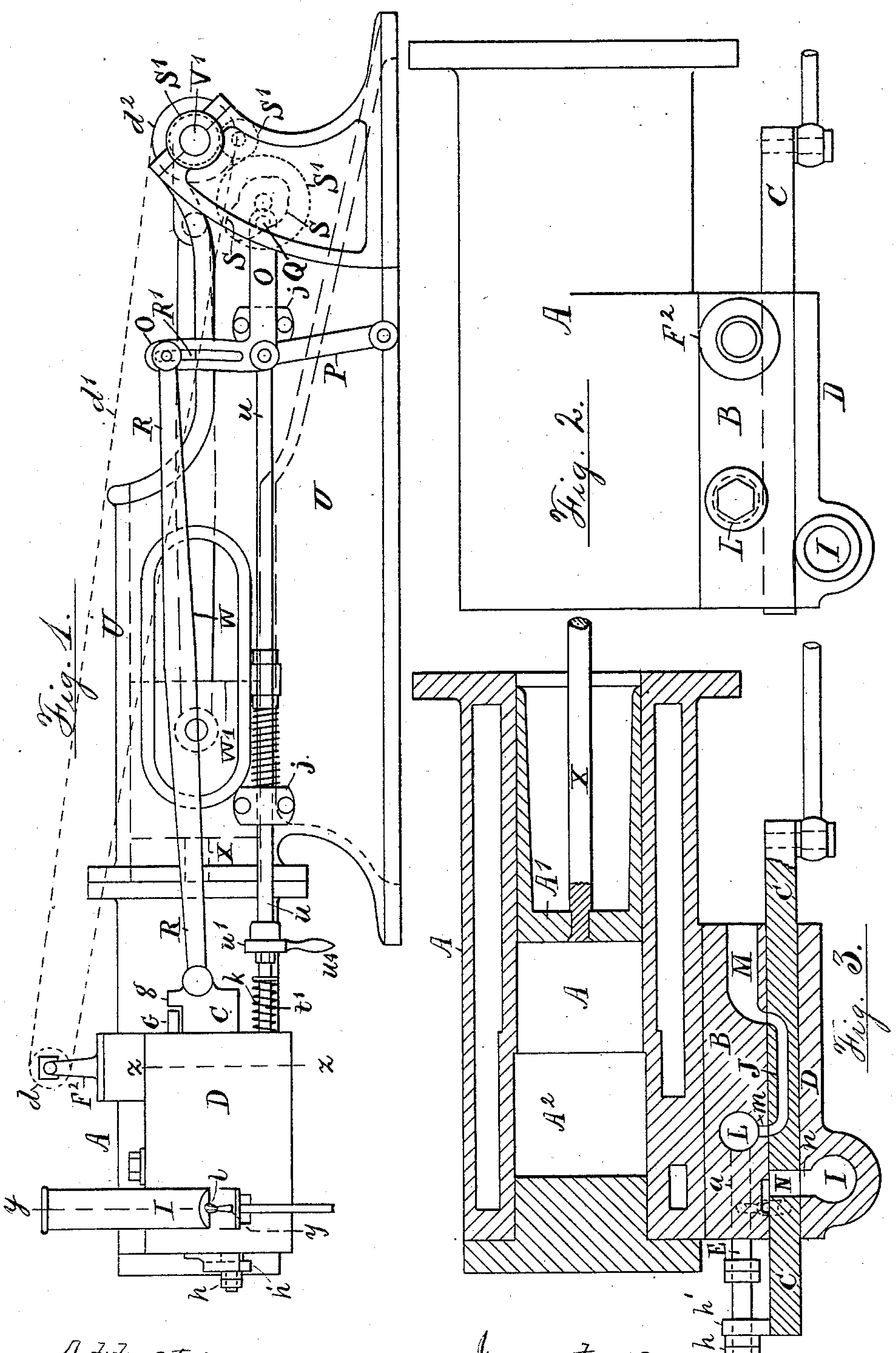
(No Model.) 3 Sheets—Sheet 1.

J. A. SERRELL & G. M. WARD.

GAS MOTOR.

No. 285,169. Patented Sept. 18, 1883.



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(No Model.) 3 Sheets—Sheet 2.

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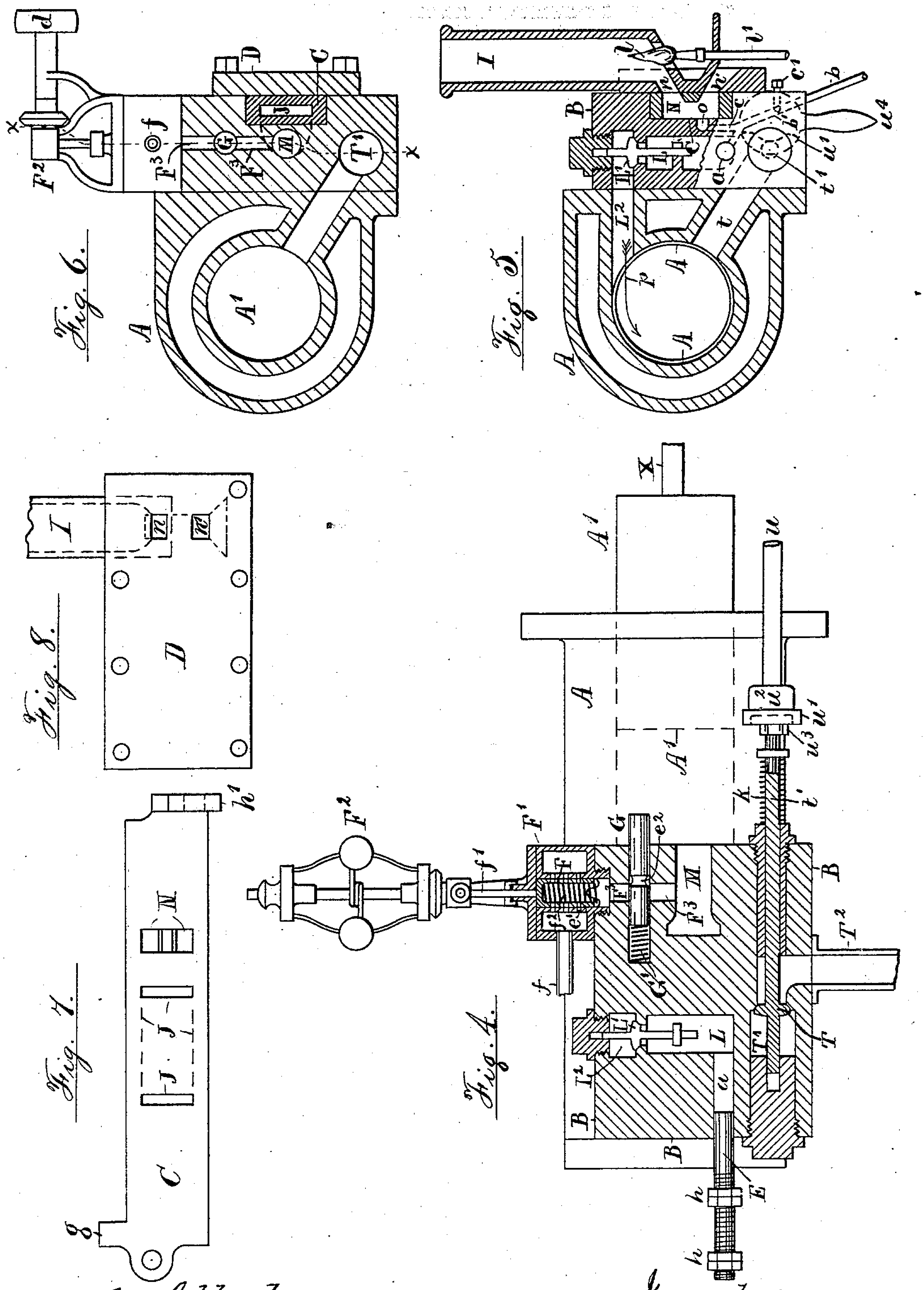

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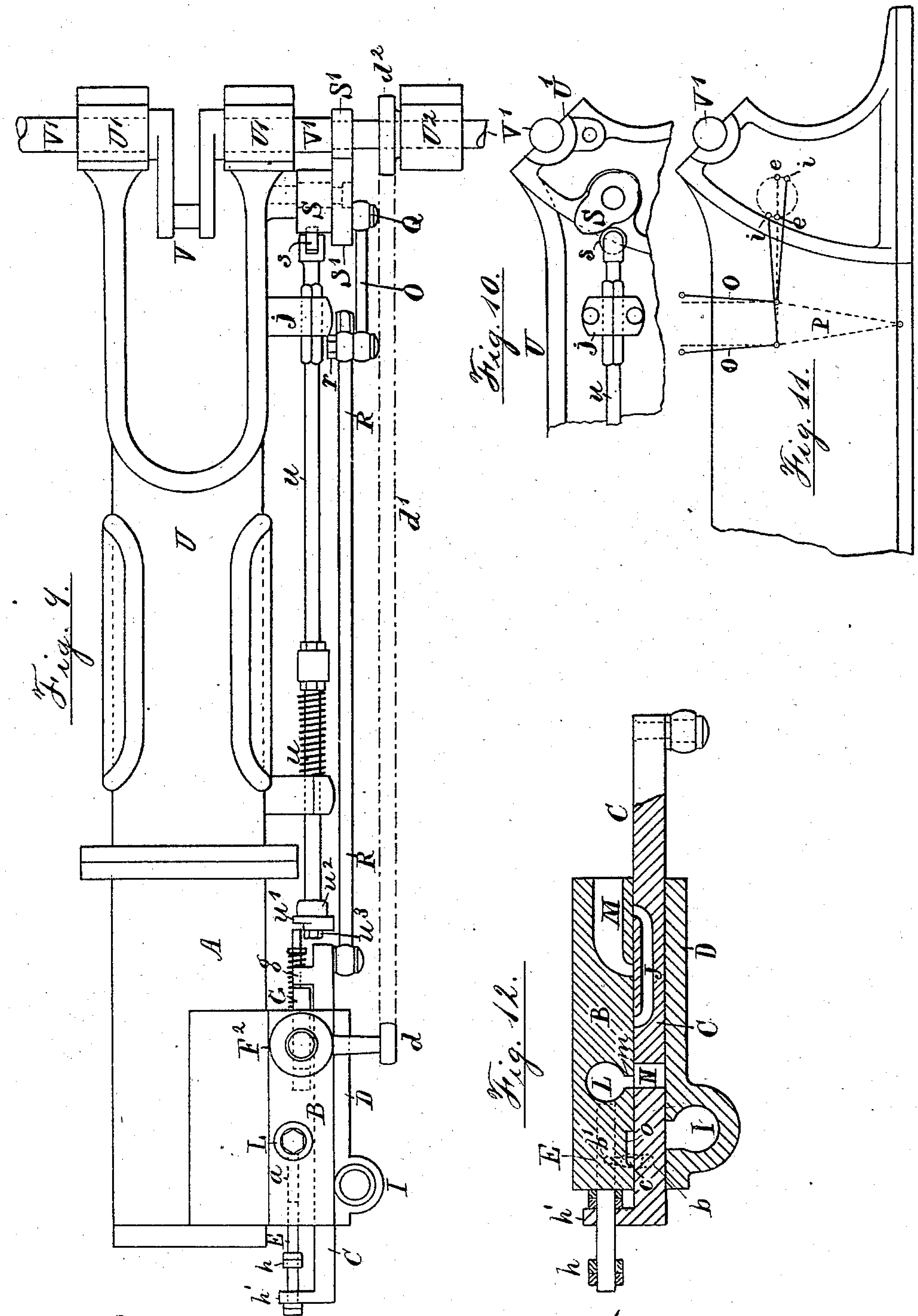

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UNITED STATES PATENT OFFICE.

JOHN A. SERRELL, OF BAYONNE, AND GEORGE M. WARD, OF NEWARK, ASSIGNORS, BY DIRECT AND MESNE ASSIGNMENTS, TO THE RALSTON GAS ENGINE AND MANUFACTURING COMPANY, OF NEWARK, N. J.

GAS-MOTOR.

SPECIFICATION forming part of Letters Patent No. 285,169, dated September 18, 1883.

Application filed December 16, 1882. (No model.)

To all whom it may concern:

Be it known that we, JOHN A. SERRELL and GEORGE M. WARD, citizens of the United States, residing, respectively, in the cities of Bayonne, Hudson county, and Newark, Essex county, New Jersey, have invented certain new and useful Improvements in Gas-Motors, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to improved methods of working gas-motors, and to various constructive features required to operate such methods; and it consists, partly, in a method of firing a compressed cylinder-charge by the explosion of a smaller separate charge not under compression, partly in a method of admitting the charge to the cylinder by introducing the same tangentially, partly in a method of avoiding the compression of the igniting-charge and of enriching it with gas during the compression of the cylinder-charge, partly in the construction of the devices for supplying and regulating the supply of gas and air, partly in the means used for operating the slide and other appliances for distributing gas and air, and partly in the means used for operating the exhaust-valve.

The means used for firing the cylinder-charge consists in a separate chamber communicating with the cylinder by a check-valve, and connected with the igniting-flame by a slide in the usual manner. In this valve-chamber gas is independently introduced to render such ignition-charge explosive.

The nature of the invention will be understood by reference to the annexed drawings, in which—

Figure 1 is a side elevation of a gas-motor provided with our improvements. Fig. 2 is a plan of the cylinder enlarged. Fig. 3 is a central horizontal section of the cylinder and its attachments. Fig. 4 is a side elevation of the same with the valve-chest shown in section on the line *x x* in Fig. 6. Fig. 5 is a transverse section of the same on line *y y* in Fig. 1. Fig. 6 is a transverse section of the cylinder and valve-chest on line *z z* in Fig. 1, the base of the governor and the governor-valve not being shown in section. Fig 7 is a view of the inner side of the slide. Fig. 8 is a view of the inner side of the slide-cover. Fig. 9 is a plan of the entire engine, the connecting-rod W being omitted. Fig. 10 is a view of the parts employed in operating the exhaust-valve. Fig. 11 is a diagram of the various positions of the cut-off eccentric pin and crank; and Fig. 12 is a horizontal section of the slide and valve-chest, to illustrate the opposite position of the slide to that shown in Fig. 3.

U is the frame of the engine; V, the crank; V′, the crank-shaft; W, the connecting-rod; W′, the cross-head, of cylindrical shape; U′, the bearing next the crank, and U^2 the outer bearing beyond the valve-gearing.

A is the cylinder; B, a valve-chest attached to the side thereof; C, a slide fitted to a longitudinal seat in the outer side of the chest, and D a cover holding the slide in place, and provided with a permanent light, as in other gas-motors.

A′ is the piston of the engine; X, the piston-rod, and A^2 a counterbore or space at the rear of the cylinder beyond the travel of the piston.

f is the gas pipe for supplying the cylinder-charge; F, a governor-valve for the gas; F′, the valve-case, and F^2 the governor.

f′ is the stem of the governor, and f^2 a spring adapted to hold the valve F open.

e′ are ports formed in the case F′ and valve F, both case and valve being cylindrical, and the latter being capable of a short end movement sufficient to close the ports *e′* when the expansion of the governor-balls depresses the stem *f′*.

G is a gas cut-off adapted to automatically close the gas-inlet from valve F when the cylinder is not taking a charge; and it consists in a plug inserted in the chest B so as to intersect the port F^3 from the valve F. The top of this port is provided with a bridge upon which the opening-spring f^2 is seated, the opposite end of the spring pressing upward against a head formed in the hollow cylinder composing the valve F. Under the influence of the spring f^2 the valve F is normally open, and the gas at such times is restrained from escape by the spring-plug G, which is formed with an annular groove, e^2, to let the gas pass when the plug is pressed into its cylindrical seat by the movement of the slide at the beginning of each inspiration-stroke. The plug at all other times is pressed outward by a spring, G′, and its body then closes the port F^3.

The parts just described are all shown in Fig. 4, the piston A′ being shown in dotted lines in the cylinder A as having completed its forward movement when drawing in a charge.

The slide is shown in Figs. 1 and 9 provided with a lug, *g*, for operating the plug G by pressing upon its projecting end. In Fig. 3 the slide is shown provided with a lighting-passage, N, operating in connection with a flame-chimney, I, in the usual way, and a double-mouthed port, J, for conducting a mixed charge of air and gas to the cylinder A through valve-chamber L and passage L^2. (Not shown in Fig. 3.) The port J receives its mixed charge from a duct, M, which is formed in the chest B, under the plug G, and into which the continuation of the port F^3 leads the gas when the plug is pressed in by the lug *g*. Air is freely admitted to the duct at one end, which is left open. The distributing-port J in the slide, instead of conducting the mixed air and gas directly into the cylinder, conducts it into a valve-chamber, L, which is formed in the chest B, between the slide and the cylinder, and is provided with a check-valve, L′, opening toward the cylinder, so as to be lifted by the charge as it enters the cylinder from the valve-chamber, and to close by its own weight when the return of the piston compresses the gases behind it in the cylinder.

With the parts described, the cylinder is filled with a uniform mixture of air and gas at each alternate outward stroke of the piston, and fired by the explosion of the charge contained in the valve-chamber L at the beginning of the intermediate outward stroke. It is obvious that as the charge enters the cylinder through the check-valve L′ the latter must retain the charge in the cylinder and secure its compression upon the return of the piston, as is necessary to obtain the best results from the main charge, and that the charge remaining in the valve-chamber L will be prevented by the valve L′ from sharing in the compression of the main charge. The slide at the time of such explosion is in the position shown in Fig. 12, with the induction-port J moved away from the passage *m*, so that no escape of the gases from the valve-chamber is possible, except into the pocket N, which is closed at its farther end by the slide-cover D. The contents of this valve-chamber are much more readily ignited when thus retained at or near atmospheric pressure when rich enough in gas, but may not be sufficiently rich without the addition of more gas to compensate for the lack of compression. Such a quota of gas is supplied by a piston, E, which is shown inserted in a bore, *a*, formed in the chest at the bottom of the chamber L, as shown in the section in Fig. 4. A gas-pipe, *b*, and inlet *b*′ supply gas to the bore *a*, the inlet being arranged several inches from the chamber L, and the piston being moved over the inlet to force the contents of the bore into the chamber at the proper time. The stem of the piston is provided with lock-nuts *h*, and the slide C is formed with a lug, *h*′, to strike the nuts and thus propel the piston as required. The inlet *b*′ is formed with a branch, *c*, by which gas is supplied to the pocket N through a duct, *o*, the duct being formed in the face of the chest adjacent to the slide, and the pocket being formed in the slide to carry the light from the flame *l* to the passage *m*, by which the chamber L opens against the slide. The pocket N is supplied with air through a passage, *n*′, and the slide is so operated by its motive force as to connect with the ducts *n*′ and *o* while opposite the lighting-passage *n*, and thus secure the light to ignite the contents of the chamber L. The contents of the chamber, being at atmospheric pressure, are readily ignited by the movement of the slide, carrying the flame in the lighting-pocket N in the ordinary manner, and the ignition of the combustible gases in the valve-chamber results (when the mixture is properly proportioned) in an explosion, which overcomes the pressure of the compressed gases in cylinder A and lifts the valve L′ and fires the cylinder-charge.

To regulate the supply of gas to the inlet *b*′ and secure the proper enrichment of the charge in the valve-chamber L, a regulating-screw, *c*′, is inserted across the inlet, and regulated as may be required.

The construction of the governor gas-valve F has already been described, and its function is to shut off the supply of gas entirely or partially at any time that the speed of the engine exceeds the desired amount. To effect this, the governor is connected by its wheel *d* and a strap (shown in dotted lines in Figs. 1 and 9 at *d*′) with a pulley, d^2, fixed on the shaft V′. The engine may be further governed in its movements by the devices used to reciprocate the slide, the same consisting in an eccentric driving-pin operating upon an oscillating bell-crank and a rod, R, attached at one end to the slide C. Figs. 1 and 9 show these parts, O being the bell-crank; P, a radius bar by which its fulcrum O′ is pivoted to the frame and restricted to a nearly horizontal movement; Q, the eccentric pin pivoted to the horizontal arm of the crank O, and imparting to it a circular motion, and R a connection joined at its ends, respectively, to the slide and the vertical arm of the bell-crank. This arm is formed with a slot, R′, and the pin connecting the rod R to the slotted arm can be clamped in any part of the slot by the nut *r*, (shown in Fig. 9,) thus securing a greater or less movement to the slide, as preferred.

Fig. 11 shows a diagram of the various positions of the crank O near the opposite ends of the stroke, *e* representing the extreme opposite positions of the eccentric driving-pin Q, and *i* the positions in which the said pin carries the slide to the opposite limits of its movement. It will be seen from this diagram that as the pin Q is turning its centers the slide must remain nearly stationary near the end of its stroke, and must then move very quickly while the pin Q is moving from the point *i* to *e*. The effect of this construction is to hold the slide in the position shown in Fig. 3 just long enough for the port J to supply the charge to the chamber L and cylinder A, and to move the slide quickly when carrying the light from *n* to *m*.

The construction and mode of operating the exhaust-valve T is shown in Figs. 1, 4, and 9, the same being seated in a passage, T′, formed in the chest B beneath the chamber L, and connected with the cylinder-counterbore A′ by a port, *t*. A discharge-pipe, T^2, connects with the passage T′ upon the opposite side of the valve T from the port *t*, and the valve is of disk form, and is provided with a stem, *t′*, which extends out of the front end of the chest B to engage with a reciprocating shaft or knocker, *u*. This shaft is mounted upon the side of the frame U in bearings *j*, and is operated intermittently by a cam, S, which is rotated at one-half the speed of the crank-shaft V′ by gears S′, which are fully shown in the plan in Fig. 9, but are merely indicated by dotted circles in Fig. 1, to avoid confusing the drawings.

The cam S is fully shown in Fig. 10, and is formed with two projections which open the valve at opposite points in the stroke by pressing upon a roller, *s*, pivoted in the end of the reciprocating shaft or knocker *u*. The projecting end of the stem *t′* is provided with a collar, and a spiral spring, *k*, is placed upon the stem to close the valve when opened by the impulse of the knocker-shaft. The shaft *u* is provided at the end in contact with the stem *t′* with a recessed disk, *u′*, which is secured to the shaft between a hub, u^2, and a nut, u^3, so as to be readily turned by a handle, u^4. One of the projections upon the cam is adjusted to open the exhaust-valve upon the return of the operative piston A′, and thus permit the escape of the exhaust-gases by the pipe T^2, and the other projection is adapted merely to open the valve T during the early part of the compression-stroke, to permit the starting of the engine without too great a resistance from the compressed gases. To prevent this partial opening of the exhaust-valve during the regular automatic working of the engine, the movements of the reciprocating shaft are transferred to the stem of the valve entirely by the recessed portion of the disk *u′*, the greater part of whose face is flush with the end of the shaft and adapted to transmit both the larger and shorter movements of the shaft to the valve. One portion of the face of the disk is, however, recessed or notched, as shown in the plan in Fig. 9, and in the dotted outline of the cam in Fig. 5, the recess being of the same depth as the shorter movement of the shaft *u*, and the shaft therefore performs such movement without producing any effect upon the valve T when the disk *u′* is turned as shown in Figs. 9 and 5. When starting the engine, the disk is otherwise turned, and the valve opened, as desired, to relieve the resistance to the piston until the engine is in motion, when the disk is turned as shown in the drawings, where it is held in position by the friction of the hub u^2, or by a spring which may be inserted within the hub to press the disk toward the nut u^3.

The cam-roller *s* is omitted in Fig. 1 to avoid confusion of the eccentric pin Q and its connection with the arm of the bell-crank O, as the pin Q is shown formed on one of the gears S′, which is concentric with the cam S.

It is obvious that an eccentric could be substituted for the pin Q, and the strap therefrom be attached to the horizontal arm of the bell-crank O, and that the slide could be operated by a direct connection to an eccentric or crank, as in other gas-motors, without the use of the bell-crank O, if its advantages be foregone.

It is also obvious that other means can be used to lengthen and shorten the knocker-shaft *u*—as, for instance, a right-and-left-hand nut applied to a divided part of the shaft between the bearings *j*, or a toggle-link connection between such divided parts of the shaft. In such case the end of the shaft adjacent to the stem *t′*, would be placed in a line with the stem, and would impinge upon it either once or twice at each rotation of the cam, as the shaft was either shortened or lengthened by any of the devices named or their equivalents.

The mode of operating an engine or motor with the above-described construction is as follows: The piston A′ being placed at the commencement of the inspiration-stroke, the port J would connect the chamber L with the gas and air supply M, nearly as shown in Fig. 3, which represents the slide at about the middle of the said stroke. The forward movement of the piston then fills the cylinder with a mixed charge of air and gas, the proportion of the latter being regulated by a cock upon the gas-pipe *f* in the usual manner, and the charge passing through the chamber L and lifting the valve L′ to gain admission to the cylinder, which it enters by a port or passage, L^2, leading from above the valve L tangentially to the edge of the counterbore A^2. The entrance of the charge in a tangential direction, as indicated by the arrow *p* in Fig. 5, induces a rotary motion in the gases as they enter the cylinder, and secures a thorough and uniform admixture of the component parts of the new charge, and also of the waste gases in the cylinder with the said component parts. At or before the end of the stroke the slide is moved to close the passage *m*, the advance of the slide also returning the spring G′ from the pressure of the lug *g*, and allowing the cut-off plug G to close the port F^3, and thus prevent any leakage of gas into the air-passage M until the next inspiration-stroke. Upon the return of the piston A′ the check-valve L′ remains closed, causing the desired compression in the main cylinder, while the contents of the chamber L are enriched with gas by means of the plug E, the continued movement of the slide in the same direction operating the plug by the contact of the lug h' with the nuts h. The slide, by its further and final movement forward, brings the lighting-pocket into communication with the passage m, and ignites the contents of the chamber L. The resulting explosion in the valve-chamber L raises the valve L′ and ignites the contents of the cylinder A. At the end of the operative stroke the cam S opens the exhaust-valve T and permits the escape of the waste gases, the small quantity remaining in the counterbore A^2 being mixed with the fresh charge when introduced by the port L^2, as described above. During the exhaust-stroke the slide returns quickly to its rearward position, having the passage m just in connection with the port J at the commencement of a new inspiration-stroke, and simultaneously operating the plugs G and E, so that they stand nearly as shown in Figs. 4 and 9. The parts are then in position to receive a new charge, and the operations are automatically repeated by the rotation of the crank-shaft and its attached cam and slide operating mechanism.

It is stated herein that the charge in the valve-chamber is not under compression, meaning that the same is not compressed by the return movement of the piston in the main cylinder. It is obvious, however, that the source of gas-supply must provide the gas under such a pressure as is required to make it traverse the supply-pipes, as, perhaps, a few inches head of water. The expression in the claims relative to the freedom of the igniting-charge from compression is not therefore to be taken literally, but is strictly true as relates to any compression equivalent to or derived from the pressure in the main cylinder, or to any compression above that under which the gas is supplied to the inlet of the motor.

Having thus fully described the nature of our invention, we claim the same as follows:

1. The method herein described of operating gas-motors, consisting in firing a compressed cylinder-charge by the explosion of a charge not under compression in a separate valve-chamber.

2. The method herein described, consisting in firing a compressed cylinder-charge by the explosion of a charge in a separate valve-chamber not under compression, but containing a greater proportion of gas than the compressed cylinder-charge.

3. The method of mixing the component parts of the cylinder's charge with the products of the former combustion by admitting the cylinder's charge tangentially to the bore of the cylinder.

4. The method of enriching the igniting-charge by the addition to it of gas during the compression of the cylinder-charge.

5. The combination, with the cylinder A, of the valve-chamber L, provided with valve L′, and the slide C, constructed and operated to ignite the contents of the chamber L, as and for the purpose set forth.

6. The combination of the cylinder A, chamber L, valve L′, and their connecting-passages, with the slide C, having the port J, and the air and gas ducts M and F^3, constructed and operated substantially as set forth.

7. The combination, with the cylinder A, chamber L, valve L′, and their connecting-passages, of the slide C, constructed and operated to supply the cylinder-charge through the chamber L, and the bore a, gas-inlet b', piston E, and means for operating the piston, substantially as and for the purpose set forth.

8. The combination, with the slide C and its port for leading the mixed air and gas to the cylinder, of the gas-supply passage F^3, the plug G, and means for operating the plug to prevent leakage from the passage F^3, substantially as shown and described.

9. The combination of the governor F^2, case F′, and valve F, constructed and operated substantially as described, with the slide C and cylinder A and suitable connecting-passages, the whole operated substantially as and for the purpose set forth.

10. The combination, with the exhaust-valve T, of the reciprocating knocker u, adjustable in the direction of its length while in motion, and the double-throw cam v, adapted to open the valve and relieve the compression when starting, substantially as herein set forth.

11. The combination, with a reciprocating device for operating the exhaust-valve, of a double-throw cam, constructed and operated substantially as described, and the recessed plate u', for adjusting the operation of the valve, substantially as shown and described.

12. The combination, with a reciprocating shaft for operating the exhaust-valve, as described, of a double-throw cam to reciprocate the shaft, and a double-faced knocker to operate the valve, substantially as shown and described.

13. The combination, with the cylinder A, slide C, and suitable passages for receiving and supplying the charge to the cylinder A, of the bell-crank link and eccentric driver, constructed and operated substantially as and for the purpose set forth.

In testimony whereof we have hereunto set our hands in the presence of two subscribing witnesses.

JOHN A. SERRELL.
GEORGE M. WARD.

Witnesses:
THOS. S. CRANE,
W. F. D. CRANE.