(No Model.) 3 Sheets—Sheet 1.

G. M. HOPKINS.

GAS ENGINE.

No. 284,557. Patented Sept. 4, 1883.

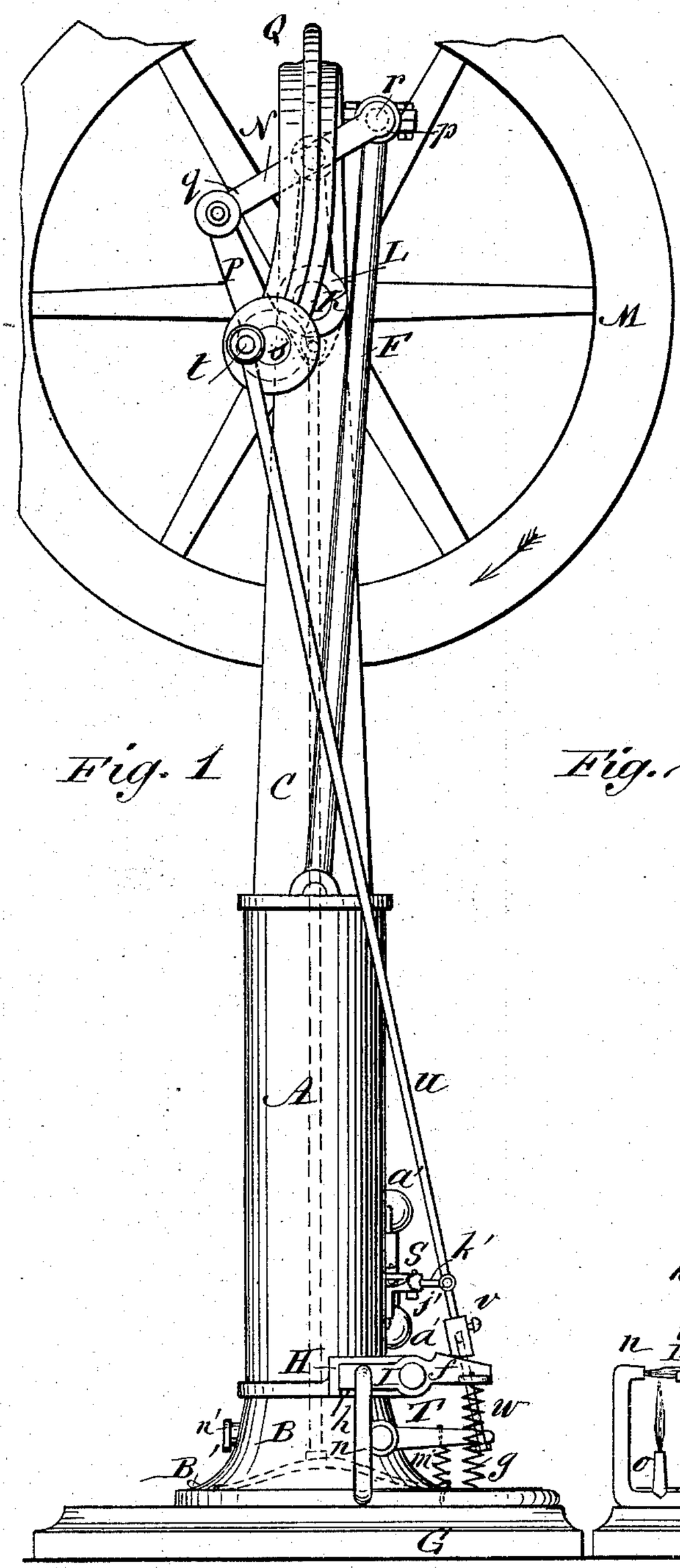


Fig. 1

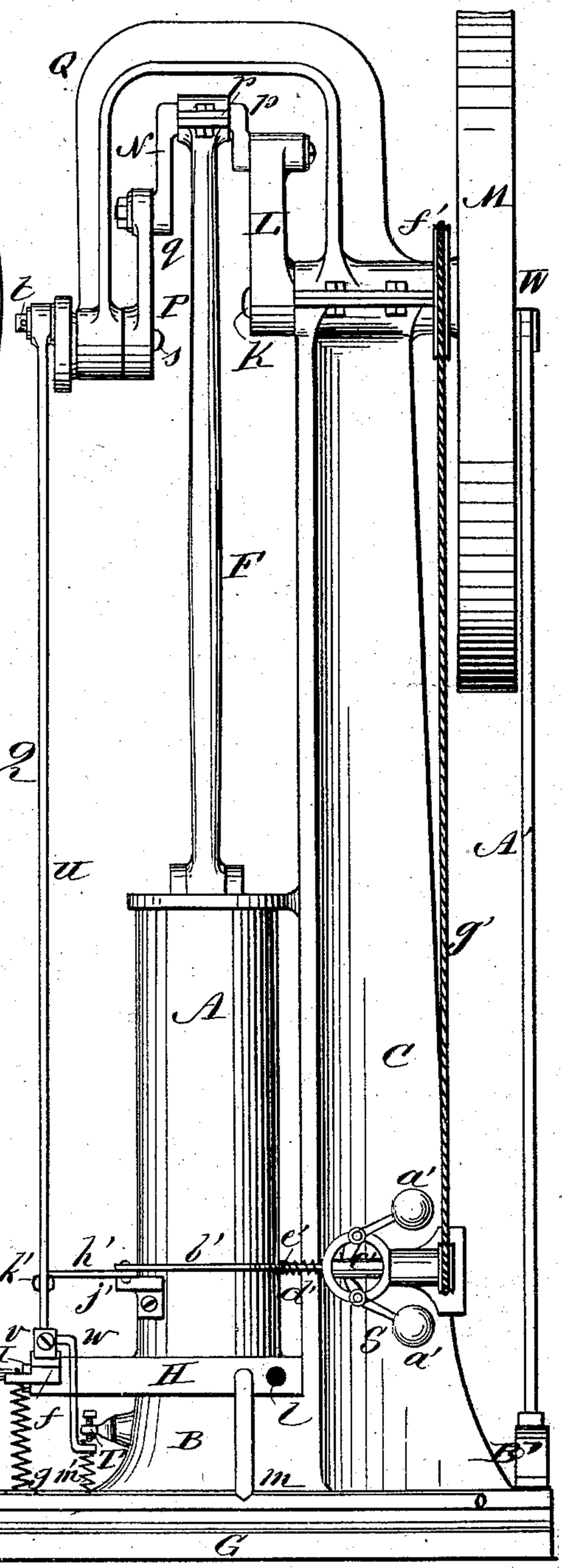


Fig. 2

WITNESSES:

C. Neveux

C. Sedgwick

INVENTOR:

G. M. Hopkins

BY Munn & Co

ATTORNEYS.

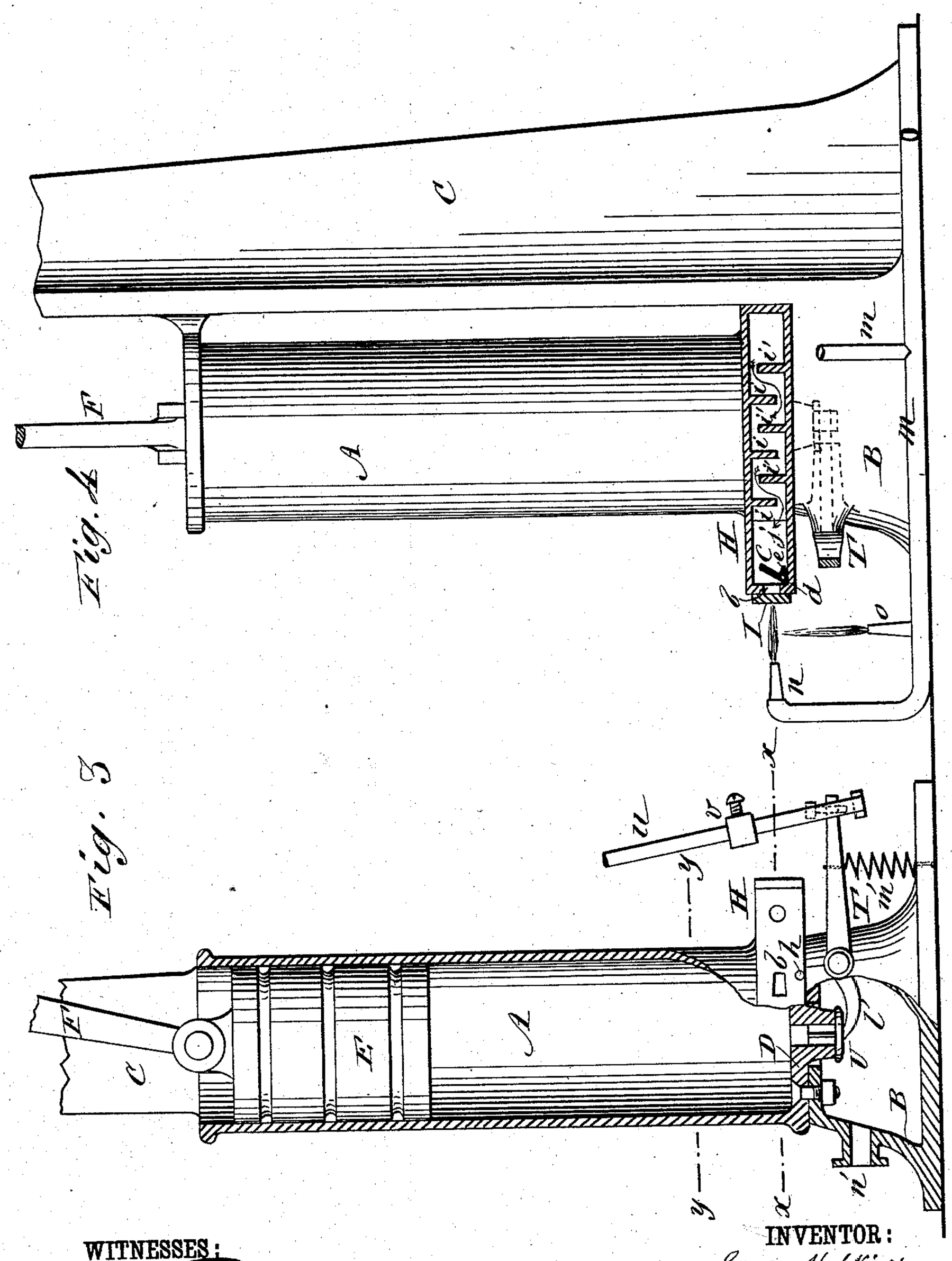
(No Model.)

3 Sheets—Sheet 2.

G. M. HOPKINS.

GAS ENGINE.

No. 284,557. Patented Sept. 4, 1883.



WITNESSES:

C. Neveux

C. Sedgwick

INVENTOR:

G. M. Hopkins

BY Munn & Co

ATTORNEYS.

(No Model.) 3 Sheets—Sheet 3.

G. M. HOPKINS.

GAS ENGINE.

No. 284,557. Patented Sept. 4, 1883.

Fig. 5

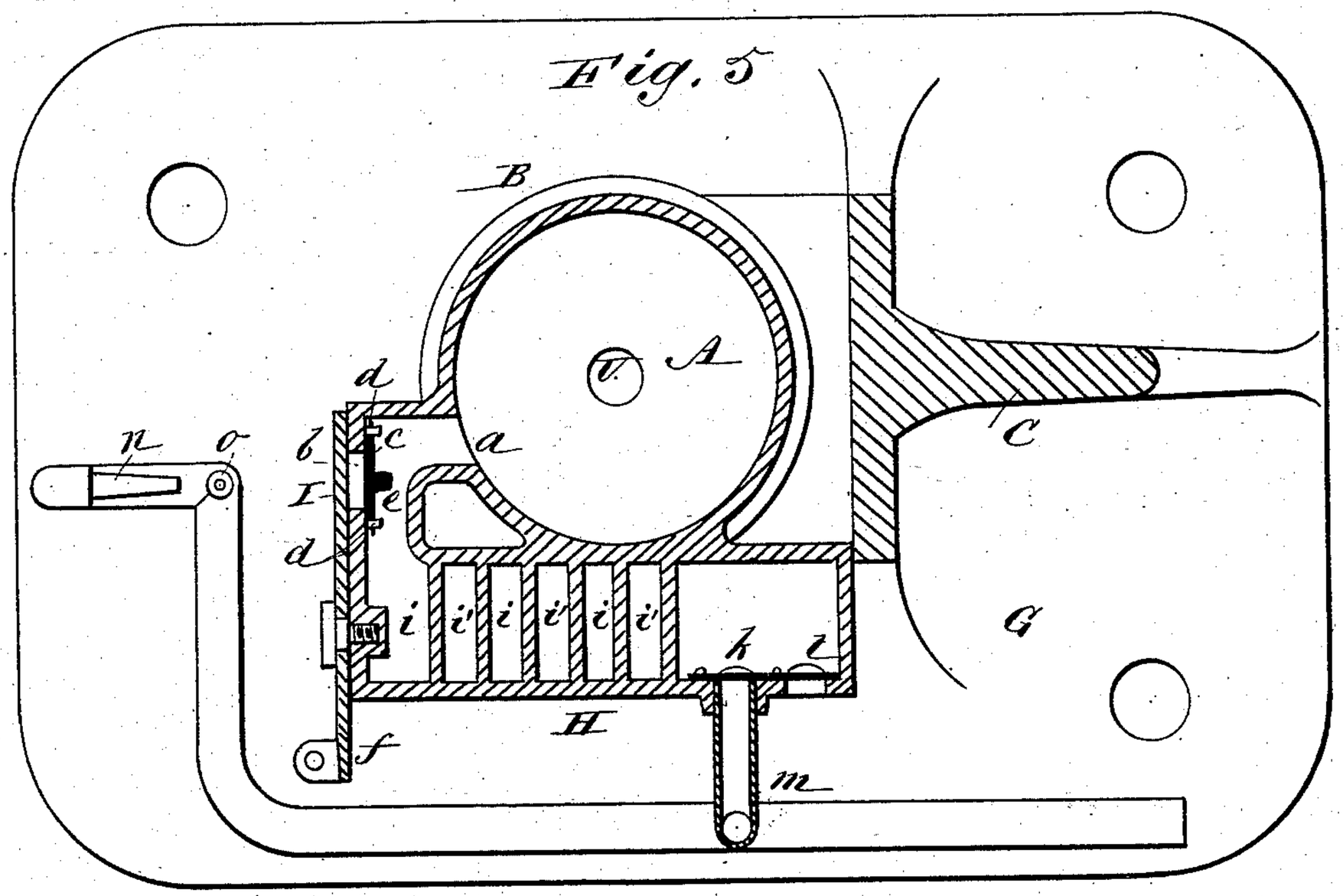
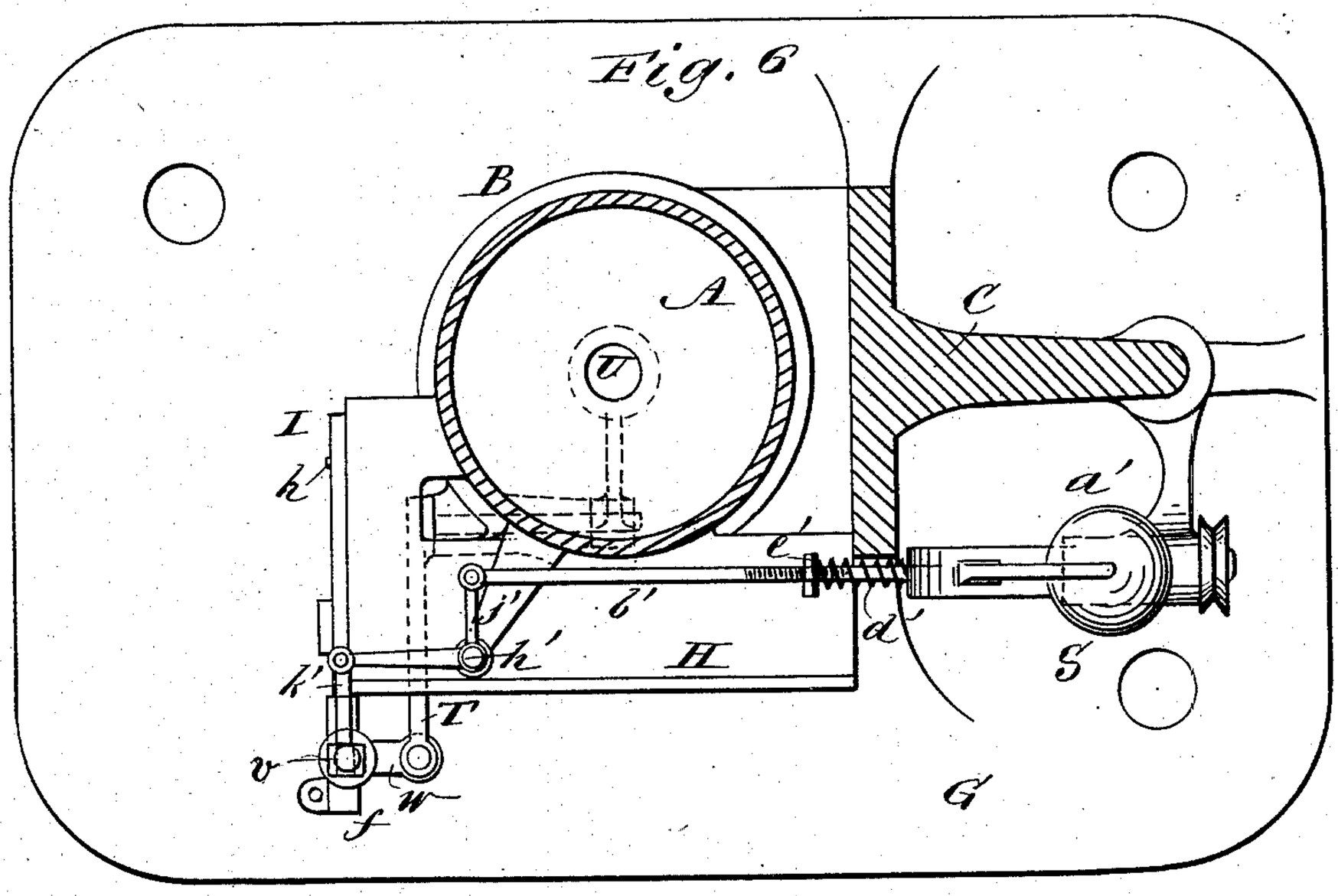


Fig. 6



WITNESSES:

C. Neveux

C. Sedgwick

INVENTOR:

G. M. Hopkins

BY Munn & Co

ATTORNEYS.

UNITED STATES PATENT OFFICE.

GEORGE M. HOPKINS, OF BROOKLYN, ASSIGNOR TO THE ECONOMIC MOTOR COMPANY, OF NEW YORK, N. Y.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 284,557, dated September 4, 1883.

Application filed November 24, 1882. (No model.)

To all whom it may concern:

Be it known that I, GEORGE M. HOPKINS, of Brooklyn, in the county of Kings and State of New York, have invented a new and Improved Gas-Engine, of which the following is a full, clear, and exact description.

Figure 1 is a front elevation of my improved gas-engine. Fig. 2 is a side elevation. Fig. 3 is an enlarged side elevation of the cylinder, partly in section. Fig. 4 is an enlarged side elevation of the cylinder, showing a vertical section of the gas-mixing chamber. Fig. 5 is an enlarged horizontal section of the cylinder and gas-mixing chamber, taken on line *x x* in Fig. 3. Fig. 6 is an enlarged horizontal section taken on line *y y* in Fig. 3.

Similar letters of reference indicate the same parts in the different figures of the drawings.

This invention relates to the class of engines in which the pressure resulting from the combustion or explosion of gas and air is employed as a motive agent; and it consists in mechanism for utilizing to the greatest advantage the pressure generated by the explosion of the gases.

In a gas-engine it is desirable to introduce gas and air into the cylinder in a thoroughly-mixed condition, so that the combustion of the gas may be complete. This I accomplish by conveying the gas and air together through a mixing-chamber having a series of partitions extending from opposite sides and alternating in position, so as to form a zigzag passage, through which the gas and air must pass before entering the cylinder. It is desirable to draw the gas and air into the cylinder before the crank upon which the power is exerted has advanced so far in its revolution as to pass through any considerable portion of the available part of the stroke before the explosion in the cylinder takes place. This I accomplish by means of a mechanical movement consisting of a crank carrying a lever of the second kind, the resistance being at the point of connection with the crank, the power of the piston being applied to one end of the lever, while the other end is fulcrumed in a movable arm whose center of rotation is eccentric to that of the crank carrying the lever. It is also desirable that the explosion of the gas should take place at a variable point in the early part of the stroke of the piston, to enable the engine to be controlled by exploding a greater or less quantity of gas in the cylinder. This I accomplish by a crank and connecting-rod carried by the eccentric arm acting on the explosion-valve, the time of contact between the valve-rod and valve being varied by a governor. Furthermore, it is desirable to store up a portion of the power generated by the explosion of the gas to assist the piston in its return-stroke and to equalize the motion of the engine. I effect this by compressing a spring during the movement of the piston under the pressure due to the explosion of the gas, and then allowing the spring to react and assist the fly-wheel during the return-stroke of the piston.

The cylinder A, in which the explosion of gas takes place, is cast with or attached to the hollow pedestal B and standard C. It is open at the top and closed by the head D at the bottom, and is provided with a solid piston, E, which is connected with the rotative parts of the engine by the connecting-rod F. Both cylinder A and standard C are secured to the bed-plate G.

To one side of the cylinder A is attached a gas-mixing chamber, H, through which the gas and air are drawn together in their passage to the cylinder. This mixing-chamber H is long and narrow, extending from the back of the cylinder, or that side next the standard C, to the front, and is angled, so as to communicate with the cylinder through the aperture *a*. Opposite the aperture *a* in the outer wall of the chamber H there is an oblong igniting-opening, *b*, capable of being closed from the inside by the flap-valve *c*. This valve is hung on pivots *d*, and is provided with a lug, *e*, to limit its inward movement.

On the front vertical wall of the mixing-chamber H is pivoted a valve, I, capable of covering the opening *b*, and provided with an arm, *f*, the under side of which receives the pressure of a spiral spring, *g*, which abuts on the bed-plate G and holds the valve in its normally-closed position, the valve being stopped by the stud *h*.

The gas-mixing chamber H has two series of transverse partitions, *i i'*, extending from opposite sides. The partitions of the series *i* extend from the top of the chamber toward the bottom without touching it, and the partitions of the series *i'* alternate in position with the partitions *i*, and extend from the bottom toward the top of the chamber without touching it. These two series of partitions form a sinuous passage, *j*, through which the gas and air must pass from their respective valves, *k l*, before they can enter the cylinder A. The gas-valve *k* and the air-valve *l* are alike in form and construction, each consisting of a metal flap suspended from pivots at the top, and capable of opening inward when acted on by external pressure, and of closing over their respective openings when subjected to pressure from within. The air-valve *l* opens directly into the surrounding air, and the gas-valve *k* communicates with the gas-supply pipe *m*. A branch of the gas-pipe *m* extends to the burners *n o*, the burner *n* being placed horizontally to direct the flame toward the igniting-opening *b*, and the burner *o* is arranged vertically to ignite the flame of the upper burner, *n*, should the latter be extinguished by the explosion of gas in the mixing chamber or cylinder.

At the top of the standard C is journaled the crank-shaft K, having at the end above the cylinder A a crank-arm, L, and at its opposite end a fly-wheel, M. In the outer end of the crank-arm L is journaled the double-crank lever N, having the short double arm *p* and the longer arm, *q*. The bearing *r* of the shorter arm receives the upper or crank-pin end of the connecting-rod F, the lower end of the connecting-rod being pivoted to the piston E. The longer arm, *q*, of the double-crank lever N is pivoted to an arm, P, whose center of rotation is below and at one side of the axial lever of the crank-shaft K. The shaft *s* of the arm P is journaled in the curved arm Q, secured to the top of the standard C, and reaching over the path of the crank-arm L and its appendages. By the eccentric arrangement of the arm P the double-crank lever N, which revolves with the crank-arm L, is made to swing quickly on its bearing in the crank-arm L during the lower portion of its revolution and slowly during the remainder of its revolution. The object of this variable movement of the double-crank arm and the piston connected therewith is twofold: first, to obtain a quick downward movement of the piston at the lower end of its stroke to expel the products of combustion, and then to quickly raise it as far as necessary to draw into the cylinder the requisite quantity of gas and air before the crank-arm has advanced far on its upward stroke; and, second, to obtain the greatest possible leverage on the crank-arm during the upward stroke of the piston following the explosion of the gas.

A crank, *t*, is attached to the outer end of the shaft *s*, for receiving a connecting-rod, *u*, which extends downward toward the arm *f* of the valve I, and is provided with an adjustable head, *v*, which is capable of touching the arm *f* of the valve I, the time of its engagement with the valve-arm being variable by the governor S. The head *v* carries a rod, *w*, bent at the ends in opposite directions at right angles, its lower end extending under the end of the exhaust-lever T.

The governor S is of the usual pattern, having the weighted arms *a' a'*, which are thrown outward by centrifugal force and act to draw the rod *b'* into the sleeve *c'* of the governor, against the pressure of the spring *d'*, which abuts against the governor-yoke and presses against the nut *e'* on the rod *b'*. The governor receives its motion from a pulley, *f'*, on the main shaft K, through the belt *g'*, and the rod *b'* connects with one arm of a right-angled lever, *h'*, fulcrumed on a bracket, *j'*, extending from the cylinder A, the other arm of the lever *h'* being connected with the rod *u* by means of a link, *k'*, having a ball-and-socket joint at each end. The exhaust-valve U, at the bottom of the cylinder A, is pressed to its seat by the arm *l'* of the lever T, the latter being drawn down by a spiral spring, *m'*, connecting with the base G. The pressure upon the valve U is in excess of the pressure generated in the cylinder A in the normal working of the engine, but it is not so great as to prevent the valve from opening under extraordinary pressure independently of the regular opening mechanism. The valve U opens into the cavity in the pedestal B, and the exhaust escapes through the opening *n'*, either directly into the open air or to a pipe leading away.

From the rear face of the boss of the fly-wheel M a crank-pin, W, projects for receiving the upper end of a rod, A', the lower end of which presses on a curved spring, B', resting on the base-plate G. The crank-pin W is diametrically opposite the crank-arm L, so that when the latter is making its upward stroke the former will act through the rod A' on the spring B' to compress it, and when the crank-arm is making its downward stroke the spring B' reacts to assist it.

The engine is started by turning on the gas and lighting the burners *n o*, and then turning the fly-wheel M in the direction indicated by the arrow until the required amount of gas and air has been drawn into the cylinder A by the upward movement of the piston. At this moment the head *v* on the lower end of the rod *u* strikes the arm *f* of the valve I and opens the latter, allowing the flame from the burner N to be drawn in through the aperture *b*, when the explosion immediately follows, driving the piston E upward, and at the same time closing the valves *c*, *k*, and *l*. While the piston is ascending, power is stored in the spring B', which is given out as soon as the crank-arm L passes its upper dead-center, and assists the fly-wheel in returning the piston E'

to the bottom of the cylinder. As the crank-arm L nears the lower portion of its stroke the double crank N, by reason of its connection with the eccentrically-arranged arm P, moves the piston downward very rapidly and draws it upward very quickly to a sufficient distance to draw into the cylinder all the gas and air required for the succeeding stroke. During the latter portion of the downward stroke of the piston the exhaust-valve U is opened by the engagement of the rod *w* with the lever T, and the products of combustion escape into the cavity in the pedestal B, whence they are conveyed away by a pipe to a flue or other suitable place for discharging the exhaust, and the operation just described takes place at each revolution of the engine. When the engine is doing its maximum work, the head *v* on the rod *u* touches the arm *f* near its outer end after the greatest possible amount of gas and air has been drawn into the cylinder; but as the speed increases above the normal the action of the governor S moves the head *v* toward the pivot of the valve I, and the latter is opened earlier in the stroke of the piston, and a less amount of gas is exploded.

It will be seen that the power and speed of the engine are regulated by exploding at each revolution thereof a variable quantity of mixed gases, the proportions of the mixture being always the same.

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

1. In a gas-engine, the gas-mixing chamber H, provided with partitions *i i'*, alternating in position and forming the sinuous passage *j*, as herein specified.

2. In a gas-engine, the pivoted valve I, closing-spring *g*, rod *u*, and crank *t*, in combination, as herein shown and described.

3. In a gas-engine, the mixing-chamber H, gas-valve *k*, air-valve *l*, check-valve *c*, and igniting-valve I, in combination, as specified.

4. In a gas-engine, the combination of the mixing-chamber H, provided with partitions *i i'*, the valves *c*, *k*, and *l*, igniting-valve I, and igniting-burners *n o*, substantially as shown and described.

5. In a gas-engine, the combination of the spring B', rod A', and the crank W, the latter being arranged in opposition to the crank-arm L, as specified.

GEO. M. HOPKINS.

Witnesses:
C. SEDGWICK,
B. G. UNDERWOOD.