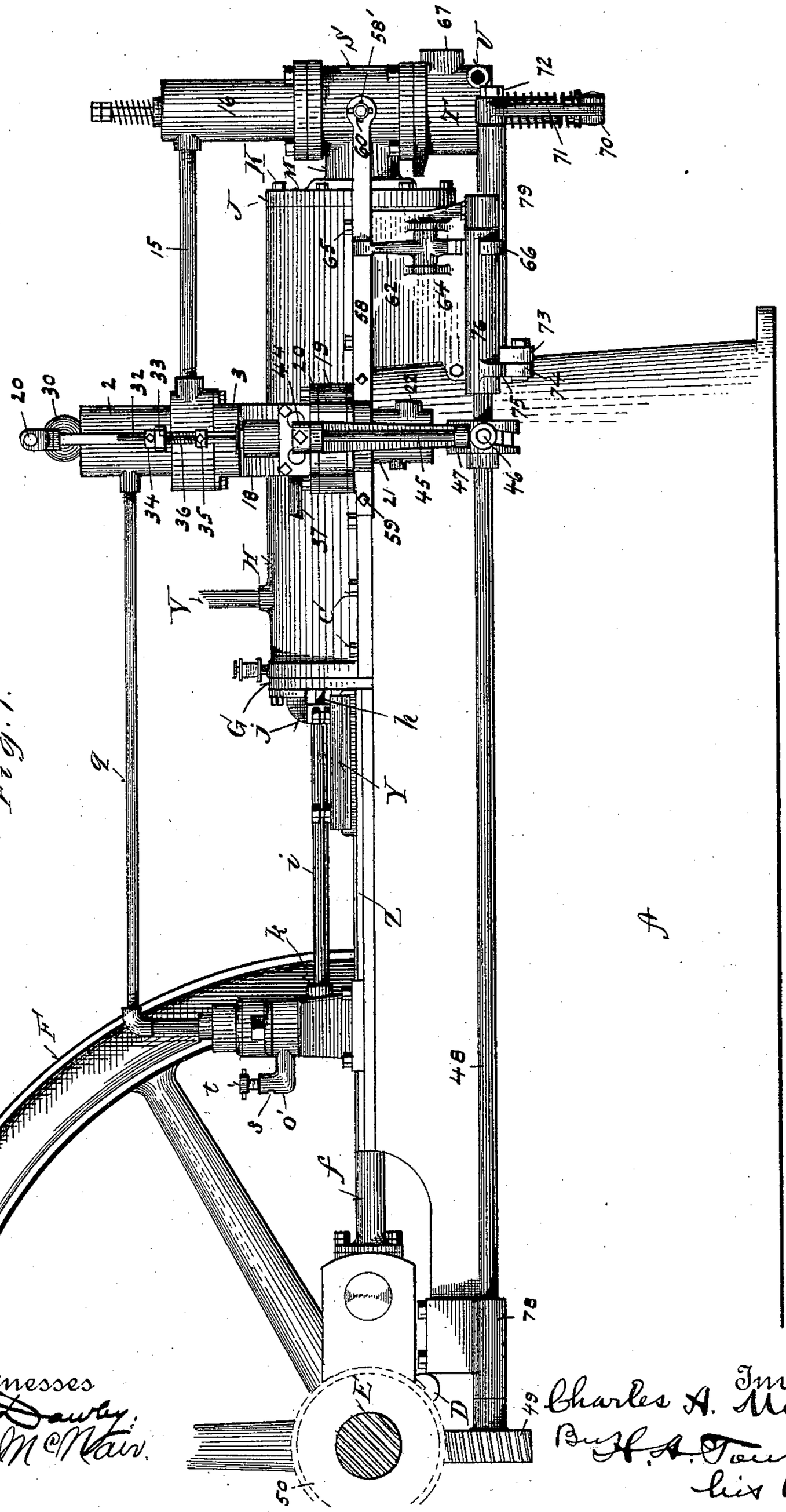
(No Model.)

4 Sheets—Sheet 1.

# C. A. MILLER.

## GAS ENGINE.

No. 585,115. Patented June 22, 1897.



Witnesses
Jas. C. Dawley.
W. M. McNair.

Inventor
Charles A. Miller.
By H. A. Toulmin,
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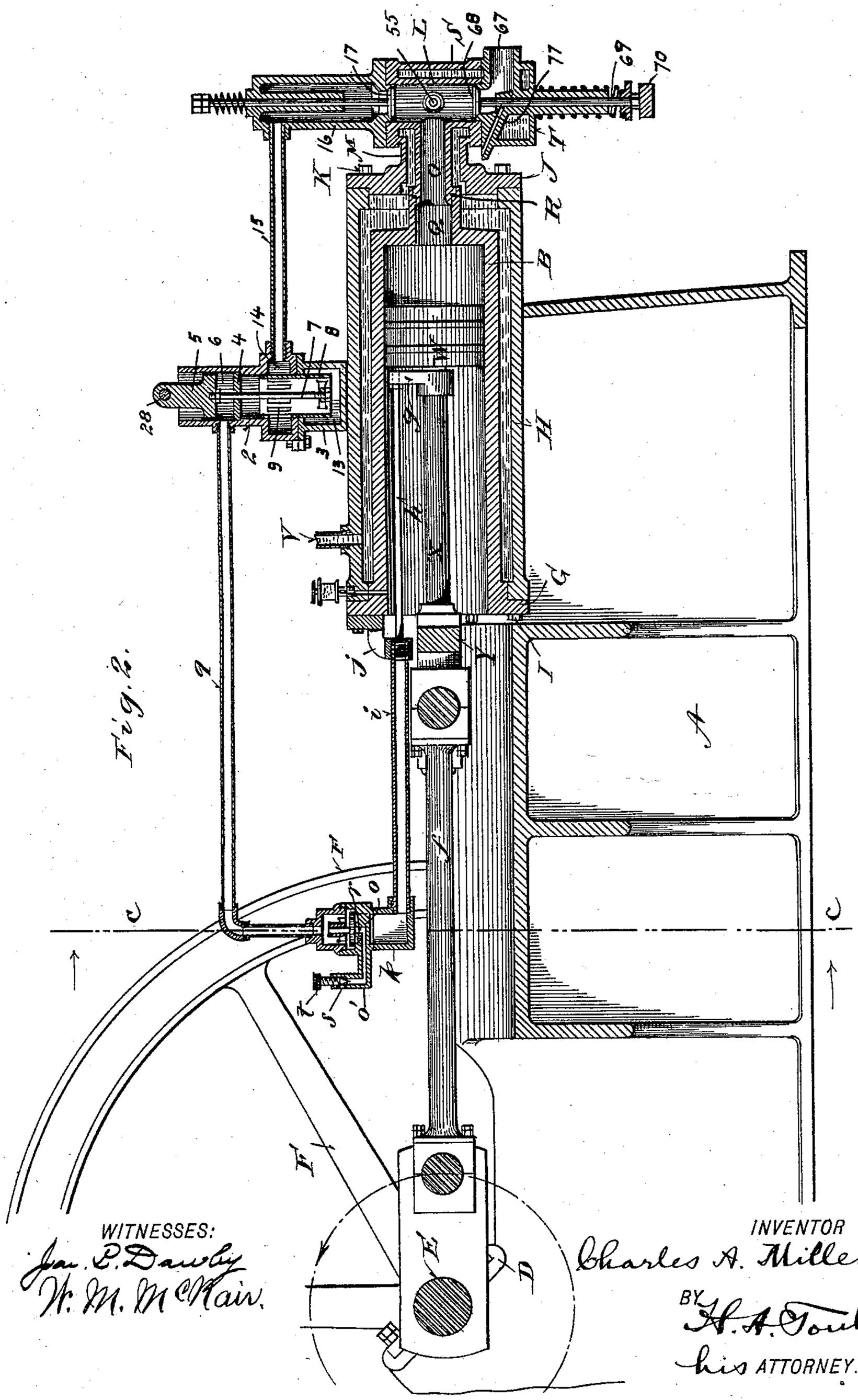
(No Model.) 4 Sheets—Sheet 2.

# C. A. MILLER.

## GAS ENGINE.

No. 585,115. Patented June 22, 1897.



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# C. A. MILLER.

## GAS ENGINE.

No. 585,115. Patented June 22, 1897.

Fig. 3.

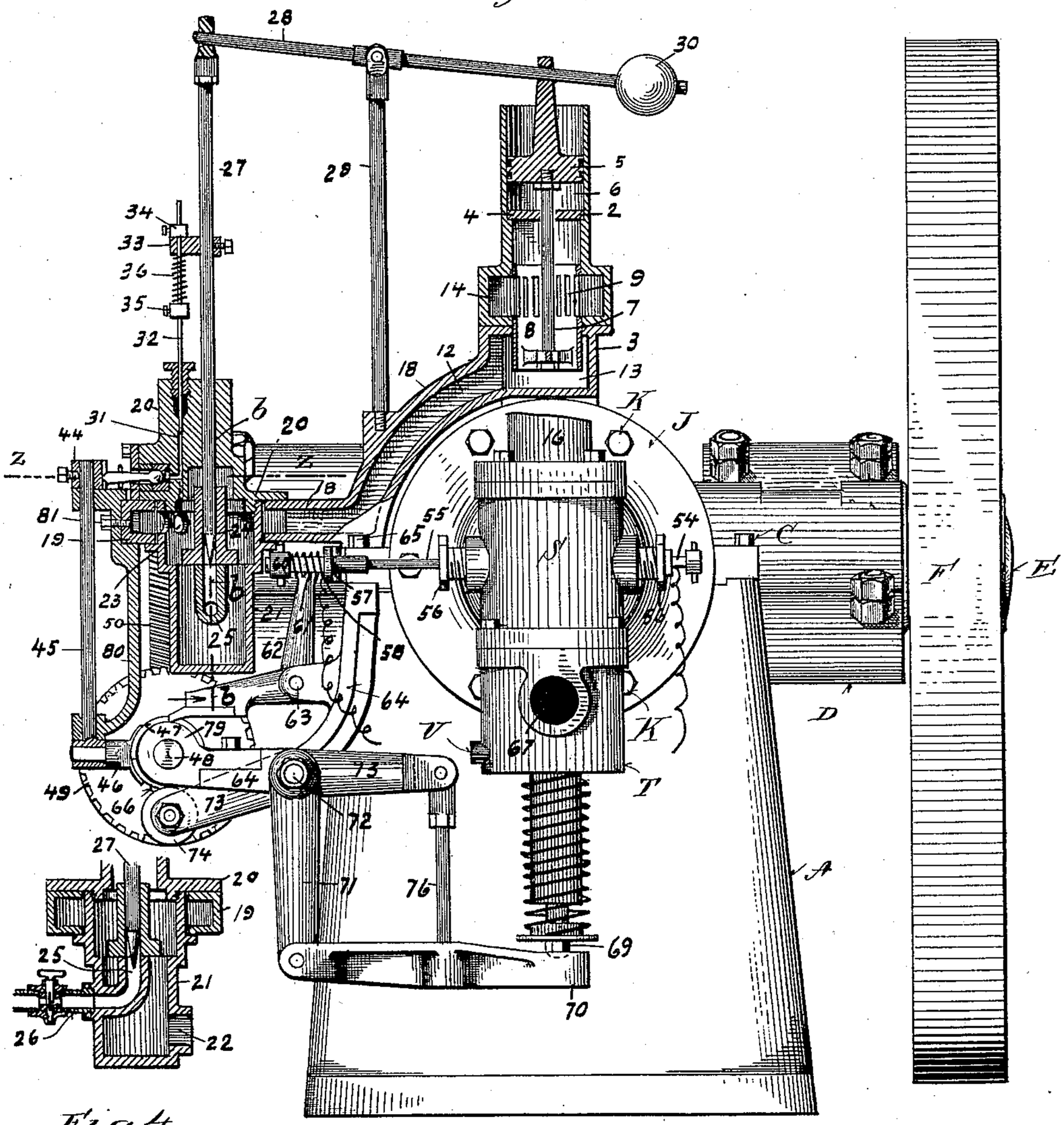
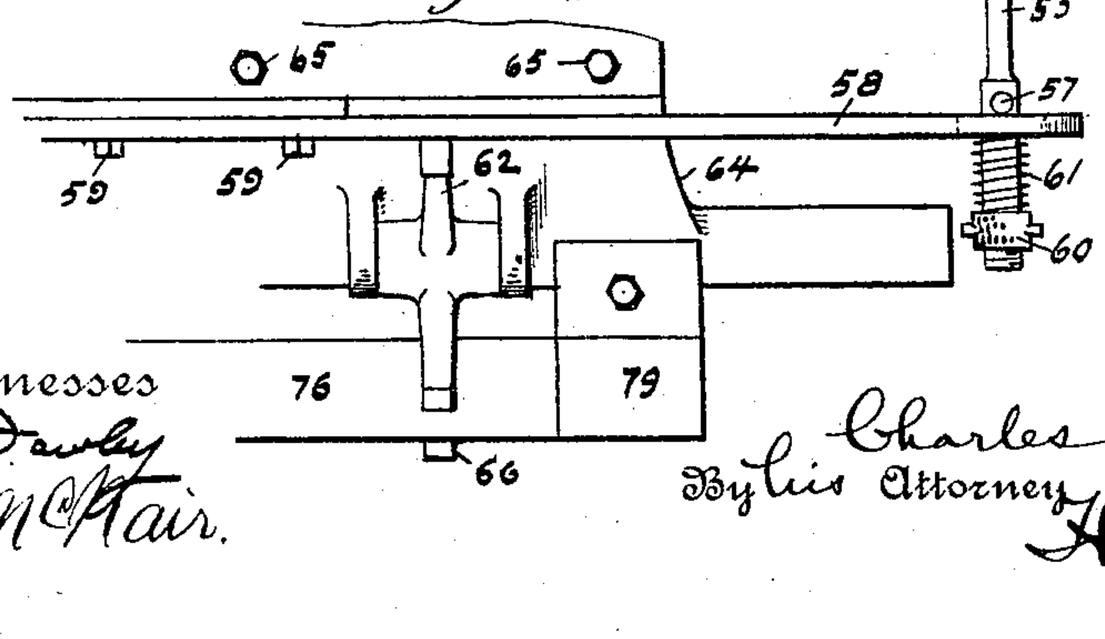



Fig. 4.

Fig. 4a

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(No Model.) 4 Sheets—Sheet 4.

# C. A. MILLER.

## GAS ENGINE.

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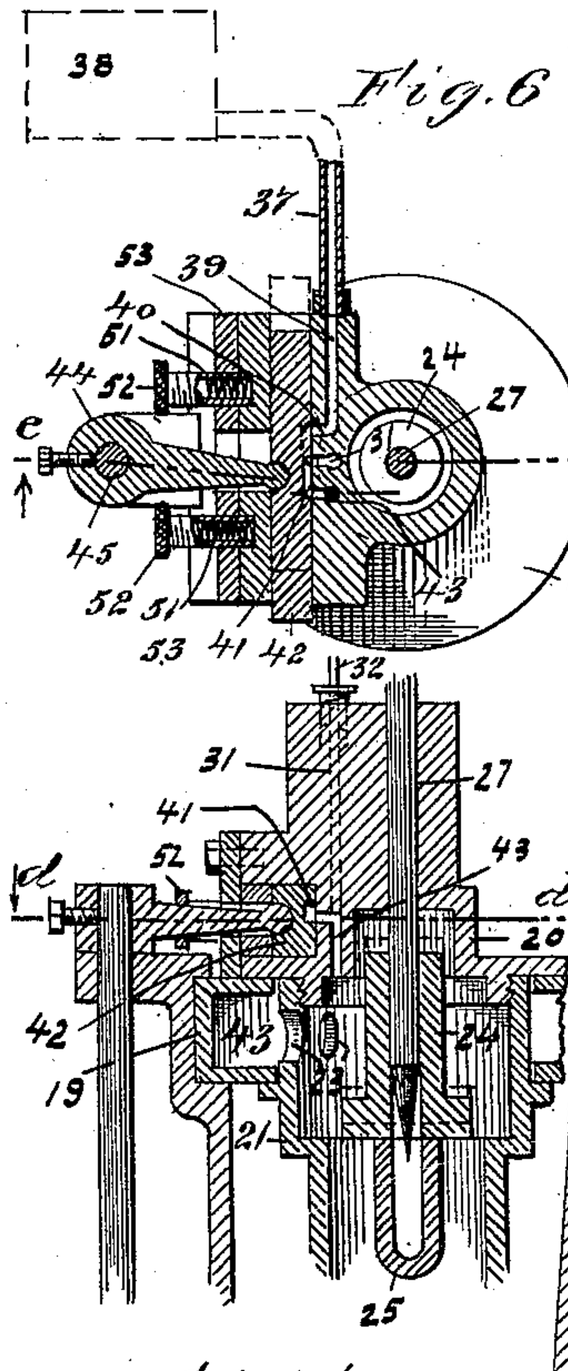


Fig. 7.

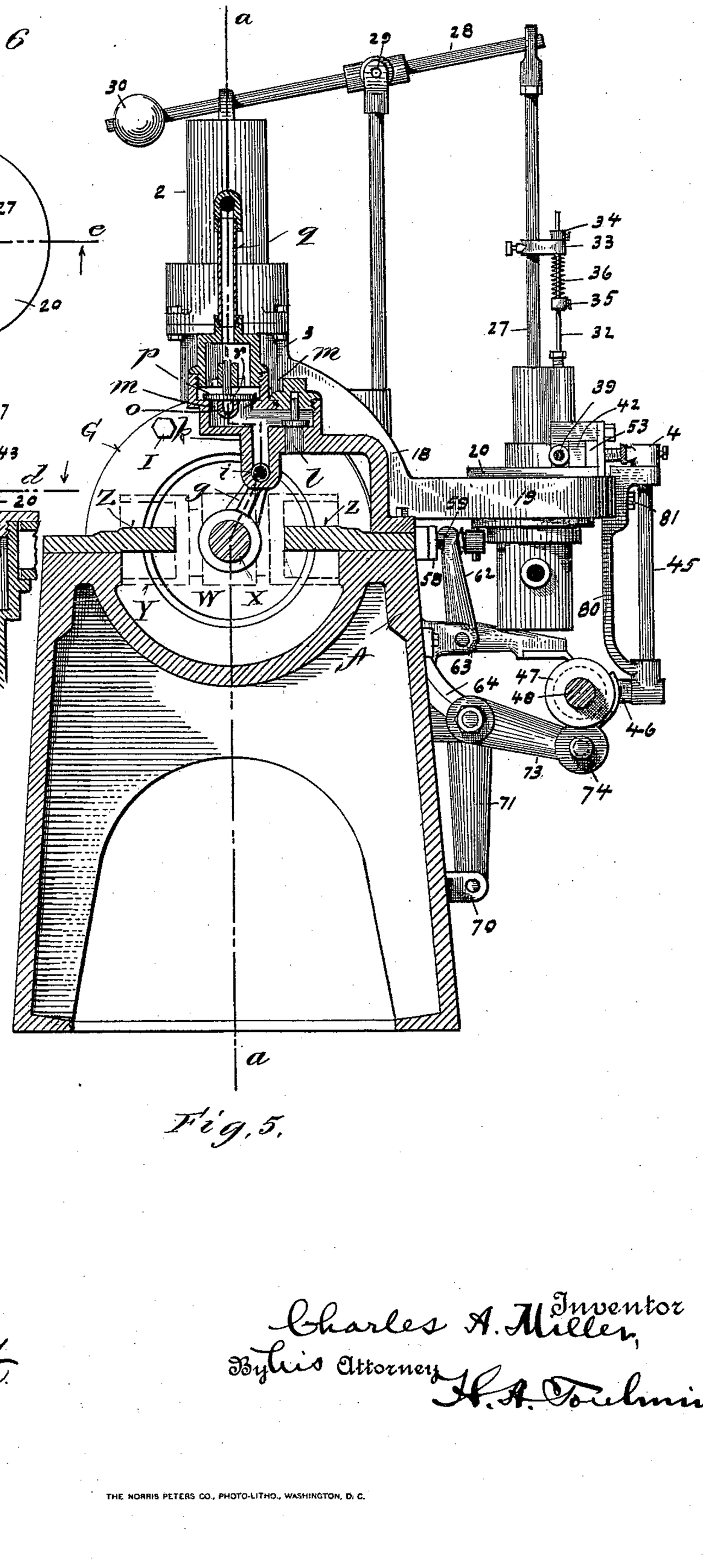


Fig. 5.

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# UNITED STATES PATENT OFFICE.

CHARLES A. MILLER, OF SPRINGFIELD, OHIO, ASSIGNOR TO THE MILLER GAS ENGINE COMPANY, OF SAME PLACE.

## GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 585,115, dated June 22, 1897.

Application filed January 6, 1896. Serial No. 574,491. (No model.)

*To all whom it may concern:*

Be it known that I, CHARLES A. MILLER, a citizen of the United States, residing at Springfield, in the county of Clark and State of Ohio, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to certain new and useful improvements in gas or gasolene engines.

These improvements relate to and are embodied in numerous features of construction and organization, but the leading and principal feature of the invention consists of a pneumatic or atmospheric pressure-governor, arranged and organized in the manner hereinafter described, and more particularly pointed out in the claims.

In the accompanying drawings I have illustrated one new form which I believe to be one of the best embodiments of the invention, but it will be also understood that it may be embodied in other and different forms.

The second principal feature of my invention consists of a cylinder and water-jacket constructed in separate and distinct pieces instead of in one piece, as heretofore. This change brings about new and improved results—to wit, it first enables the builder to thoroughly inspect the exterior of the cylinder with the view of finding any flaws or defects, as a result of casting, which cannot be done under the old construction. A large per cent. of cylinders for gas-engines have to be thrown away because of such flaws and defects on account of the strength they are required to have. It frequently happens that the cylinders are bored out and the work of perfecting them is nearly completed when a flaw is discovered. Under my construction the thorough exterior inspection of the cylinder which it permits reduces the loss thus entailed by many per cent. The second advantage is that where hard water or water containing lime in suspension is used in the water-jacket the cylinder can be removed and the incrustation which the heat causes to form thereon and in the jacket can be removed. This cannot be done where the jacket is cast around the cylinder in one piece with it.

The several other features of construction and organization will be hereinafter fully described, and particularly pointed out in the claims.

In the accompanying drawings, forming a part of this specification and on which like reference letters and numerals indicate corresponding parts, Figure 1 is a side elevation of a gas-engine embodying my said improvements. Fig. 2 is a vertical longitudinal sectional view of the same on the line *a a* of Fig. 5; Fig. 3, a partial rear elevation and transverse sectional view; Fig. 4, a detail vertical sectional view on the line *b b* of Fig. 3 of the air and gas admission valves; Fig 4ª, a detail plan view of a part of the sparking mechanism; Fig. 5, a transverse vertical sectional view on the line *c c* of Fig. 2, looking in the direction of the arrow, and a partial end elevation of certain parts; Fig. 6, a detail horizontal sectional view on the line *d d* of Fig. 7, looking in the direction of the arrows of the latter figure and showing the valve mechanism, particularly the gasolene-valve; Fig. 7, a vertical sectional view of the same mechanism, taken on the line *e e* of Fig. 6 and looking in the direction of the arrows of the latter figure.

The letter A designates a suitable bed for a gasolene or gas engine, upon which is mounted a cylinder B, secured by bolts C. The bed also supports suitable bearings D for the engine crank-shaft E, on which is mounted the fly or balance wheel F.

The cylinder is shown at B, and has fitted over it a separately-cast and independent water-jacket H, secured thereto by bolts I at one end and having a flange G bolted to the bed. The other end of the jacket is closed by a cap J, which is secured thereto by bolts K. The check-valve casing L is formed in one piece with or separate from the cap J and connected through a neck M.

From the casing L a tube O extends to a similar tube Q, projecting from the cylinder, and a suitable joint R is formed between such tubes by a packing of asbestos.

The casing L has a jacket S around it and the water circulates from this jacket through

the space around the tubes O and Q and thence around the cylinder, the water entering the lower part T of the check-valve casing, as seen at U in Fig. 3, and passing out through the pipe V, as seen in Fig. 2. Thus by unscrewing the bolts I and K the parts may be separated and the cylinder withdrawn from the jacket for cleansing purposes, while the inspection of the cylinder and jacket takes place before fitting one within the other. I have already pointed out new results flowing from this construction of the cylinder and jacket.

The cylinder has a piston-head W, with a piston-rod X, carrying a cross-head Y, which travels upon ways Z on the bed A. The usual pitman *f* connects with the cross-head and the crank of the main shaft. Thus it will be seen that much of the weight of the piston-rod X and the pitman *f* is supported by the ways Z, with the result that I am enabled to shorten and greatly lighten the piston W, with the further result of reducing the frictional wear between the piston and cylinder, which, when the piston is long enough to support the piston-rod and to resist the side strains due to pushing against the pitman at an angle, is rendered very great. Its weight is objectionable, as it produces excessive friction and as constituting a heavy body whose momentum has to be suddenly checked and its inertia suddenly overcome at the end of its stroke.

Attached to the piston-rod X by an arm *g* is a pump-piston *h*, working in a pump-cylinder *i*, supported at one end by a bracket *j*, secured to the end of the cylinder, and supported at the other end by the pump-valve casing *k*, resting on the bed, as seen in Fig. 1. Thus when the engine-piston reciprocates it operates this air-pump, the instroke of the piston W giving the outstroke of the pump-piston and the outstroke of the engine-piston giving the instroke of the pump-piston. Air is drawn into the pump through a check-valve-controlled orifice *l*, (see Fig. 5,) and thence forced up the passages *m* on each side of a seat *o*, upon which is placed a check-valve *p*. The pressure of air lifts the valve *p* and the air passes up past the valve *p* and between it and the casing *k*. Thence it enters the air-pipe *q* and passes to the cylinder or chamber of the governor proper.

Any excess or any quantity of air which it is desired should escape, so as to lessen the pressure in the governor, passes into the channel *r* and within the elbow *o'* and out through the orifice *s*, controlled by the screw *t*, so that more or less air may so escape. The amount escaping determines the air-pressure for the governor, because the more air that escapes the less will be the pressure, and vice versa. Thus if the engine is to run with a large charge, the screw *t* is run up and the escape made larger, but if it is to run with a less charge then the screw is run down and the escape reduced, so as to increase the pressure in the governor and close off more of the area of the feed-ports.

Turning now to the governor proper, it consists of a casing supported for convenience upon or near the cylinder and composed of a section 2, bolted to a section 3. The section 2 has a head 4 and a diaphragm or piston 5, thus leaving a chamber 6, into which the air is introduced. The pressure of the air supports the piston or diaphragm, so that when the pressure decreases by reason of a decreased quantity of air the piston or diaphragm settles down, while the increased pressure or quantity lifts the piston or diaphragm. A valve-rod 7 carries a valve or cut-off 8, the slots or other openings 9 of which are more or less opened or closed by the reciprocation of the piston or diaphragm 5. Thus a "charge"—by which I mean air and gas mixed or air and gasolene mixed, as the case may be—coming through the channel 12 in a manner presently to be described enters the chamber 13 and passes into the chamber 14 in a greater or less quantity, according to the position of the valve or cut-off 8. This charge then passes on through the pipe 15 to the check-valve casing 16 and past the spring-supported check-valve 17, when it is drawn in by what is commonly known as the "suction" of the engine-piston W on its outstroke.

I will now refer to the valve mechanism by which air is introduced to the channel 12 and by which also the gas, when gas is used, or gasolene, when gasolene is used, are introduced into said channel 12. The figures in which this valve mechanism is most clearly shown are Figs. 3, 4, 6, and 7. The channel 12 is formed in a pipe 18, and a belt or circular part 19 of this pipe supports the upper section 20 of this valve-casing, to which is screwed the lower section 21. The lower section has an air-inlet opening 22 (see Fig. 4) and openings 23, which communicate with the interior of the part 19. The air in passing up through the section 21 lifts a valve 24 as it passes by the lower end of such valve. This valve 24 rests on the inner elbow 25 and, together with the air, enters the channel 12 and thus forms the charge which is admitted by the governor, as above described; but in order to regulate the quantity of gas according to the position of the governor a needle-valve 27 passes through the valve 24 and more or less into the elbow 25. This needle-valve is tapered to vary the size of the orifice in the upper end of such elbow and thereby controls the quantity of gas admitted. This valve-stem 27 is connected to the governor piston or diaphragm 5. One form of connection consists in the lever 28 on a fulcrum 29 with a counterbalance-weight 30. Thus the needle-valve 27 becomes likewise sensitive in its adjustments, which are automatically controlled by the governor according to the air-pressure therein.

I will turn now to the valve device for admitting gasolene, when gas is not to be used, it

being cut off by a suitable cock in the gas-pipe 26, as shown in Fig. 4. The upper section 20 of the valve-casing has an orifice 31 for the needle-valve 32 therein, such valve being connected to the governor through the needle-valve 27 and the lever 28 by means of a collar 33 on the valve 27 and collars 34 and 35 and spring 36. Thus when the valve 27 descends it yieldingly forces the valve. 32 through the spring 36, and when valve 27 ascends it lifts through the collar 34 the valve 32. This valve 32 I call the "gasolene-valve" because it floats up and down with the varying pressures in the governor, and thus varies the length of the orifice 31 and so varies the quantity of gasolene taken in. The pipe 37 supplies gasolene from an elevated tank, as at 38, and the gasolene flows through the orifice 39 and the branch 40 into the port 41 of a slide-valve 42 when such port is opposite such branch. Such position is shown in dotted lines in Fig. 6. The oil flows into the orifice 31 from the port 41 in such quantity as the position of the valve 32 permits of. Then when the slide 42 moves to the position shown in full lines in Fig. 6 the gasolene flows from the orifice 31, through the port 41, into the discharge-orifice 43, down into the section 21 of the valve-casing, and there mixes with the air and passes with it through the openings 23 and up the channel 12 and into the chamber 13, whence the governor controls its delivery to the cylinder.

Referring now to the means for sliding the valve 42, it will be seen that the arm 44 of a rock-shaft 45 engages the said valve, such shaft at its lower end having an arm 46, engaging with the cam 47 on a rotating shaft 48, receiving motion through the worm-gearing 49 from a worm 50 on the engine-shaft E. The slide-valve 42 is kept properly in place by means of springs 51, fitted in hollow screws 52, the screws being adjustable in and out to vary the pressure of the springs against an intermediate bar 53, which presses against the slide-valve 42.

I will refer now to the electrodes and means for actuating one of them. Attention is directed particularly to Figs. 1, 3, and 5, wherein the electrode 54 passes into the valve-casing L, and the reciprocating electrode 55 likewise passes therein. Suitable insulating stuffing-boxes 56 are provided. On the movable electrode 55 is a pin 57, forming a stop, against which presses a spring-bar 58, secured at 59. Between a nut 60 and this spring-bar I place a spiral spring 61. The spring-bar is vibrated inward to make the movable electrode touch the fixed electrode, and by the return vibration of the spring-bar the movable electrode is quickly thrown out of contact, the spring 61 acting as a cushion between the spring-bar and the nut 60. The spring-bar 58 is vibrated inward by a bell-crank lever 62, pivoted to a lug 63, extending from a bracket 64, secured to the flange of the cylinder by a bolt 65. Here a cam 66 on the shaft 48 actuates the bell-crank lever 62, and when the cam passes off of the lever the spring-bar 58 vibrates outward and breaks the contact. I will refer now to the exhaust mechanism, attention being directed particularly to Figs. 1, 2, and 3, wherein part T of the valve-casing L is shown with an aperture 67, controlled by a spring-seated valve 68, whose stem 69 is lifted at the proper time by a trip-lever 70, suspended from a link 71, hung on a stud 72, carried by a bracket 64. A lever 73, also hung on the stud 72, has a roller 74, actuated by a cam projection 75 from a sleeve 76, fixed on a rotating shaft 48. At the other end of the lever 73 is a pitman 76′, connecting with the trip-lever 70, so as to raise it when the other end of the lever 73 is depressed by the cam 75 acting on the roller 74. Thus the exhaust-valve is lifted and the exhaust allowed to discharge. An oil-orifice 77 in the casing T runs to the valve-stem 69. The shaft 48 is mounted in a bearing 78, secured to the bed, and a bearing 79, secured to the bracket 64. The rock-shaft 45 is mounted in bearings formed in the bracket 80, (see Fig. 3,) secured to the part 19 by a bolt 81, as shown.

Viewing Fig. 2, it will be seen that the engine shown explodes on every alternate revolution, requiring one revolution to draw in a charge and compress it, another revolution to explode and exhaust, and a third revolution to draw in another charge and compress it, so that the power is exerted on the outstroke of every second revolution. Such is the case when a single cylinder is used, but my improved governor may be used with a double cylinder also. While the engine is running with this governor, as I have ascertained in actual use, I can vary the speed in an instant almost from, say, seventy revolutions of the crank-shaft per minute to two hundred revolutions per minute by a simple adjustment of the screw *t*, (see Fig. 2,) by which more or less air is allowed to escape and the pressure in the governor proper varied accordingly. The effect of this control over so powerful a machine by the manipulation of the screw *t* with the thumb and finger is most striking, and while the quickness with which the engine gains the normal speed for which the screw has been set after an additional load has been put on or some of the load thrown off is still more striking. This is one of the results derived from my atmospheric governor, namely, that, having set the engine for a given speed, it will maintain it irrespective of the variations in the load; an additional load being added it will slow down, or some of the load being thrown off it will increase momentarily, but the next few moments it regains such normal speed.

The spring-bar 58 is slotted at 58′, so that by turning the electrode 55 to bring the pin 57 in line with such slot the electrode can be inserted and withdrawn, the pin thus passing through the spring 58.

Having thus fully described my invention,

what I claim as new, and desire to secure by Letters Patent, is—

1. In a gas-engine, the combination with an air-pressure-creating device adapted to vary the pressure with the varying speed of the engine, of an air-governor proper to which said air-pressure is conducted, a charge-admission valve controlled by said governor according to the air-pressure in the governor, a casing for the air and explosive ingredient, communicating with said admission-valve, and suitable valve devices for said casing whereby the air and gas are admitted to said admission-valve and the quantity of both controlled.

2. In a gas-engine, the combination with its reciprocating piston-rod, an air-pump whose piston is operated thereby, an air-governor having a piston or diaphragm connected to said pump by a pipe, a reciprocating charge-admission valve controlled by said governor according to the air-pressure in the governor, a casing for the air and explosive ingredient, a communication between said casing and said admission-valve through which the air and gas pass together into said admission-valve, and suitable valve devices for said casing to control the air and gas admitted to it.

3. In a gas-engine, the combination with an air-pressure-creating device adapted to vary the pressure with the varying speed of the engine, of an air-governor proper to which such air-pressure is conducted, a charge-admission valve controlled by said governor according to the air-pressure in the governor, an air let-off to dispose of the surplus air, a casing, communicating with said admission-valve, for the air and explosive ingredient, the explosive-controlling valve being a needle-valve connected to said air-governor.

4. In a gas-engine, the combination with a pump having its piston connected with the engine-piston, of a governor consisting of a chamber, with a piston or diaphragm, and connected to said pump, whereby variable air-pressures are produced against such governor piston or diaphragm, and a charge-admission valve having openings opened and closed, more or less, by the varying pressure in said governor, an air let-off to dispose of the surplus air, a casing for the air and explosive ingredient connected with said admission-valve, suitable valves therein, the one controlling said ingredient being a needle-valve, fitting in a suitable orifice, and a lever connecting said needle-valve with said governor piston or diaphragm.

5. In a gas-engine, the combination with an air-governor consisting of a chamber with a piston or diaphragm, and a charge-admission valve connected to said piston or diaphragm, of a casing for the air and gas communicating with said admission-valve, and having therein a valve fitting over the gas-orifice, a needle-valve controlling said orifice connected to said piston or diaphragm.

6. In a gas-engine, the combination with a governor consisting of a chamber with a piston or diaphragm, a charge-admission valve connected to said piston or diaphragm, a casing for air and gasolene communicating with said admission-valve, said casing having gasolene admission regulating and discharging orifices, a slide-valve for communicating the admission-orifice with the regulating-orifice, and a regulating-orifice with the discharging-orifice, and a needle-valve in the regulating-orifice connected to said piston or diaphragm.

7. In a gas-engine, the combination with a casing for air and the explosive ingredient, of a valve 24 therein, a gas-orifice 25, a needle-valve 27, therefor, gasolene-orifices 39, 40, 31 and 43, a slide-valve 42 with a port 41 and a needle-valve 32 connected to the valve 27, whereby alternative constructions are provided for the use in the same engine of either gas or gasolene.

8. In a gas-engine, the combination with a casing for air and gasolene, said casing having gasolene-orifices 39, 40 and 43, of a slide-valve 42 having a port 41, a needle-valve 32 in the orifice 31 and an air-governor consisting of a chamber having a piston or diaphragm, a charge-admission valve connected to said piston or diaphragm, a lever connecting the latter with said valve 32, and a passage connecting said casing and chamber.

9. In a gas-engine, the combination with a casing for air and gas, having an orifice 25, a valve 24, a needle-valve 27 for the orifice 25, of an air-governor consisting of a chamber having a piston or diaphragm, and a lever connecting the latter with the valve, a charge-admission valve connected to said piston or diaphragm 27, and a passage connecting said casing with said admission-valve.

10. In a gas-engine, the combination with an air-pump operated thereby, an air let-off for said pump, an air-governor connected to said pump and consisting of a chamber with a piston or diaphragm, a charge-admission valve connected to the latter, a casing for the air and explosive ingredient, suitable valves therein, the one controlling the said ingredient being connected to said piston or diaphragm, and a valve-casing communicating with the cylinder, connected with the air-governor to receive charges from said admission-valve, a check-valve in said valve-casing, a suitable exhaust-valve, and the requisite intermediate adjunctive devices.

11. In a gas-engine, the combination with the main cylinder and piston, an air-pump whose piston is connected to the main piston, an air let-off for said pump, an air-governor connected to the pump and consisting of a chamber with a piston or diaphragm, a charge-admission valve connected to the latter, a casing for air and the explosive ingredient connected to supply a charge to said admission-valve, suitable valves in said casing including a needle-valve for the explosive ingredient, connected by a lever to said piston or diaphragm, a valve-casing opening into the

cylinder and connected to the admission-valve, a check-valve in said valve-casing, and an exhaust-valve also therein, and suitable intermediate adjunctive devices.

12. In a gas-engine, the combination with the main shaft, having a worm, a rotatable shaft having a worm-gear meshing with said worm and a cam of a rock-shaft operated by said cam and a slide-valve operated by said rock-shaft, a casing in which said valve is mounted, and having gasolene-orifices 39, 40 and 43, said valve having a port 41.

13. In a gas-engine, the combination with the main reciprocating piston, a pump-cylinder near it, the pump-piston connected to the engine-piston, a casing connected to said pump-cylinder, an elbow in said casing with a passage at each side of it and an air let-off passage in said elbow a valve in the casing seated upon said elbow and an adjusting-screw controlling an outlet-orifice in the elbow outside of the casing.

14. In a gas-engine, the combination with the cylinder thereof, having a flange at one end and a tubular neck at the other, of a water-jacket secured to said flange at one end and having a cap at the other, a valve-casing connected with said cap and having a tubular neck extending and connected to said tubular neck of the cylinder.

15. In a gas-engine, a gasolene-valve mechanism consisting of a casing having an orifice 39, 40, an orifice 31 and an orifice 43, an endless valve 32 in the orifice 31, and a slide 42 with a port 41, adapted in one position to form communication between the orifice 39, 40, and the orifice 31, and in another position to form communication between the orifice 31 and the orifice 43, and means to actuate said slide 42.

In testimony whereof I affix my signature in presence of two witnesses.

CHARLES A. MILLER.

Witnesses:
EDWIN L. ARTHUR,
W. M. MCNAIR.