(No Model.)

4 Sheets—Sheet 1.

J. F. DURYEA.

ENGINE OR MOTOR.

No. 557,496. Patented Mar. 31, 1896.

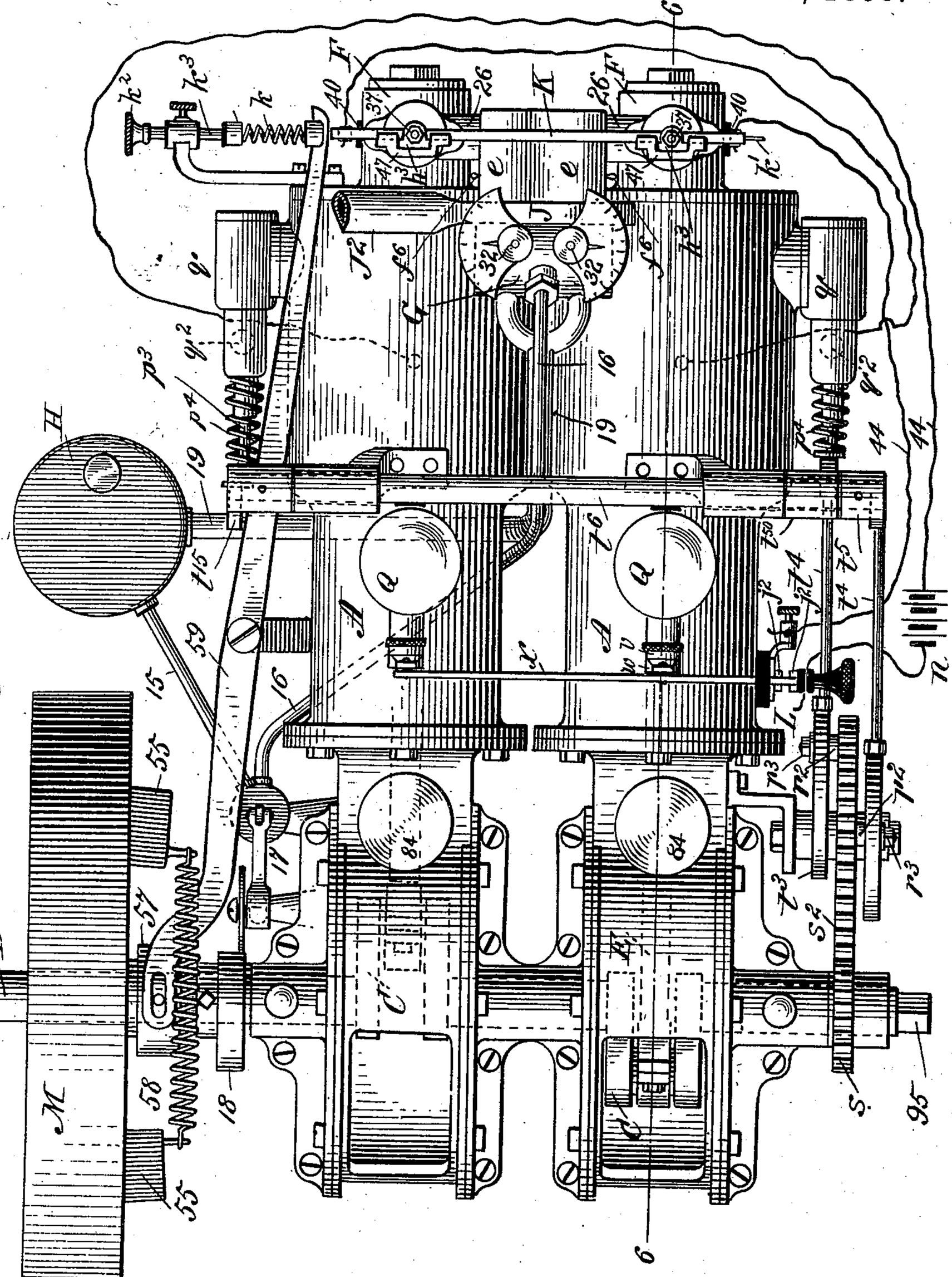

Fig. 1.

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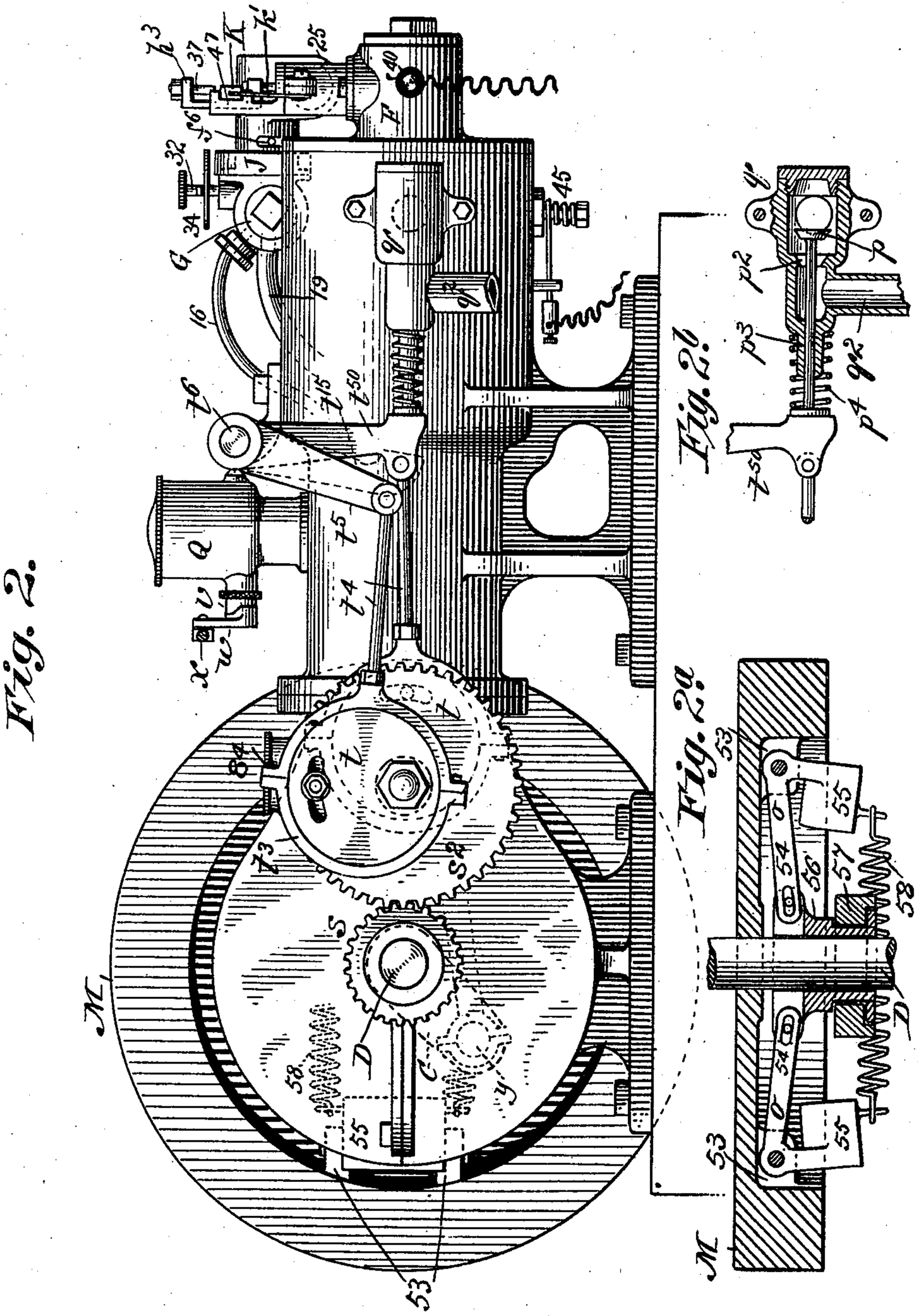

Fig. 2.

Fig. 2b.

Fig. 2a.

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J. F. DURYEA.

ENGINE OR MOTOR.

No. 557,496. Patented Mar. 31, 1896.

Fig. 3.

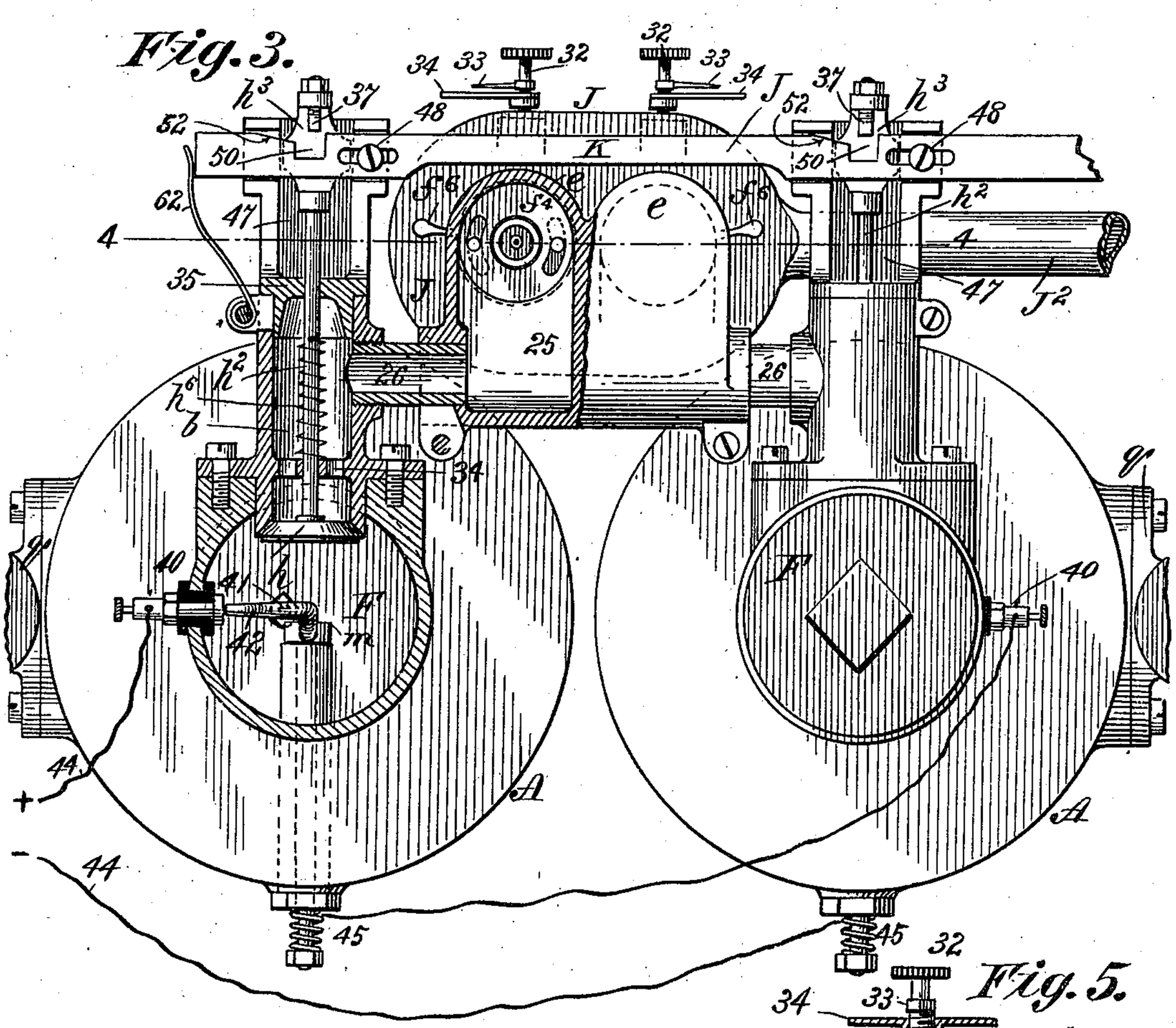

Fig. 4.

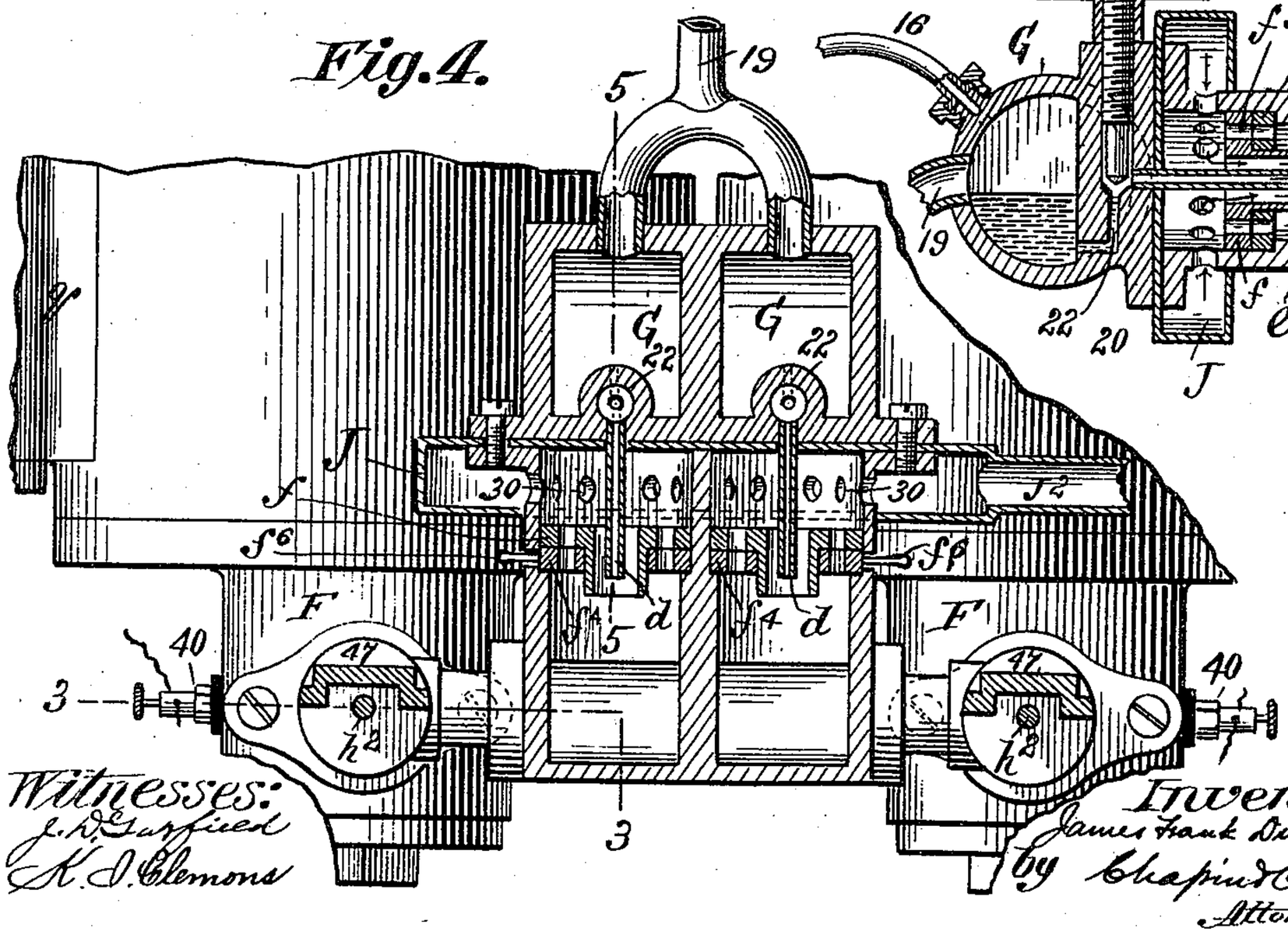

Fig. 5.

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J. F. DURYEA.

ENGINE OR MOTOR.

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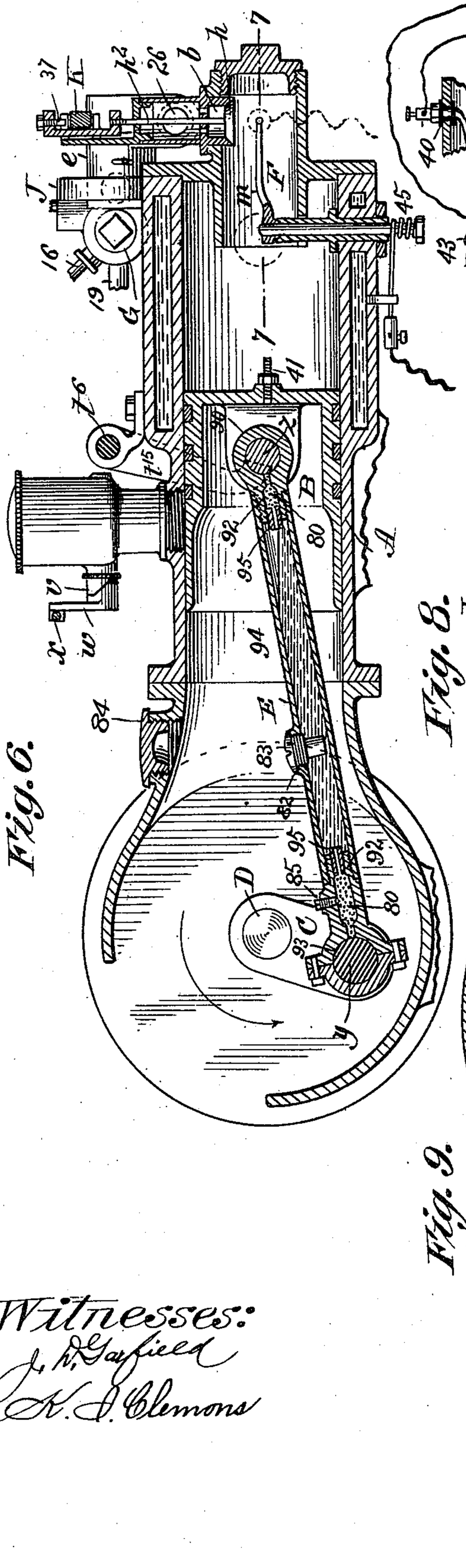

Fig. 6.

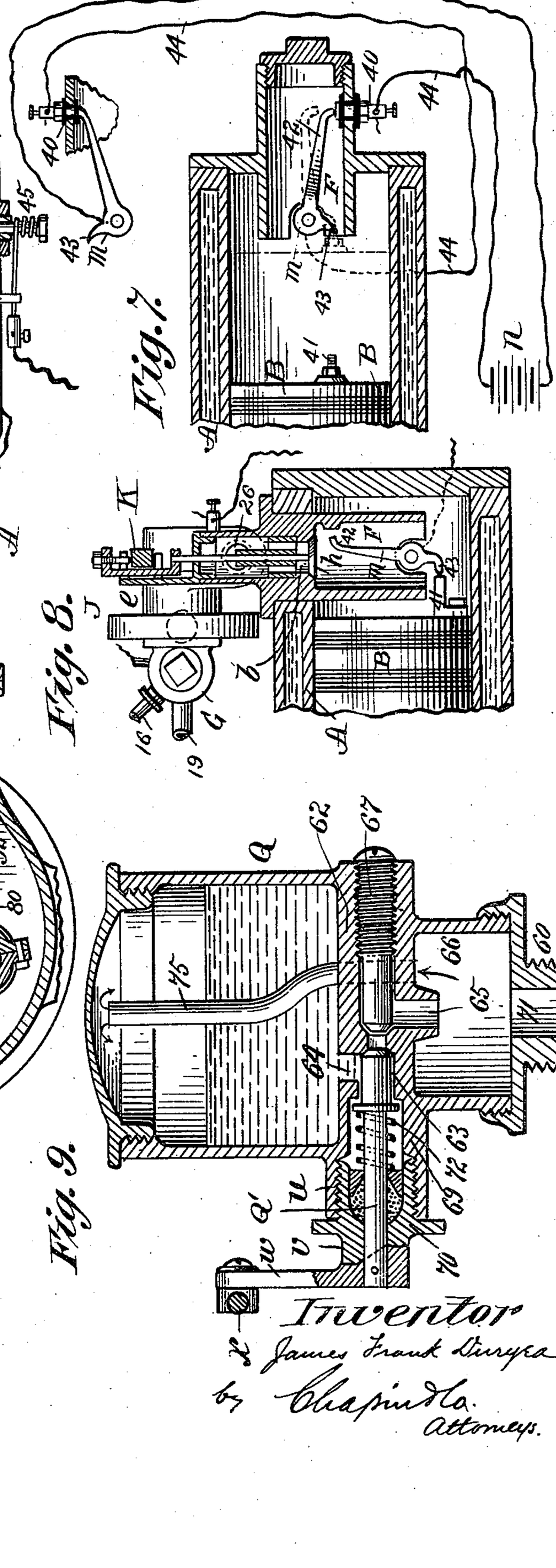

Fig. 7.

Fig. 8.

Fig. 9.

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UNITED STATES PATENT OFFICE.

JAMES FRANK DURYEA, OF SPRINGFIELD, MASSACHUSETTS.

ENGINE OR MOTOR.

SPECIFICATION forming part of Letters Patent No. 557,496, dated March 31, 1896.

Application filed June 7, 1895. Serial No. 552,029. (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 Engines or Motors, of which the following is a specification.

This invention relates to improvements in engines or motors which are driven by an explosive gas—such, for instance, as aerated and vaporized gasolene.

The improved motor is specially devised for the propulsion of road-vehicles, launches, and other conveyances, the special objects to be attained being compactness, lightness, certainty and efficiency in operation, ease of controlling, and the avoidance of cumbersome equipments or accessories.

The invention consists in constructions and combinations of parts, all substantially as will hereinafter fully appear, and be set forth in the claims.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which a double-acting motor is shown, and in the drawings—

Figure 1 is a plan view of the motor. Fig. 2 is a side elevation of the same. Fig. 2^a is a section horizontally through the fly-wheel, the same comprising the governor devices in part. Fig. 2^b is a sectional view through the valved exhaust-outlet for one of the cylinders. Fig. 3 is an end view of the principal parts of the motor, the same being on a larger scale than the preceding figures and showing certain parts, comprising the vapor or gas inlets into one of the cylinders, in vertical sectional view. Fig. 4 is a partial plan taken at one end of the motor and a partial horizontal section. The plane on which the parts are shown in section is indicated by the line 4 4, Fig. 3. The line 3 3 on this Fig. 4 indicates the plane on which the parts in section in Fig. 3 are taken. Fig. 5 is a partial vertical sectional view taken in a plane parallel with the length of one of the cylinders and as indicated by the line 5 5, Fig. 4. Fig. 6 is a longitudinal section taken vertically and centrally through one of the cylinders. Fig. 7 is a partial horizontal section taken on line 7 7, Fig. 6. Fig. 8 is a view in section similar to the right-hand end portion of Fig. 6, but showing a modification of the arrangement of the entrance-chamber for the gas or vapor and of the sparking device. Fig. 9 is a vertical sectional view, on a large scale, of the improved lubricator and showing in a manner connections therewith for automatically shutting it off concurrently with the switching out of the electric sparking-circuit.

This motor, as shown, comprises two cylinders A A, each having a piston B, to and between which and the crank C on the driving-shaft D is secured and interposed the connecting-rod E. The cranks are set at different radial lines to accord with the usual alternating operations of the two pistons, as usual. At the rear end of each cylinder, which is approached by the piston on its backward movement, is an induction-chamber F, which opens freely to communication with the cylinder-chamber back of the piston and which has connection through the valved passage *b* with the service tank or receptacle G for each cylinder, in which is contained the gasolene, there being passages and chambers intermediate between the said service-tank G and the said valved passage *b*, which will be hereinafter particularly described.

The adequate supply of the gasolene is carried in a properly-located storage or supply tank H of suitable capacity, the same being indicated in the plan view Fig. 1, and with this tank the conduits 15 16 have connection, leading thence to the aforesaid service-tank G. The pump indicated at 17, which is automatically operated by the cam 18 on the motor-shaft, serves to force the fluid in sufficient quantities into the service-tank. This pump, in connection with the conduits leading from the supply-tank to the service-tank for the cylinders, is not regarded as an important part of the present invention and is not illustrated in detail or claimed and is regarded as only one of many ways for maintaining a sufficient quantity of the motor fluid in the service-tank. Any of the well-known gravity systems with regulating devices might be substituted with good effect.

19 represents an overflow-pipe having branched connections with each of the service-tanks G and extending therefrom back into the supply-tank II.

The double-chambered service-tank G may be located above the rear ends of the cylinders, and the rear of this service-tank is constituted by the comparatively thick wall 20, (see Fig. 5,) within which is the angular passage 22, leading from a low part of the interior of the service-tank upwardly through and within the thickness of the wall, and with this passage connects the injector-tube *d*, which projects horizontally rearwardly and is surrounded widely by the hollow coating *e*, which constitutes what will be herein termed the "injector-chamber." Said chamber has the depending enlargement 25 at its rear end, with which the pipe 26 leads to the aforesaid vertically-arranged valved passage *b*, which opens into the gas-inlet chamber F at the rear of each cylinder.

The injector-chamber has the partition *f* across it intermediately of its length, the same being provided with the concentric annular extension or thimble f^2, the circular opening entirely through which is of a considerably greater diameter than the exterior of the injector-tube, and said annular extension f^2 projects rearwardly endwise slightly beyond the end of the injector-tube. The said partition has the arc-formed apertures f^3 therethrough, overlaid by which at its rear is the movable register-plate f^4, having apertures therethrough and provided with the handle-arm f^6, which projects through a slot in the side of the injector-chamber casing. The injector-chamber casing forward of the aforesaid partition *f* has the several perforations 30, and this perforated portion of the injector-chamber is somewhat widely surrounded and inclosed by the air-jacket at J, which has an opening leading thereinto for the entrance therewithin of atmospheric air. The air may enter through a pipe J^2, which may have a suitably large mouth, whereby, by being properly directed relative to the travel of the motor, (when the same is used for propelling a vehicle, vessel, or other conveyance,) there may be more or less of a forced draft or inflow of air into the aforesaid air-jacket J.

It will be noted on reference to Figs. 4 and 5 that there will be always a constant facility for passage of air through the central thimble-surrounded opening in the partition through which the injector-tube passes. There may be more or less further flow of air from the forward to the rear portion of the injector-chamber *e*, according as the register f^4 is more or less open.

The amount of oil which may be drawn through the injector-tube will be regulated by the screw-plug 32, which screws vertically down into the tapped hole therefor, which is in a line coincident with the vertical branch of the aforementioned angular passage 22. Each of these valved plugs has a suitable head or knob, whereby it may be conveniently turned, and it also has an index-finger 33 thereon which may register with a fixed scale or graduated plate 34 thereunder or adjacent thereto.

Each valve *h*, which has its seat in the lower end of the aforesaid passage *b*, which is connected with the injector-chamber, is carried by the vertically-arranged valve-stem h^2, which is guided in a suitable apertured spider and head 35 and 36, and has at its upper end a yoke h^3, which at the upper overhanging portion thereof is equipped with the vertically-applied and depending adjustable screw 37 that has a coöperative relation to the bar K, which is comprised in the governor mechanism, and which mechanism will be hereinafter described in its entirety.

The gas and vapors of the gasolene which are with a proportion of air entered in the induction-chambers F F at the rear ends of the cylinders are periodically and alternately exploded by means of electric sparks produced by sparking mechanism, which is illustrated in the drawings and which will be very briefly described as follows, reference being had to Figs. 1, 3, 6, and 7: Within each gas-induction chamber F is entered a metallic contact 40, which is a continuation of the external binding-post, and upon a suitable stud or support located within the chamber F is an angular lever *m*, pivotally mounted and having one arm 42 adapted to rest against the aforesaid contact 40 and having its other arm 43 so located as to be subject to the impingement thereagainst of the screw or other form of projection 41 at the rear end of the piston. The lever and contact 40 are included in a normally-closed circuit, which in Fig. 7 is represented in a conventional way comprising the wires 44 44 and which includes a battery or generator *n*. The spring, applied as seen at 45, Fig. 6, serves to maintain the lever against the contact 40.

In practice the circuit comprises the circuit-breaking lever *m* and contact 40 of two of the cylinders, and the circuit may be rendered suitably continuous by wiring, or, as preferably practiced, by utilizing, in addition to some wires, also metallic parts of the motor—as, for instance, the cylinders, as indicated in Fig. 1—and at L is shown a circuit-breaking device, which includes metallic parts jj^2, to which the circuit-wires 44 are connected, so that when not desired to operate the motor the circuit may be rendered open for an indefinite length of time.

Each piston has its movements in the operation of the motor as follows: Upon the explosion of the gas by the electric spark it has its working stroke and is then returned rearwardly, whereupon the dead or spent gas is exhausted, (the exhaust-valve being by the valve-motion opened therefor;) the piston has a second forward movement as carried by the momentum of the fly-wheel, to which added impulse is given by the other cylinder-piston, and upon this second forward movement of the given piston, by which a vacuum is cre-

ated in the cylinder back of the piston and also in the induction-chamber F for gas, the valve *h* is drawn downwardly open, the vacuum or suction thereby induced drawing inwardly such a quantity of air from within the air-jacket J through the thimble f^2, which is within the ejector-chamber *e*, that a quantity of the gasolene will be from the service-tank G injected through the tube *d*, whereupon it becomes commingled with the air in the injector-chamber and passes into the connected ingress-chamber F, and also into the cylinder-chamber within which the ingress-chamber is, as to all or a portion thereof, located and with which said ingress-chamber has free and open communication. The piston again rearwardly returning compresses the gas which is in the chambers behind it and which is now in readiness to be exploded, and just as the piston reaches its rearmost extent the projection 41, by contacting with the arm 43 of the circuit-breaking lever *m*, so swings such lever as to carry its extremity 42 away from the contact 40, the spark following the said extremity 42, as well known in electric spark-producing devices, whereupon the piston will again have its stroke as impelled by the exploding gas. Thus briefly summarizing the movements of the piston in each cylinder there is, first, the forward stroke on the explosion of the gas; secondly, return of the piston and exhaust of the dead gas; thirdly, another forward movement of the piston drawing in the vaporized gasolene and commingled air, and, fourthly, the return of the piston compressing the gas and air, and, finally, causing the spark and explosion for the next stroke.

The valve *h* has a spring h^6 applied thereto for normally maintaining it closed at all times, except when the piston has its forward motion between the working strokes on explosions, which are the times when the valve should be allowed to open for the ingress of the motor fluid. The valve is opened against its spring by the vacuum or suction within the cylinder when the latter moves forward between each working stroke.

The governor hereinbefore referred to and comprising in part the bar K will be now more fully described. The said bar K is guided to move horizontally on the ways of the bracket-supports 47 therefor and has the pin-and-slot engagements with the said bracket, as seen at 48. This bar operates in common relative to both of the yokes h^3 of the valve-stems, which are provided at the back of each cylinder, and has beneath the screw 37, which is adjustable on each of the yokes, the recess 50, at the left of which the upper edge of the bar K is inclined, as seen at 52.

The fly-wheel M, which is cored out suitably, has pivoted to the ear-lugs 53 thereof the angular levers *o*, having the arms 54 and 55, the latter being weighted, while the arms 54 have pin-and-slot engagements with the sleeve 56, which rotates with the motor-shaft D and which slides along the same. Said sleeve 56 is suitably grooved and is surrounded by the collar 57, which partakes of the sliding movement of the sleeve, but not of its rotary movement. The opposite weighted arms 55 are connected by the spiral spring 58.

The long lever 59, which is intermediately pivoted, has a pin-and-slot connection with the aforesaid collar 57, and its rear end has an engagement with the aforesaid governor-bar K, whereby upon the sliding movement of the collar, as induced by variations in the speed of the motor and the consequent centrifugal operation of the governor, the said governor-bar K will have such an endwise movement as to bring its inclined portions 52 under the screw 37 of the valve-stem yoke, whereby upon excessive speed, which induces a more considerable endwise movement to the bar K, the inclined portion 52 will have a position to limit, in degree, the downward movement of the valve-stems and the extent of opening of the valves *h*.

The sensitiveness of the governor is regulated by applying the springs *k* and *k'* for pressing longitudinally upon the bar K, at opposite ends thereof, and providing means for varying the compression of one or both of the springs, and in Fig. 1 the spring *k* is shown as applied between the extremity of the lever 59 and a button k^2 at the end of the rod k^3, which rod is adjustable longitudinally coincident with the length of the said bar K and of the spring *k*. By this means a greater or less resistance may be imposed against the force generated by the governor-levers against their spring 58 at the fly-wheel, so that the motor may be adjusted to be governed for a high or comparatively low maximum speed.

The exhaust mechanism is constructed and arranged so as to open the exhaust-port on the return of the piston next after each working stroke thereof, and therefore as the cylinder is to be exhausted only once to every two reciprocations of the piston a special mechanism for this purpose is provided for operating the exhaust-valve *p*, which has its seat at p^2 within the casing inclosing the exhaust-chamber *q* at a rear lateral part of each cylinder. The exhaust-chamber is, when the valve *p* is open, in communication with the pipe or passage q^2, which leads and opens to or into any desired place or receptacle.

At one side of the motor, upon one end of the motor-shaft D, is a spur gear-wheel *s*, which meshes into a second spur gear-wheel s^2 of double the diameter, and which is mounted on a suitable stud or arbor supported upon a bracket at the side of the motor. Rotating in unison with this gear s^2 are two eccentrics *t t*, which are set at quarters, as seen in Fig. 2. Each eccentric is surrounded by an eccentric-strap t^3, which has as the radial continuation thereof the eccentric-rod t^4. One of

these eccentric-rods t^4 connects with the depending lever t^5, which is fast upon the transverse horizontal rock-shaft t^6, while the other eccentric-rod t^4 is connected with a lever t^{50}, which depends from its loose encircling support upon the rock-shaft, and this depending lever t^{50} has its lower end in pressure-contact against the outer end of the valve-stem p^3 of the exhaust-valve p. Each exhaust-valve has a spring p^4, which normally maintains it closed. The said rock-shaft t^6, which extends crosswise of and above the motor, has at its other end, which is at the side of the motor opposite from that at which are located the two eccentric-straps and the gearing therefor, the fixed depending lever-arm t^{15}, which has the same manner of engagement with the spring-pressed valve-stem at the farther side of the motor, as has already been described for the valve-stem t^4 at the near side. Each of the eccentric disks t, which is eccentrically of its own center mounted upon the arbor or axis of the gear-wheel s^2 to rotate as one with such wheel, has concentrically of its point of support the arc-formed slot r, through which projects a screw-stud r^2, which is mounted at a suitable place off from the center of the gear-wheel s^2, and which stud receives the confining-nut r^3. In order that the time of the exhaust of both of the cylinders may be properly accomplished, the one relative to the other and each with proper relation to the instant of the working stroke of the piston, the eccentrics may be by the provision of the stud-and-slot mode of connection with the gear-wheel s^2 (with which under running conditions they are as fixed parts) properly adjusted.

Q Q represent lubricators for the pistons, they being mounted at the tops of the cylinders by having their lower externally-screw-threaded hubs 60 screwed within tapped holes therefor in the tops of the cylinders. Each lubricator is of a construction shown in the sectional view, Fig. 9—that is to say, it has a false bottom or partition 62, within which is the horizontal passage 63, extended diametrically of the lubricator-body and within the thickness of the said false bottom. This passage has leading from the oil-chamber above the partition the duct 64, which extends to the passage 63, while in an offset vertical line from the axis of the passage 64 is the passage 65, which leads downwardly through the lower half of the thickness of the partition 62, forming a communication from the horizontal passage 63 into the subchamber 66. The screw-plug 67 may entirely, or more or less nearly, close the communication between the intermediate part of the horizontal passage 63 and the passage 65.

u represents a shaft, which extends axially through the half of the horizontal passage 63, opposite the screw-plug 67. The lubricator-case is provided with the radially-extended boss 69, which is hollow and adapted to receive the stuffing-box 70 and to contain the spring 72, which exerts an inwardly-forcing pressure upon the said shaft u, which is suitably shouldered to provide a rest for the one end of the spring. The end of the stuffing-box, which is to be continued as a part of the lubricator-body, is formed with the end-faced cam v, while the hub of the lever-arm w, which is affixed to the shaft, is also constructed to conform to the cam-formed end contour of the stuffing-box.

The levers w, applied to the shaft Q of both of the lubricators, have a connection with the common bar x, which, in the arrangement shown in Fig. 1, forms part of the circuit-breaker, which bar is connected to one of the contact parts of the circuit-breaking device hereinbefore referred to, as indicated at L. Therefore at the time the motor is to be stopped, when the motorman will operate the circuit-breaker L to leave the circuit open, he will also, without purposely so doing, but necessarily, effect the swinging of the levers $w\ w$ in such a way as to allow, by the arrangement of the cam-faces, the inner ends of the shafts u to close the communication between the passage 64 and the passage 63, so that no oil may unnecessarily run down into the cylinder. Of course it is understood that the reversed action of the circuit-breaker will correspondingly reverse the swinging movements of the levers $w\ w$, whereupon they will be cammed outwardly, opening the passage-way for oil.

The oil is not maintained in the lubricator-chambers fully to the top thereof, and there is a pipe 75, which has its lower end set within or connected at a hole through the horizontal partition or false bottom 62, so that there is communication between the space above the oil in the main chamber of the lubricator and the subchamber.

At each time when the piston passes so far rearwardly as to uncover the opening 71 in the lower end of the lubricator the oil may drip or flow into the cylinder, while of course at other times there may be a certain amount of oil supplied upon the periphery of the piston. The pipe 75 provides for a full atmospheric pressure above the oil when the piston uncovers the opening 71, whereupon the downflow of oil is the better assured. The subchamber 66 provides that there will be a sufficient volume of air for the establishment, periodically, of the atmospheric pressure and without interfering with or being interfered by the outflowing oil.

The position of the lubricator is such relative to the stroke of the piston that passage 71 is never open to communication with the cylinder-chamber to the rear of the piston, and therefore no gas may ever pass into the lubricator.

The crank and piston pins y and z, to which the connecting-rod E has its connection by strap or eye engagement, are lubricated by means which will be now described, reference

being had to Fig. 6. The piston-rod E is tubular, the passage or chamber therein being of reduced size at its ends, and in these reduced end passages, which lead to the internal wall of the strap or eye which surrounds the crank or piston pin, is a quantity of absorbent fibrous compressible material, which is indicated at 80. The tubular piston-rod is intermediately, at its upper side, provided with the hole 82, which is closed by the screw cap or plug 83. This is accessible through the opening at 84 in the apron of the motor for the entrance of oil into the hollow piston-rod. The oil will slowly ooze through the compressible absorbent material 80 and be conveyed upon the crank-pin and the cylinder-pin. At the left-hand end of the piston-rod, as shown in Fig. 6, a screw-plug 85 is shown as laterally entering the chamber in which is contained the absorbent material, which may be turned inwardly, so as to cause the oil-saturated compressible material therein to be crowded by displacement against the crank-pin. As shown, this piston-rod is made sectional, the same comprising parts as follows: At the right-hand end the eye-section 90 has the longitudinally-bored and externally-screw-threaded stem 92. The strap at the other end is similarly constructed, with the exception that it is made in the form of a two-part strap 93, united by bolts to embrace the crank-pin. The intermediate part 94 of the connecting-rod is in the form of a tube, with the opening therethrough of considerable size, and having its ends internally screw-tapped to engage the externally-threaded stems 92 of the sections 90 and 93. The orifice of each of the stems 92 is also internally screw-tapped to receive the externally-threaded axially-bored nipples 95, which produce the contraction of the passage or chamber adjacent the ends of the piston-rod and which may be turned at the time of setting up or overhauling the motor to the proper crowding action against the oil-absorbing material in the hollow end sections.

In Fig. 8 a slightly different specific construction of the gas-induction chamber F is shown, the same in this case entering the end portion of the cylinder transversely of the length of the latter, its lower open end not extending so far down as the bottom of the cylinder-chamber. The sparking device in this case is located at a point which at the time of producing the spark will be fully surrounded or flushed by fresh gasolene vapor. The provision, in all cases, of the induction-chamber, within or adjacent which is the sparking device, always insures a good and fresh supply of the explosive vapor or gas at and surrounding the point at which the spark is produced, and obviates any possibility or failure to explode or to completely utilize in the explosion all of the effective explosive gas or vapor by reason of any dead carbonic-acid gas which might remain in the cylinder after the preceding stroke.

In starting up the motor the switch L is moved to close the electric circuit, and the motor-shaft is rotated by hand-power, turning the fly-wheel M or applying a crank at the squared end 95 of the motor-shaft D, whereupon the movements to the pistons will be in this way imparted, causing the injection of the gas into the cylinders and the sparking and explosion thereof. After a few turns have been thus given to the motor-shaft the motor will continue to be run by the successive explosions of the motor fluid so long as the gasolene supply is maintained and the current continues through the sparking-circuit.

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

1. In a motor, in combination, a piston-cylinder, an injector-chamber and a valved passage communicating therefrom with the cylinder, a service-tank and an injector-tube communicating therewith and extending rearwardly into the injector-chamber, a partition which transversely divides the injector-chamber and which has the longitudinally-passaged thimble extension widely surrounding the injector-tube, an air-chamber having communication with the rear compartment of the injector-chamber, and means for periodically igniting the motor fluid which is entered at the rear of the piston, substantially as described.

2. In a motor, in combination, a piston-cylinder, an injector-chamber having a valved passage communicating with the cylinder, a service-tank, and an injector-tube communicating therewith and extending rearwardly into the injector-chamber, a partition which transversely divides the injector-chamber which has the longitudinally-passaged thimble of greater diameter than the injector-tube which it surrounds, and which partition has the perforations, f^3, f^3, the apertured register-plate, f^4, overlying the perforated partition, and means for moving it, an air-chamber having communication with the rear compartment of the injector-chamber, and means for periodically igniting the motor fluid at the rear of the piston, substantially as described.

3. In a gasolene or analogous motor, in combination, the service-tank, G, having the passage, 22, leading from a lower portion of its interior upwardly and rearwardly therefrom, the injector-tube connecting with said passage, the injector-chamber, *e*, inclosing the injector-tube and having the thimble inclosed therein which widely surrounds the tube, and which has its rear end in communication with atmospheric air, the cylinder, and piston therein, and connecting ways leading from the injector-chamber to the rear part of the cylinder-chamber, substantially as described.

4. In a gasolene or analogous motor, in combination, the service-tank, G, having the passage, 22, leading from a lower portion of its interior upwardly and rearwardly therefrom,

and the screw-plug for regulating the said passage, the injector-tube connecting with said passage, the injector-chamber, *e*, inclosing the injector-tube and having the thimble inclosed therein which widely surrounds the tube, and which has its rear end in communication with atmospheric air, the cylinder, and piston therein, and connecting ways leading from the injector-chamber to the rear part of the cylinder-chamber, substantially as described.

5. In a gasolene, or analogous motor, the combination with the service-tank, G, having the passage, 22, leading from a lower portion of its interior upwardly and rearwardly therefrom, the inlet oil-supplying pipe leading into an upper part of the service-tank and the overflow-pipe, 19, leading from an intermediate point in the height of the tank, the injector-tube connecting with said passage, the injector-chamber, *e*, inclosing the injector-tube and having the thimble inclosed therein which widely surrounds the tube, and which has its rear end in communication with atmospheric air, the cylinder and piston therein and connecting ways leading from the injector-chamber to the rear part of the cylinder-chamber, substantially as described.

6. In combination, in a gasolene-motor, a cylinder having the induction-chamber; F, opening thereinto at the rear of the cylinder-piston, a service-tank, an injector comprising a tube connecting with the tank, and an air-tube having a communication at a rear portion thereof with a source of air supply, surrounding the injector-tube and a chamber into which both of said tubes forwardly enter, the passage, *b*, leading upwardly from the induction-chamber, F, and having the check-valve, *h*, downwardly opening, provided therefor and the passage, 26, connecting the injector-chamber with said valved passage, *b*, and a spark-producing apparatus located within the said chamber, F, comprising a circuit-breaker adapted to be moved open mechanically by the piston upon its rearward movement and also comprising electrical conductors and a generator, substantially as described.

7. In a gas-engine, the combination with the passage or conduit, *b*, leading to the chamber in the cylinder back of the piston having the valve, *h*, therefor and the valve-stem provided at its top with the yoke, h^3, on which is the abutment, 37, of the bar, K, which is movable transversely of the valve-stem and having the recess, 50, and its upper edge adjacent the recess inclined, together with a speed-governor actuated concurrently with the running of the motor and having a connection with said bar for moving it variably proportionate to the developed speed of the motor, substantially as and for the purposes set forth.

8. In a motor, the combination with the induction-passage, *b*, and valve, *h*, therefor having the valve-stem provided with an abutment member, of the bar, K, which is movable transversely of the length of the valve-stem and which has the recess, 50, and the inclined edge, 52, adjacent the recess; the fly-wheel on the motor-shaft having mounted thereon the centrifugal-governor arms, and a sliding collar actuated thereby; and a lever, 59, deriving movement from said sliding collar and correspondingly imparting movement to the said bar, K, substantially as described.

9. In a motor of the character described, the combination with the pair of cylinders and exhaust-passages for each arranged at opposite sides of the rear end of the cylinders having valves respectively therefor with projecting valve-stems and springs applied for maintaining the said stems normally extended and the valves closed, the gear-wheel, *s*, on the motor-shaft, and the gear-wheel, s^2, of twice its diameter meshing with said gear, *s*, and having secured thereto to move in unison therewith, the eccentrics, *tt*, one arranged to revolve in advance of the other, the rock-shaft, t^6, having the depending fixed lever-arms, t^5 and t^{15}, and the lever-arm, t^{50}, loosely hung thereon, the eccentric-straps, and the eccentric-rods connected to the arms, t^5 and t^{50}, the said arms, t^{50} and t^{15}, having engagements with the said exhaust-valve stems, substantially as described.

10. In a motor of the character described, the combination with the pair of cylinders and an exhaust-passage for each having valves and springs applied for maintaining them normally closed, of the gear-wheel, *s*, on the motor-shaft and the gear-wheel, s^2, which is of double the diameter of said gear, *s*, in mesh therewith and having the two eccentrics mounted revolubly thereon and each provided with an arc-formed slot, *r*, the bolt or studs mounted upon the said gear-wheel and protruding through the said slots in the eccentrics and having the nuts, r^3, all whereby the eccentrics may be adjusted relative to each other and with relation to the crank-shaft, substantially as described.

11. In a motor of the character described, the combination with cylinders and pistons and provisions for introducing an explosive gas into the cylinder-chamber behind the piston, of a circuit having a circuit-breaking spark-producing device located in the gas-chamber at the rear of the piston and a switch for opening the circuit independently of said spark-producing device, lubricators for oiling the cylinders having valves or plugs movably arranged for closing its outlet and a connection between said valves and the switch whereby when the switch is closed the lubricator-valves will be opened and vice versa, substantially as described.

12. In a motor of the character described, the combination with the circuit which comprises the circuit-breaking, spark-producing device, and a switch for independently opening the circuit, the same comprising the bar, *x*, of the lubricators having egress-passages

and each with a shaft, Q′, provided with a spring for forcing it closed and each shaft having a lever-arm, *w*, to which said bar, *x*, is connected, and a cam, *v*, which so coöperates with the hubs of the arms, *w*, as the latter are swung, as to cause, in conjunction with their swinging movements, also outward movements thereof in the direction of the axis of the shaft, substantially as and for the purpose set forth.

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