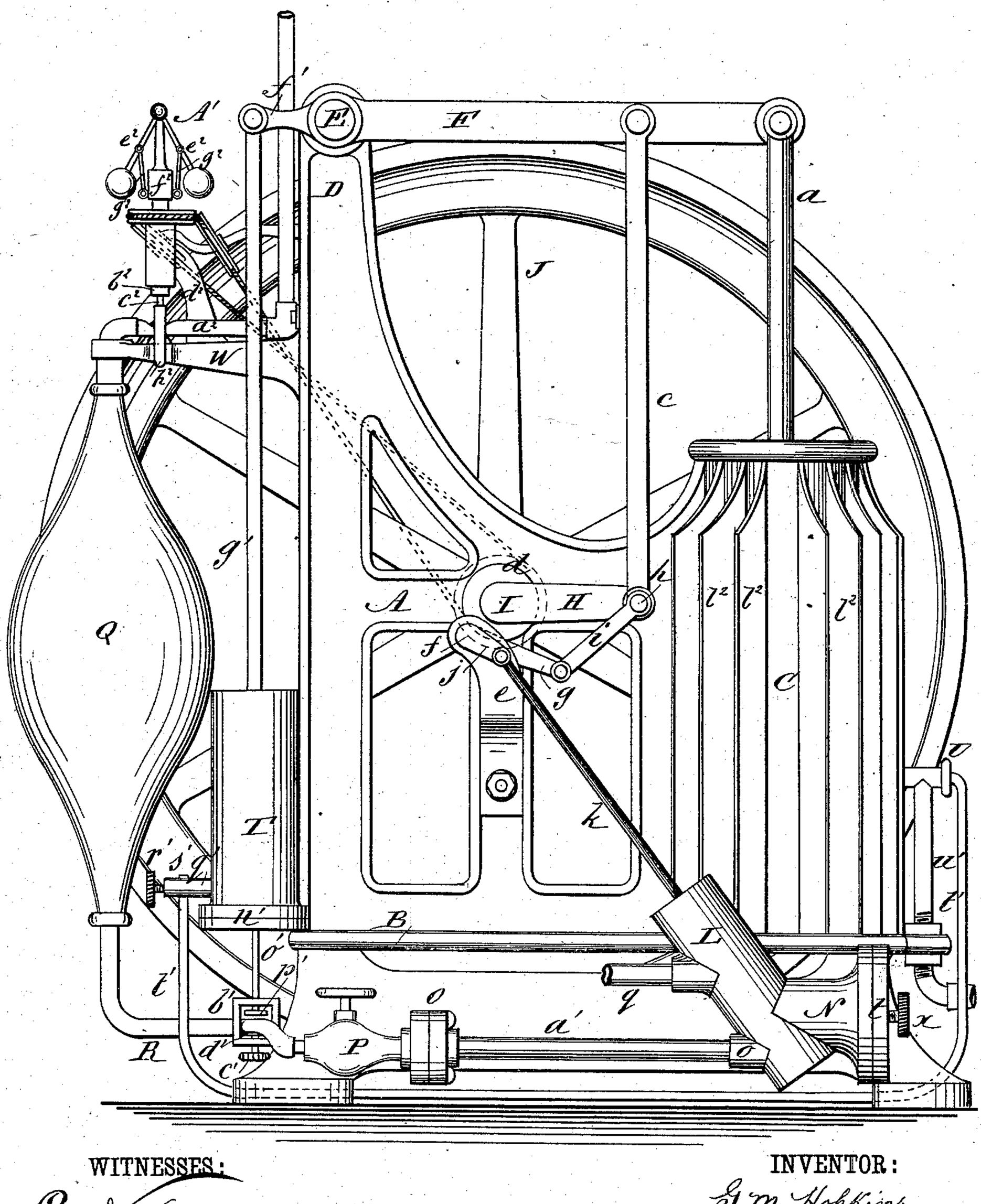
(No Model.) 3 Sheets—Sheet 1.

G. M. HOPKINS.

GAS ENGINE.

No. 284,555. Patented Sept. 4, 1883.

Fig. 1



WITNESSES:

C. Neveux

C. Sedgwick

INVENTOR:

G. M. Hopkins

BY Munn & Co

ATTORNEYS.

(No Model.) 3 Sheets—Sheet 2.

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Fig. 2

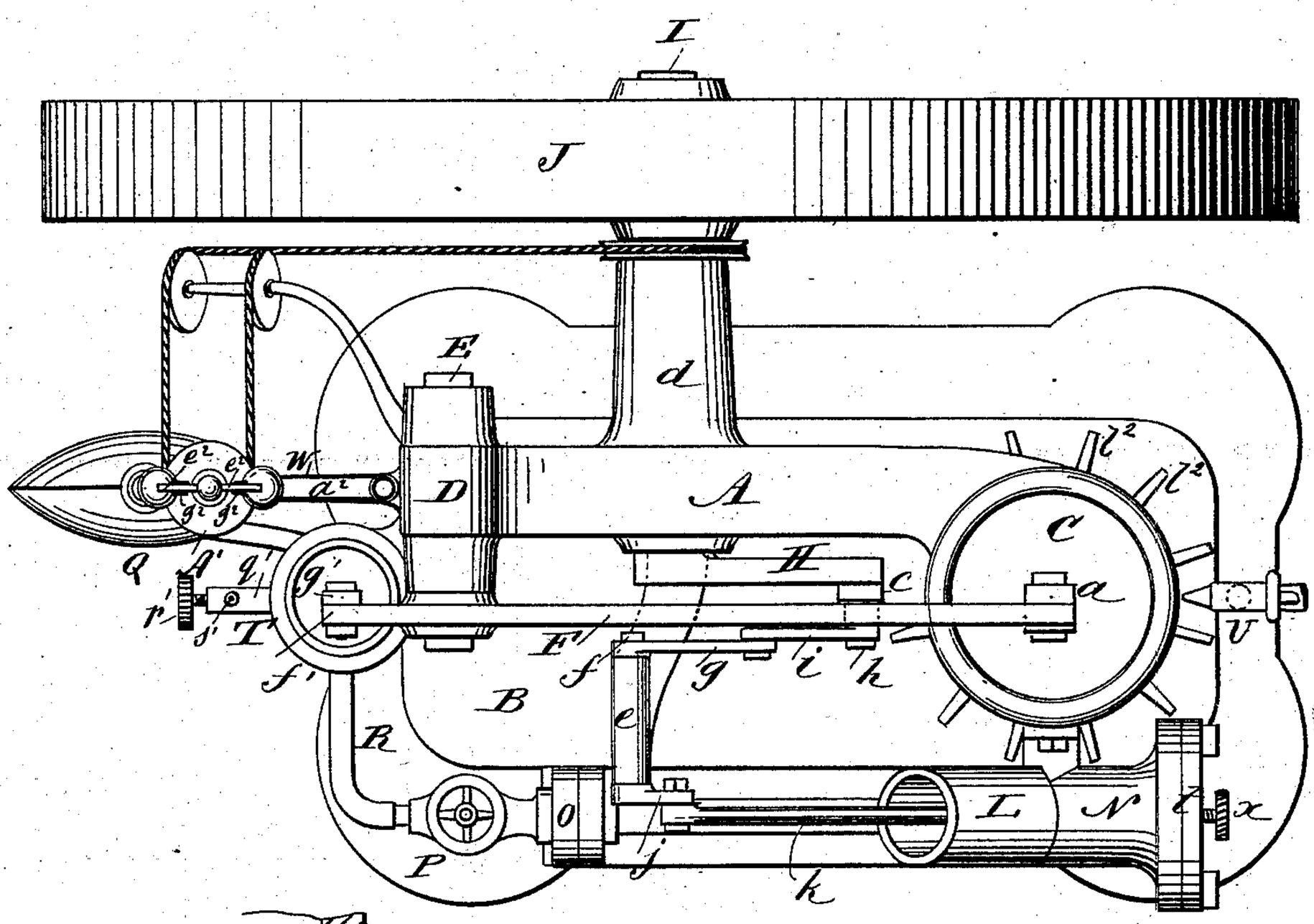
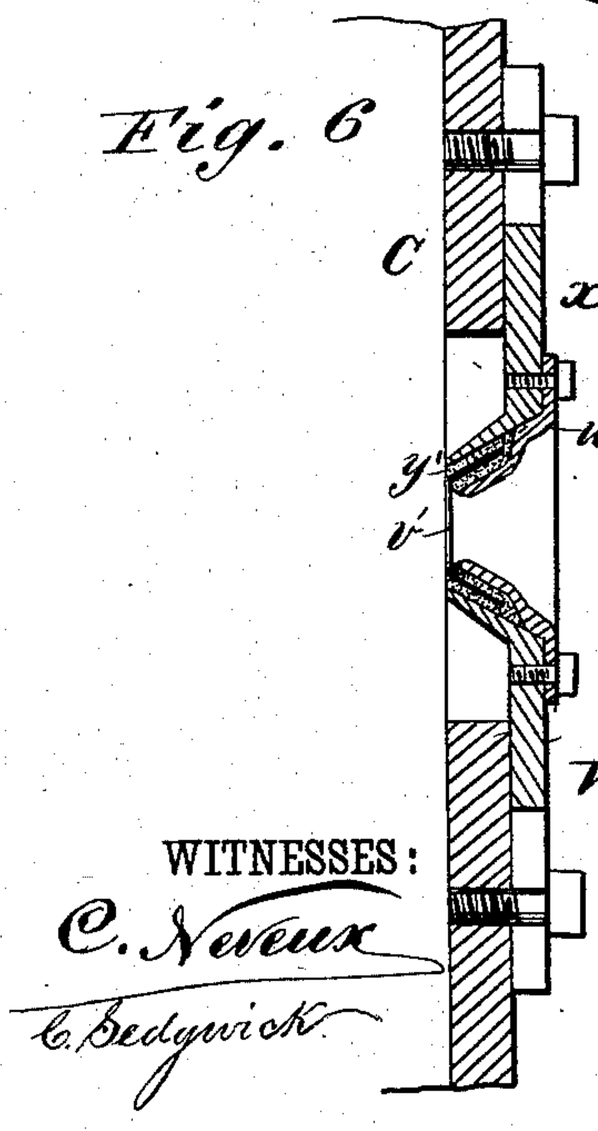
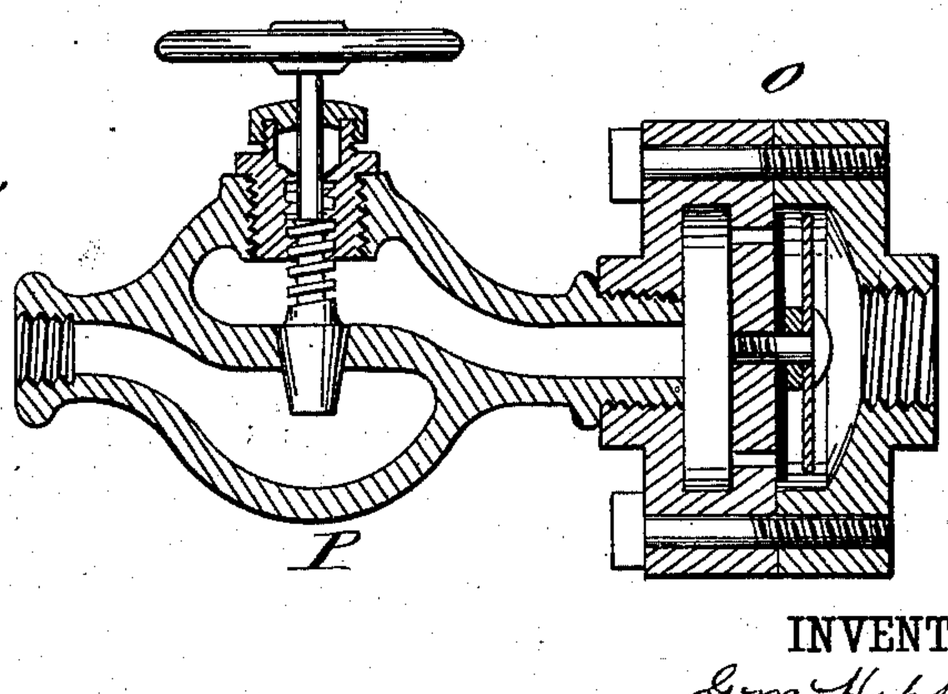


Fig. 5

Fig. 6





WITNESSES:

C. Neveux

C. Bedgwick

INVENTOR:

G. M. Hopkins

BY Munn & Co

ATTORNEYS.

(No Model.) 3 Sheets—Sheet 3.

G. M. HOPKINS.

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Fig. 1

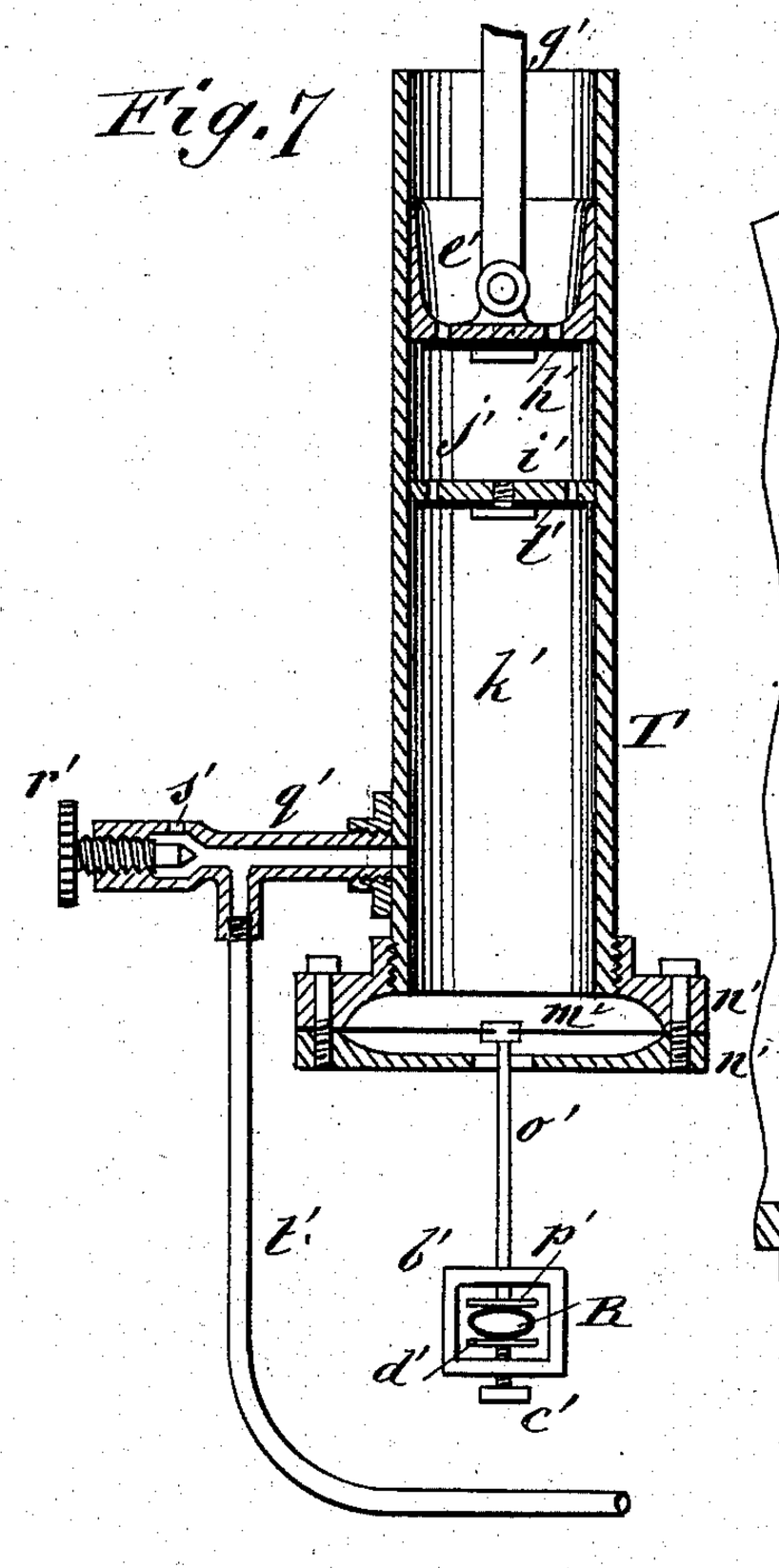


Fig. 3

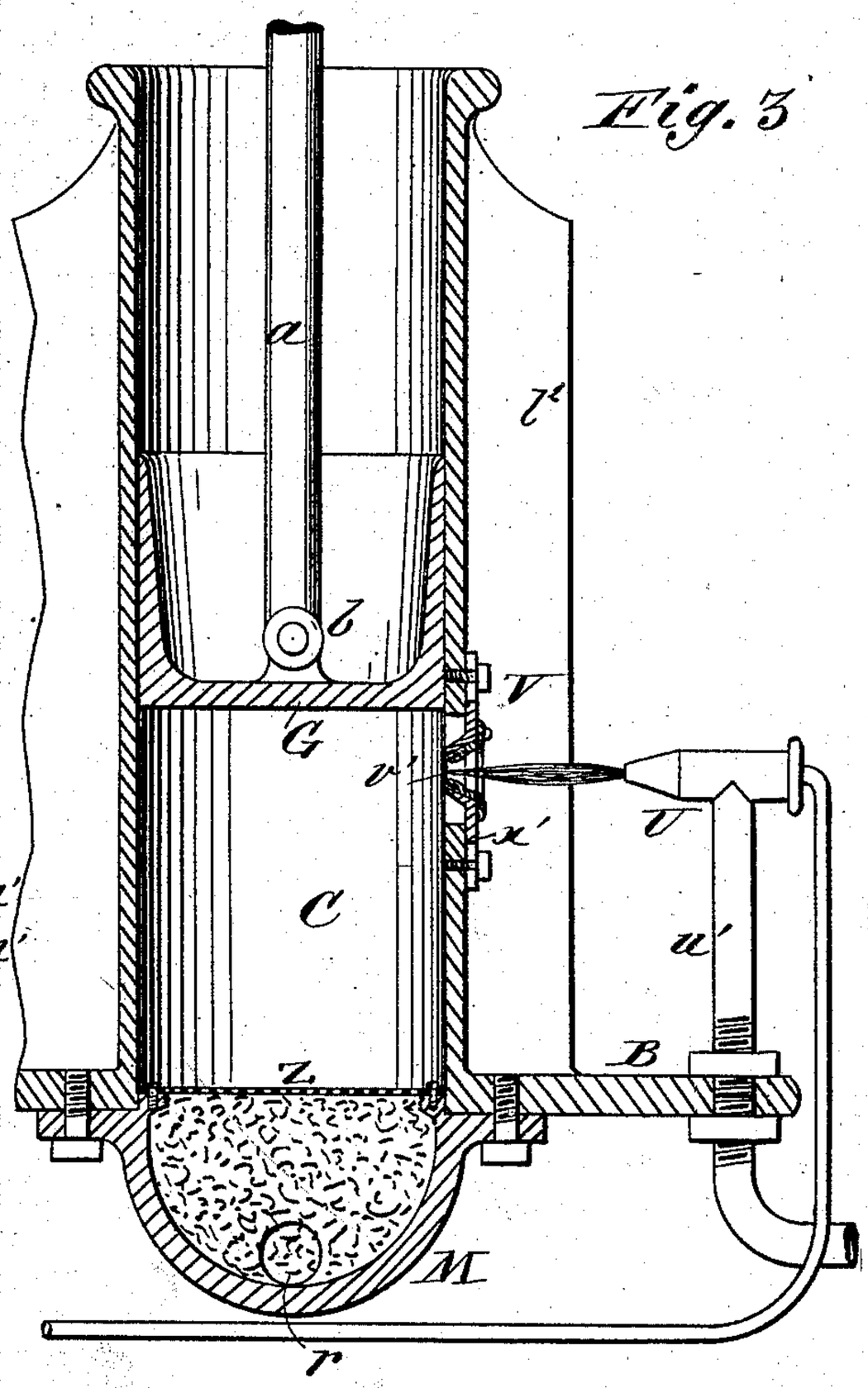
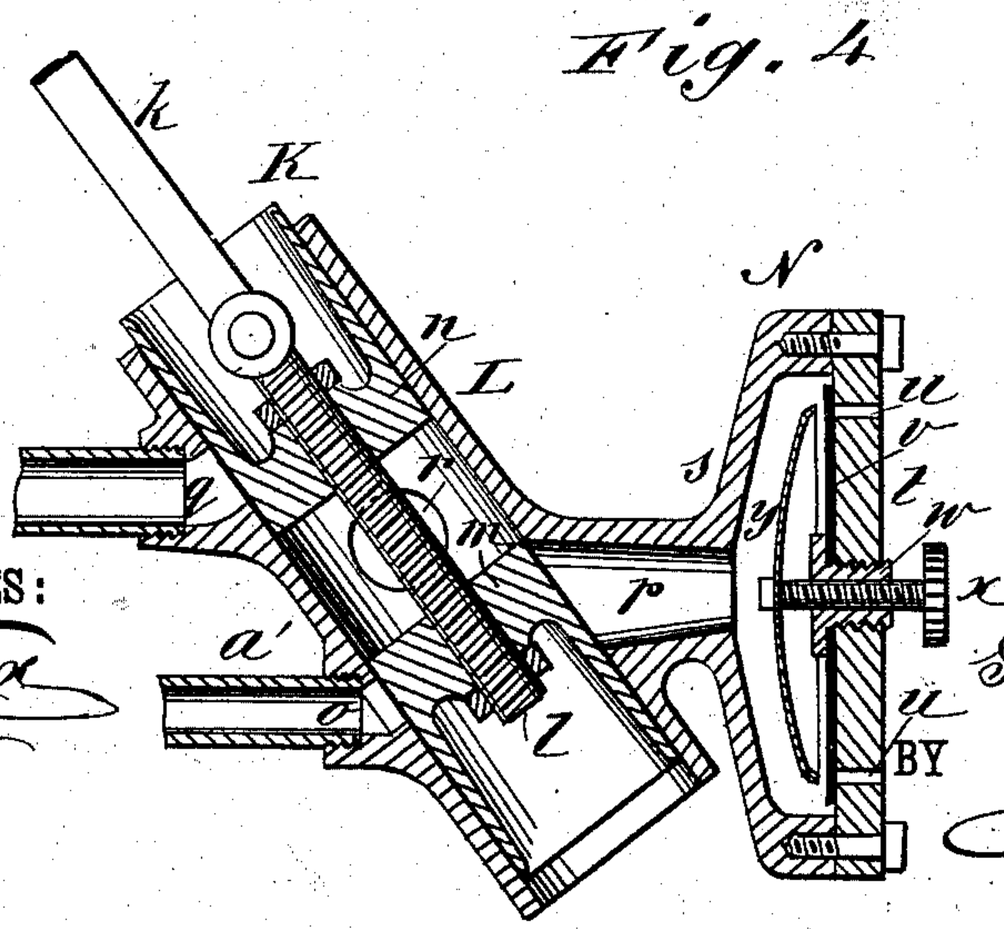


Fig. 4



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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. 284,555, dated September 4, 1883.

Application filed February 17, 1883. (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 useful Improvement in Gas-Engines; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, forming a part of this specifiation, in which—

Figure 1 is a side elevation of my improved gas-engine. Fig. 2 is a plan view of the same. Fig. 3 is a vertical section of the cylinder and piston, taken through the center of the igniter. Fig. 4 is a vertical section of the slide-valve and air-check valve. Fig. 5 is a vertical longitudinal section of the gas-regulating valve and gas-check valve. Fig. 6 is an enlarged vertical section of the igniter. Fig. 7 is a vertical section of the air pump and governor.

My invention relates to the class of gas-engines in which an explosive mixture of combustible gas and common air are drawn into the cylinder during the early part of the stroke of the piston and subsequently exploded, the expansion of the gases propelling the piston through the remainder of the stroke; and the invention consists, first, in an air-pump driven by the engine and serving the double purpose of a governor to the gas-supply of the engine, and of supplying the igniter blow-pipe with air; second, in a slide-valve formed of two independently-adjustable pistons admitting of regulating the admission of gas and the exhaust of the products of combustion independently of each other; third, in a valve-motion which insures a quick opening and closing of the gas and air supply, while allowing them to remain wide open during the period of supply and the period of exhaust; fourth, in a regulator for the air-check valve, by means of which the lift of the valve may be regulated from the outside of the valve without the necessity of opening it for the purpose; fifth, in the combination of a check-valve with the gas and air supply for preventing the heat resulting from the explosion in the cylinder from heating the gas and air check valves.

Referring to the drawings, in which the same letters are used to designate the same parts in the different figures, the frame A is cast integral with the base-plate B and cylinder C, and has an arm, D, in which is journaled the bearing E of the lever F, the latter extending from its bearing to a point over the center of the cylinder, where it is pivoted to a connecting-rod, *a*, the lower end of which is attached by a pivotal joint, *b*, to the piston G in the cylinder C. At a point about one-third of the length of the lever F from the free end of the same a connecting-rod, *c*, is jointed to the said lever, and extends downward, receiving in its lower end the pin *h* of the crank H on the main shaft I of the engine. The shaft I is journaled in a boss, *d*, cast with the frame A and carries the fly-wheel J.

In front of the path of the crank H there is an arm, *e*, secured to the frame A, and having in its upper end the bearing of a short shaft, *f*, whose axis is eccentric to that of the main shaft I, being below and at one side thereof.

To the inner end of the shaft *f* is secured an arm, *g*, which is shorter than the crank H, and is connected with the outer end of the pin *h* of the said crank by means of the link *i*. The outer end of the shaft *f* carries a crank *j*, which is connected by a rod, *k*, with the valve-rod *l*. The two parts, *m n*, of the valve K are threaded internally, and the valve-rod *l* is threaded externally, so that the position of the parts *m n* of the valve may be changed on the valve-rod by turning them in one direction or the other, so as to vary their adjustment in relation to the gas-supply port *o*, air-supply port *p*, and exhaust-port *q* in the valve-cylinder L. The valve-cylinder L communicates, by a tubular connection, *r*, with the concave bottom M of the cylinder C, and attached to one side of the valve-cylinder, and communicating therewith through the air-port *p*. There is an air-check valve, N, having a casing, *s*, to which is secured a plate, *t*, provided with a circular row of holes, *u*, covered by a flexible valve, *v*, held in its place on the inner surface of the plate *t* by a tubular internally-threaded screw, *w*, which passes centrally through the valve and the plate. A screw, *x*, passing through the tubular screw *w*, carries on its inner end a concave metallic disk, *y*, whose periphery is about opposite the row of holes *u*. The said concave disk can be moved by means of the screw *x* toward or away from

the valve *v*, so as to limit the lift of the valve, and in this way regulate the air-supply.

The concave bottom M of the cylinder C is filled with snarls of wire, or with broken pumice-stone, or other incombustible granular or fibrous material, which serves to intimately mix the gas and air on their passage to the body of the cylinder C, and this material is held in place by a perforated disk, *z*, secured to the upper surface of the concave bottom.

The gas-supply port *o* communicates with the gas-check valve O through the pipe *a'*, and the check-valve O is connected with a regulating-valve, P, which in turn is connected with the gas-bag Q by means of the soft-rubber tube R. The gas-check valve O is of the ordinary well-known description, and the regulating-valve P differs from the ordinary well-known globe-valve only in having a more conical valve and valve-seat. The rubber tube R, which connects the valve P and the gas-bag Q, passes through a rectangular frame *b'*, secured to the base of the engine, and having in the lower side an adjusting-screw, *c'*, carrying on its inner end a plate, *d'*, upon which the rubber tube R rests.

Directly above the frame *b'* there is an air-pump, T, attached to the frame A, and provided with a piston, *e'*, connected with the short arm *f'* of the lever F by means of the rod *g'*. The piston *e'* has a valve, *h'*, opening downward and covering a series of air-holes passing vertically through the piston. The cylinder of the air-pump is divided by a horizontal partition, *i'*, into the compartment *j'*, containing the piston *e'* and the compartment *k'*, forming an air-reservoir for receiving the air forced by the downward stroke of the piston through holes in the horizontal partition *i'*. A valve, *l'*, covering these holes, prevents the air from returning to the pump-barrel. The piston *e'* is reciprocated by the lever F, and each time the piston rises, the air, passing through its valve, enters the compartment *j'*, whence it is forced, by the downward stroke of the piston, into the air-reservoir *k'*. The bottom of the air-reservoir *k'* consists of a flexible diaphragm, *m'*, clamped by its edges between collars *n'*, secured to the lower end of the pump-barrel. A rod, *o'*, secured to the center of the diaphragm *m'*, extends downward through the top of the frame *b'*, and is provided with a plate, *p'*, touching the top of the rubber gas-tube R.

In the side of the reservoir *k'* there is an air-outlet tube, *q'*, having in its outer end a screw-valve, *r'*, by which it may be closed more or less. In the sides of the air-outlet tube *q'*, outside of the seat of the valve *r'*, there is an opening, *s'*, communicating directly with the external air, and a tube, *t'*, communicating with the air-tube *q'*, between the seat of the valve *r'* and the air-reservoir *k'*, leads to a compound blow-pipe, U, placed axially in line with the center of the igniter V. The blow-pipe is of the ordinary well-known form, and receives its gas through the tube *u'*.

The igniter consists of a plate, *v'*, of platinum, having its edges turned outward and clamped between the conical ring *w'* and the conical seat in the plate *x'*, a heat-insulating medium, *y'*—such as asbestus—being interposed between the platinum and its support to prevent the heat from being conducted away by the metal part of the support. The plate *x'* is slotted to receive two screws, which clamp it to the side of the cylinder, and the conical support of the platinum plate *v'* projects into an oblong slot in the side of the cylinder. This igniter can be adjusted vertically within prescribed limits, so as to vary the time of the ignition of the gas relative to the stroke of the piston G.

Gas is supplied to the gas-bag Q through the flexible tube a^2, extending along the upper side of the bracket W, attached to the edge of the frame A and supporting the upper end of the gas-bag. Upon the bracket W is mounted a small centrifugal ball-governor, A', consisting of a sleeve, b^2, inclosing the rod c^2, and journaled in the arm d^2 of the bracket W, the weighted arms e^2 jointed to the top of the sleeve b^2, and the sleeve f^2 connected with the weighted arms e^2 by links g^2 and with the rod c^2 by a transverse pin passing through a slot in the sleeve f^2 into the said rod c^2. The lower end of the rod c^2 carries a fork, h^2, which embraces the tube a^2 and the bracket W loosely and is capable of being moved up and down by the governor.

The governor A' is driven by a belt from a small pulley on the main shaft of the engine, and when in motion it supports the fork h^2 out of contact with the flexible tube a^2; but whenever the engine stops from any cause the balls drop, forcing downward the parts connected therewith, including the fork h^2, and the latter compresses the flexible tube a^2 shutting off the gas.

The operation of my improved gas-engine is as follows: On turning the wheel J the balls of the governor A' are raised by centrifugal force, carrying with them the fork h^2, permitting the flexible tube a^2 to open and allow gas to enter the bag Q. The gas at the blow-pipe U having been previously lighted, the air-blast caused by the operation of the air-pump T forces a strong flame against the platinum plate *v'*, rendering it incandescent. The slide-valve K, being in position to close the exhaust-port *q* and to uncover the ports *o* and *p*, gas and air are drawn in through these respective valves O and N in the proper proportions and follow the piston G in its upward movement, having been thoroughly mixed in passing through the contents of the concave cylinder-bottom M. When the piston passes above the incandescent platinum plate *v'*, the mixture of gas and air coming into contact with the platinum becomes ignited and explodes, driving the piston G to the upper end of the cylinder. The movement of the valve K and the piston G are so timed relative to each other that as the piston passes the igniter V, the gas-port *o*

will be closed. The air-port *p* is allowed to remain open until after the explosion, to admit air in case of the formation of a vacuum after the explosion, and before the exhaust-port *q* is opened. The air-port *p* closes before the piston G reaches the limit of its upward stroke, and the exhaust-port *q* is opened at the beginning of the downward stroke of the piston and remains open until the end of the stroke, when it closes. After the engine is started by a few turns of the fly-wheel, the gas and air is drawn in, the explosion takes place, and the products of combustion are expelled at every revolution of the engine, the operation of the engine being entirely automatic. Should an increase in speed occur, the extra amount of pressure of air upon the diaphragm *m'* will force the plate *p'* downward and shut off more or less of the supply of gas, and thus regulate the speed of the engine. Should the engine stop from any cause, the gas will be shut off by the governor A' preventing any escape of gas from the engine or its connections.

The cylinder C is cast with the frame A to secure the radiating surface of the frame to assist in carrying off the heat generated in the cylinder. The cylinder is also provided with the ordinary well-known heat-dispelling device consisting of a series of radial ribs, l^2, which receives the heat from the cylinder by conduction and convey it to the surrounding air.

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

1. In a gas-engine, the combination, with a gas-supply pipe and an igniter blow-pipe, of a pump, serving the double purpose of a governor to the gas-supply and means for supplying air to the blow-pipe, substantially as herein shown and described.

2. In a gas-engine, the combination, with the pump T and blow-pipe U, of the igniter V, secured in the side of the cylinder, and the piston G, serving as a guard to prevent ignition until it has passed above said igniter, substantially as herein shown and described.

3. In a gas-engine, the air-pump T, having the reservoir *k'* and flexible diaphragm *m'*, in combination with the flexible gas-supply tube R, as shown and described.

4. In a gas-engine, the combination of the flexible air-pressed diaphragm *m'*, flexible gas-supply tube R, and adjusting-screw *c'*, as specified.

5. In a gas-engine constructed as herein described, the air-pump T, having the diaphragm *m'* and regulating-valve *r'*, the gas-supply pipe R, and blow-pipe U in combination, as and for the purposes specified.

6. In a gas-engine, the piston slide-valve K, made in two parts, *m n*, mounted adjustably on the valve-rod *l*, as herein specified.

7. In a gas-engine, the shaft *f*, carrying the crank-arms *j g*, and journaled eccentrically in relation to the main shaft I, the link *i*, and crank H, in combination for operating the valve K, as herein specified.

8. The combination of the disk *y* and adjusting-screw *x* with the air-check valve *v*, as herein specified.

9. In a gas-engine, the concave cylinder-bottom M, filled with granular or fibrous non-combustible material, and provided with the perforated plate *z*, as shown and described.

GEO. M. HOPKINS.

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