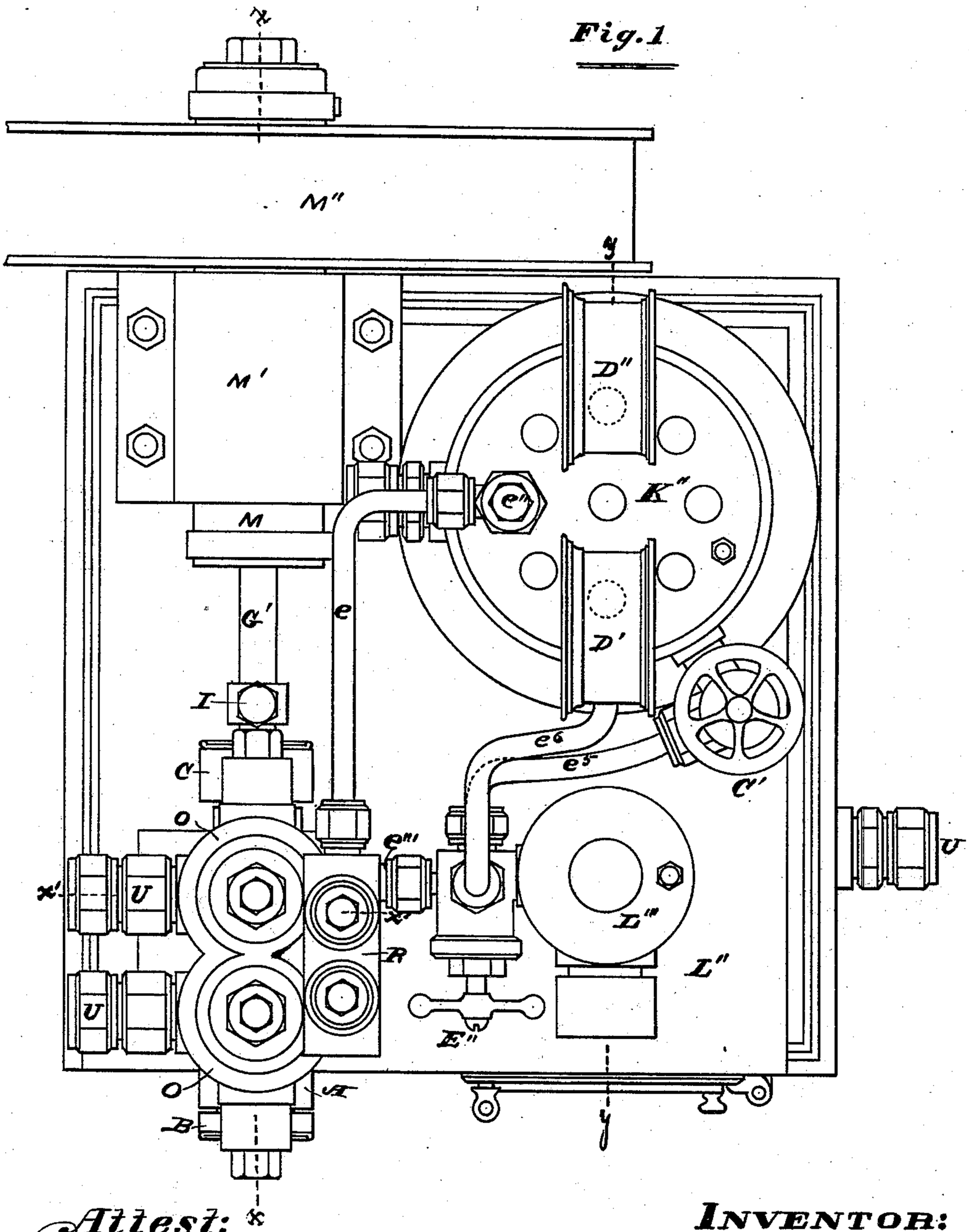
5 Sheets—Sheet 1.

A. GATEAU.

Liquid Gas Motor.

No. 222,184. Patented Dec. 2, 1879.

Fig. 1.



Attest:

James H. Coyne

Charles L. Schoff

INVENTOR:

Antoine Gateau

By F. F. Warner — his Attorney.

5 Sheets—Sheet 2.

A. GATEAU.

Liquid Gas Motor.

No. 222,184. Patented Dec. 2, 1879.

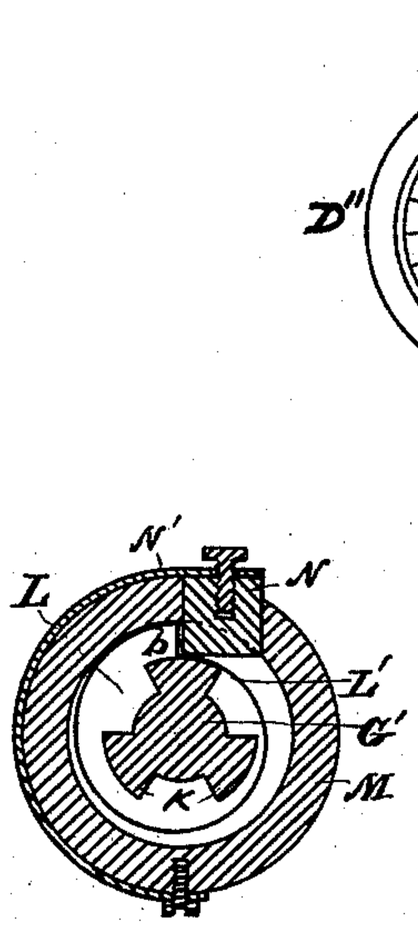


Fig. 3

Attest:

James H. Coyne

Charles H. Schoff

INVENTOR:

Antoine Gateau

By- F. F. Hansen, his

Attorney

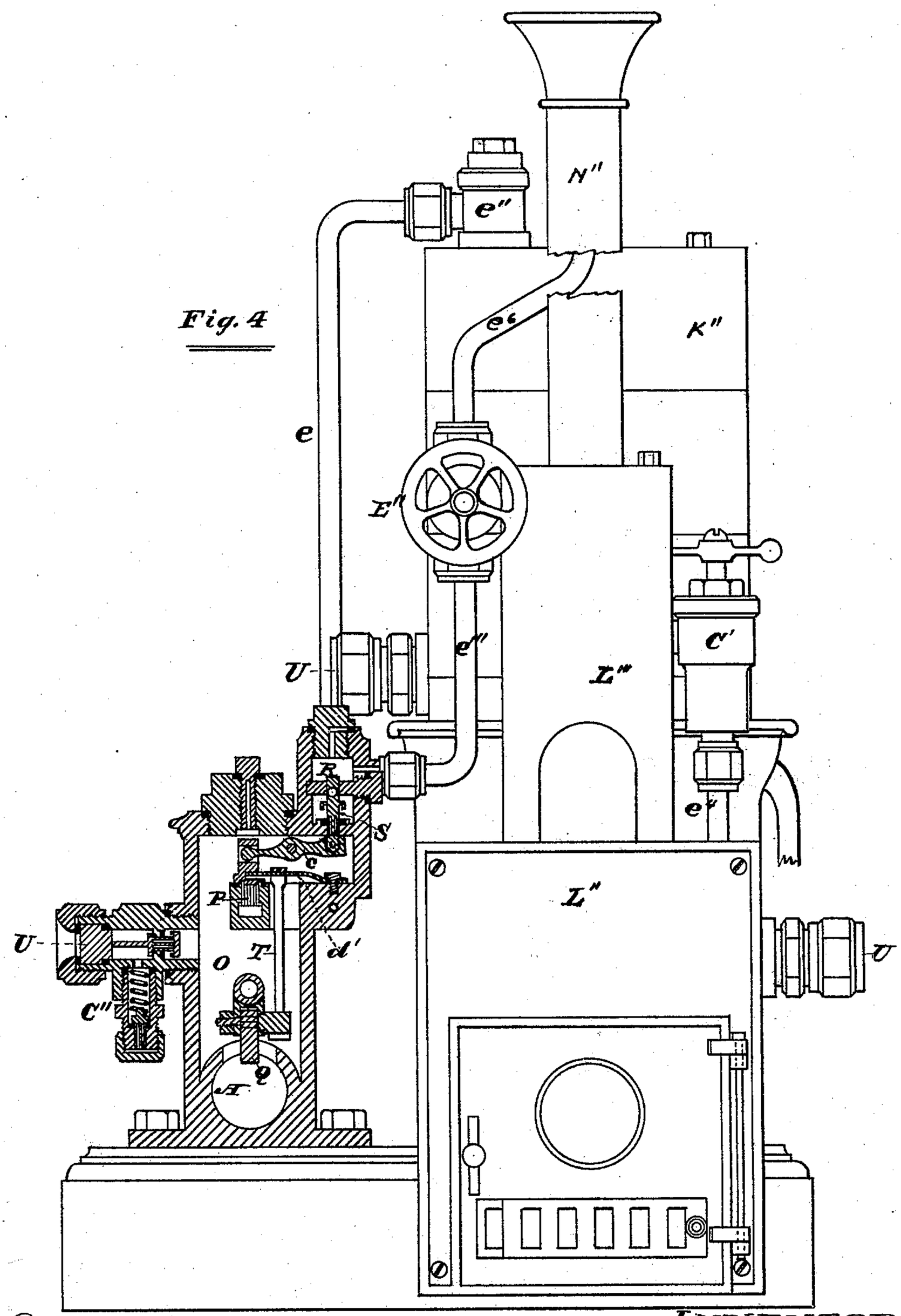
5 Sheets—Sheet 3.

A. GATEAU.

Liquid Gas Motor.

No. 222,184. Patented Dec. 2, 1879.

Fig. 4



Attest:

James H. Coyne

Charles H. Schoff

INVENTOR:

Antoine Gateau

By F. F. Harris, Jr.

Attorney

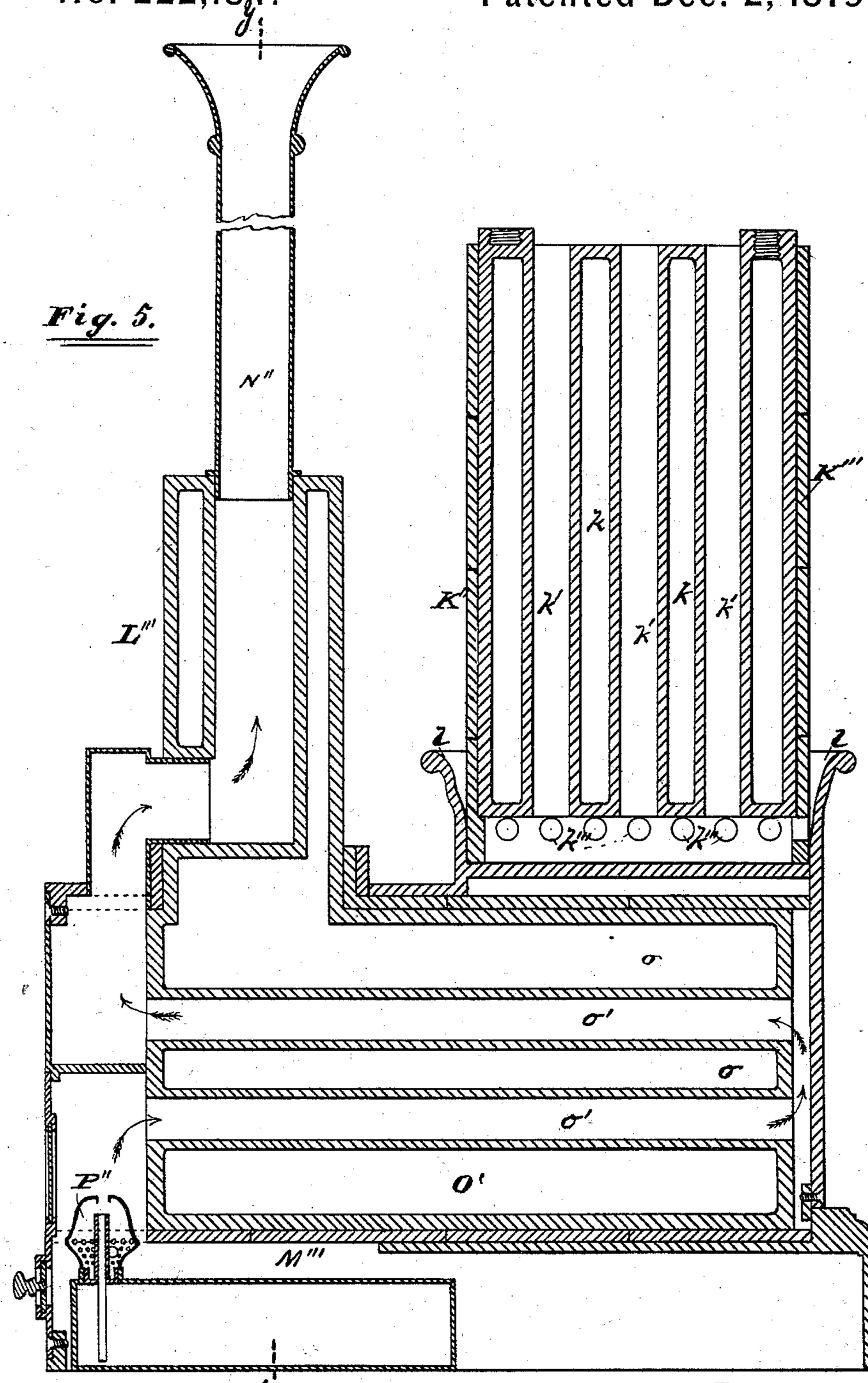
5 Sheets—Sheet 4.

A. GATEAU.

Liquid Gas Motor.

No. 222,184. Patented Dec. 2, 1879.

Fig. 5.



Attest:

James H. Coyne

Charles A. Schioff

INVENTOR:

Antoine Gateau

By F. F. Warner, his

Attorney.

5 Sheets—Sheet 5.

A. GATEAU.

Liquid Gas Motor.

No. 222,184. Patented Dec. 2, 1879.

Fig. 6.

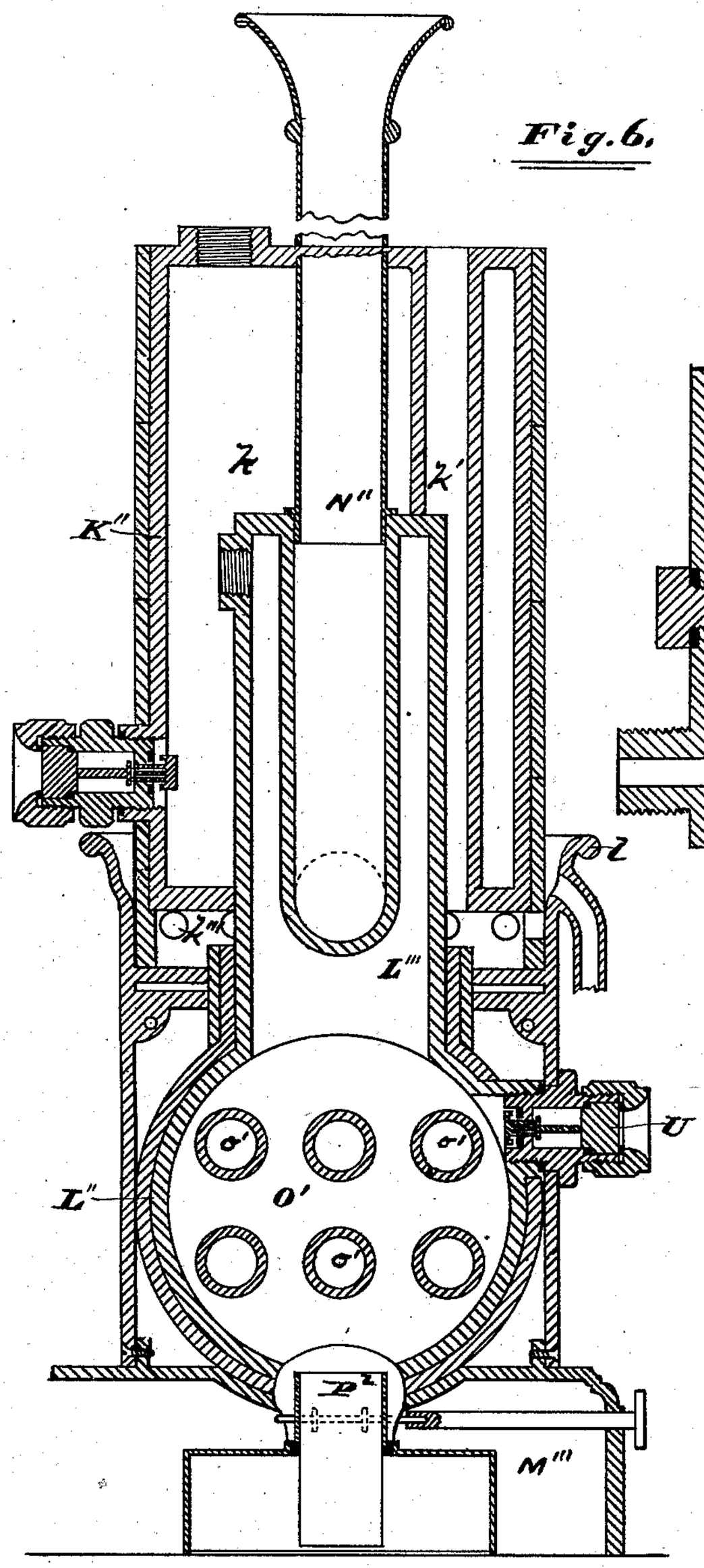
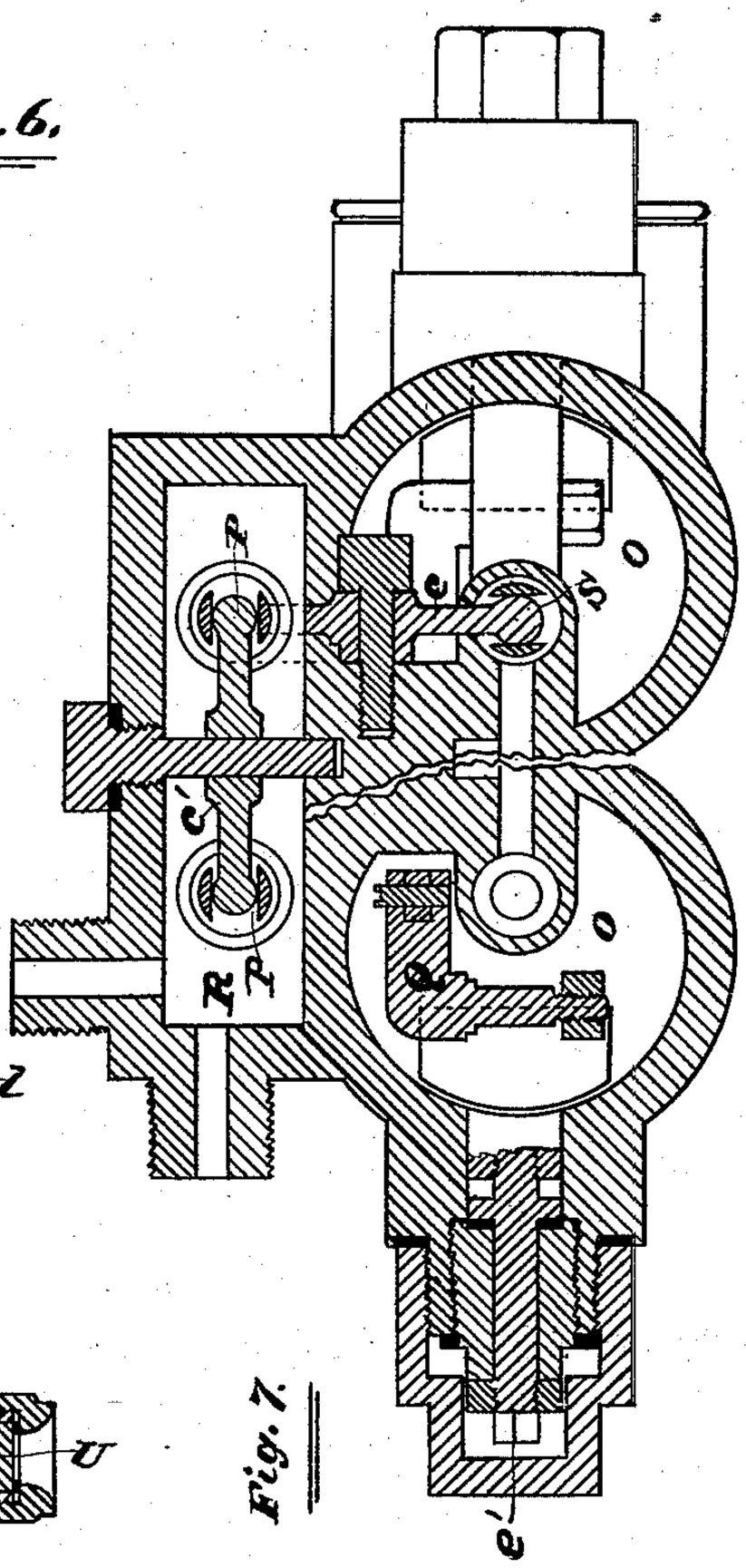


Fig. 7.



Attest:

James H. Coyne

Charles H. Schoff

INVENTOR:

Antoine Gateau

By F. F. Harmer, his

Attorney.

UNITED STATES PATENT OFFICE.

ANTOINE GATEAU, OF TOURNUS, FRANCE.

IMPROVEMENT IN LIQUID-GAS MOTORS.

Specification forming part of Letters Patent No. **222,184**, dated December 2, 1879; application filed August 30, 1879; patented in France, April 30, 1879.

To all whom it may concern:

Be it known that I, ANTOINE GATEAU, of Tournus, Department Saône-et-Loire, France, have invented certain new and useful Improvements in Liquid-Gas Motors, of which the following, in connection with the accompanying drawings, is a specification.

In the drawings, Figure 1 is a top or plan view of a motor embodying my invention; Fig. 2, a section in the plane of the line *x x* of Fig. 1, and in which certain parts shown in elevation therein are broken away; Fig. 3, an end elevation or view of the cammed end of one of the rotary nuts, the surrounding and interior parts being shown in section; Fig. 4, a front elevation of the motor, also showing a part thereof in a broken or sectional view taken in the plane of the line *x' x'* of Fig. 1; Fig. 5, a section in the plane of the line *y y* of Fig. 1; Fig. 6, a section in the plane of the line *y' y'* of Fig. 5; and Fig. 7 is an irregular horizontal section or sectional plan of the parts broken away or shown in elevated section in Fig. 4.

Like letters of reference indicate like parts.

This invention is substantially the same as shown and described in Letters Patent of France issued to me the 30th day of April, 1879, for liquid-gas motors, as will fully appear by reference thereto.

The object of my invention is to furnish a motor or engine of great power compared to its size, and adapted to propel carriages and wagons and other vehicles with certainty and safety, as well as to perform other work in like manner and with economy. To this end my invention relates to a motor wherein the motive power may be derived from the expansive force of liquid gases, such, for example, as carbonic-acid gas generated within the motor from the gas reduced to a liquid condition.

For the purpose of accomplishing the objects above set forth my invention consists chiefly and severally in the means, substantially as hereinafter set forth, which I employ for adapting the motor to the utilization of liquid gases as the motive force, and also for adapting it for use with convenience, safety, and economy as a motor for various work.

It also consists in certain novel details of construction, substantially as hereinafter described, which I employ for the specific purposes hereinafter set forth.

A represents the cylinder, and B is a screw or threaded stopper closing the end of the cylinder.

B' is a lead washer, closing the joint between the cylinder and the stopper B, thus making a very tight joint on that end of the cylinder. C is a threaded box on the opposite end of the cylinder A, and D is a metallic ring arranged in the box C.

E is a packing, made, by preference, of leather, and arranged in an offset or recess, E', in the end of the cylinder, the ring D being arranged between the said packing and the outer end of the box C, as shown in Fig. 2, so that by running the said box upon the cylinder the ring D will press the packing E tightly upon the piston-rod, as will hereinafter more fully appear.

F is a flexible ring or packing arranged on the inner face of the inner end of the cylinder.

G is the piston, and H is a packing arranged on its perimeter. G' is the piston-rod, through a part of which runs a channel, *a*, one end of which terminates behind or underneath the packing H, and the other end of which enters a valved cap, I, the object of the said channel and cap being to admit of the packing H being expanded against the cylinder by means of fluid forced by means of a hand-pump through the said cap and channel. The cap device I may be constructed in any suitable way admitting of the expanding of the packing H in the manner described, being provided with a removable top or cap, *a'*, and an outwardly-pressing check-valve, J, as indicated in Fig. 2, by preference, it being understood that the device I is carried on the rod G', and that it may work in a guide, I', to prevent rotation of the rod G'. By this means the packing H may be expanded against the cylinder without removing any of the parts therefrom.

K K are male screws or spiral ribs, one right and the other left, near the end of the rod G'; and L L are screw-nuts fitted to run on the screws K K. M is a hollow cylindrical shaft, supported on a suitable bearing, M', and containing the nuts L L, which, by reason of their end-to-end contact with each other

and the ends of the said shaft, are prevented from moving except rotatively therein. N N are key-blocks or lockers, passing freely through correspondingly-formed openings in the cylinder M and resting on a cam, L′, on the outer end of each nut L, respectively, as indicated in Fig. 3. N′ N′ are springs, resting on the blocks N N and holding them down yieldingly on the cams L′ L′. As the piston is reciprocated it is prevented from being rotated by reason of the right and left screws K K engaging, as described, the confined and non-reciprocating nuts L L; for a rotation of the rod G′ would tend to force apart the said nuts; but as they cannot move apart they lock the rod G′, so as to prevent its rotation. The nuts L L, however, are free to rotate, and hence the reciprocation of the rod G′ will rotate them in opposite directions at the same time, and the movement of each nut will be reversed with each stroke of the piston. The blocks N N, by riding on the cams L′ L′, will thus be caused to rise and fall, and will be engaged by the said cams only when the vertical shoulders *b* thereof abut against the said blocks, which abutting only occurs when the nuts are rotated in one direction, as will be perceived on reference to Fig. 3, and only one block N will be so engaged at the same time, one dropping to engagement while the other is raised therefrom. One of the blocks N N will thus be always engaged, the engagement being alternate, and the block so engaged will travel with the nut engaging it, and the rotary movement of the nut will thus be communicated to the shaft M, and the latter will by this means be rotated constantly and in the same direction. M″ is a drive wheel or pulley on the shaft M. It will be perceived that there are no dead-points or dead-centers to obstruct the even or regular movement of the piston.

O O are reservoirs surmounting the cylinder A, and P P are exhaust-valves in the said reservoirs. Q Q are articulated levers. R is a gas-box, and S S are receiving-valves therein. T T are rods connecting the levers Q Q with the valves P P and S S, respectively, each reservoir O O being thus furnished with an exhaust-valve. Beams *c c* connect the valves P P with the valves S S, and the latter are connected to each other by means of the beam *c′*. *d d* are rubber seats for the said valves, and *d′ d′* are springs passing through the rods T T and entering the valves P P. B″ is a port in the exhaust-chamber, and *e* is an exhaust tube or pipe.

Regulating-screws *e′ e′* are employed, in connection with the bearings supporting the levers Q Q, to throw the said bearings in or out to a greater or less extent, so that the said levers, which may also be termed "bell-cranks," will be struck sooner or later by the piston G′ during its reciprocation, thus actuating the valves P and S in such manner that the stroke of the piston will be such as to cause the engagement of the blocks N N with the nuts L L at the proper time to produce an even and uniform rotation of the shaft M′, it being understood that the said levers Q Q extend into the cylinder A sufficiently to be struck by the piston during its strokes; that these levers, through the medium of the rods T T, control the valves P and S, and that the latter control the reciprocation of the piston, as will be hereinafter more fully explained, and as appears from reference to Fig. 2, wherein it also appears that the levers Q Q play in the ports connecting the cylinder A with each reservoir O O.

The means employed to adjust the bearings of the levers Q Q for the purpose set forth may be various; and I do not therefore describe the same in detail, as the drawings, especially Fig. 2, indicate one mode of making such adjustment, the only essential feature of which is that the joints should be tight, and that the said bearings may be nicely adjusted to or from each other, substantially as specified.

L″ is the generator, and L‴ is a dome thereon. This generator and dome I make in one part or piece, and it contains a chamber, O′, for receiving the liquefied gas, and through this chamber pass the flues *o′ o′*. The generator proper is set in a heating-chamber, M‴, which communicates with a smoke pipe or flue, N″, in such manner as to create a draft through the chamber M‴ and flues *o′ o′* and N″ in the direction indicated by the arrows shown in Fig. 5.

P″ is a lamp, arranged in the lower part of the chamber M‴, to supply a sufficient degree of heat to generate expansive gas from the fluid matter contained in the generator. As a very small degree of heat is necessary for this purpose, coils of platinum wire, connected with an electro-magnetic machine actuated by the motor, may be substituted for the lamp or other heater.

K″ is the condenser, which may also be made in one piece, containing a condensing-chamber, *k*, through which flues *k′ k′* pass. I set the condenser in a jacket, K‴, near the bottom of which are air-ports *k‴*, to reduce the temperature of the contents of the chamber *k*. A dish-shaped flange, *l*, may also be provided to receive cold water to aid condensation. Both the condenser and the generator may be strengthened by means of jackets made in sections or rings.

The exhaust pipe or tube *e* communicates with the port B″ and communicates with a valve, *e″*, on the condenser. C′ is an injector, to return to the generator the gas brought by the tube *e* to the condenser. D′ is a manometer, to indicate the pressure in the generator, and D″ a manometer to indicate that in the condenser. E″ is a cock to divide the gas from the generator and admit it to the box R, to the injector C′, and to the manometer D′.

In the reservoirs O O and in the generator and condenser are the glasses U U, to admit of the height of the fluid in these parts being ascertained with facility. These glasses I

make removable; and, in order that the fluid may be introduced at convenient places—for example, near some of these glasses—check-valves and packing should be employed at these places to prevent leakage; but I do not deem it necessary to describe particularly these induction ports and valves, as various means may be employed, obviously, for the same purpose. Neither do I deem it essential to particularly describe the construction of the distributing-cock E″, and of the injector and manometers, as their functions are well known, and any like or suitable devices may be used in their stead.

A tube, e''', connects the dome of the generator with the chamber or box R. The tube e^4 connects the injector with the generator, and a tube, e^5, connects the dome with the injector. A tube, e^6, connects the dome with the manometer for measuring the pressure of the gas therein.

To prepare this motor for work, the generator should be filled up to its glass U with the gas in its liquid condition. The reservoirs O O are to be filled up to within about two centimeters below the exhaust-valves P P with a fluid which will not dissolve the gas generated in the generator. A semi-fluid fatty oil, like lard-oil, will not dissolve the gas generated from liquid carbonic-acid gas.

It will be perceived that I thus interpose between the gas-chamber R or the gas and the piston G a liquid, thus preventing a leakage below that chamber of the gas employed as a motive force; for this liquid, as is obvious, will leak out, if at all, through the joints there arranged before those joints are reached by the gas. Hence nicety of construction and care in packing joints are to some extent diminished, for the liquid, as is well known, will not leak as easily as the gas, and economy in the use of gas is also thus gained. The height of the liquid in the reservoirs O O may be known at any time by viewing their interiors through their glasses U U.

If any of the fluid in the reservoirs O O should leak out it may easily be replaced by forcing more through an induction-valve arranged, for example, as shown at C″, Fig. 4, a hand force-pump being employed for that purpose. The gas in its liquid condition may be introduced into the generator through a valve, and the aeriform gas there generated passes through the tube or conductor e''' into the gas box or chamber R, where it finds one of the valves S S open, and the other closed, and through this open valve it passes into that one of the reservoirs O O then in communication with the said open valve.

The liquid in this reservoir is thus pressed behind the head of the piston G, entering the cylinder A through a port there arranged, and the piston is thus pushed forward, it being understood that during this movement the exhaust-valve P in the said reservoir stands closed, while the other exhaust-valve P in the other reservoir O stands open, as shown in Fig. 2. The liquid in front of the piston is thus forced out of the cylinder A through the forward port therein, and re-enters that one of the reservoirs O O in which the exhaust-valve is open. Consequently the aeriform gas in that reservoir passes out through the exhaust and enters the condenser, is condensed, ejected again into the generator, and again aerified. As the piston approaches the forward end of the cylinder A it strikes the lever Q, there arranged, throws its lower end forward, and thus draws down the connecting-rod T, connected thereto, and this downward movement of that rod depresses the spring d', passing through it. This descending movement closes the exhaust-valve operating in connection with the reservoir from which the gas is discharged during the forward movement of the piston, and opens the corresponding or closed induction or receiving valve, and also reverses the positions of the other valves and throws the lower arm or end of the rear lever, Q, forward. This movement of the valves simultaneously results from their being connected by means of the beams c and c' in the manner shown and described. It is evident, however, that these valves, so far as now appears, would so move as to be in equilibrium. The springs d', however, prevent this equilibrium, for, as shown in Fig. 4, they enter notches in the valves P P, and these notches, as shown, are sufficiently large to allow the spring some play therein without moving the said valves, it being understood that the action or force of the spring itself is upward. Consequently when one valve P and its spring are drawn down by the contact of the piston with the corresponding lever Q, the other lever Q, which is free from the piston, leaves free the other spring, d', and as soon as equilibrium takes place, or a little before, the latter spring raises its valve, and all the valves are so properly placed, and the equilibrium is destroyed. The pressure is thus shifted around behind the piston again, and this action is continually repeated, and produces a constant rotation of the driver.

To take the machine apart without loss of gas, it is only necessary to provide cocks on the various pipes and outer ports, which otherwise would admit of such escape.

It will be observed that I have avoided, to a great extent, outside or external working parts, and that this system of construction, in connection with the intermediate body of liquid in the reservoirs O O, and with careful packing of joints, renders leakage of gas almost impossible.

It will also be observed that I use the same gas constantly, or over and over again. There is comparatively little danger of explosion, for, the heat required to generate the gas being very slight, the metal will nowhere become overheated; and in case of explosion a convenient part of the generator-dome, which may be made lightest for that purpose, will be the only part injured, and a loss of gas will follow.

It will be perceived, also, that I employ no fly-wheel, for one would be inconvenient in motors for carriages and wagons. At the same time there is no dead-center. The lightness, compactness, and great power of such a motor will render it available for very many useful purposes, and for purposes for which other motors would be impracticable. It is, for example, adapted, on account of its smallness, lightness, and comparatively great power, to aerial navigation. Economy, security, and durability are important results attained by the construction and mode of operation which I have now described.

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

1. The combination, in a motor, of the piston-rod G′, provided with the right and left screws or spirals K K, the hollow rotative shaft M, the rotative cammed nuts L L, and the loose keys or blocks N N, substantially as and for the purposes specified.

2. The combination of the piston G, the expansible packing H, the piston-rod G′, having therein the channel *a*, and the induction I, substantially as and for the purposes specified.

3. The combination, substantially as specified, in a liquid-gas motor, of the gas-receiving chamber R, the separate reservoirs O O, and the yielding valves P P and S S, connected to each other by means of articulated beams *c c* and *c′*, and to articulated levers Q Q, all arranged, substantially as described, with relation to the piston and its cylinder and to each other, for the purposes set forth.

4. The combination, substantially as described, in a liquid-gas motor, of the receiving and exhaust valves, the articulated levers Q Q, and the rods connecting them to the said valves, and the adjusting-screws *c′ e′*, for adjusting the bearing of the said levers to regulate the stroke of the piston, substantially as and for the purposes specified.

5. The combination, substantially as specified, of the springs *d′ d′*, the valves P P and S S, the beams *c c′*, the rods T T, and the articulated levers Q Q, entering the cylinder A, when the said valves are arranged, substantially as specified, with relation to each other, and the chamber R and separate cylinders O O, for the purposes set forth.

6. The combination, in a liquid-gas motor, of the glasses U U and the induction or check valves C″, arranged together to admit of the liquid being viewed at the point where it is fed in or supplied, substantially as specified.

ANTOINE GATEAU.

Witnesses:
F. F. WARNER,
H. C. BALLARD,