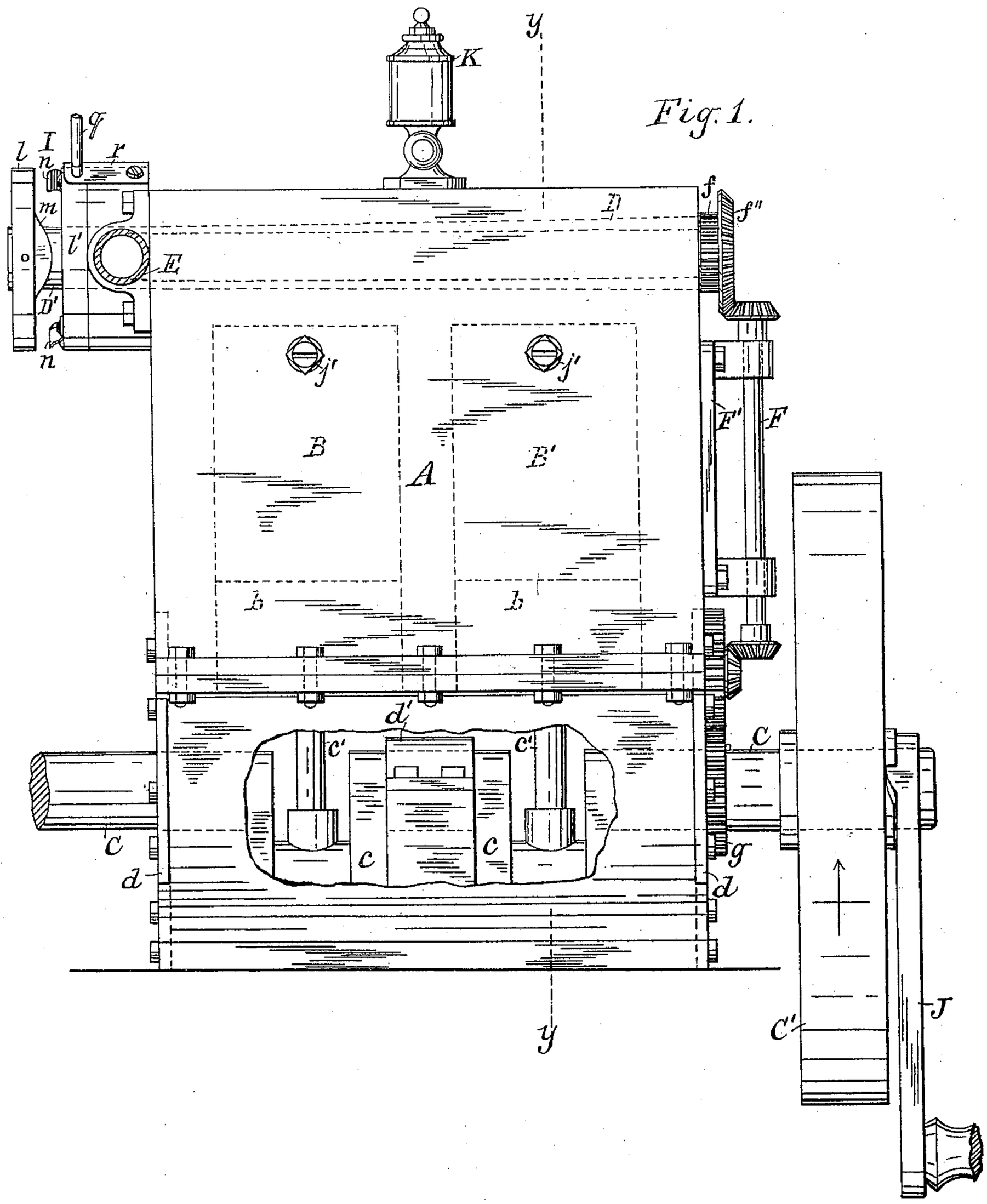
(No Model.) 6 Sheets—Sheet 1.

D. M. TUTTLE.

GAS ENGINE.

No. 604,241. Patented May 17, 1898.

Fig. 1.



Witnesses.
B. L. Levy
H. M. Seamans

Inventor.
Daniel M. Tuttle
By C. H. Duell
his Attorney.

(No Model.) 6 Sheets—Sheet 2.

D. M. TUTTLE.

GAS ENGINE.

No. 604,241. Patented May 17, 1898.

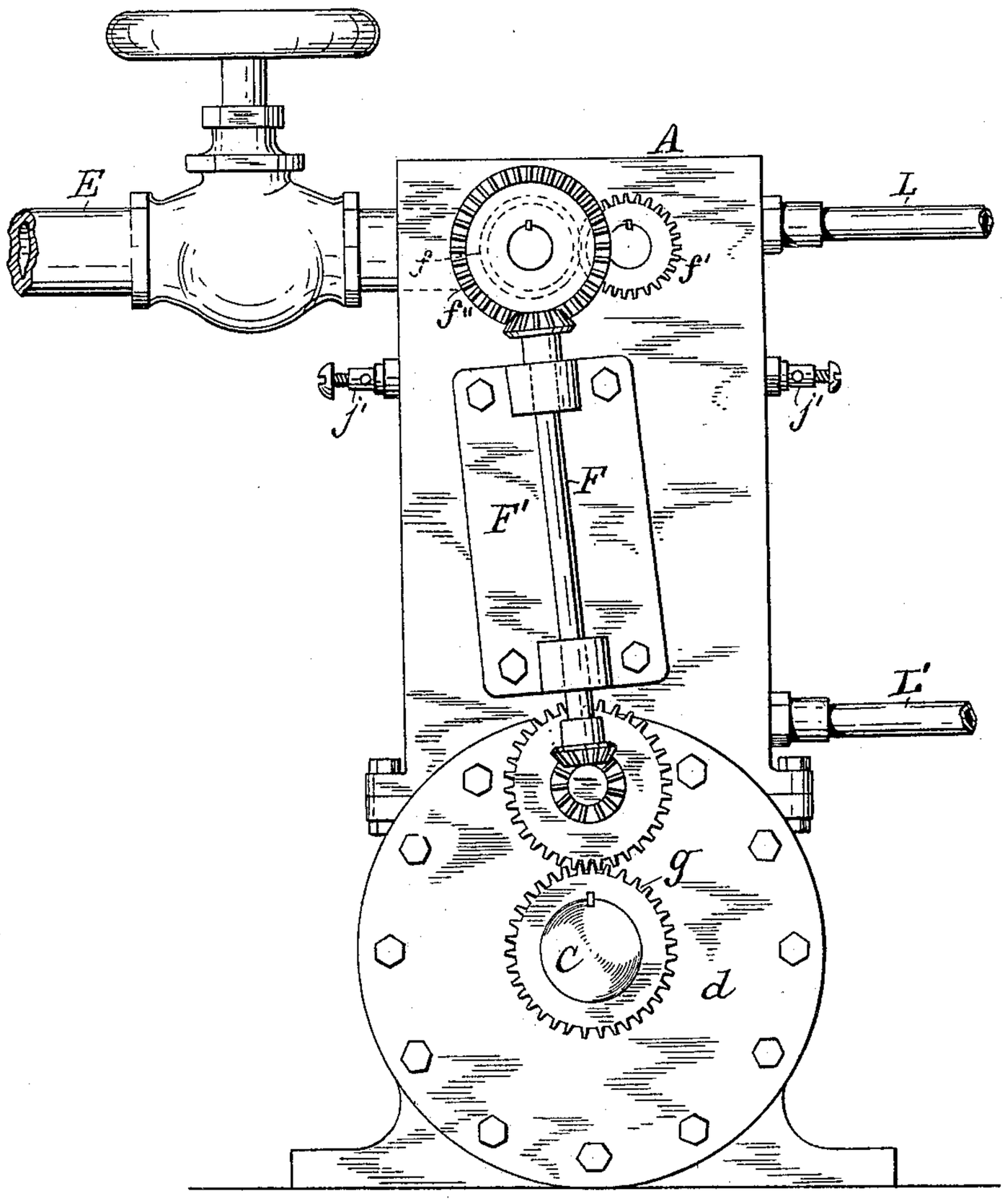


Fig. 2.

Witnesses:
R. L. Lowry
H. M. Seamans.

Inventor.
Daniel M. Tuttle
By C. H. Duell
his Attorney.

(No Model.)

6 Sheets—Sheet 3.

D. M. TUTTLE.

GAS ENGINE.

No. 604,241. Patented May 17, 1898.

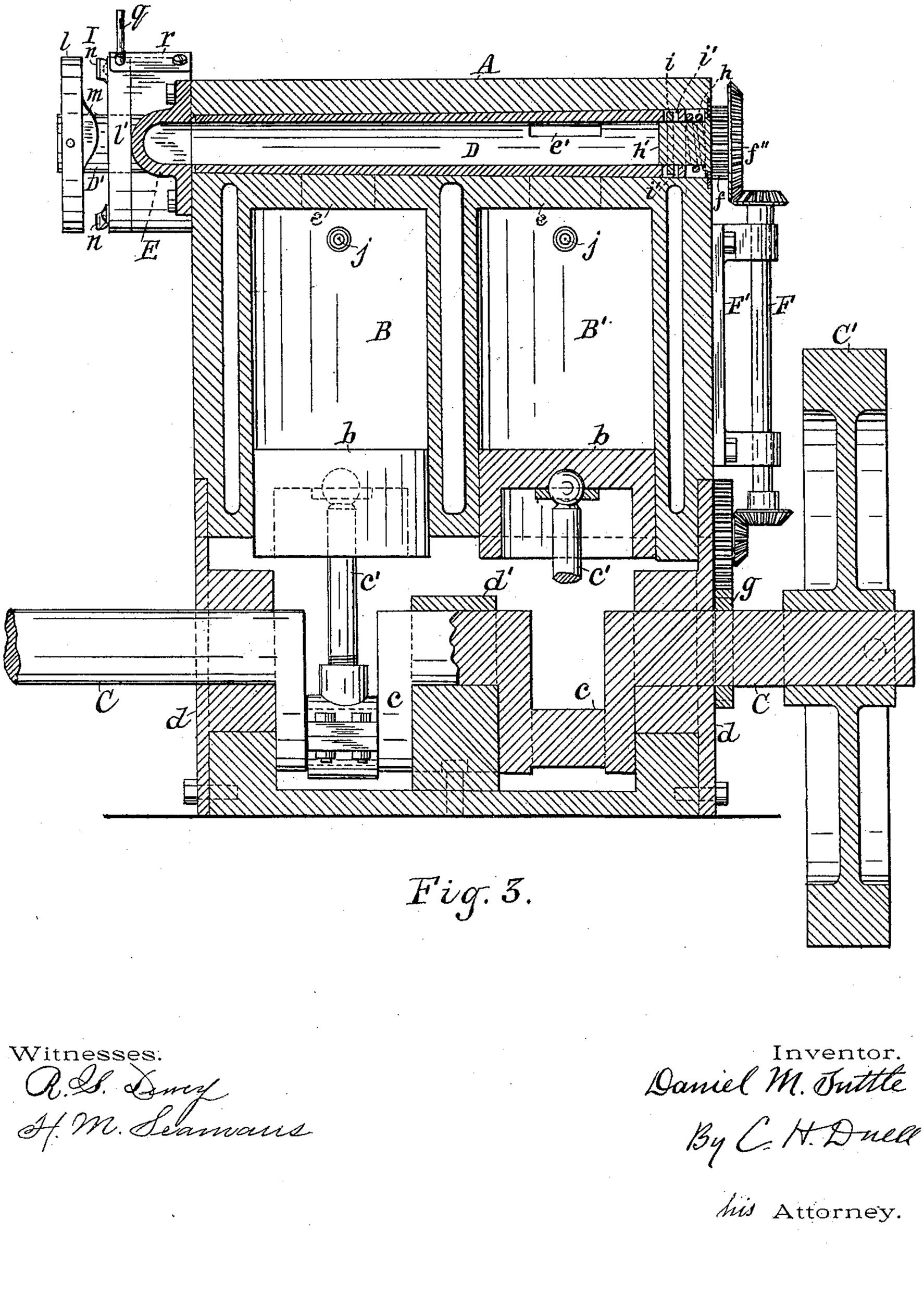


Fig. 3.

Witnesses:
R. S. Dorsey
H. M. Seamans

Inventor.
Daniel M. Tuttle
By C. H. Duell
his Attorney.

(No Model.) 6 Sheets—Sheet 4.

D. M. TUTTLE.

GAS ENGINE.

No. 604,241. Patented May 17, 1898.

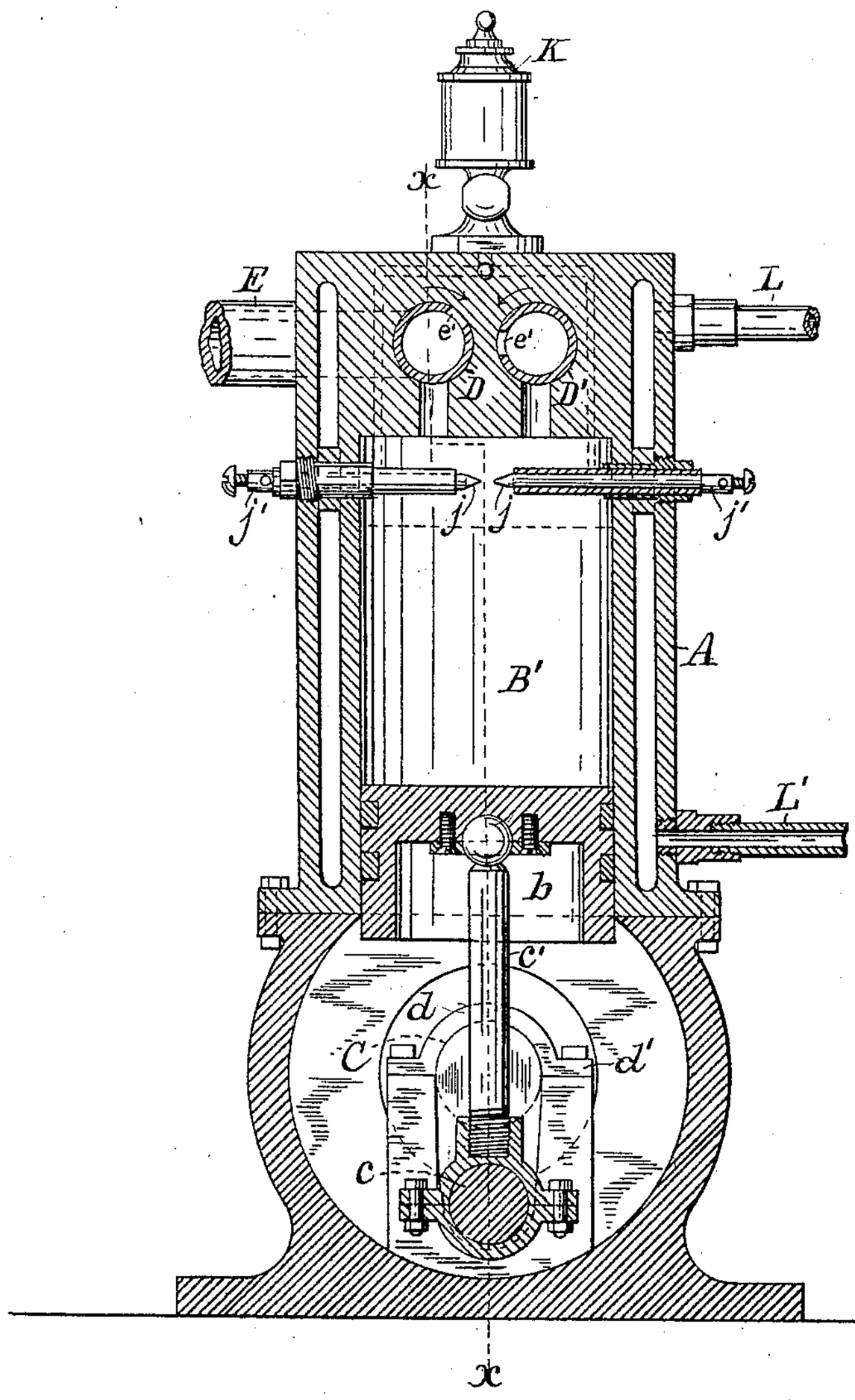


Fig. 4.

Witnesses.
R. S. Lacey
H. M. Seamans

Inventor.
Daniel M. Tuttle
By C. H. Duell
his Attorney.

(No Model.) 6 Sheets—Sheet 5.

D. M. TUTTLE.

GAS ENGINE.

No. 604,241. Patented May 17, 1898.

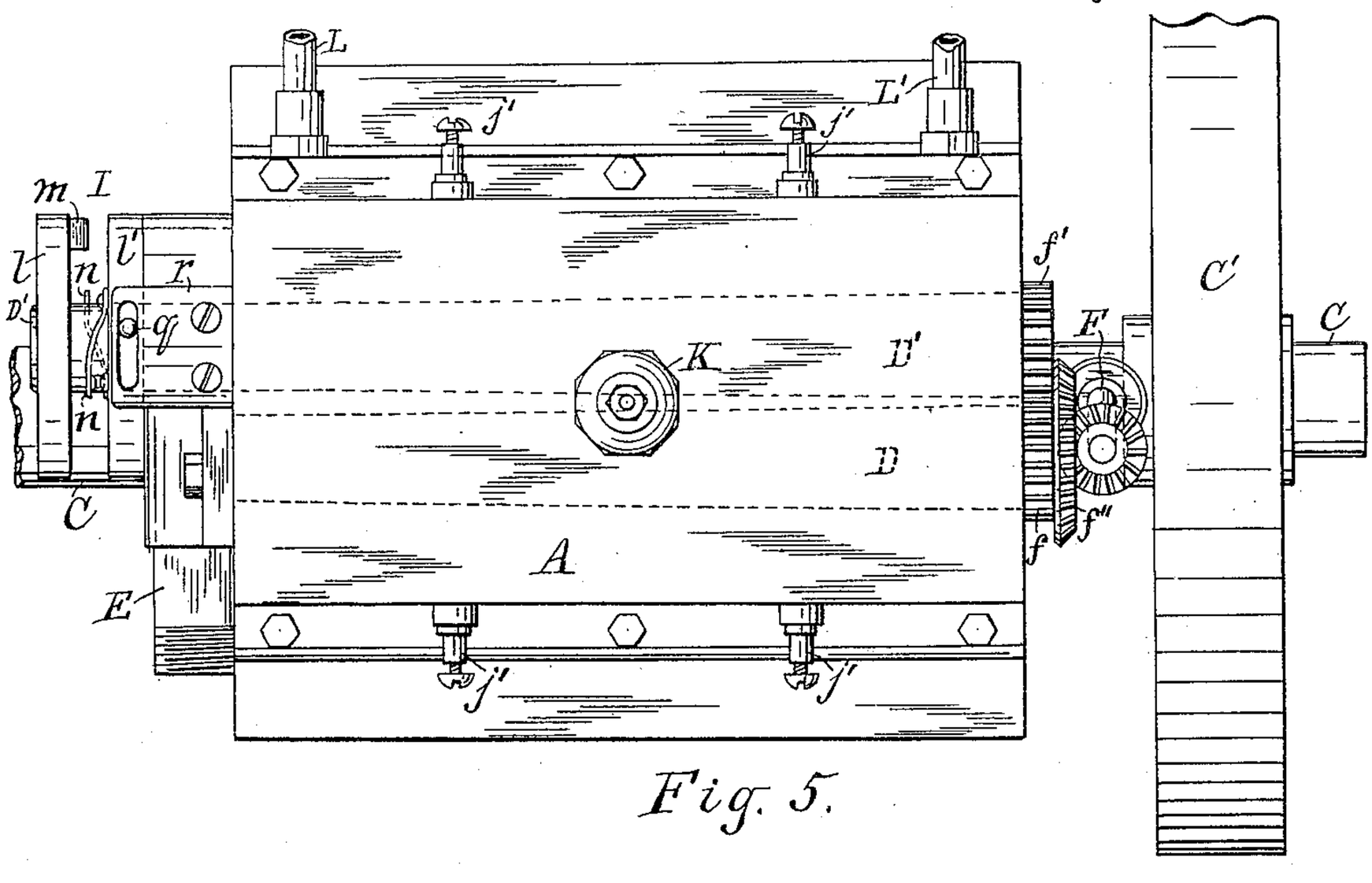


Fig. 5.

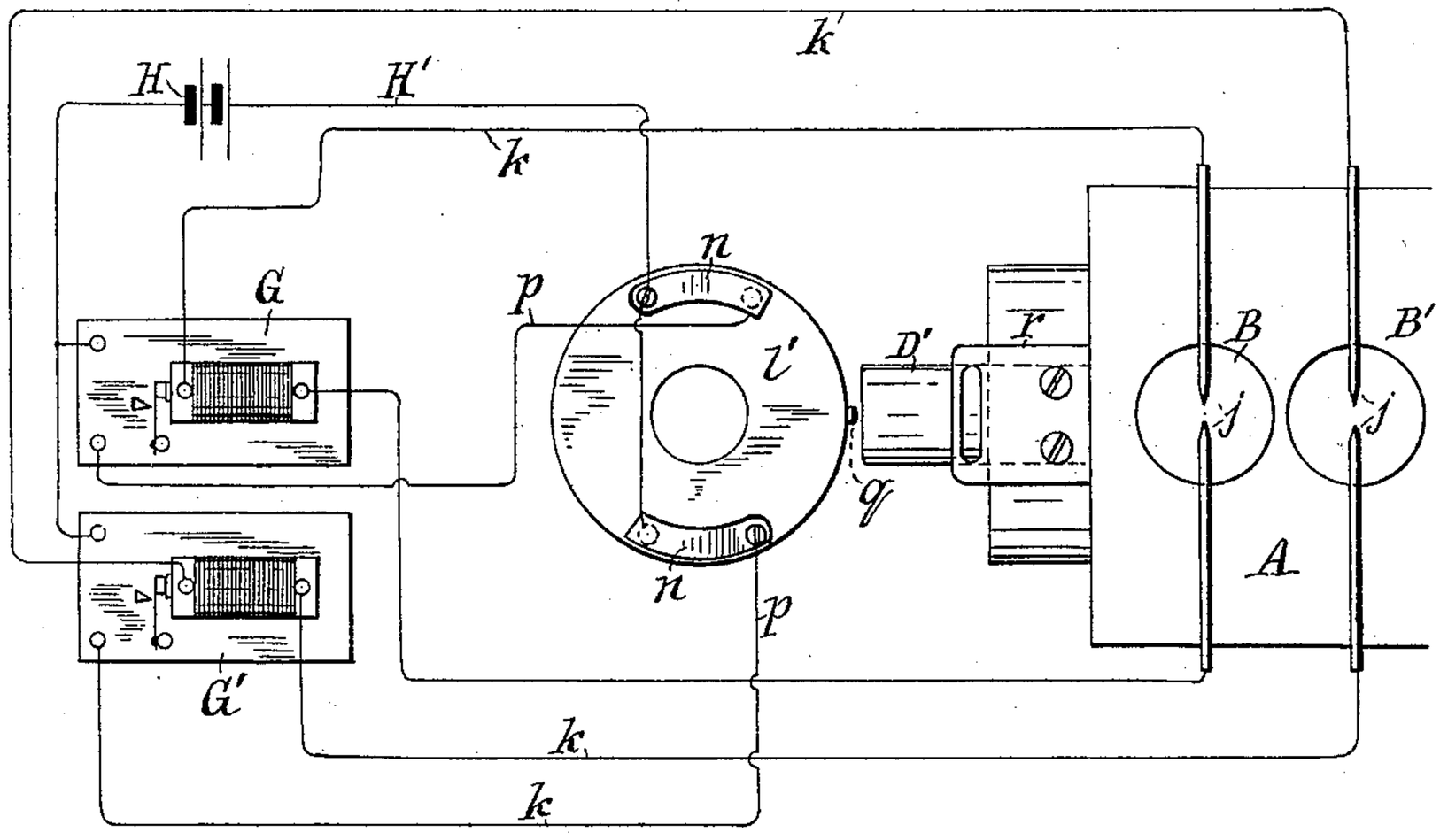


Fig. 6.

Witnesses.
R. S. Lacey
H. M. Sekmans

Inventor.
Daniel M. Tuttle
By C. H. Duell
his Attorney.

(No Model.) 6 Sheets—Sheet 6.

D. M. TUTTLE.

GAS ENGINE.

No. 604,241. Patented May 17, 1898.

Fig. 7.

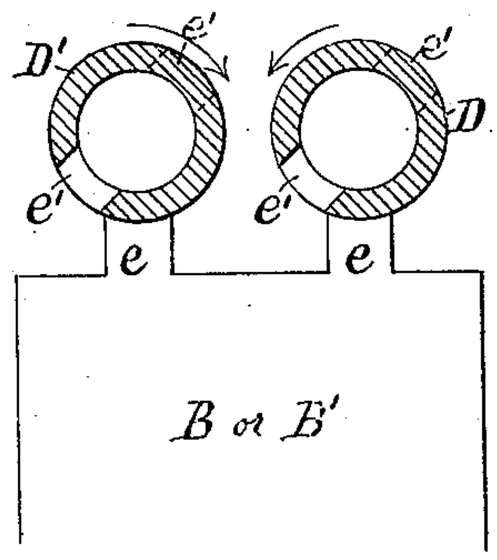
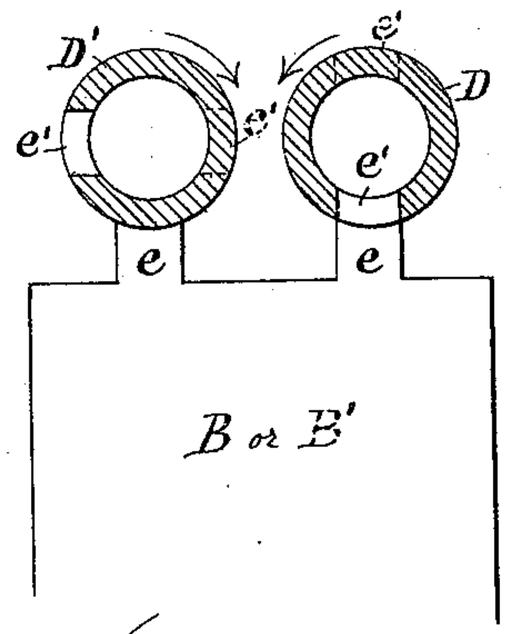


Fig. 8.



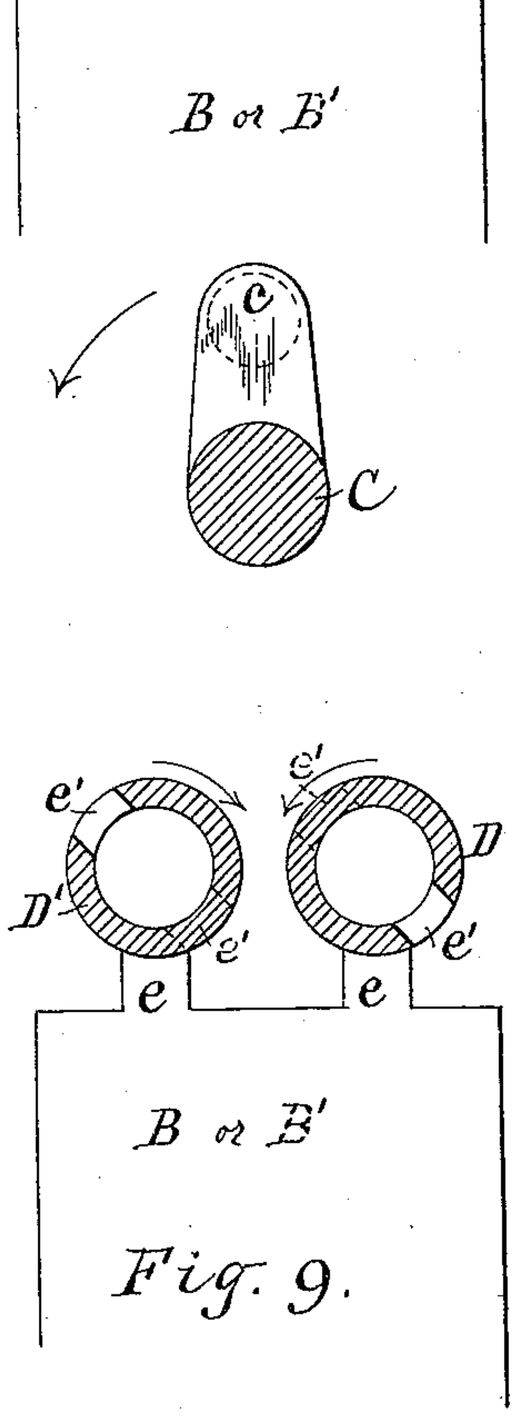


Fig. 9.

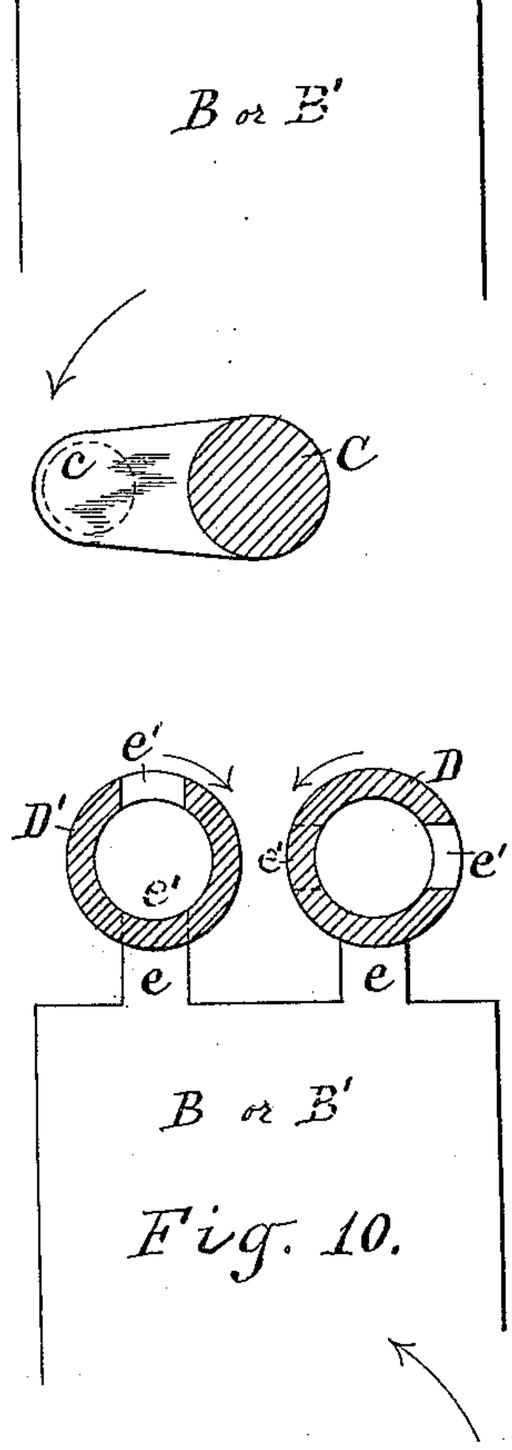


Fig. 10.

Witnesses.
R. L. Dewey
H. M. Seamans

Inventor.
Daniel M. Tuttle
By C. H. Duell
His Attorney.

UNITED STATES PATENT OFFICE.

DANIEL M. TUTTLE, OF ONEIDA, NEW YORK.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 604,241, dated May 17, 1898.

Application filed December 17, 1896. Serial No. 615,965. (No model.)

To all whom it may concern:

Be it known that I, DANIEL M. TUTTLE, of Oneida, in the county of Madison, in the State of New York, have invented new and useful Improvements in Gas-Engines, of which the following, taken in connection with the accompanying drawings, is a full, clear, and exact description.

My invention relates to certain new and useful improvements in gas-engines having reciprocating pistons and electric igniting means; and the object is to provide a simple and powerful engine that can be easily regulated or governed. Gases of different kinds may be employed, as those derived from naphtha, gasolene, or other volatile hydrocarbons, or natural gas. The gas is mixed with atmospheric air in suitable proportions, as usual, so that when ignited it will produce the desired explosive force economically.

To this end my invention consists in the combination, with the casing, a plurality of cylinders, pistons, and a driving-shaft having cranks connected to the pistons, of rotary supply and exhaust conduits journaled in said casing and communicating periodically and alternately with the cylinders, gearing between the driving-shaft and the said rotary conduits, electric igniting means for each cylinder, and a revolving commutator for controlling the passage of the current through the cylinders; and my invention consists in certain other combinations of parts herinafter described, and specifically set forth in the claims.

In the drawings hereto annexed and forming a part of this specification, Figure 1 is a side elevation of one form of my invention, with a portion broken away to show the cranks. Fig. 2 is an end view. Fig. 3 is a longitudinal vertical sectional view taken approximately on line *x x* of Fig. 4. Fig. 4 is a vertical transverse sectional view on line *y y* of Fig. 1. Fig. 5 is a top plan view. Fig. 6 is a diagrammatic view of the electric igniting means, including the circuits; and Figs. 7 to 10, inclusive, show the relative positions of the cranks and rotary valves or the supply and exhaust tubes at each quarter-revolution of the crank-shaft.

Referring specifically to the drawings, A is the casing, having a pair of vertical cylinders B and B′ therein side by side and preferably integral therewith, a horizontal driving-shaft C passing longitudinally through the lower part of the casing and journaled therein, and cranks *c c* in the shaft below the cylinders, connected by pitmen *c′ c′* with pistons *b b* in the cylinders.

The end bearings *d d* for the crank-shaft are screwed to the ends of the casing A and are removable for the purpose of removing the shaft. The central bearing *d′* may be also removable.

C′ is the balance-wheel on one end of the shaft, the opposite end of which may be suitably connected to the machinery or device to be driven.

In an engine having two cylinders, as that illustrated in the drawings, the cranks *c c* are on one and the same side of the shaft; but when a greater number of cylinders are in the engine the cranks may be on different sides of the shaft. The pitmen are connected to the pistons by a ball-and-socket joint.

Passing longitudinally through the casing parallel with the driving-shaft and above the upper ends of the cylinders B and B′ are a pair of tapering tubes D and D′, having their axes in the same horizontal plane. These tubes constitute not only the supply and discharge conduits, but rotary valves which open and close at the proper times the pair of apertures or slots *e e* in the upper end of each cylinder. To accomplish this, each rotatable tube is provided with a pair of slots *e′ e′* in diametrically opposite sides thereof, but at points along its length, which when the tube is rotated will open and close alternately the slots *e e* in the ends of the cylinders. The small end of the tube D is connected with a gas-supply pipe E and the small end of the tube D′ is the exhaust. The larger ends of the said tubes are closed and provided with gear-wheels *f* and *f′*, in mesh with each other, so that the tubes will revolve in opposite directions. A beveled gear-wheel *f″* is also mounted on the large end of the tube D and is connected by means of a nearly perpendicular shaft F, turning in brackets F′ on the end of the case, and suitable gearing with a gear-wheel *g* on the driving-shaft. By this means motion is imparted from the driving-shaft to the rotatable tubes. The gearing

above referred to causes the tubes D and D′ to make one complete revolution while the driving-shaft makes two revolutions.

The tubes D and D′ may be straight and not tapered. They are, however, preferably tapered more or less and provided with springs *h h* between their large ends and the flanges on the gudgeons or plugs *h′ h′* in said ends and upon which the gear-wheels *f* and *f′* are fixed, so that the tubes will be forced slightly endwise to fit closely in their bearings and prevent the escape of the gas from the cylinders.

The plugs *h′* have pins *i* extending through them, as shown in Fig. 3, their ends projecting and entering a pair of small slots *i′ i′* in diametrically opposite sides of the tubes, and thus, while the plugs *h′ h′* serve to turn the tubes, they allow the springs to move the tubes relatively to the plugs as the tubes and bearings become worn, and thus keep the tubes closely fitted in their bearings.

Near the upper end of each cylinder, above the highest point reached by the piston and passing through opposite sides of the case, are a pair of pins *j j*, suitably secured in place and insulated from the case. Said pins have their points in proximity to each other, while their opposite ends are provided with binding-posts *j′ j′*, to which are connected the terminals of secondary circuits *k k*, leading from a pair of induction-coils G G′. (Shown in Fig. 6 of the drawings.) The primary circuit H′ of said coils is in circuit with a battery H and a revolving commutator I on the small end of the tube D′. This commutator has a rotatable part *l*, fixed on the tube D′ and turning with it, and a stationary or adjustable part *l′*, which is provided with a pair of spring-contacts *n n* on its face, which engage a projection or rubber *m* on the rotatable part *l*, causing the contacts to be closed alternately when the rotatable part is operated. The spring-contacts are in branches *p p* of the primary circuit leading to the coils G G′ and are normally in an open position, as shown in Fig. 5.

It will be apparent from the above that when the engine is in operation the part *l* of the commutator will by means of its rubber *m* close each secondary circuit once during a single revolution of the tubes D and D′, or during two revolutions of the driving or crank shaft, thus firing or igniting the gas once in each cylinder. The firing is effected or the electric spark passed through a cylinder at the commencement of the operation of the engine, when the crank-shaft and tubes D and D′ stand in relation to each other as illustrated in Fig. 7. As the speed of the engine increases it is necessary to fire the gas some time before the crank reaches its highest position in order to derive the greatest power from the explosion. This is effected by turning the part *l′* of the commutator more or less on its axis by means of the stem *q*, passing through the slotted plate *r*, secured permanently to the case. The more the stem or handle *q* is pushed over to the rear side of the engine the more quickly the cylinders will be fired.

Assuming that the cranks are in the position shown in Fig. 7 when the firing of the gas in cylinder B takes place, the apertures or slots *e′ e′* in the tubes D and D′ are in the position shown in the same figure. The cranks *c c* and the tubes or rotary valves moving in the direction of the unfeathered arrows, the tubes stand as shown in Fig. 8 when the crank-shaft has made a quarter of a revolution. When a half-revolution of the shaft is made, they stand as in Fig. 9, and three-fourths as in Fig. 10. When a complete revolution of the crank-shaft is made, the slots *e′ e′* shown by broken lines in the tubes stand in the position the slots *e′ e′* shown in full lines in Fig. 7 stand; but these slots are opposite the other cylinder or cylinder B. In this position the latter cylinder is fired. Continuing the revolution of the crank-shaft as before explained with reference to the cylinder B, the Figs. 8, 9, and 10 illustrate the positions of the rotary valves D and D′ at each quarter-revolution. It is therefore apparent from the above that the cylinders are fired alternately and when the cranks extend upward at the center or approximately near the center, and also that two complete revolutions are necessary for the charging, compressing, firing, and discharging or exhausting of a cylinder, although at each revolution of the cranks one of the cylinders is fired. While the cranks *c c* are making the first semirevolution, or from the position shown in Fig. 7 to that shown in Fig. 9, the slot *e′* in tube D is open and the gas is drawn into cylinder B. During the next semirevolution the piston *b* is pushed upward and the gas is compressed. Then the electric circuit is closed by the commutator I, which passes a spark between the points of the pins *j j* in cylinder B and fires the gas, thus forcing the cranks downward again. Upon reaching the lowest point, or after another semirevolution, the slot *e′* of tube D′ begins to open the outlet *e* of the cylinder, thus allowing it to exhaust or discharge, which occupies the time of the fourth semirevolution, or two complete revolutions of the crank-shaft. The same action being repeated again and again, the driving-shaft C is rotated continuously and uniformly. If desired, the inlet-slots *e* of the cylinders may be made narrower than the outlet-slots, so that the former may not remain open so long. The lower part of the casing containing the cranks being completely closed, the air therein is compressed when the pistons descend, and by its expansion helps the pistons to ascend after the cranks pass the center, thus tending to promote increased uniformity of motion of the driving-shaft. In an engine having a greater num-

ber of cylinders and cranks, the cranks being in different sides of the shaft, the balance-wheel C′ may be dispensed with.

K is an oil-cup which is connected with suitable conduits for keeping the parts oiled, and L and L′ are pipes for circulating water around the cylinders to keep said cylinders and casing cool, as is usual in gas-engines.

The crank J on the end of the driving-shaft C may be used to start the engine. The nature of its connection with the hub of the balance-wheel allows it to remain at rest after the engine is set in motion, as is well known.

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

1. In a gas-engine, the combination with the casing, a plurality of cylinders having inlets and outlets, pistons, and a driving-shaft having cranks connected to the pistons, of rotary supply and exhaust tubes journaled in said casing and provided with apertures for opening the said inlets and outlets, said apertures being located at different points on the periphery and different points along the length of each tube, gearing between the driving-shaft and the rotary tubes to rotate the tubes continuously, electric igniting means for each cylinder, and a commutator to control the passage of the electric currents through the cylinders, as set forth.

2. In a gas-engine, the combination with the casing, a plurality of vertical cylinders having inlets and outlets in their upper ends, pistons, and a horizontal driving-shaft passing through the casing below the cylinders and having cranks connected by pitmen with the pistons, of a pair of rotary tubes journaled in said casing above the cylinders and parallel with the driving-shaft, said tubes having apertures in opposite sides to open the inlets and outlets in the cylinders, gearing between the driving-shaft and the said rotary tubes to rotate the tubes continuously, electric igniting means for each cylinder, and a revolving commutator to control the passage of the electric currents through the cylinders, as set forth.

3. In a gas-engine, the combination with the casing, a pair of cylinders in the casing side by side, said cylinders having each an inlet and an outlet, pistons, and a driving-shaft having a pair of cranks on one and the same side of the shaft, pitmen connecting the cranks with the pistons, of a pair of rotary tubes having apertures in opposite sides to open and close the inlets and outlets in the cylinders, gearing between the driving-shaft and the tubes to rotate the tubes continuously, and suitable igniting means for each cylinder, as set forth.

4. In a gas-engine, the combination with the casing, a pair of cylinders in the casing side by side, said cylinders having each an inlet and an outlet, pistons in the cylinders, and a driving-shaft having a pair of cranks on one and the same side of the shaft, pitmen connecting the cranks with the pistons, of a pair of rotary tubes passing through the casing and having apertures therein to open and close the inlets and outlets in the cylinders alternately, gearing between the driving-shaft and the tubes to rotate the tubes continuously, a commutator operated by the engine to control electric currents through circuits, and electric igniting means within each cylinder connected with the circuits, as set forth.

5. In a gas-engine, the combination with the casing, a pair of cylinders in the casing side by side, said cylinders having each an inlet and an outlet, pistons in the cylinders, and a driving-shaft having a pair of cranks on one and the same side of the shaft, pitmen connecting the cranks with the pistons, of a pair of rotary tubes passing through the casing and having apertures therein to open and close the inlets and outlets in the cylinders alternately, gearing between the driving-shaft and the tubes to rotate the tubes continuously, a commutator operated by the engine to control electric currents through circuits, electric igniting means within each cylinder connected with the circuits, and an adjustable part in said commutator to vary the time of closing the circuits, as set forth.

6. In a gas-engine, the combination with the casing, a plurality of cylinders having inlets and outlets, pistons, and a driving-shaft having cranks connected to the pistons, of tapered rotary supply and exhaust tubes journaled in said casing and provided with apertures for opening the said inlets and outlets, gearing between the driving-shaft and the rotary tubes to rotate the tubes continuously, electric igniting means for each cylinder, and a commutator to control the passage of the electric currents through the cylinders, as set forth.

7. In a gas-engine, the combination with the casing, a plurality of cylinders having inlets and outlets, pistons, and a driving-shaft having cranks connected to the pistons, of rotary supply and exhaust tubes journaled in said casing and provided with apertures for opening the said inlets and outlets, said tubes being tapered and provided with means to force them endwise, gearing between the driving-shaft and the rotary tubes to rotate the tubes continuously, electric igniting means for each cylinder, and a commutator to control the passage of the electric currents through the cylinders, as set forth.

8. In a gas-engine, the combination with the casing, a plurality of cylinders having inlets and outlets, pistons, and a driving-shaft having cranks connected to the pistons, of rotary supply and exhaust tubes journaled in said casing and provided with apertures for opening the said inlets and outlets, said tubes being tapered, loose plugs in the ends of the shafts to turn the latter, a spring to force the tubes endwise, gearing between the driving-

shaft and the rotary tubes to rotate the tubes continuously, electric igniting means for each cylinder, and a commutator to control the passage of the electric currents through the cylinders, as set forth.

9. In a gas-engine, a pair of cylinders, pistons, and a crank-shaft connected with the pistons, rotary valves for the cylinders operated continuously by the crank-shaft, a commutator operated by the engine, having a rotatable part carrying a rubber and an adjustable part carrying spring-contacts in the path of the rubber, a primary electric circuit having branches containing the spring-contacts and the primaries of induction-coils, and secondary circuits leading from the coils to igniting means in the said cylinders, as set forth.

10. In a gas-engine, a pair of cylinders, pistons, and a crank-shaft connected with the pistons, rotary valves for the cylinders operated continuously by the crank-shaft, a commutator having a rotatable part carried by one of the rotary valves, another part of the commutator bearing electric spring-contacts to be operated by the said rotatable part, a primary electric circuit having branches containing the spring-contacts and the primaries of induction-coils, and secondary circuits leading from the coils to igniting means in the said cylinders, as set forth.

In testimony whereof I have hereunto signed my name.

DANIEL M. TUTTLE. [L. S.]

Witnesses:
MARK W. DEWEY,
H. M. SEAMANS.