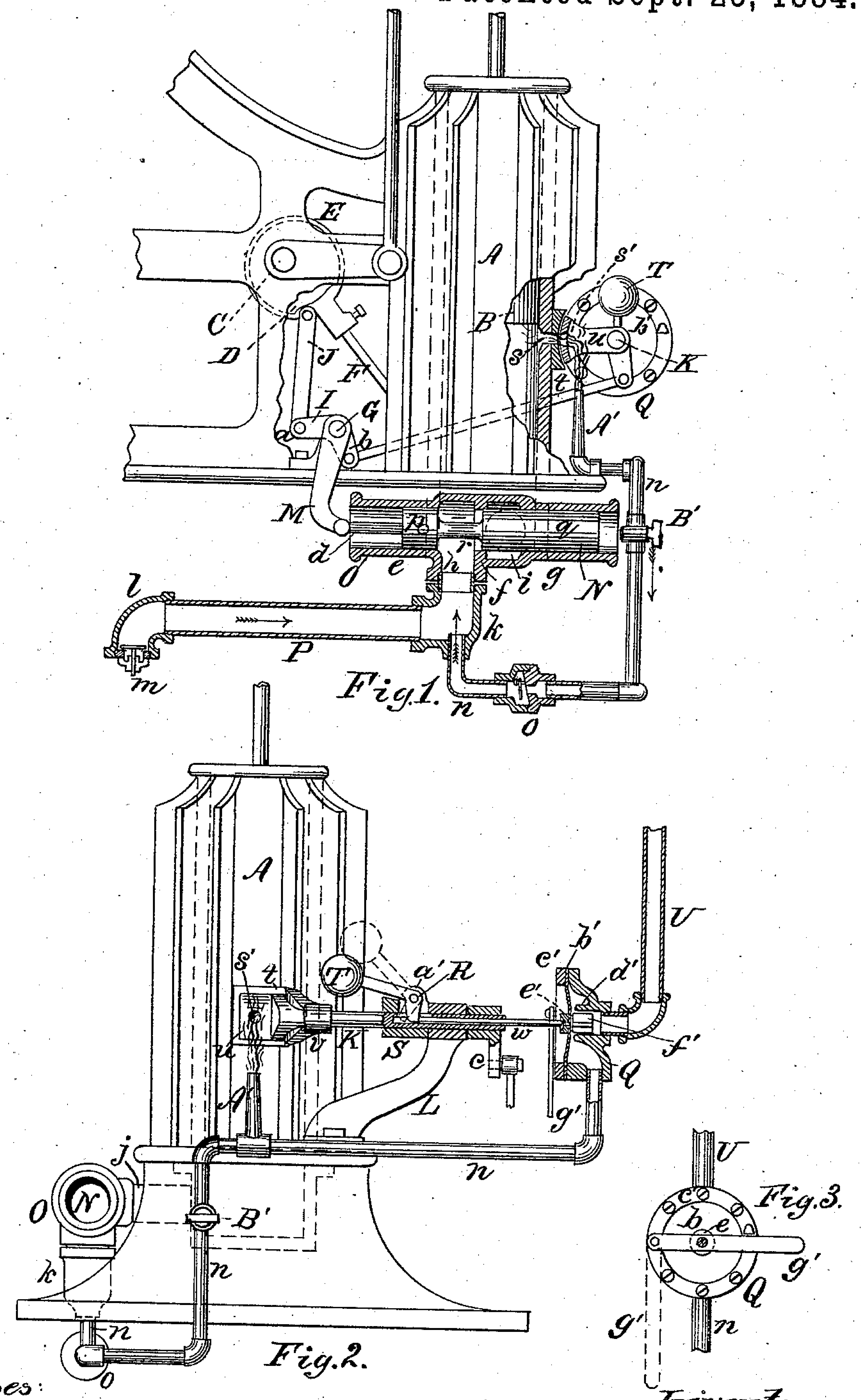
(No Model.)

G. M. & I. N. HOPKINS.

GAS ENGINE.

No. 305,452. Patented Sept. 23, 1884.



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UNITED STATES PATENT OFFICE.

GEORGE M. HOPKINS AND I. NEWTON HOPKINS, OF BROOKLYN, N. Y.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 305,452, dated September 23, 1884.

Application filed February 26, 1884. (No model.)

To all whom it may concern:

Be it known that we, GEORGE M. HOPKINS and I. NEWTON HOPKINS, of Brooklyn, in the county of Kings and State of New York, have invented a new and useful Improvement in Gas-Engines, of which the following is a specification.

Our invention relates to the class of gas-engines in which the gas and air are drawn into the cylinder by the power-piston during the early part of its stroke, and then exploded to propel the piston to the end of its stroke.

The improvement consists in a method and apparatus for admitting gas and air to the cylinder, and in apparatus for controlling the ignition of the explosive mixture.

Our invention further consists in mechanism for automatically shutting off the supply of gas when the engine stops.

In this specification reference is made to the annexed drawings, in which similar letters of reference indicate the same parts in all of the figures.

Figure 1 is a side elevation of a portion of a gas-engine, partly in section, showing the application of our improvement. Fig. 2 is a front elevation, partly in section; and Fig. 3 is a detail view of the gas cut-off valve.

The cylinder A contains the piston B, whose reciprocating motion imparts rotary motion to the shaft C through well-known connective mechanism.

Upon the shaft C is secured the eccentric D, surrounded by a strap, E, which connects by the rod F with the exhaust-valve of the engine. A rock-shaft, G, extends across the bed-plate H of the engine, parallel with the main shaft, and is journaled in bearings secured to the bed-plate.

Upon the end of the rock-shaft G, immediately under the eccentric D, is secured an angled lever, I, having arms *a b*. The arm *a* is connected with the eccentric-strap E by the connecting-rod J, and the arm *b* is connected with an arm, *c*, on a rock-shaft, K, journaled in a support, L, at the front of the engine. In the end of the rock-shaft G remote from the lever I is secured a curved arm, M, to the free end of which is connected the piston slide-valve N by means of the connecting-rod *d*. The bearing-surface of the slide-valve N in the casing O is divided into three parts *e*, *f*, and *g*, leaving an annular chamber, *h*, and port *i* on opposite sides of the part *f*. The port *i* communicates with the lower end of the cylinder through the pipe *j*, and the chamber *h* communicates with the air-supply pipe P through the elbow *k*. The outer end of the air-supply pipe P terminates in an elbow, *l*, which opens downward, and is provided with an ordinary check-valve, *m*, opening inward. In the elbow *k* is inserted a pipe, *n*, which extends downward a short distance, thence upward, communicating with the valve Q. In the horizontal part of the pipe *n*, near the elbow *k*, is placed a flap check-valve, *o*, opening toward the elbow *k*, and having an inclined valve-seat and a flap-valve hanging normally open. The slide-valve N is in two parts, *p q*, connected by a spindle, *r*, the space between the two parts being about equal to the width of the chamber *h*. In the front of the cylinder, at a point distant from the bottom thereof about equal to two-fifths of the stroke of the piston, there is an ignition-aperture, *s*, and to the side of the cylinder is secured a concave valve-seat, *t*, having an ignition-aperture corresponding in position to the aperture *s* in the cylinder, and to the rock-shaft K is secured an oscillating valve, *u*, which is adapted to the concave surface of the valve-seat *t*, and is provided with an ignition-aperture, *s'*, which is capable of coinciding with the ignition-aperture *s*. The center of curvature of the valve *u* and valve-seat *t* corresponds with the center of the rock-shaft K. An igniting-burner, A', taking gas from the pipe *n*, is placed in position to permit its flame to pass in front of the ignition-aperture *s*.

The rock-shaft K, besides having a bearing in the support L, is journaled in an arm, *v*, projecting from the valve-seat *t*. The rock-shaft K is bored axially to receive a rod, *w*, and is slotted in its upper surface, inside of the outer bearing, to receive the shorter arm of an angled lever, R, which is fulcrumed between ears *a'*, formed on a sleeve, S, secured to the rock-shaft K. The longer arm of the lever R carries a weight, T. The valve Q is placed axially in line with the rock-shaft K, is capable of being engaged by the rod *w*, and has a flanged casing, to which a flexible diaphragm, *b'*, is clamped by a ring, *c'*. An annular valve-seat, *d'*, projects into the valve-casing, and a disk, e', and guide f', secured to the center of the diaphragm, form, in connection with the said diaphragm, a valve which is capable of seating on the valve-seat d'. The gas-supply pipe U communicates with the valve Q. To one side of the ring c' is pivoted a latch, g', which is capable of holding the rod w out of engagement with the valve Q. Gas flows continuously through the pipe n into the elbow k and pipe P, and as the piston completes its downward stroke and is about to begin its upward stroke the valve N is moved forward by the action of the eccentric D through the connecting-rod J, lever I, rock-shaft G, and arm M, opening the port I and allowing the mixture of gas and air contained by the chamber h, elbow k, and pipe P to pass into the cylinder as the piston rises. The flow of gas through the pipe n is regulated, so that the mixture formed in the chamber h, elbow k, and pipe P, during the time that the valve N closes the port i, will be very rich in gas; but when the port i is open, and air is being rapidly drawn into the cylinder, the volume of gas admitted with the air will be comparatively small. Just before the piston passes the ignition-opening s, the valve N closes the port i, and the ignition-opening s' in the valve u coincides with the ignition-opening s of the cylinder, and when the piston uncovers the said ignition-opening the flame of the ignition-burner A' is drawn into the cylinder, igniting the combustible mixture therein; but before the ignition of the gas is complete the valve u moves so as to close the opening s, when the explosion pushes the piston to the top of the stroke. The exhaust-valve is then opened in the usual way, and the products of combustion are allowed to escape as the piston descends. During the movement of the piston through the upper half of its stroke and through its entire downward stroke, a highly-combustible mixture of gas and air is being formed in the chamber h, elbow k, and pipe P, ready to be drawn into the cylinder when the piston again ascends.

The escape of gas from the pipe P into the surrounding atmosphere is prevented by the check-valve m, and any accidental explosion of the mixture contained by the chamber h, elbow k, and pipe P is prevented from blowing back into the gas-supply pipe by the check-valve o. The oscillation of the rock-shaft K causes the weight T to carry up the longer arm of the lever R by centrifugal action, where it is retained so long as the engine continues to act. The rod w, being released by the raising of the lever R, allows the diaphragm b' to retract and open the passage through the valve Q, allowing the full supply of gas to flow through the pipe n. When the engine stops from any cause, the weight T drops and the lever R pushes forward the rod w against the disk e', bringing the diaphragm b' into contact with the valve-seat d', entirely shutting off the supply of gas to the engine.

When the engine is to be started, the rod w is pushed back, moving the lever R and raising the weight T, when the latch g' is raised and the rod w is allowed to rest upon it. The valve Q now opens and gas flows into the pipe n. The igniting-burner A' is lighted, and gas is turned on at the regulating-cock B'. The engine is revolved by hand until the first explosive charge is drawn into the cylinder and ignited, after which the engine will propel itself. When the engine reaches its normal speed, the weight T is raised by centrifugal force, the latch g' is released and drops into vertical position, as shown in dotted lines in Fig. 3, when the automatic cut-off mechanism is in condition to shut off the gas should the engine stop. By placing the lever R upon the extremity of the rock-shaft K outside of the arm c, the shorter arm of the lever R may be allowed to act directly upon the valve Q without the intervention of the rod w.

Having thus described our invention, what we claim as new, and desire to secure by Letters Patent, is—

1. The method of operating a gas-engine, which consists in forming in the air-supply passage thereof a rich mixture of air and gas during the latter portion of the upward stroke and the entire downward stroke of the piston, drawing the said rich mixture into the cylinder during the early part of the upward stroke of the piston, afterward drawing in a comparatively weak mixture, the flow of gas into the air-pipe being continuous, the strength of the mixture being varied by an intermittent air-supply, finally igniting the charge by drawing into the cylinder a flame at the point of the piston-stroke at which an ignition is desired.

2. The combination, with the cylinder of a gas-engine, of a slide-valve, N, an air-pipe, P, communicating therewith, and a gas-pipe, n, connected with the air-pipe and adapted to furnish a continuous supply of gas thereto, as specified.

3. The combination, with the cylinder of a gas-engine, of a valve-casing, O, having a port, i, chamber h, slide-valve N, air-supply pipe P, check-valve m, gas-supply pipe n, and normally open check-valve o, as herein described.

4. The combination, with the gas cut-off valve, of a weighted oscillating lever capable of closing the said valve when the lever is at rest, as herein specified.

5. The combination, with the cut-off valve and weighted oscillating lever for closing the same, of a latch for holding the said weighted lever out of engagement with the cut-off valve while the engine is being started, as herein specified.

6. The combination, with the cylinder A of a gas-engine having the ignition-opening s at the point in the stroke of the piston at which an ignition is desired, of a concave valve-seat, t, attached to the cylinder, and provided with an opening corresponding with the ignition-opening s, and an oscillating valve,

u, adapted to the said seat and provided with an ignition-opening, *s'*, as herein specified.

7. The axially-bored rocking shaft K, the angled weighted lever R, capable of being operated by centrifugal force, and the rod *w*, in combination, for operating a gas cut-off valve, as specified.

8. The gas cut-off valve Q, formed of a casing containing a valve-seat, *d'*, and provided with a diaphragm, *b'*, carrying the disk *e'* and guide *f'*, as specified.

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