No. 676,907. Patented June 25, 1901.

H. M. McCALL.

VALVE GEAR FOR EXPLOSIVE ENGINES.

(Application filed Dec. 3, 1900.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 1.

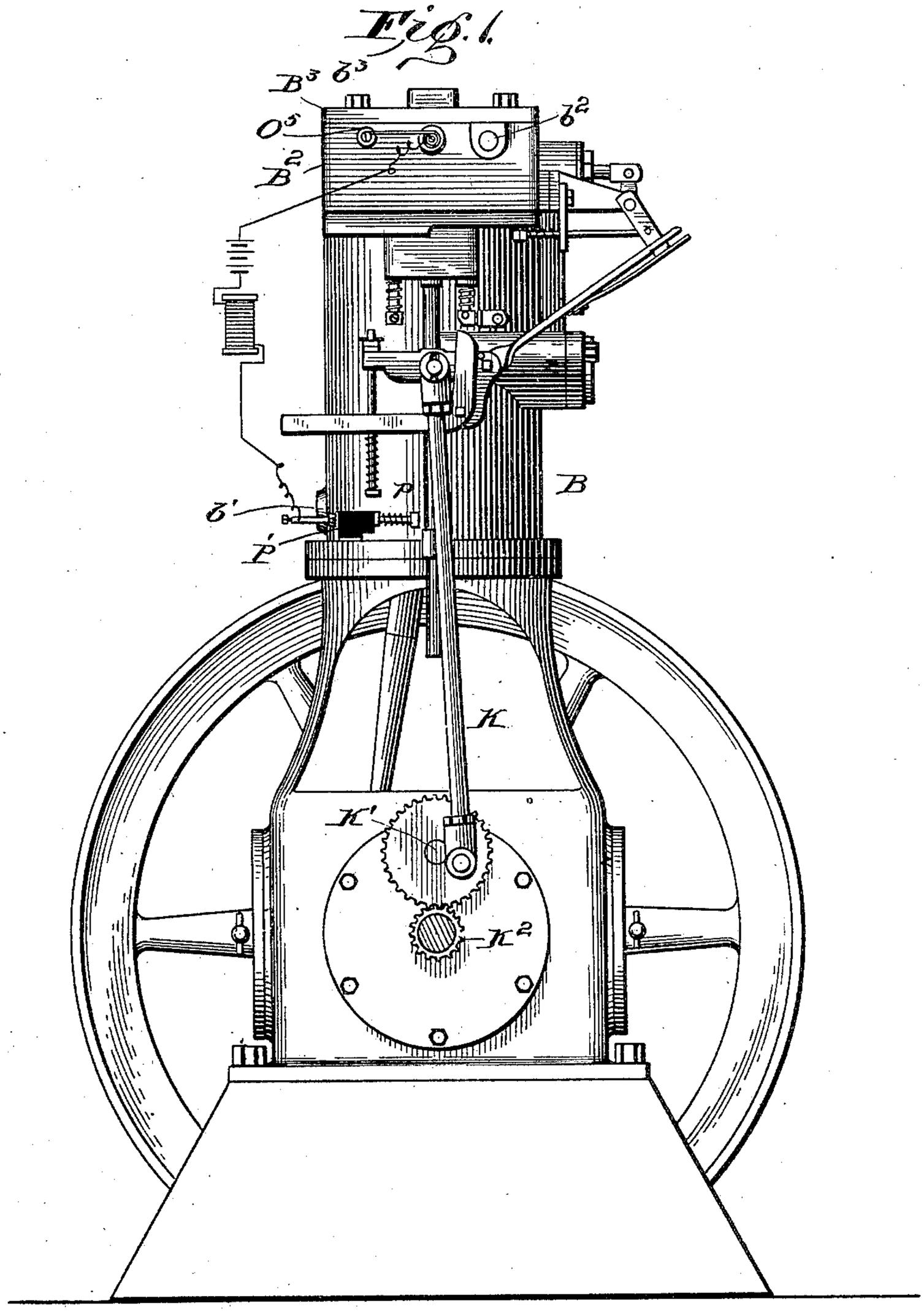

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Fig. 2.

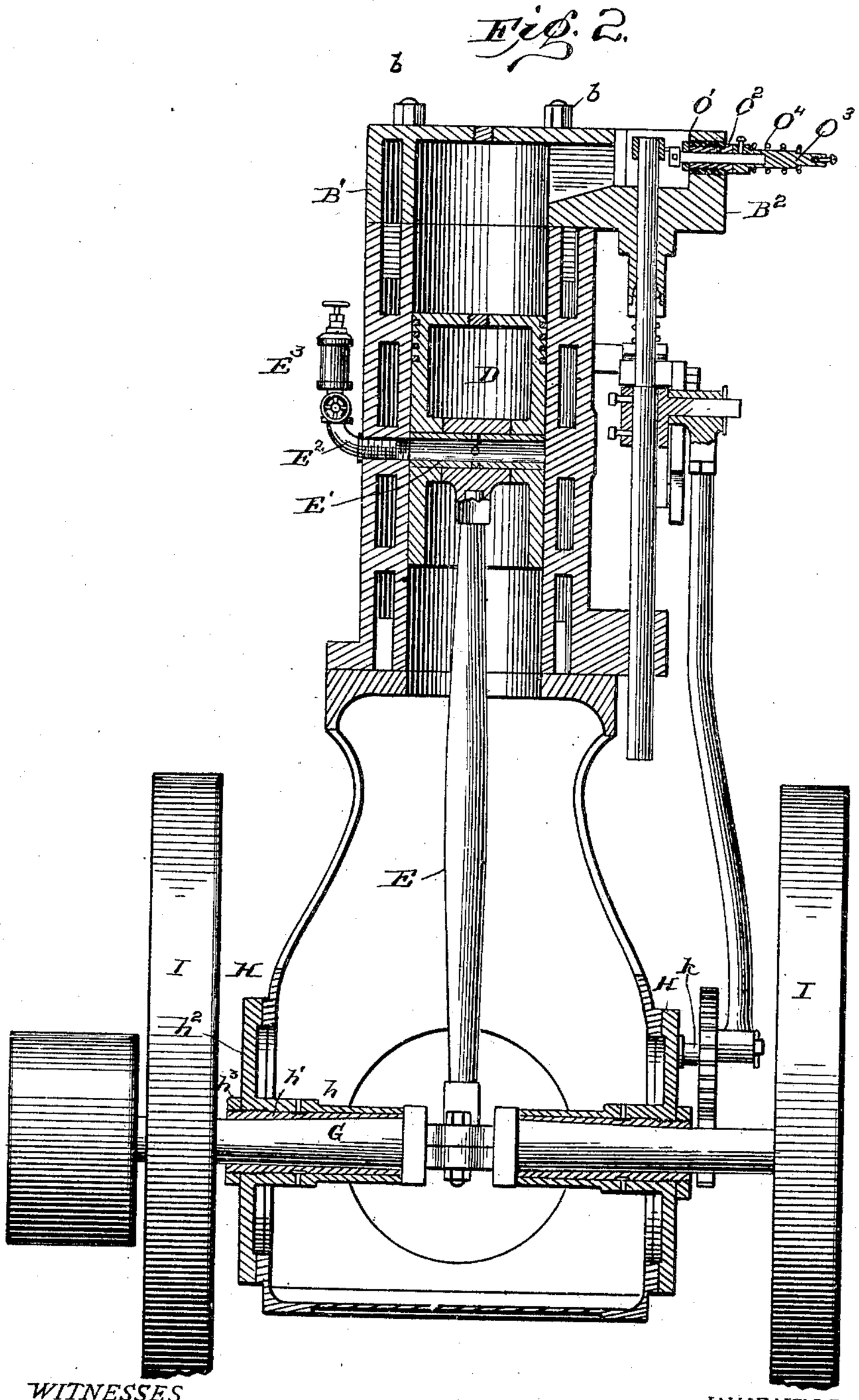

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Fig. 3.

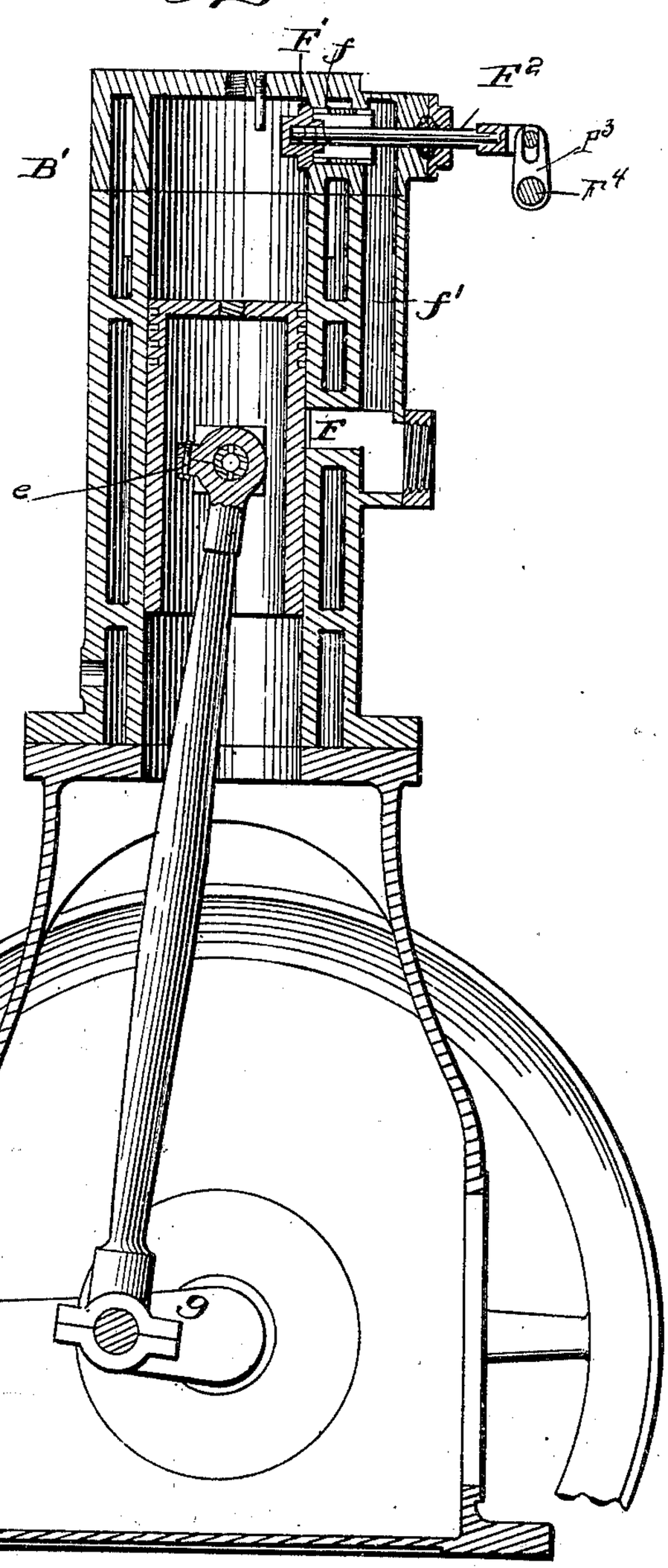

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Fig. 4.

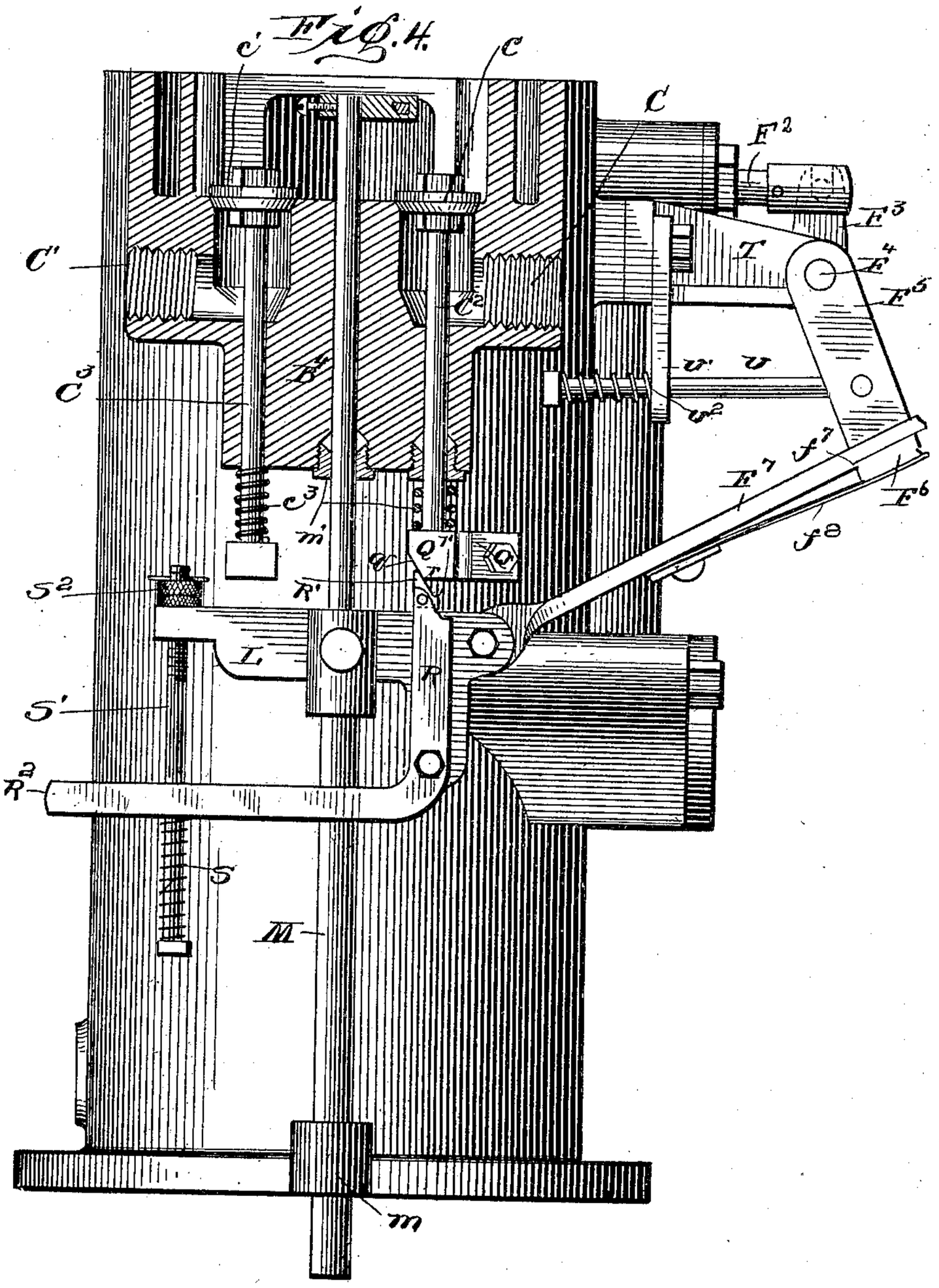
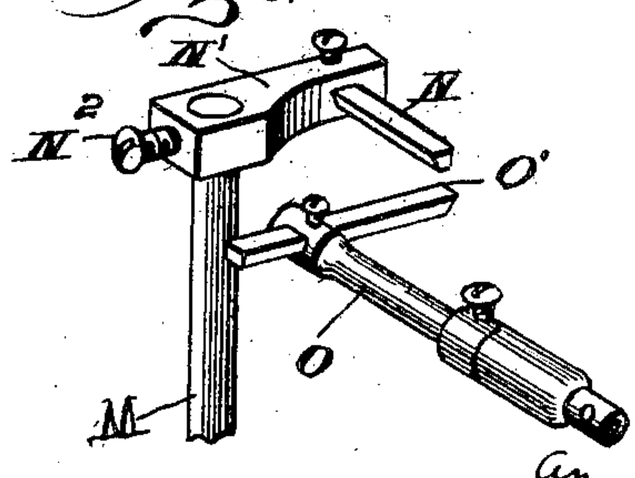


Fig. 5.



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UNITED STATES PATENT OFFICE.

HARRY M. McCALL, OF PITTSBURG, PENNSYLVANIA.

VALVE-GEAR FOR EXPLOSIVE-ENGINES.

SPECIFICATION forming part of Letters Patent No. 676,907, dated June 25, 1901.

Application filed December 3, 1900. Serial No. 38,557. (No model.)

To all whom it may concern:

Be it known that I, HARRY M. McCALL, a citizen of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Internal-Combustion Engines; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming a part of this specification, and to the letters of reference marked thereon.

This invention relates to improvements in engines popularly known as "gas-engines;" and the particular type illustrated in the accompanying drawings and to be described in connection with my present improvements is an internal-combustion engine of the four-cycle type, the objects of the invention being to simplify the working mechanism and provide an engine which will be practically automatic in its action, embody a minimum number of parts, and provide for the effective clearing of the cylinder after each explosion and prior to the admission of a fresh charge of explosive mixture.

The invention consists in certain novel details of construction and combinations and arrangements of parts, all as will be now described, and pointed out particularly in the appended claims.

Referring to the accompanying drawings, Figure 1 is a side elevation of an engine embodying my present improvements, one of the balance-wheels being removed and the crank-shaft shown in section. Fig. 2 is a vertical section taken in the plane of the crank-shaft. Fig. 3 is a vertical section taken at right angles to the plane of the crank-shaft. Fig. 4 is a detail sectional elevation, on an enlarged scale, showing the air and gas valve with their operating mechanism and the operating mechanism for the exhaust-valve for the upper end of the cylinder. Fig. 5 is a detail perspective view of the sparking-contacts.

Like letters of reference in the several figures indicate the same parts.

Referring to Figs. 1, 2, and 3 of the accompanying drawings, the letter A indicates a base-frame or housing, to the top of which a cylinder B is rigidly attached, such cylinder being open at the lower end and at the upper end closed by a cap B′, in which all of the valves are located and which may be readily removed for inspection or repair of said valves or the cap or cylinder themselves. In the preferred construction the cap is held in place by bolts screwing into the upper end of the cylinder and having nuts b applied to their upper ends. The cylinder is water-jacketed, as usual, an entrance for water being provided at b', near the bottom of the cylinder, and an exit at b^2 in the cap B′, it being understood, of course, that when the cap is in place the openings constituting the water-jacket in the cap and cylinder register, and suitable packing is interposed between the faces of the parts.

The cap B′ is provided with an overhanging projection B^2, in which the supply-valves and sparking-contacts are located and the top of which is made removable in the form of a cap B^3, held in place by suitable bolts b^3. A gas-supply C and air-supply C′ enter the overhanging projection B^2 on opposite sides, such passages being angular passages and terminate in upwardly-opening ports closed by puppet-valves c c', mounted on the upper ends of downwardly-extending stems C^2 and C^3, the stem C^2 for the gas-valve preferably passing through a packed stuffing-box at the lower end, and both stems are provided with springs c^3 for seating the valves and holding them to their seats until positively elevated by the valve-operating mechanism, to be presently described.

Working within the cylinder B is a relatively long piston D, which in its movements is adapted to control an exhaust-port at the lower end of the cylinder, as indicated at F, Fig. 3, while a second exhaust-port, located at the upper end of the cylinder, is adapted to be controlled by an exhaust-valve F′, operated by the valve-operating mechanism, to be presently described, so as to open both ends of the cylinder to permit of the complete and effective clearing out of the products of combustion and heated gases.

To connect the piston D with the connecting-rod E, the said piston is provided with a transverse opening, in which is mounted a tubular pin E′, which constitutes the pivot-pin for the upper end of the connecting-rod E. In addition said tubular pin affords a

convenient means for conducting lubricant to the said bearing, for which purpose it is provided with suitable oil-holes and is adapted to register at an intermediate point in the stroke of the piston with an oil-supply passage E^2, leading from a lubricator E^3, located outside of the cylinder. This lubricator supplies lubricant, therefore, not only to the cylinder itself, but to the bearing for the connecting-rod. In the preferred construction the bearing at the upper end of the connecting-rod is in the form of a split bearing adapted to be adjusted for taking up wear by means of a bolt *e*, and at the lower end, where said connecting-rod is jointed to the crank *g* of the crank-shaft G, a bearing of any usual or preferred type is introduced. The crank-shaft G is journaled in bearings formed as inward extensions of removable plates H, bolted to the sides of the housing A. In the preferred type such forward extensions (lettered *h*) are adapted to receive longitudinally-adjustable cone bearings or sleeves *h'*, which fit corresponding cones on the shaft, and are therefore well adapted for taking up wear and centering the shaft against a tendency to move longitudinally. Obviously any usual means may be employed for moving the cones longitudinally in their supporting extensions; but in the preferred construction a short section at the outer end is threaded and adapted to coöperate with a correspondingly-threaded section in the plate H, as indicated at h^2, and a lock-nut h^3 is provided for holding the parts rigidly in adjusted position. Suitable balance and drive wheels I may be applied to the crank-shaft in order to secure the desired momentum which is necessary for the successful operation of an engine of the four-cycle type.

The mechanism for operating both of the supply-valves, the sparking-contact, and the upper exhaust-valve is moved entirely by a valve-pitman or connecting-rod K, which at its lower end is journaled on a crank-pin carried by a gear K', journaled on a stud-axle *k*, mounted on one of the plates H. Said gear is adapted to mesh with a pinion K^2 on the crank-shaft, the proportions of the gears being such that the gear K' will make one revolution to two revolutions of the pinion K^2. At its upper end the connecting-rod K is jointed to a cross-head L, mounted rigidly, but adjustably, on a vertically-reciprocating rod M, mounted in a bearing *m* at the lower end and passing through the lower wall of the projection B^2 of the cap B'. The lower portion of the bearing in the cap B' for this rod M is preferably packed by a gland *m'*, and in order to afford long bearings for all of the rods—namely, the rod M and the valve-rods C^2 C^3—the overhanging projection B^2 is provided with a solid downward extension B^4, through which extension all of the rods pass. The upper end of the slide-rod M carries one of the sparking-contacts, which may be designated as the "movable" contact, being, preferably, in the form of a prism N, adjustable longitudinally in a head N', mounted adjustably by means of a set-screw N^2 on the upper end of the rod M. The movable contact N is adapted to engage a spring-pressed contact O, preferably of substantially the same cross-sectional conformation and having a wedge-shaped end, such contact O being adjustably mounted in an end of a spindle O', journaled in an insulated bearing O^2 in the front wall of the projection B^2, the outer end of said spindle O' terminating in an adjustable cap O^3, to which one of the terminals of the electric circuit may be connected. A coil-spring O^4, attached at one end to the cap O^3 and at the opposite end to an insulated support O^5 on the cap-piece B', as illustrated in Fig. 1, holds the contact O normally in position, but permits it to be swung in either direction by the engagement of the contact N therewith, and when said contacts pass a spark will be produced if at that time the electric circuit be not broken elsewhere.

By the universal adjustability of the sparking-electrodes the time of sparking may be regulated with the utmost nicety, and by providing a means whereby the circuit is broken at all times save when the piston is in position to commence its effective stroke all danger of sparking during a different cycle or at the wrong moment is avoided. In order to accomplish the breaking or the establishing of the circuit at the correct moment, the transverse movement of the connecting-rod K is utilized, for which purpose at the base of the cylinder there is provided a spring-pressed contact P, mounted in an insulated support P', which contact P constitutes the other terminal of the electric circuit. The contact P is in position to be engaged by the connecting-rod K when said rod is in the position corresponding to the cycle of compression and explosion, and the sparking-contact may be set, as before explained, to make a spark at the proper instant when the cycle of compression is closing or reaching its end or slightly thereafter, as desired in the working of the engine.

The cross-head L contacts directly with the lower end of the air-supply valve *c'*, so as to raise the same while the cross-head is making the upper portion of its excursion; but in order to raise the gas-valve *c* an interponent is introduced for engaging the lower end of the stem of the gas-valve, such interponent having a shoulder and an incline coöperating with a corresponding incline on the valve-stem, the inclines being in such relation that should they contact with sufficient force the shoulder will be caused to pass without engagement, and thus prevent the opening of the gas-valve; but under normal conditions said inclines guide the shoulder into engagement with the valve-stem, thereby raising the gas-valve simultaneously with the air-

valve and permitting the commingling of the charge in the cap and upper end of the cylinder.

Referring particularly to Fig. 4, it will be seen that the lower end of the gas-valve stem is provided with a head Q, having an incline *q* on one side and held against rotation by a fixed guide Q′ on the cylinder-body, while the cross-head L is provided with a pivoted arm R, having at its upper end a block R′, provided with an incline *r* and a shoulder *r′* at the base of the incline, which shoulder when the cross-head is raised engages the bottom edge of the block Q and raises the valve *c*. The block R′ constitutes the interponent before referred to, and it is held to its work by a spring S, preferably coöperating with a horizontally-extending arm R^2 of the arm R, such spring being mounted on a rod S′, adjustably connected with the cross-head L by set-nuts S^2, whereby the strength of the spring may be readily set to cause the interponent to be held in position with a greater or less pressure, as desired.

In operation under normal conditions as the cross-head L rises the inclined surfaces *q* and *r* coöperate and slide upon each other until the shoulder *r′* engages the bottom of the valve-stem, when said valve-stem and valve will be elevated and gas admitted; but should the cross-head L acquire a greater speed than normal the inclined surfaces, contacting with each other, will throw the interponent away from the block Q, and under such circumstances the shoulder *r′* will fail to engage with said block or valve-stem, and no gas will be admitted until the speed of movement of the cross-head has been reduced sufficiently to permit the inclined surfaces to again slide in contact without being separated sufficiently to prevent the engagement of the said shoulder.

The difficulty in effectually clearing the cylinder from the gases and products of combustion prior to the admission of the new charge of explosive and the effect of permitting any proportion of such consumed material to remain in the cylinder to become mixed with the succeeding charge are well understood, and it is one of the objects of the present invention to provide a means whereby the cylinder may be effectually cleared after each explosion. For this purpose the two ports F′ and F, before referred to, are employed, one, F, located at a point to be just uncovered by the piston in its forward movement and the other, F′, located at the top of the cylinder and adapted to be operated by means of a mechanism which will open and hold the same open until just before the next charge is to be admitted, or during what might be termed the "exhaust-cycle" of the engine, and then cause said valve to close quickly, so as to prevent the escape of any portion of the new charge of explosive. The valve F′ is preferably in the form of a puppet-valve; but in order to effectually support and guide the same it is provided with a cylindrical extension *f*, working horizontally in a bearing in the cap and communicating with a vertical branch exhaust *f′*, leading down outside of the cylinder and at the lower end communicating with the main exhaust F. The valve-stem F^2 extends horizontally through the side wall of the cylinder, and at its outer end it is provided with a head having a transverse pin adapted to coöperate with the upwardly-extending forked end of a crank-arm F^3, mounted on or forming part of a rock-shaft F^4, journaled in a bracket T, secured to the side of the cylinder. The rock-shaft F^4 carries at one end a crank-arm F^5 and is adapted to be oscillated through a tripping connection with the cross-head L, whereby as said cross-head rises said connection will at a certain point coöperate with the crank-arm F^5, swing the same outwardly, and open the exhaust-valve F′, and just as the said cross-head coöperates with the valve-stem the trip operates and the crank-arm F^5 is released, allowing the exhaust-valve F′ to instantly close under the influence of a spring. In the preferred type of tripping connection the crank-arm F^5 is provided with a block F^6, and the cross-head L is provided with a pivoted arm F^7, having a shoulder or notch f^7, adapted to coöperate with the edge of the block F^6 as the cross-head rises, thereby swinging said arm outwardly; but the combination of movements—namely, the swinging of the arm and the upward movement of the cross-head—will cause the shoulder f^7 to disengage by transferring the bearing-point of the link or arm F^7 from said shoulder to a point nearer its outer end, as well illustrated in Fig. 4, and it is obvious that by adjusting the angle of the block F^6, which may be done by loosening its attaching-screw, the point when such tripping action will take place may be regulated accurately. A flat spring f^8 is preferably employed to hold the crank F^7 down to its work, and in order to close the valve quickly when the shoulder f^7 is disengaged I prefer to employ a link U, pivotally connected with the arm F^5 at one end, passing through a bearing in a bracket U′ on the frame at the other end and having a coil-spring U^2 applied thereto for drawing the link and arm F^5 inwardly, oscillating the shaft F^4 and drawing the valve-stem and valve outwardly, so as to close the valve. With such an arrangement the exhaust may take place throughout one whole upward movement of the piston, completely clearing the cylinder, and as the piston reaches the upward limit of its movement the exhaust-valve will be suddenly closed and during the next downward movement of the piston a fresh charge is drawn in. It is not under compression, however, but is rather under tension. Consequently there is no appreciable escape of the charge through the lower exhaust-port; but said charge is held in the cylinder and is compressed by the next upward stroke of the piston, ready for ignition. When the

piston descends under the impulse of the explosion, the products and gases being heated and under compression will first find vent through the main exhaust-port F, and as said port is closed by the upward movement of the piston will find fresh vent through the supplemental exhaust-port f' by reason of the opening of the valve F', as before explained.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is--

1. In an internal-combustion engine, the combination with the cylinder having an exhaust-port at the upper end and a second exhaust-port at an intermediate point adapted to be opened by the forward movement of the piston, and a port and valve for admission of a charge, of a piston, a spring-pressed valve controlling the exhaust-port at the upper end of the cylinder and a valve-operating mechanism for all of said valves embodying a movable member and a tripping connection between said movable member and exhaust-valve for permitting said valve to close suddenly under the influence of its spring before the movable member has reached the limit of its throw; substantially as described.

2. In an internal-combustion engine of the four-cycle type, the combination with a cylinder having admission and exhaust ports and a piston working in said cylinder, of admission-valve gear operating to admit explosive during alternative forward movements of the piston and embodying a member reciprocated once during two reciprocations of the piston, a spring-pressed valve controlling the exhaust-port and a tripping connection between said member and exhaust-valve adapted to open said valve during the first portion of the upward movement of said member and to release the valve and permit it to remain closed during the latter portion of such movement; substantially as described.

3. In an internal-combustion engine, the combination with the cylinder, piston, crank-shaft, cross-head and gearing interposed between the cross-head and crank-shaft whereby the cross-head is reciprocated, of air and gas inlet valves opened by the cross-head when at the upper end of its excursion, an exhaust-valve, a rock-shaft controlling the same, a crank-arm on said rock-shaft, a shoulder on said crank-arm, a link pivoted on the cross-head and coöperating with the shoulder to turn the rock-shaft during the upward movement and means for disengaging the crank-arm and link at a predetermined point in the upward movement of the cross-head; substantially as described.

4. In a gas-engine the combination with the cylinder, piston, crank-shaft, reciprocating rod, cross-head adjustably mounted thereon and gearing interposed between the cross-head and crank-shaft to reciprocate the same once during two revolutions of the crank-shaft, of gas and air valves with which the cross-head coöperates at the upper end of its excursion, an exhaust-valve, a rock-shaft controlling said valve, a crank-arm on the rock-shaft, a projection having a flat face carried by the crank-arm, a link pivotally connected with the cross-head and resting on the flat face of the projection and a shoulder on the link adapted to engage the projection during the upward movement of the cross-head and to be disengaged therefrom by the continued motion of the cross-head and arm; substantially as described.

5. In an internal-combustion engine, the combination with a spring-seated exhaust-valve, of an operating mechanism for said valve comprising a rock-shaft having a crank-arm, an adjustable projection on said crank-arm, a link pivotally mounted on a reciprocating member of the engine, a shoulder on the link adapted to engage the projection to rock the shaft and to be disengaged therefrom by the change in the angular positions of the parts due to such operation; substantially as described.

6. In an internal-combustion engine, the combination with the cylinder, having admission and exhaust ports, the piston, crank-shaft and reciprocating cross-head moved by the crank-shaft, of a guide-rod on which the cross-head is adjustably mounted, sparking-contacts controlled by the guide-rod, one of said contacts being adjustably mounted directly on said rod, admission and exhaust valves and connections whereby the admission and exhaust valves are operated by the cross-head; substantially as described.

7. In an internal-combustion engine, the combination with the cylinder having the admission and exhaust ports, of the admission-valve, a reciprocating cross-head for operating said valve, a rod connected with said cross-head, a sparking-contact adjustably mounted on said rod, a second contact adjustably mounted on an oscillatory shaft, and a spring located outside of the explosion-chamber for holding said shaft in normal position while permitting it to oscillate in either direction; substantially as described.

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