(No Model.) 4 Sheets—Sheet 1.

J. F. DURYEA.

GAS ENGINE.

No. 605,815. Patented June 14, 1898.

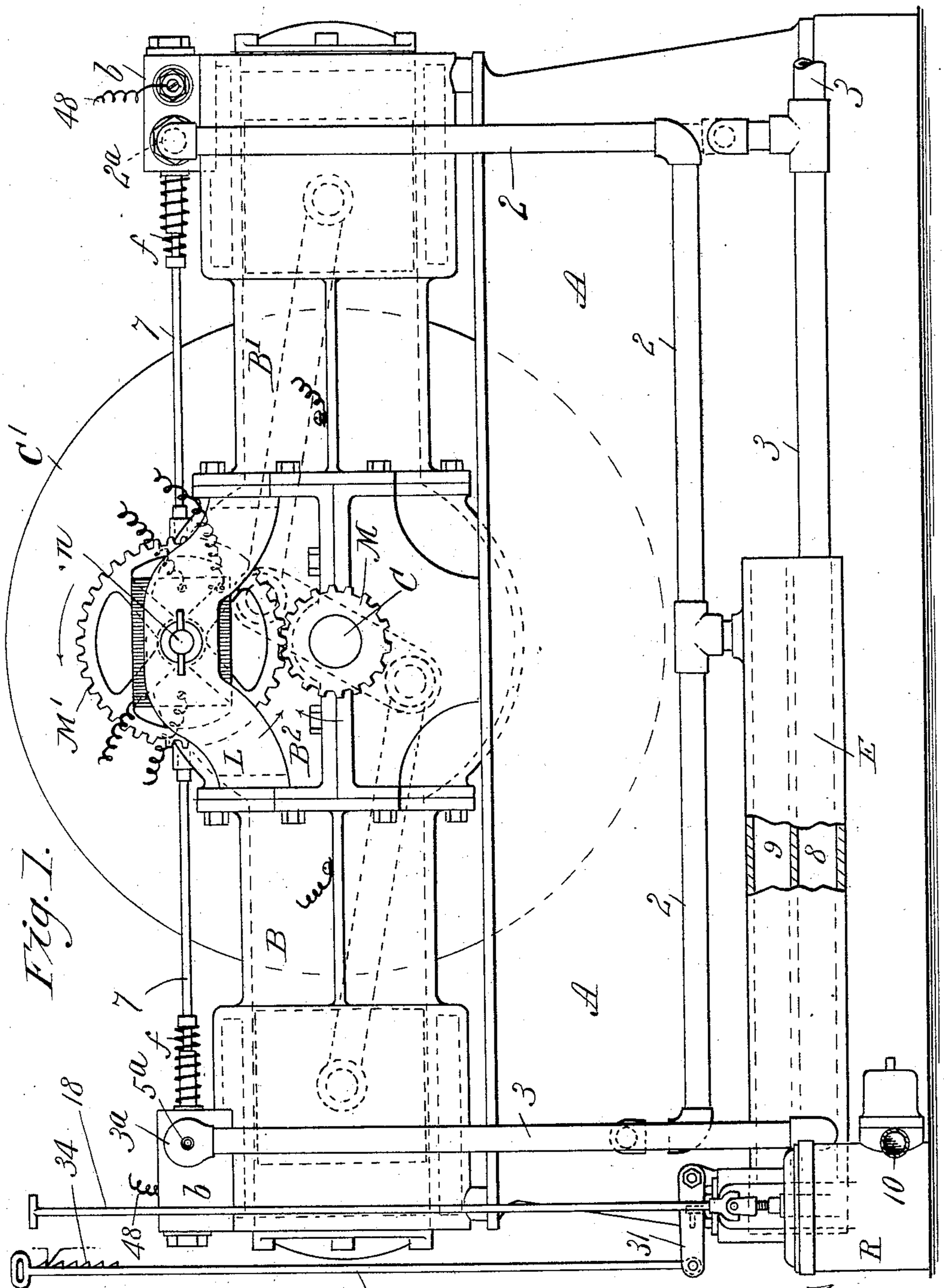

Fig. 1.

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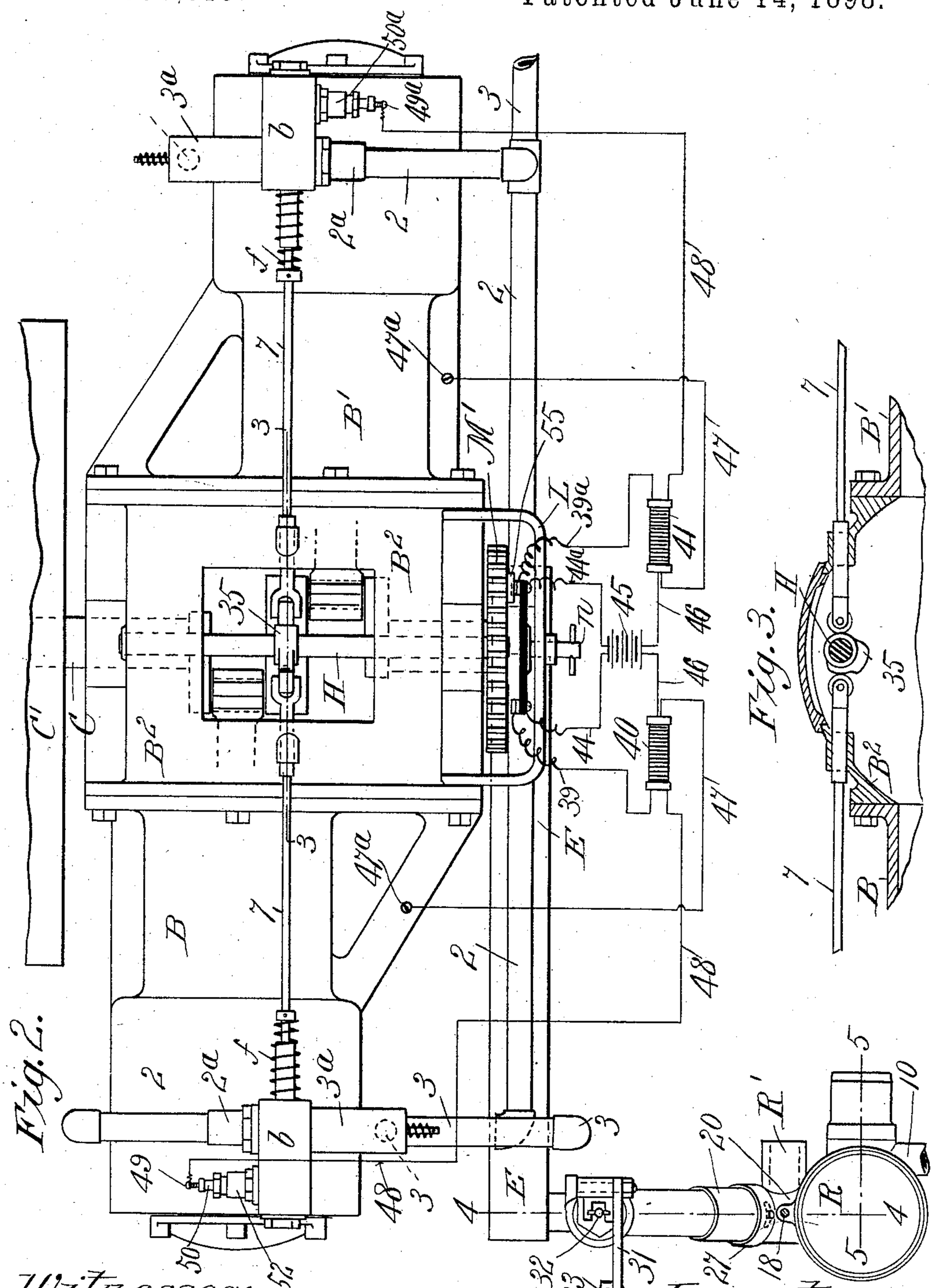

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J. F. DURYEA.

GAS ENGINE.

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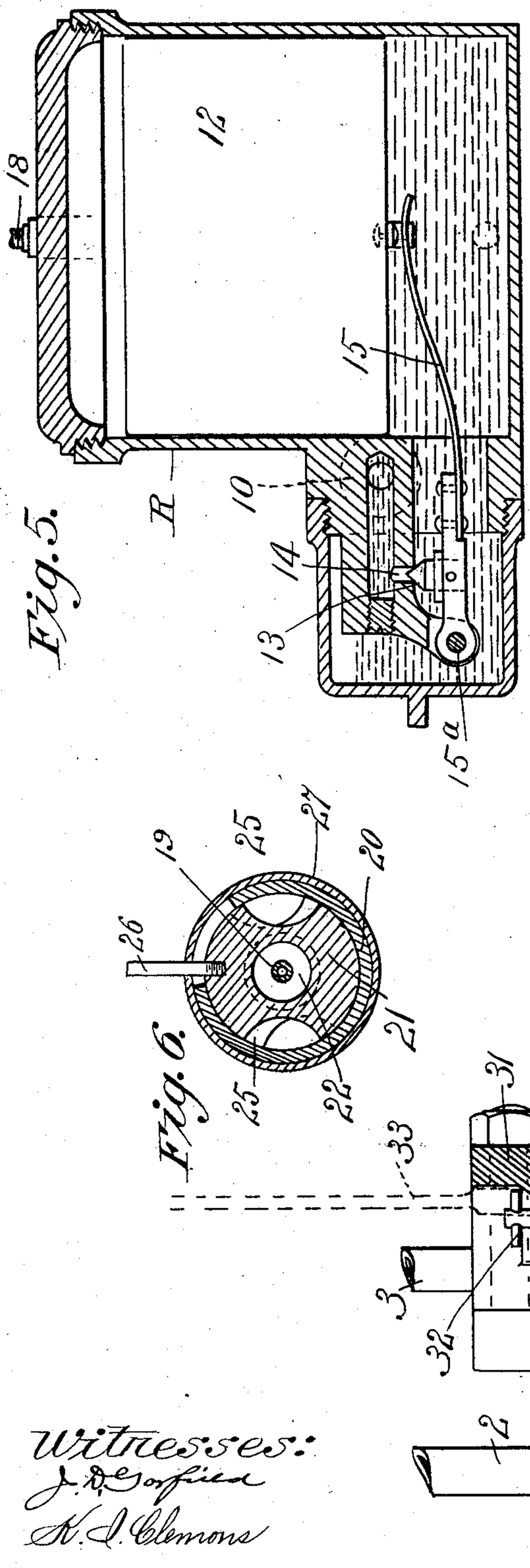

Fig. 5.

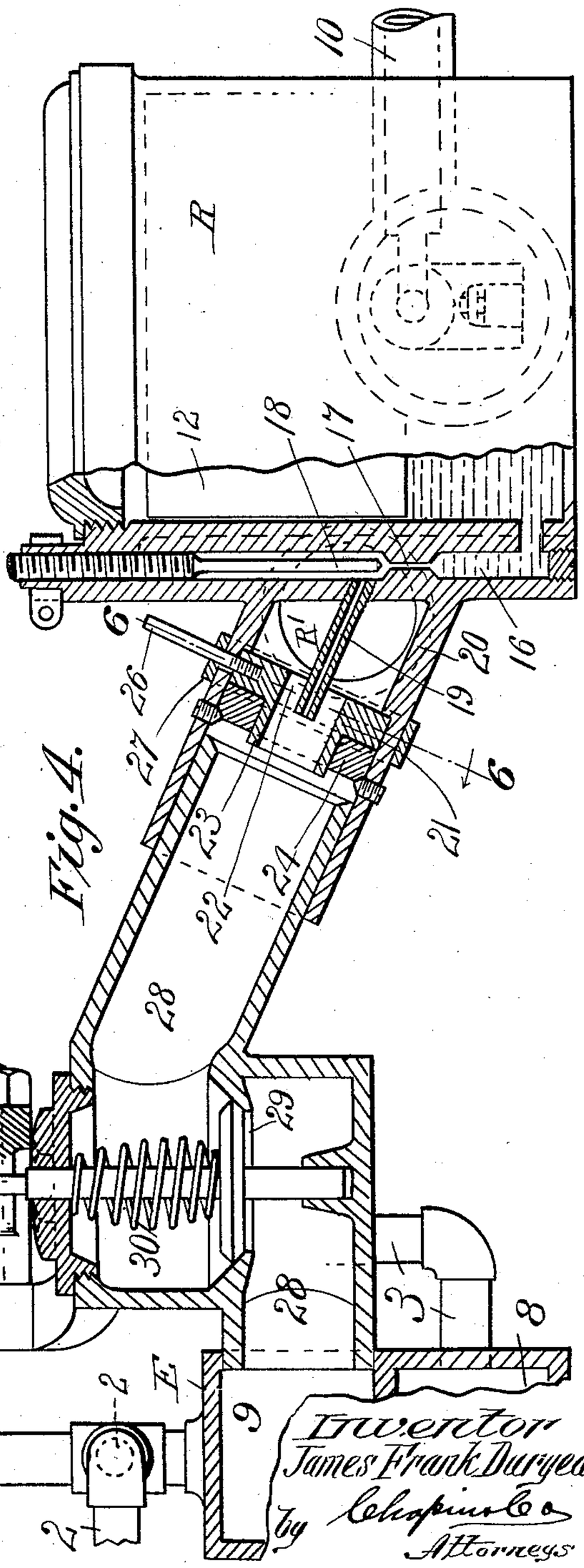

Fig. 4.

Fig. 6.

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No. 605,815. Patented June 14, 1898.

Fig. 7.

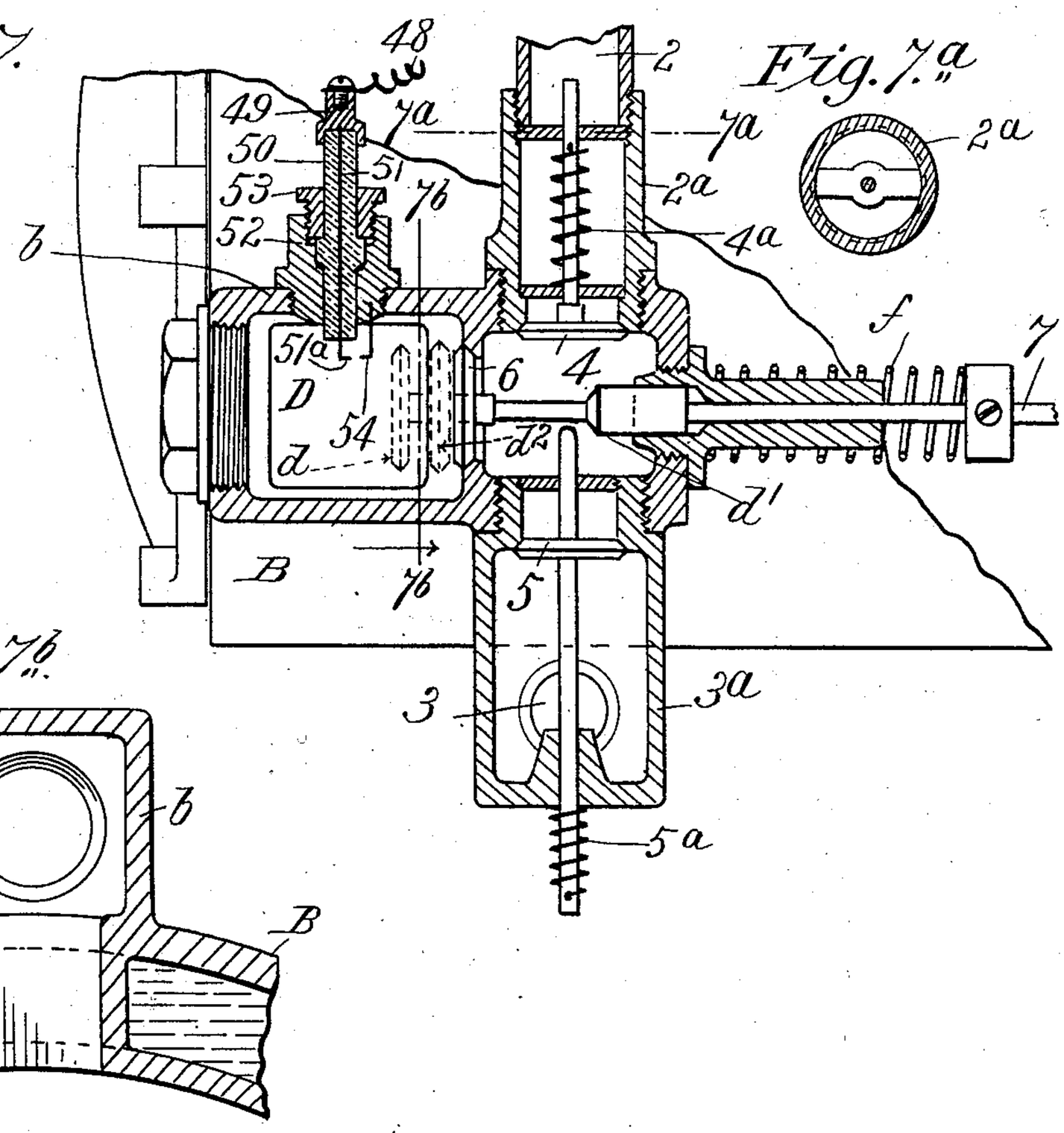
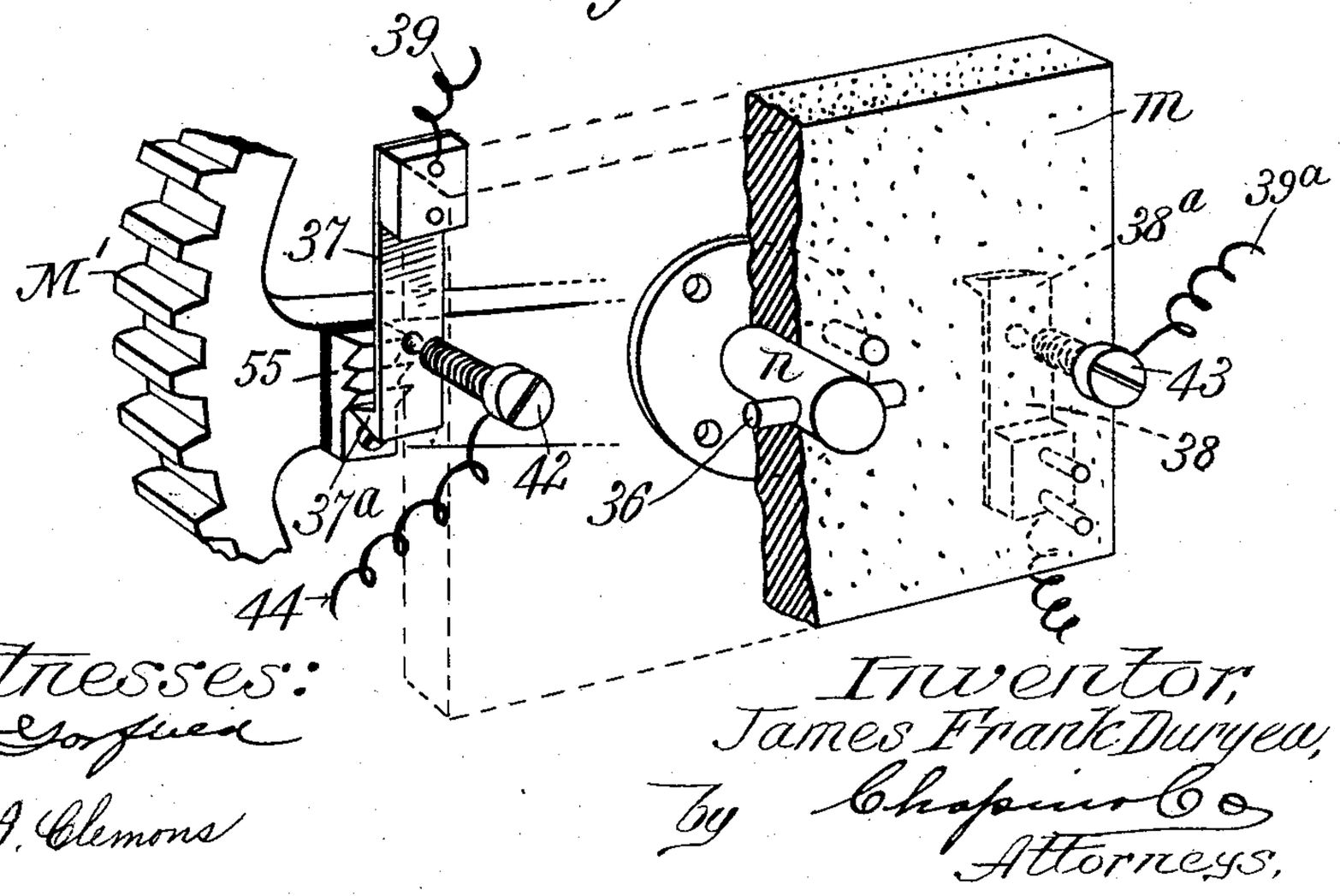


Fig. 7a.

Fig. 7b.

Fig. 8.



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UNITED STATES PATENT OFFICE.

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GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 605,815, dated June 14, 1898.

Application filed June 14, 1897. Serial No. 640,697. (No model.)

To all whom it may concern:

Be it known that I, JAMES FRANK DURYEA, a citizen of the United States of America, residing at Springfield, in the county of Hampden and State of Massachusetts, have invented new and useful Improvements in Hydrocarbon or Gas Engines, of which the following is a specification.

This invention relates to improvements in hydrocarbon or other gas engines, and has for its objects the construction of an engine in which the supply of liquid hydrocarbon from the supply-tank to the atomizing devices can be automatically regulated and the relative proportions of said atomized hydrocarbon and air be easily and quickly adjusted, and to volatilize by heat the atomized liquid hydrocarbon before it passes into the cylinders of the engine, and also to improve the construction of the electric igniters for exploding the charge of gas in the cylinders and means for regulating the time of such ignition; and the invention consists in the construction of the engine, all as fully described in the following specification and pointed out in the claims.

In the drawings forming part of this specification, Figure 1 is a side elevation of an engine constructed according to my invention. Fig. 2 is a plan view of Fig. 1. Fig. 3 is a sectional view on line 3 3, Fig. 2, showing the cam-shaft by which the exhaust-valves are operated. Fig. 4 is an enlarged sectional view on line 4 4, Fig. 2, of the mechanism for controlling the supply of the hydrocarbon fed to the atomizer and adjustment of the delivery of atomized hydrocarbon to the cylinders and means for regulating the supply of air to be united with said hydrocarbon and for regulating the quantity of said mixture admitted to said cylinders. Fig. 5 is an enlarged sectional view of a part of Fig 4, taken on line 5 5, Fig. 2. Fig. 6 is a section on line 6 6, Fig. 4. Fig. 7 is a sectional view of the explosion-chamber and the intake and exhaust ports of one of the cylinders. Fig. 7^a is a section on line 7^a 7^a of Fig. 7. Fig. 7^b is a section on line 7^b 7^b of Fig. 7. Fig. 8 is a perspective view of a part of the igniter device, showing means for making and breaking the circuit and for regulating the time of such making and breaking relative to the position of the piston in the cylinder.

The engine herein described is of that class having two cylinders, the inner ends of which are open and each of which receives an impulse only on every other stroke, the dead stroke being utilized to expel the burned gases from the cylinders and to draw in and compress a fresh charge of aerated hydrocarbon gas.

Referring to the drawings, A is the base of the engine; B B′, the oppositely-located cylinders, whose piston-rods are connected to a common crank-shaft C, on which is secured a balance-wheel C′. A suitable casing B^2 incloses the crank-shaft and piston-rods, as is customary in many engines of this class. Hollow bosses *b b* are cast on the tops of each of the cylinders near the outer end thereof, in which bosses the explosion-chamber D is located. The supply-pipe 2 and the exhaust-pipe 3 are connected with said bosses, the ends of said pipes entering the castings 2^a and 3^a, which are screwed into said hollow bosses opposite each other. The supply-valve 4 and the exhaust-valve 5 fit the inner ends of said supply and exhaust connections, respectively, and the valve 6 fits the port leading into the said explosion-chamber D. One end of a rod 7 is supported in said boss *b*, by means of which rod, operated by a suitable cam, the valve 6 is operated to open and close the port of the explosion-chamber at the proper time and which rod also operates to open the exhaust-valve 5.

The valve 4 of the supply-pipe is opened by the suction of the piston on its dead stroke when it is drawing a supply of aerated hydrocarbon gas into the cylinder and closes automatically by means of the spring 4^a on its stem at the termination of said dead stroke of the piston.

The stem of the exhaust-valve is provided with a spring 5^a, which closes the exhaust-valve at the proper time—viz., just before the movement of the piston takes place—by which a fresh charge is drawn into the cylinder. The operation of the rod 7 and valve 6 thereon relative to the exhaust and intake valves will be described farther on.

The exhaust-pipes 3 and the intake or supply pipes connected to the hollow boss *b*, as above described, lead downwardly from opposite sides of both cylinders and are connected to an exhaust and expansion chamber, (represented by E, Figs. 1 and 2.) This chamber is made, preferably, of cast-iron and is divided by a longitudinal partition into two separate chambers 8 and 9, the former being in connection with the exhaust-pipes of one of the cylinders and the latter, 9, being in connection at one end with the supply-pipes 2 of both cylinders, the other end of the chamber being connected to the atomizer.

It will be observed that as the chamber E is located to one side of the base A it is necessary on one end of the engine to take the exhaust-pipe through said base and at the other end to take the supply-pipe therethrough. From the above it will be seen that all of the hot burned gases pass through the exhaust-ports of one of the cylinders and are conducted to and through the chamber 8, and the supply of aerated hydrocarbon gas for both of said cylinders is conducted to and through the chamber 9, located above the chamber 8 and having heat imparted to it by the exhaust passing through the latter. This atomized gas, thus subjected to a high temperature, is expanded in said chamber 9, and the finely-atomized particles of hydrocarbon become volatilized and the gas becomes a fixed gas and remains fixed as long as the temperature necessary to the complete volatilization of the hydrocarbon is maintained. This treatment insures such perfect combustion of said gas that practically no odor results from said combustion.

The means for supplying the liquid hydrocarbon to the atomizer and regulating said supply and the proper quanty of air to be mixed therewith are constructed and arranged as follows: A supply of suitable liquid hydrocarbon is provided and connection is made therewith through a pipe 10. (Shown in Figs. 1, 2, and 4 and indicated in dotted lines in Fig. 5.) Said pipe 10 leads from said supply to a small reservoir R, in which are a float 12 and a valve 13, operated thereby for opening and closing an inlet 14, through which liquid hydrocarbon is supplied to said reservoir by the pipe 10 from said supply-tank, which is located above said reservoir R. The object of the float and its valve is to maintain as nearly as possible the same level of liquid hydrocarbon in the reservoir. The said float 12 is made to fit rather freely the interior diameter of the reservoir R and is connected to said valve by a spring-arm 15, having a swinging movement in a vertical plane on its pivot-pin 15ª, to the end that any jolting or other movement that the engine may be subjected to, if applied to a motor wagon or launch, will permit a slight movement of the float without any corresponding opening and closing of the valve 13, the float being designed to deflect the spring-arm 15 to some extent in closing said valve, so that with a normal level of liquid in the reservoir said spring-arm will be always under a certain tension. Connection from said reservoir R to the expansion-chamber 9 is clearly illustrated in Fig. 4, and consists in the passage 16, contracted as at 17, the upper end of said contracted part being controlled by a valve-rod 18, as shown, having a screw connection with the upper end of said passage 16 and whose upper end extends up to a point within convenient reach of the operator. By turning said valve-rod the contracted portion 17 of the passage 16 may be closed entirely or opened as much as desired. Above said contracted portion 17 and upwardly inclined relative thereto the atomizer-tube 19 is inserted and communicates with said passage, and said tube is centrally located in a neck 20, cast on the side of said reservoir. At right angles to said neck and close to the wall of the reservoir R an opening R′ is provided, through which air is drawn for mixing with the atomized liquid hydrocarbon as it emerges from the atomizer-tube 19.

The passage through the neck 20 is restricted by the plate 21, having a circular opening 22 therein concentric with said atomizer-tube and into which the latter projects a short distance. This plate 21 has a hub 23 thereon, over which the plate 24 fits loosely. This plate 24 is fixed in the neck 20 by means of screws, as shown, or otherwise. Both of these plates 21 and 24 fit the interior diameter of the neck 20 closely and have opposite portions 25 thereof cut away, as shown in Fig. 6. The plate 24 being fixed and the plate 21 being rotatable in said neck 20, it follows that by turning or rotating the plate 21 the cut-away portions 25 may be made to register, whereby a passage through both of the said plates is provided equal in area to the said cut-away portions. By rotating said plate 21 on its axis said opening may be restricted more or less, as may be desired, and the amount of air, in addition to that which passes through the central opening 22, may thus be controlled. The rotation of the plate 21 is effected by means of a pin 26 passing through the wall of the neck 20 in a suitable slot and engaging with a hole in the edge of said plate. A ring or band of metal 27 is applied to the neck 20 over the slot therein to prevent the entrance of air through said slot should the plate 21 be turned far enough around to permit it. A suitable passage 28 between the end of said neck 20 and the end of the chamber 9 is provided, (see Fig. 4,) and in that passage is a vertically-located valve 29, having a spring 30 on the stem thereof to hold it to its seat and close said passage, which is the normal position of the valve when the engine is at rest. Said valve 29 is operated by the operator by means of a suitably-pivoted lever 31, which engages with

the stem thereof, as shown in Fig. 4 at 32, and also indicated in Figs. 1 and 2. A rod 33 engages with the free end of said lever 31, which rod is so located as to be within convenient reach of the operator. A series of notches 34 (see Fig. 1) on the said rod, near the upper end thereof, serve to hold it at any desired degree of elevation and to thereby indicate to the operator the extent to which the valve 29 may be open. This valve is opened more or less, according to the amount of aerated hydrocarbon it is desired to draw through the chamber 9 and into the cylinder of the engine.

The means employed for operating the rods 7 for opening the exhaust-valves and for operating the valve 6 for opening and closing the port leading into the explosion-chamber consist in a shaft H, parallel with the crank-shaft C and supported in proper bearings above it. (See Figs. 1, 2, and 3.) Said shaft H is revolved once to two revolutions of the crank-shaft C by suitable gear connections with the latter, said gears being indicated by M M'. On said shaft H is a cam 35 of such contour as will move the valve 6 to the two positions shown in dotted lines in Fig. 7 for the purpose to be described farther on.

In Fig. 8 is illustrated, on an enlarged scale, a portion of the gear-wheel M' and the plate *m*, of some good non-conductor of electricity, having secured centrally thereon a stud *n*, which has a bearing in a suitable supporting-frame L, secured to the casing of the engine, said stud being in line axially with the shaft H and the said plate in proximity to and in a plane parallel with the gear M'. A bar 36 is provided in the outer end of said stud *n*, whereby the plate *m* can be rotated by hand more or less in its bearing in the frame L. On diagonally opposite corners of said plate *m* two spring-fingers 37 and 38 are secured, whose free ends are located substantially opposite each other on a line running centrally across said plate. Each of said fingers 37 and 38 is at its point of attachment connected by a wire 39 and 39[a] to one end of the secondary circuit of induction-coils 40 and 41, as shown in Fig. 2. The free ends of said fingers each have a lip 37[a] and 38[a] formed thereon, projecting outwardly therefrom toward the gear M'. Opposite the said free ends of said spring-fingers are two screws 42 and 43, passing through said plate *m*, whose inner ends lie just back of the ends of said fingers, but not in contact therewith. Wire connections 44 44[a] lead from said screws to one pole of a battery 45 or other suitable source of electricity. From the opposite pole of said battery two wires 46 lead to one end of the primary circuit of the induction-coils 40 41. From the opposite ends of said primary circuits of said coils wires 47 lead to any convenient point, as 47[a], on the frame of the engine, and from the ends of the secondary circuits of said coils, opposite to the ends to which the wires 39 39[a] are attached, wires 48 lead to the binding-posts 49 49[a] of the igniter-posts 50 50[a], located in the wall of the explosion-chambers D and projecting therethrough into said chambers. Said igniter-posts 50 50[a] are of porcelain, preferably, (or other suitable material,) and a wire of some resistant metal, such as platinum, is molded therein and connected to said binder-posts 49 49[a] and having a point 51[a] projecting from the end of the post in the explosion-chamber D. Said post 50 is securely held in a metal plug 52, which screws into the wall of the explosion-chamber D, a set-nut 53 holding said post firmly in said plug. A wire 54, also preferably of platinum, is inserted in said plug 52 in proximity to the inner end of the igniter-post 50. Said two platinum wires 51 and 54 have their points bent toward each other and terminate in close proximity to each other, as shown in Fig. 7.

On the side of the gear M' is secured the insulated notched metal block 55. This block is so located that during the revolution of the gear M' the edges of the notches thereon will have a light contact with the lip 37[a] of the finger 37 and the lip 38[a] of the finger 38. Said contact will force the spring-finger back against the end of the screws 42 and 43 alternately. This contact establishes an electric circuit which includes the battery 45 and one of the induction-coils 40 or 41, which circuit is broken only at the point of separation between the two wires 51 and 54 in the explosion-chamber. The passing of the block 55 across the end of the spring-finger breaks this electric current as many times as there are notches in said block, thereby producing an intermittent sparking between the two wires 51 and 54 in the explosion-chamber, the current being of sufficient intensity to bridge the space between the points of the said wires.

The operation of the exhaust devices is as follows: When the piston has been propelled forward by the explosion of a charge in the cylinder and has reached the limit of its movement therein, the cam 35 on the shaft H moves the rod 7 to open the valve 6 to its fullest extent, as indicated by the dotted position thereof at *d*, Fig. 7. The movement of said rod 7 causes the beveled shoulder *d'* thereon to engage with the end of the stem of the exhaust-valve 5 and raise the latter from its seat. The valves 6 and 5 remain in these positions during the movement of the piston back toward the explosion-chamber again, which movement expels all of the burned gases in the cylinder. At the end of this backward movement of the piston the cam 35 on the shaft H arrives at the position shown in Fig. 3, the spring *f* serving to retract said rod 7 and to always keep the end of said rod, which is provided with a suitable roll, against the edge of said cam. When the cam 35 is in the position shown in Fig. 3, the valve 6 is in the dotted position shown in Fig. 7, (indicated by d^2,) and the rod 7 has been retracted by its spring far

enough to allow the spring 5^a to close the valve 5, and at the moment of closing of the latter the piston, carried by the balance-wheel, moves again toward the opposite end of the cylinder and, acting as a pump, draws a charge of aerated hydrocarbon into the cylinder from the reservoir R and through the heating-chamber 9. At the moment the piston has finished its stroke above described the explosion takes place in the opposite cylinder, driving back the first-named piston and compressing its charge of gas, which in turn is ignited at the proper time. The valve 6 is closed by the further retraction of rod 7 just before the piston begins its movement for compressing the charge of gas in its cylinder, and as soon as the valve 4 is relieved from the suction of the piston on its pumping stroke said valve is closed by its spring 4^a.

Assuming now that the position of the block 55 on the gear M′ relative to the lip 37^a on the spring-finger 37 represents the point of contact when the piston of the engine has reached the end of its stroke, if it is desired to cause the charge of hydrocarbon gas to explode before the piston reaches that point or after it has passed it, then the plate *m* is turned either to the left or to the right until the point of contact between said block and said fingers causes the ignition of the charge to take place at the point desired.

The construction herein shown and described obviates the necessity of any means within the cylinders for making or breaking a circuit, which, owing to the very high temperature under which they operate, and are very unsatisfactory and great difficulty has been experienced in securing unfailing ignition.

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

1. In a hydrocarbon-engine, means for supplying volatilized hydrocarbon to said engine consisting of a supply-tank, a reservoir placed below the level of the bottom of said tank, a pipe connection from said tank to said reservoir, a float-actuated valve for automatically maintaining a quantity of liquid hydrocarbon in said reservoir, a pipe connection from said reservoir to the cylinders of said engine, an atomizer-tube in said pipe, communicating with the interior of said reservoir, an opening in said pipe for the admission of air, and means for regulating the quantity of air so admitted, a valve in said pipe for regulating the quantity of atomized hydrocarbon and air to be drawn into the said cylinders, and a heating-chamber in said pipe connection for heating said atomized hydrocarbon between said reservoir and said cylinders, substantially as described.

2. In a hydrocarbon-engine in combination, a supply-tank for liquid hydrocarbon, an intermediate reservoir between said tank and said engine, located on a lower level than said tank, suitable pipe connections between said engine, reservoir, and tank, means in said reservoir for regulating the quantity of hydrocarbon which can be drawn therefrom by one stroke of the piston of said engine, and means for automatically controlling the quantity of hydrocarbon in said reservoir, consisting of a float therein, an inlet-port communicating with said tank, a suitably-pivoted valve having a seat in said port, and a spring-arm attached thereto by one end and whose opposite end has a free engagement with said float, substantially as described.

3. In a hydrocarbon-engine, means for operating the exhaust-valves consisting of the rod 7 having a suitable endwise movement, a valve 6 thereon, a beveled shoulder *d′*, on said rod 7, the valve 5, closing the exhaust-port, the stem of which valve is engaged by said beveled shoulder for opening the valve, and a suitable spring 5^a on said valve-stem against which said opening movement takes place, combined with a suitable cam-operated rod 7, for opening said valve 6, and permitting said valve 5 to close before the closing of said first-named valve, substantially as described.

4. In a hydrocarbon-engine, means for atomizing liquid hydrocarbon and regulating the quantity of air to be mixed therewith, consisting of an atomizer-tube connected with a suitable reservoir containing a supply of hydrocarbon, a neck on said reservoir inclosing said tube, a plate 21 axially rotatable in said neck, a plate 24 fixed in said neck, and in contact with said plate 21, as shown, air-passages 25, in said plates, a central air-passage 22 through said plate 21, an opening R′, through the side wall of said neck, and a pipe connection from said neck to the cylinder of said engine, substantially as described.

5. In a hydrocarbon-engine, means for atomizing liquid hydrocarbon and regulating the quantity of air to be mixed therewith, consisting of an atomizer-tube connected with a suitable reservoir containing a supply of hydrocarbon, a neck on said reservoir inclosing said tube, a plate 21 axially rotatable in said neck, a plate 24 fixed in said neck, and in contact with said plate 21, as shown, air-passages 25 in said plates, a central air-passage 22, through said plate 21, an opening R′, through the side wall of said neck, and a pipe connection from said neck to the cylinder of said engine, a valve 29, and a heating-chamber in said pipe connection between said atomizer and the cylinder of said engine, substantially as described.

6. A gasolene or other hydrocarbon engine consisting of a plurality of cylinders connected to a common crank-shaft, a gasolene-supply tank, one exhaust-chamber common to said cylinders, pipe connections between the latter and said chamber, pipe connections between said supply-tank and said cylinders, a heating-chamber interposed in said last-named connection and adjoining said ex-

haust-chamber, an atomizer in said connections between said heating-chamber and said tank, means for regulating the supply and relative proportions of gasolene and air, a float-valve for automatically controlling the flow of gasolene from the supply-tank to said atomizer, and a closed-circuit electric igniting device in said cylinders, and means outside of the latter for automatically opening said circuit at a predetermined point in the stroke of the piston of said engine, substantially as described.

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