-induct opening H, and mixing with said air-current is carried thereby into the combustion-chamber when the inlet-valve D is open.

In the initial starting of the engine the auxiliary pressure-tank I is employed, which is connected through the medium of the pipe *d* to a source of water-supply under pressure. (Not shown.) The opening of the valve *d*′ will cause the water to flow into said tank and compress the air in the top thereof until the desired pressure is attained, when the valve *d*′ is closed. The cup *d*″ is then filled with explosive liquid and the valve *e* opened to permit said liquid to flow downward into the chamber *e*′ and spread upon the screen *e*″ therein. The valve *e* is then closed, and the valve *f*, located in the pipe *f*′, connecting said tank with the chamber *e*′, is opened, allowing air from said tank to pass through said chamber and vaporize the explosive liquid on the screen therein, carrying the explosive vapor into the combustion-chamber B, past the check-valve *f*″, located in the pipe connecting the chamber *e*′ with said combustion-chamber. As soon as the pressure in the combustion-chamber and the tank I becomes equal the charge in the combustion-chamber is ignited, which, acting upon the piston in the cylinder through the communicating passage B′, starts the engine. To empty tank I, open valve *d*‴. As the engine starts the damper *g*, pivoted within the passage-way E, is closed, as shown in Fig. 3 and by dotted lines in Fig. 2. In the edge of said damper, opposite the opening *c*′, through which the explosive fluid enters the passage-way E, is a circular opening in which is located a screen *g*′, and surrounding said screened opening on the damper side is an upwardly-projecting flange *g*″, against which the explosive fluid impinges and by which said fluid is thrown upon said screen. The closing of said damper in the air passage-way causes the air to rush with force through said screened opening, thereby insuring a perfect vaporization of the explosive fluid thrown thereon, and the consequent presence in the combustion-chamber of a requisite volume of explosive gas while the engine is running slowly before it acquires its normal speed. As soon as the engine has acquired speed the damper *g* is opened, as shown by dotted lines in Fig. 2, in which position the explosive fluid, passing with force from the valve *i* through the opening *c*′, impinges against said damper and is thrown downward upon the horizontal screen *i*′, crossing the air passage-way E below said damper, and is conveyed in the form of an explosive gas into the combustion-chamber with the air-current, which enters said chamber when the valve D is opened.

In the operation of the engine, the parts being in the position shown in Figs. 1 and 2 and the engine turning in the direction of the arrow shown in Fig. 1, the eccentric C″, as will be seen, is placed on the quarter with respect to the position of the crank C, so that when said crank is at the limit of its rearward throw the rock-arm G′, to which the eccentric-rod D is attached, will be actuated by said rod, so as to carry the arm J, pivoted to the lower end thereof, against the end of the stem of the exhaust-valve D′, opening said valve, as shown by dotted lines, thereby permitting the escape from the cylinder and combustion-chamber of the products of the preceding explosion as the piston returns to the forward end of the cylinder. As the piston reaches the limit of its forward stroke the rock-arm G′ will have been actuated by the eccentric to have retracted the arm J and permitted the exhaust-valve D′ to close. As the stem of the exhaust-valve is moved forward in the operation of opening said valve it slides through the collar *b*″ thereon, which upon the return of the valve-stem in the operation of closing the valve is carried rearwardly with said stem, permitting the curved arm G″ to drop behind said collar through the action of spring *y*, as clearly shown in Fig. 9. This dropping of the curved arm G″ carries downward the curved finger I′, upon which rests the arm J′, which is pivoted to the upper end of the rock-arm G′, permitting the free end of the arm J′ to drop, in response to the spring *y*′, into alinement with the end of the inlet-valve stem *b*. At the same time the downwardly-curved finger I″, also mounted on the arm G″, is carried downward by the dropping ot said arm. This finger has upon its lower end a projection *i*″, which engages the bent flat spring *j*, attached to the

arm J, whereby said arm J is permitted to be drawn downward by the coiled spring j', attached to the under side thereof, so that the free end of said arm J is out of alinement with the end of the exhaust-valve stem, as also shown in Fig. 9. The parts are in the above described position as the piston starts on the return stroke. The eccentric C', passing the upper arc of its circle and swinging to the rear, draws upon the rod G and throws the upper end of the rock-arm forward, causing the pivoted arm J' to engage the end of the stem b of the inlet-valve and open said valve. The opening of the inlet-valve D will cause the carbureted air to flow through the passage-way E into the combustion-chamber and cylinder to fill the vacuum created by the receding piston. As the collar E'' upon the stem of the inlet-valve is carried forward by the opening of said valve, the spring-actuated lever j'', pivoted in the frame and engaging said collar, is released, so that its spring will actuate said lever to draw upon the rod k, which is attached to said lever and to the bell-crank k', (shown by dotted lines in Fig. 2,) journaled in the wall of the carbureting chamber and having upon the inwardly-projecting end thereof a depending gate k'', whereby as said rod k is actuated, said gate is swung from in front of the aperture c' in the wall of said chamber, permitting the explosive fluid from the valve i to enter the air passage-way E when the inlet-valve is open and the engine is taking air. Upon the closing of the inlet-valve D the collar E'' on the stem thereof engages the end of the lever j'' and returns it to its former position, thereby swinging downward the gate k'' in front of the valve-opening i, so that the explosive fluid is prevented from entering the passage-way E when the engine is not taking air. The explosive fluid, which is directed into the bottom of the chamber H when the gate k'' is in the position above described, escapes therefrom through the egress-aperture l.

At the point in the operation of the engine when the valve D closes after admitting a charge of explosive gas, the piston having reached the extreme end of the cylinder, starts upon the return stroke at which time the position of the eccentric C'' is such as to again swing the lower end of the rock-arm G' forward, causing the pivoted arm J, the end of which is depressed, to engage the collar b'' upon the stem of the exhaust-valve and slide said collar forward thereon against the bearing a''. The beveled face of said collar engaging the end of the arm G'' raises said arm, thereby carrying upward the finger I', which engages and raises the pivoted end of the arm J' out of alinement with the end of the valve-stem d. At the same time the lower finger I'' on said curved arm is raised, placing a tension upon the spring j, which, as the lower end of the rock-arm recedes so as to cause the end of the arm J to clear the end of the valve-stem B', raises said arm J again into alinement with the valve-stem of the exhaust-valve. During this operation the piston is moving forward, compressing the charge in the forward end of the cylinder and the combustion-chamber. At the time the piston has reached the limit of its forward stroke and is about to start upon the return stroke the charge is ignited in the combustion-chamber through the medium of the arm J, which at that moment has reached the limit of its rearward movement in a depressed position, said arm being provided with a laterally-projecting incline l' into the path of which projects a correspondingly-beveled arm l'', (see Fig. 5,) which is loosely mounted on a rock-shaft m. Fixed to said shaft is a right-angled dog m', which projects onto the upper face of the arm l''. Secured to the opposite end of the shaft m is a crank m'', which is adapted to engage a corresponding crank n on the projecting end of a short rock-shaft n', passing through the wall of the combustion-chamber and carrying upon its inner end a contact-point n'', which is adapted to have contact with a second contact-point o, which is in circuit with one pole of the battery J'', through the line o', the opposite pole of said battery being in circuit with the contact n'', through line o'' and the frame of the engine, the arrangement being such that as the arm l'' is raised by the incline l' of the arm J passing thereunder the contact-points n'' and o are permitted to come together, and when said incline on said arm J passes the arm l'' and drops it the crank m'', actuated by the spring p on the shaft m, strikes the crank n and separates the contact-points, making a spark, thereby exploding the charge in the combustion-chamber and giving an impulse to the engine. After operating the igniter the arm J is raised by the flat spring j, as before described, so as to again open the exhaust-valve on the return of the piston, and so the operation continues, the engine receiving a charge and the charge being ignited in alternate succession. As the upper end of the rock-arm G' reciprocates, the lug p' thereon engages the stops q upon the piston-rod q' of the pump q'' and operates said pump so as to force the explosive liquid through the pipe r, which connects said pump with the valve I, so as to drive the explosive liquid from said valve with sufficient force to carry it through the opening c' into the passage-way E when the inlet-valve is open.

The speed of the engine is controlled by the governor mechanism, (shown more particularly in Figs. 2 and 7,) in which s designates a shaft which is journaled between the opposed brackets K, projecting from the engine-frame. Mounted upon said shaft at one end is a flanged spool K', which is adapted to slide longitudinally on said shaft and rotate therewith. Upon the opposite end of the shaft s is a collar s', and environing said shaft between said spool and collar is a coiled spring s''. Attached to said collar and said

spool at opposite ends are the flat springs *t*, located on opposite sides of said shaft and having secured thereto at their longitudinal centers the governor-weights *t'*. Upon the main shaft of the engine is a pulley K'', and connecting said pulley with the spool K' is a belt L, whereby the shaft *s* is rotated.

Fixed to the pin *c*, which is journaled in the engine-frame and serves as a pivot for the rock-arm G' and the bifurcated arm G'', is a spring-arm L', whose outer curved end bears against the projecting flange of the spool K'. Also fixed to the pin *c*, at the outer end thereof and adapted to move in unison with the spring-arm L', is a crank L'', which extends downwardly and to the end of which the rod *u* is coupled, the opposite end of said rod being coupled to a spring *u'*, projecting from the detent *u''*, pivoted in the engine-frame and adapted to engage the collar E'' on the stem of the exhaust-valve to hold said valve open, as hereinafter described. Projecting from the rock-arm G' is an auxiliary arm M, which is formed integral with the rock-arm and is provided at its outer end with a laterally-projecting button *v*, adapted to be attached by the screw *v'*. Projecting from the side of the spring-arm L' is a like button *v''*, which is adapted to be engaged by the button on the auxiliary arm M in the following manner: When the speed of the engine is above the normal, the centrifugal force exerted by the governor-weights *t'* will bow the springs *t* upon which said weights are mounted and cause the spool K' to slide longitudinally on the shaft *s*. The flange of said spool engages the spring-arm L', causing said arm to spring over sufficiently to carry the button *v''* thereon into the path of the button *v* on the arm M, so that said buttons engage as the arm M moves downward, carrying the arm L' therewith, thereby rocking the pin *c* and actuating the crank L'' to operate the rod *u* and place a tension upon the spring *u'*, connected with the detent *u''*, so that as the stem of the exhaust-valve is moved forward in the operation of opening the valve the collar E'' will be carried beyond the end of said detent, when because of the tension placed upon the spring *u'* the point of said detent will rise into the path of said collar and prevent the closing of said valve, as clearly shown by dotted lines in Fig. 2, the tension of the spring F holding said collar against said detent with sufficient force to maintain said detent in position. In this position of parts the collar *b''* on said valve-stem remains under the curved arm G'', maintaining said arm in its raised position and holding the arm J', through the medium of the finger I', in an elevated position out of alinement with the stem of the inlet-valve D, whereby said inlet-valve remains closed, and no further impulse can be given the engine until its speed decreases sufficiently to cause a disengagement of the buttons *v v''*, when the arm L' will be released, permitting the spring *w* to raise the arm L'' and draw upon the rod *u*, so as to cause the detent *u''* to drop from engagement with the collar of the stem of the exhaust-valve, permitting said valve to close and carrying the collar *b''* on the stem thereof from engagement with the curved arm G'', allowing said arm to drop and presenting the arm J' again in alinement with the stem of the inlet-valve D, when said valve will be opened and another impulse given to the engine.

To stop the engine, the pivoted lever *w'* is thrown over, so that the shoulder *w''* thereon will engage the upper end of the spring-actuated lever *j''*, thereby preventing the spring *z* from moving said lever *j''* to open the gate *k''*, whereby the explosive fluid is excluded from the air-passage way E, thereby depriving the engine from a further charge. At the same time the movement of said lever above described breaks the contact thereof with the insulated spring-terminal *z'*, to which the conductor *o''* from the battery leads, thereby breaking the electrical circuit through the contact-points within the combustion-chamber.

Having thus fully set forth this invention, what is claimed is—

1. In a gas-engine, the combination of the reciprocating valve-stems carrying valves which are located in the combustion-chamber, springs for holding said valves normally closed, the rock-arm having the valve-actuating arms adapted to operate upon said valve-stems to open said valves, a pivoted arm independent of the rock-arm-carrying fingers adapted to operate the valve-actuating arms to carry them into and out of alinement with said valve-stems, and means for actuating said finger-carrying arm.

2. In an engine, the combination with the reciprocating valve-stems, the sliding collar upon one of said valve-stems, a rock-arm, valve-actuating arms pivoted on said rock-arm and adapted to engage the ends of said valve-stems, a pivoted arm carrying curved fingers adapted to operate the valve-actuating arms, said finger-carrying arm engaging said sliding collar whereby it is successively raised and lowered substantially as and for the purpose set forth.

3. In a gas-engine, the combination of the inlet-valve closing and opening communication with the combustion-chamber, an air passage-way communicating with said valve, a fixed collar on the end of said valve, a carbureting-chamber adjacent to said air passage-way, an opening connecting said passage-way with said chamber, a fluid-emitting valve projecting into said chamber in line with said opening, a movable gate interposed between said valve and opening, a spring-actuated lever pivoted in the engine-frame adapted to be engaged by the fixed collar on said valve-stem, a rod connecting said lever with said movable gate whereby said gate is actuated by the opening and closing of said valve.

4. In a gas-engine, the combination of the inlet-valve having a reciprocating valve-stem, a rock-arm carrying a pivoted arm adapted to engage and actuate said valve-stem to open said valve, a second pivoted arm carrying a finger adapted to engage and raise the valve-actuating arm, means controlled by the speed of the engine for swinging said finger-carrying arm to raise said valve-actuating arm and maintain it out of alinement with said valve-stem so as to prevent the opening of said inlet-valve until the speed of the engine is reduced.

5. In a gas-engine, a governor mechanism comprising a rotary spool adapted to slide upon its spindle, means for sliding said spool as its rotary speed varies, a pivoted spring-arm engaging a flange of said spool and carrying a projecting button, a lever on the pivot of said arm adapted to be moved thereby, a movable arm carrying a button adapted to engage the button on said spring-arm when moved into the path thereof by the sliding of said spool whereby the lever on the pivot of said spring-arm is actuated, means connected with and operated by said lever for preventing an impulse to the engine while said buttons are in position for engagement.

In testimony whereof I sign this specification in the presence of two witnesses.

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Witnesses:
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W. J. SOVEREIGN.