(No Model.)

5 Sheets—Sheet 1.

J. J. R. HUMES.

HYDROCARBON VAPOR ENGINE.

No. 350,200.

Patented Oct. 5, 1886.

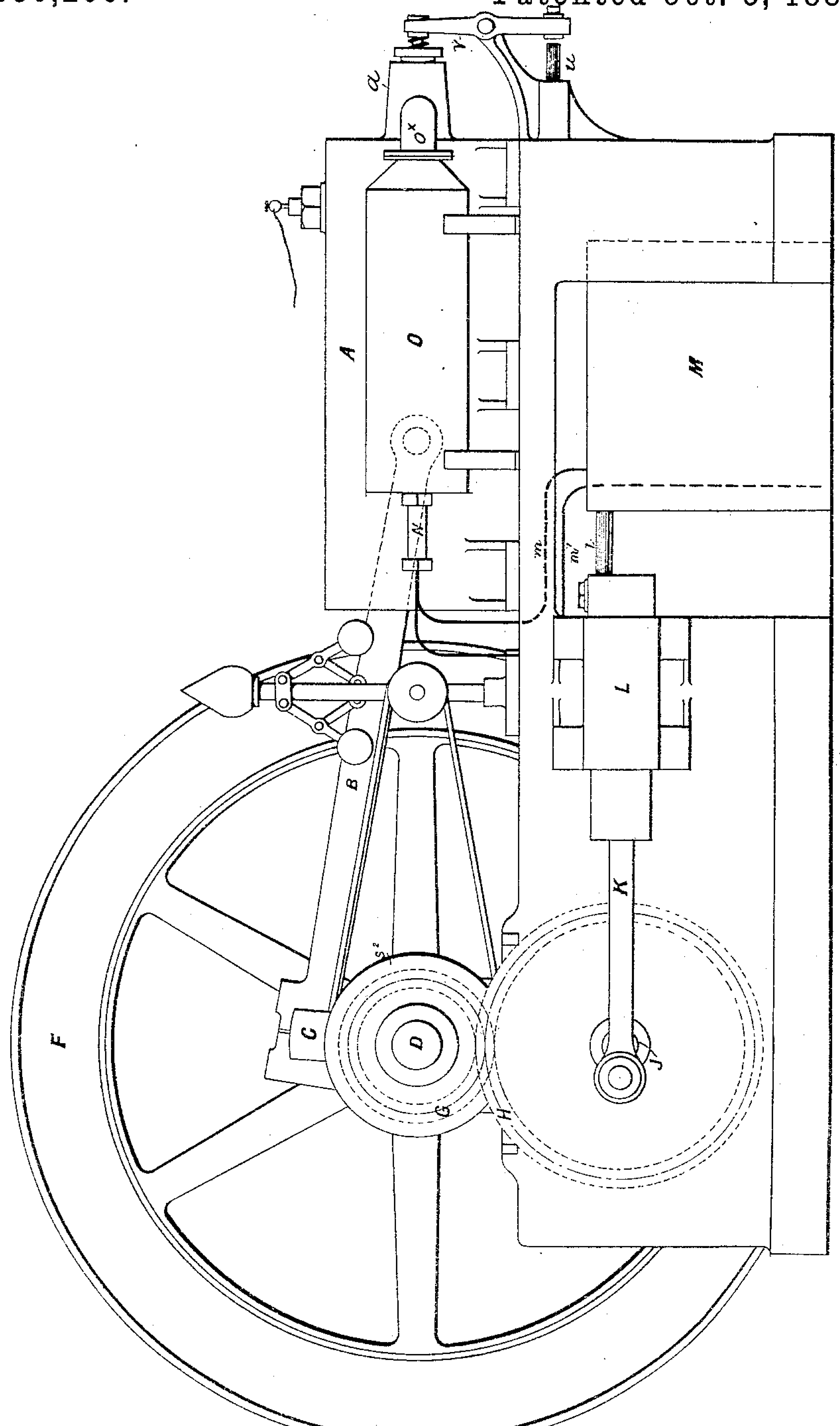

FIG. 1.

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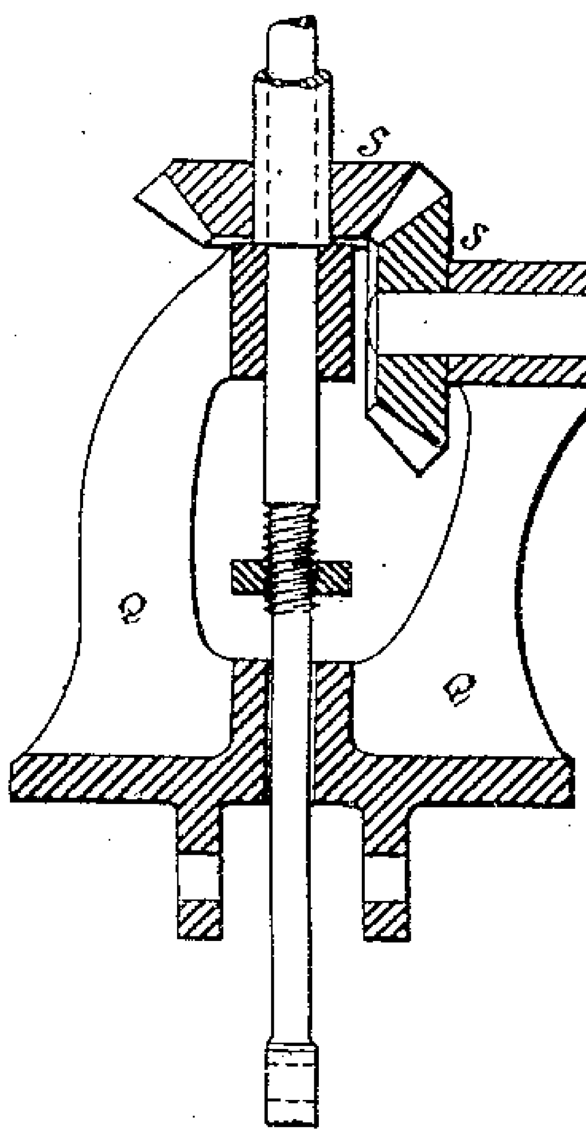

FIG. 7.

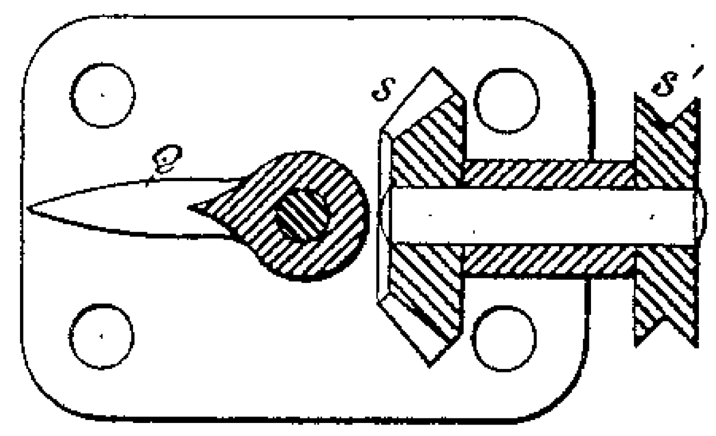

FIG. 8.

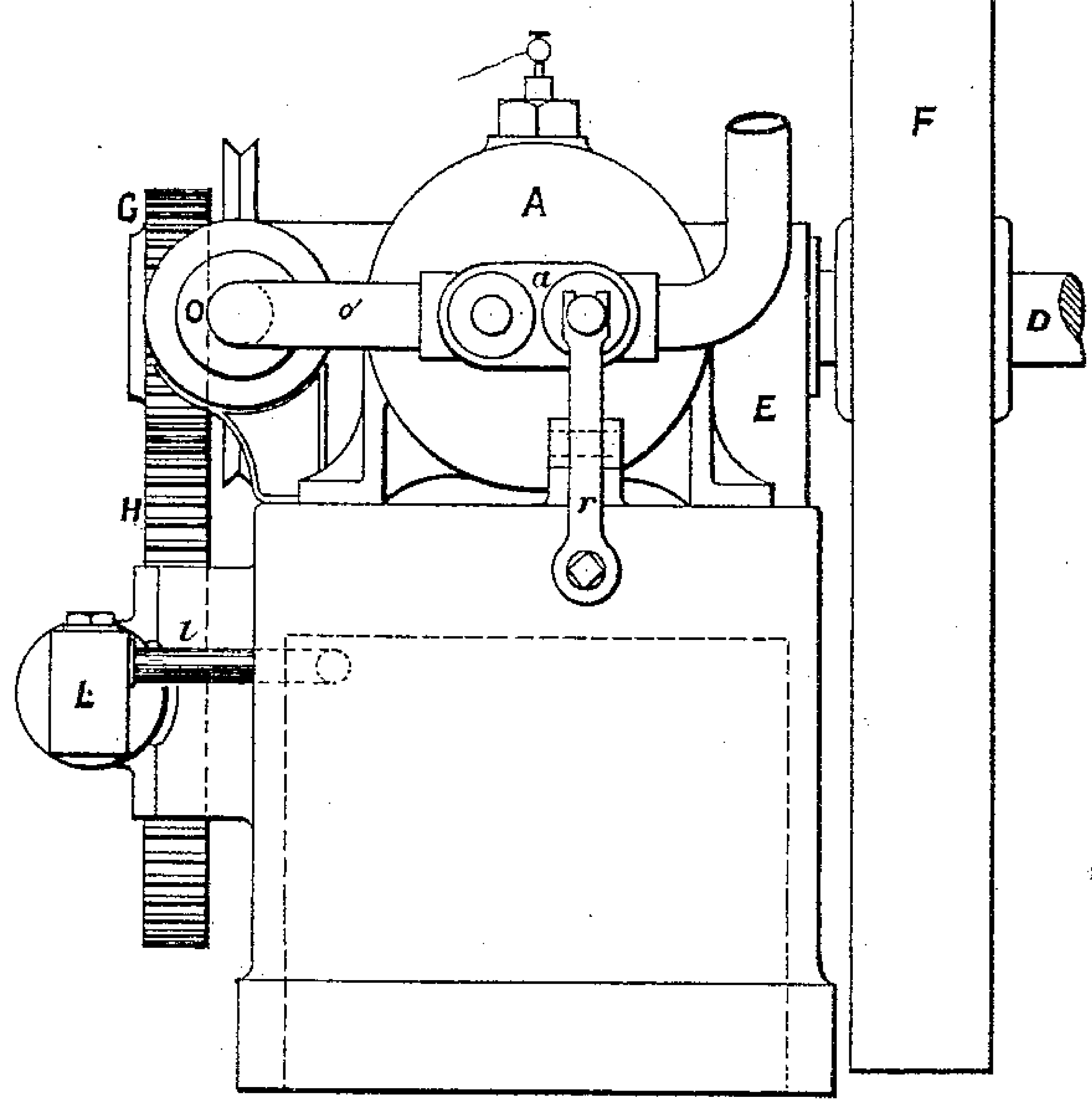

FIG. 2.

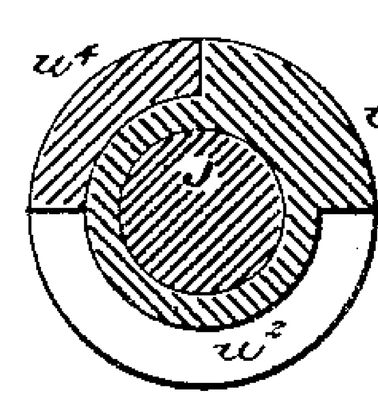

FIG. 12.

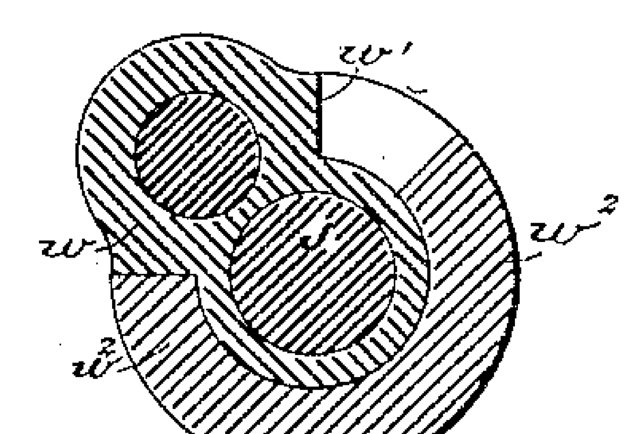

FIG. 13.

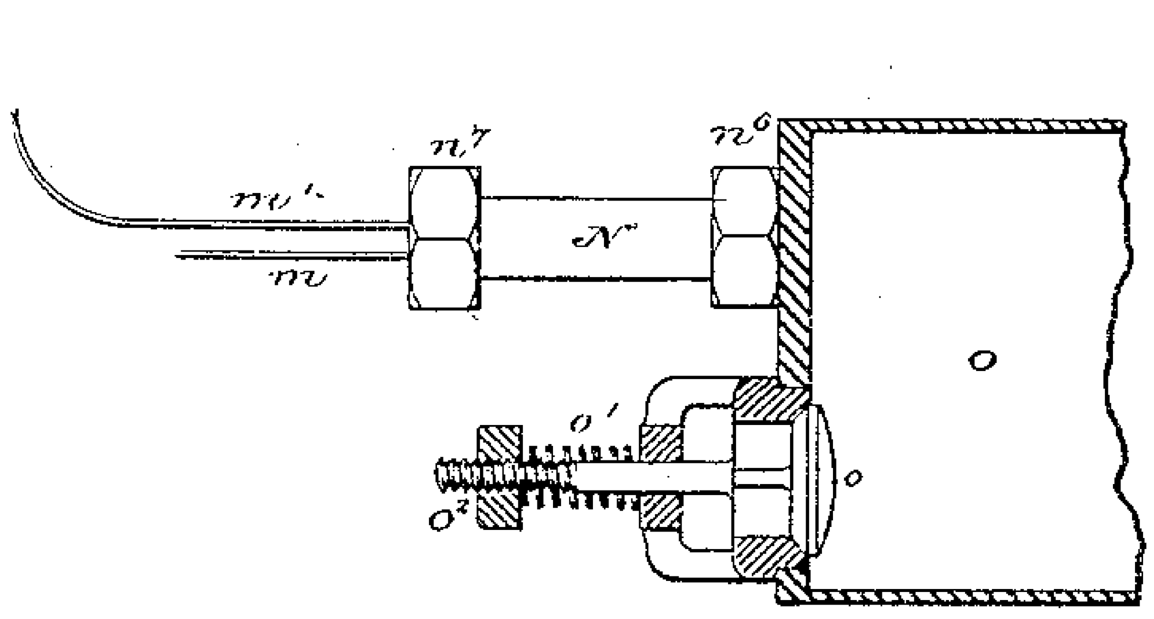

FIG. 9.

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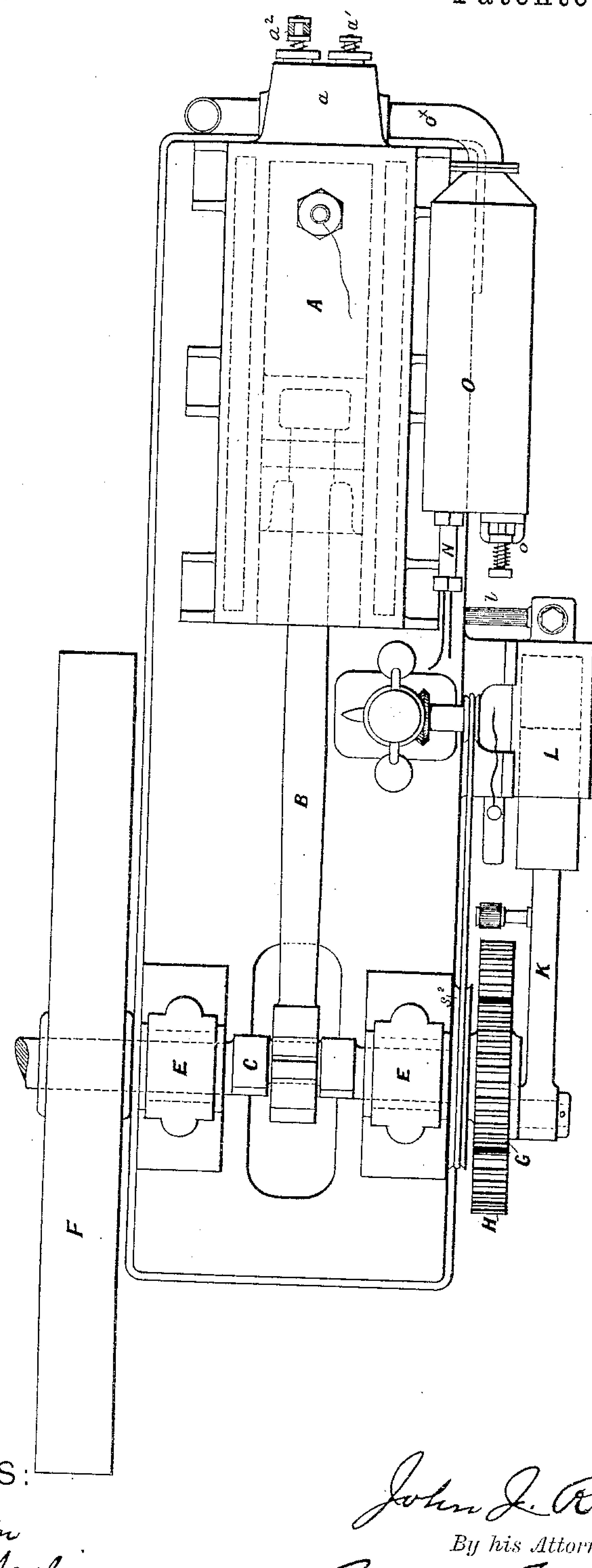

FIG. 3.

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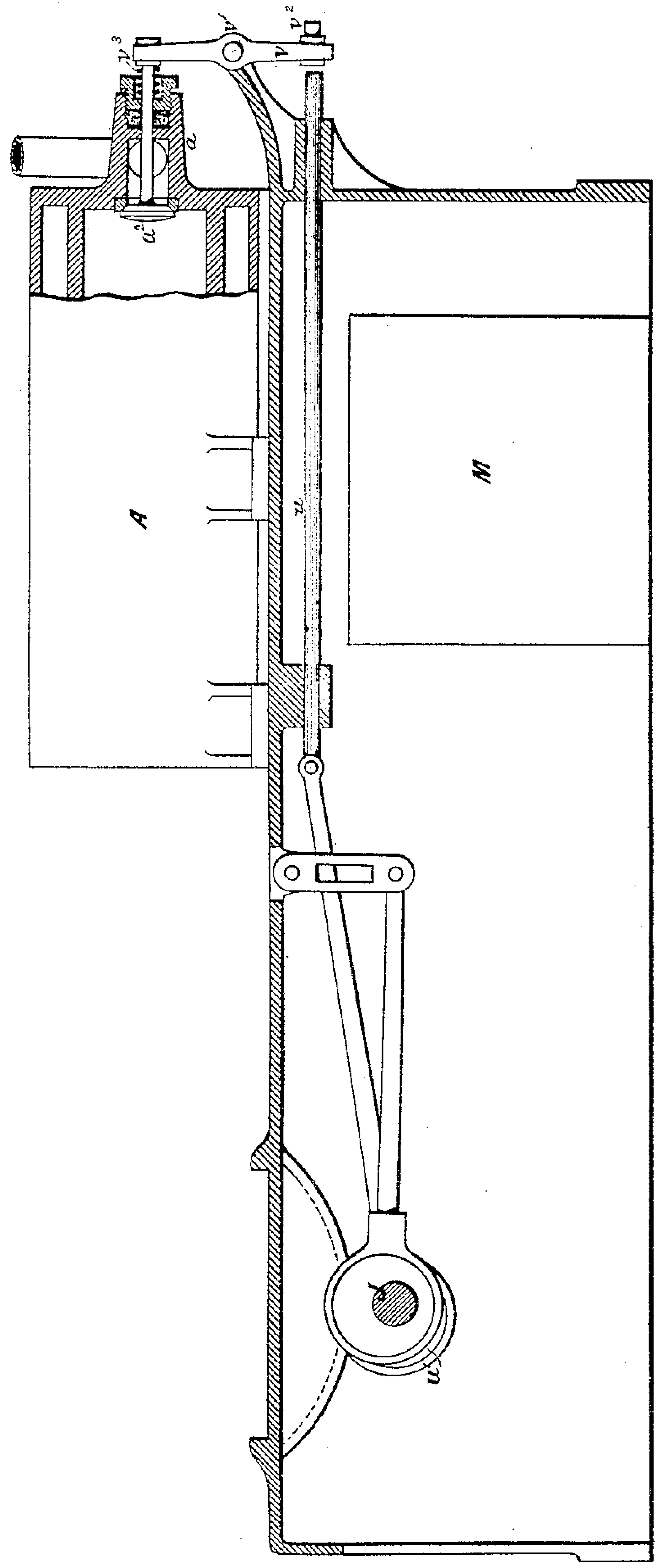

FIG. 10.

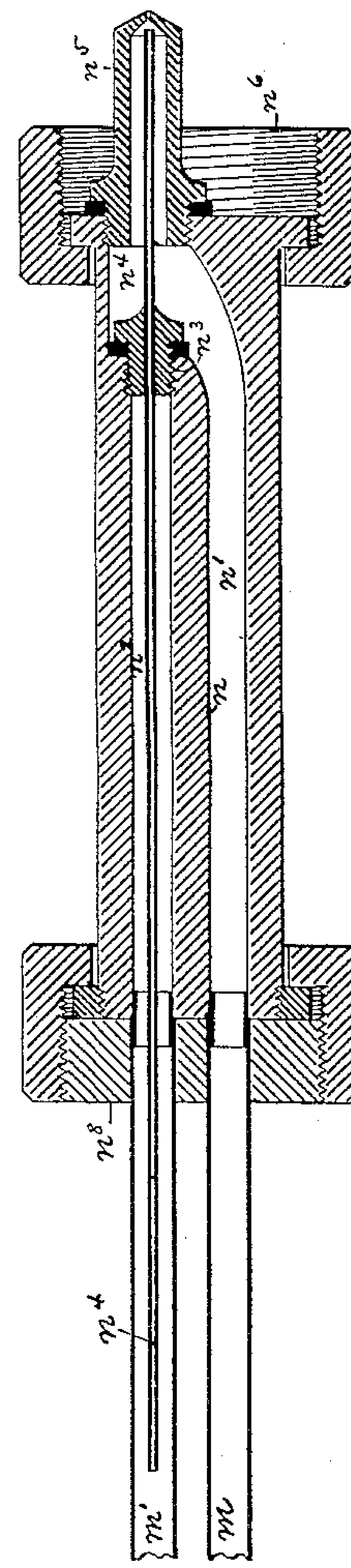

FIG. 4.

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N. PETERS. Photo-Lithographer, Washington, D. C.

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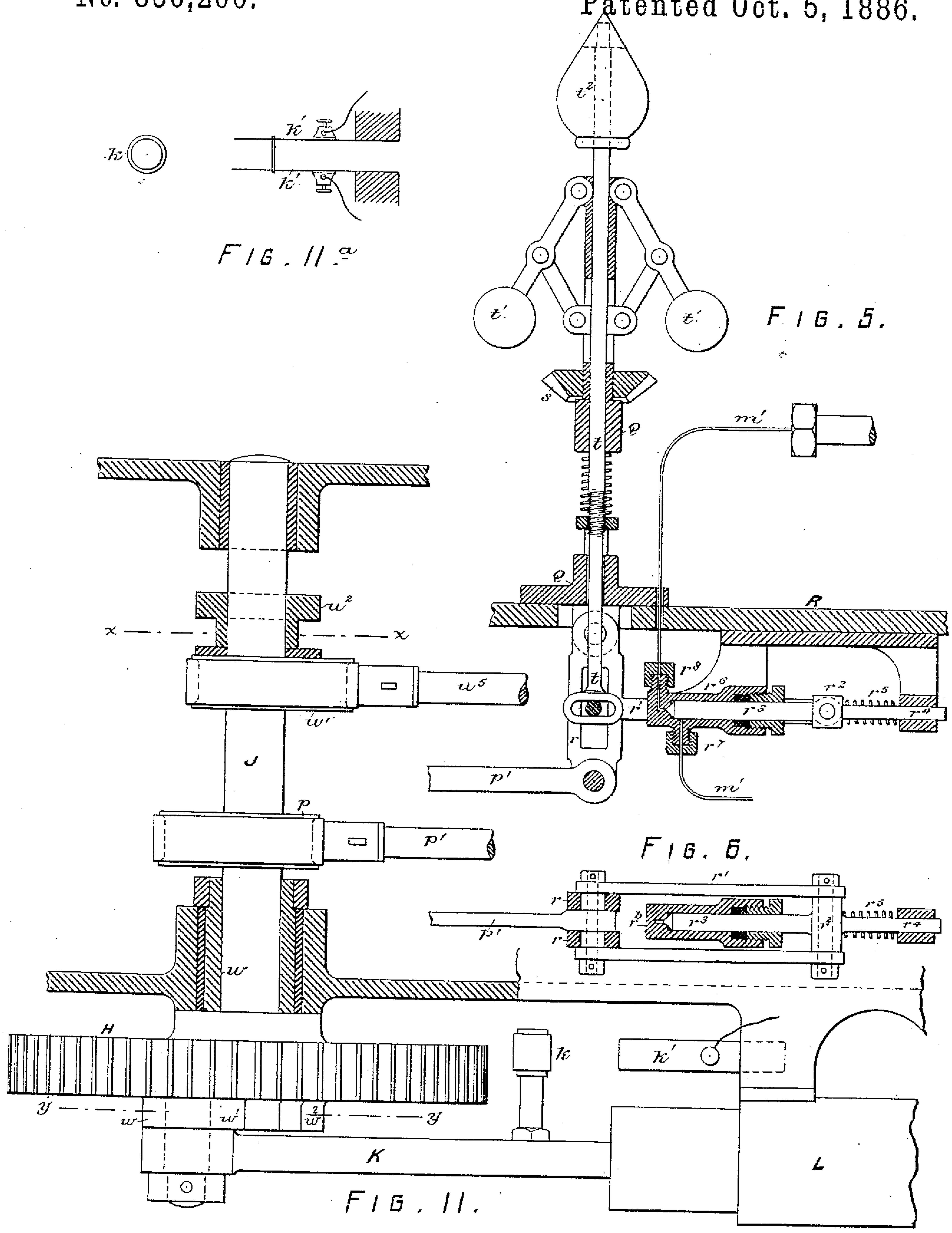

FIG. 11.a FIG. 5. FIG. 6. FIG. 11.

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UNITED STATES PATENT OFFICE.

JOHN JOSEPH REVELEY HUMES, OF CAMBERWELL, COUNTY OF SURREY, ENGLAND.

HYDROCARBON-VAPOR ENGINE.

SPECIFICATION forming part of Letters Patent No. 350,200, dated October 5, 1886.

Application filed May 8, 1886. Serial No. 201,612. (No model.) Patented in England July 11, 1885, No. 8,411.

To all whom it may concern:

Be it known that I, JOHN JOSEPH REVELEY HUMES, a subject of the Queen of Great Britain and Ireland, residing at Camberwell, in the county of Surrey, England, have invented new and useful Improvements in or Applicable to Hydrocarbon-Vapor Engines, (for which I have applied for Letters Patent in Great Britain, No. 8,411, bearing date July 11, 1885,) of which the following is a specification.

This invention relates to motor-engines operated by the combustion of liquid hydrocarbon—such, for example, as benzoline—and has special reference to means for mixing the liquid with air or other gas to form the combustible charge, and to means for automatically and otherwise varying the relative proportions between the said fluids composing the mixture.

The invention further relates to means for igniting the charges in effecting the working of the engine, and to means for rendering such engines reversible.

A motor-engine embodying my improvements is represented in the accompanying drawings, whereof Figures 1 and 2 are side and end elevations, respectively, and Fig. 3 a plan view. Figs. 4, 5, 6, 7, 8, 9, 10, 11, 11^a, 12, and 13 are illustrative detail views, that will be referred to hereinafter.

A is the motor-cylinder, which, by preference, is water-jacketed, with a view to preventing its becoming too greatly heated by the combustion of the gases which takes place in its interior, as hereinafter described. The cylinder is fitted with a piston, which is connected by means of the rod B to the crank C of the crank-shaft D. The latter is carried in bearings E E, and is provided with a fly-wheel, F. Upon the crank-shaft D is secured a spur-pinion, G, which, through the intervention of a spur-wheel, H, drives the shaft J at half the speed of the crank-shaft D. The outer face of the spur-wheel H is furnished eccentrically with a pin, from which, by means of the rod K, a pump, L, is operated. This pump is employed to compress air, which is conveyed by the pipe *l* to a tank, M, which may be conveniently arranged within the engine bed-plate, and which serves as a reservoir for the hydrocarbon liquid, assumed, in the present instance, to consist of benzoline. The air in the upper part of the tank M and the benzoline in the lower portion thereof are, under these circumstances, subjected to practically the same pressure per unit of area. Air passes from the tank M by way of a pipe, *m*, to a vaporizer or mixing apparatus, N, the construction of which will be more fully explained hereinafter with reference to Fig. 4. The benzoline passes from the tank M by way of a pipe, *m'*, which reaches nearly to the bottom of the liquid, and also communicates with the vaporizer N. To this pipe may be applied apparatus for controlling or regulating the flow of the benzoline, as hereinafter more fully explained with reference to Figs. 5 to 8. The air and benzoline issuing from the mixing apparatus N are received in a vapor-chamber, O, to which an additional quantity of air is admitted by the valve *o*, as illustrated in the enlarged view, Fig. 9. The inflammable mixture passes thence by the pipe $o^{\times}$ to the valve-chamber *a* of the motor-cylinder A. In this valve-chamber are arranged a self-acting inlet-valve, *a'*, and an exhaust-valve, a^2, the latter being arranged and operated as hereinafter more fully described with reference to Fig. 10. The motor-cylinder A is also provided with means whereby the inflammable charge may be ignited. In the present instance it is assumed that the agency of electricity is employed for this purpose. If it be desired to render the direction of rotation reversible, I employ means such as hereinafter described with special reference to Figs. 11 to 13.

The type of engine employed in the present illustration for the purpose of explaining the application of my improvements is single-acting, and of the class in which the motor-cylinder is also used for compressing the inflammable charge previous to its ignition, as proposed by Beau de Rochas, A. D. 1862. According to this system of working, the piston at one outstroke draws a charge of combustible fluid into the cylinder, and on its return-stroke compresses the charge into the clearance-space existing between the piston and the cylinder end. The charge being thereupon ignited, the piston is propelled during its next outstroke by the expansion of the heated gases. The exhaust-valve is then opened and the expanded gases liberated, the greater portion of these being swept out of the cylinder during the next return-stroke of the piston. It should nevertheless be understood that my improvements are applicable to liquid-hydrocarbon engines, constructed with separate compressor and motor cylinders, and wherein the crank receives an impulse at each revolution, or two impulses during the same period if the engine be double-acting.

For mixing benzoline or other liquid hydrocarbon with air or other gas capable of supporting combustion, and thus producing an explosive or inflammable compound consisting of gas permeated with liquid as distinguished from a purely gaseous compound, I employ apparatus previously referred to as the vaporizer N, but which is represented in detail and to an enlarged scale in the longitudinal section, Fig. 4. This device consists of a body, n, traversed by two longitudinal passages, n' n^2, of which n' extends the whole length of the body, and serves to convey air arriving from the benzoline-tank M, while the other passage, n^2, stops short of the extremity of the body and terminates in a screwed socket, n^3, in which is mounted a small tube, n^4, extending in one direction through the passage n^2 to the liquid flowing from the benzoline-tank, and projecting in the opposite direction into a removable nozzle, n^5, the inner end of which is in communication with the air-passage n'. The projecting portion of the benzoline-tube n^4 terminates in close proximity to an orifice formed in the extremity of the air-nozzle n^5. The outer extremity of the air-nozzle n^5 is in the form of a blunt cone, the space between the inner surface thereof and the end of the benzoline-tube forming a passage for the air, which, owing to the form of the nozzle at this part, is directed obliquely across the stream of liquid issuing from the benzoline-tube n^4.

By means of the union n^6 the vaporizer N may be connected to the vessel O, the communication in the opposite direction with the tank M being effected by means of the union n^7, screwed to a body, n^8, in which the pipes m m' terminate. One advantage resulting from this construction is, that the small tube n^4, through which the benzoline passes, may be readily removed for cleaning purposes.

The object I have in extending the hydrocarbon-supply tube n^4 back into passage n^2, and even into pipe m', should be explained. This tube n^4 is quite slender, and I find it convenient to regulate the quantity of liquid hydrocarbon that will flow through it under a given pressure by varying its length, rather than by using a cock or valve. With a given pressure, and a tube, n^4, of a given diameter, for example, I find that if the tube be three and one-half inches long it will supply a six-and-three-fourths-inch engine-cylinder; but if the tube be increased to six inches in length it will only supply (owing to retardation by friction) a four-inch engine-cylinder. Thus by varying the length of this tube n^4, I am enabled to adjust it to supply the particular engine to which it is attached.

The mixture of air and inflammable liquid, formed as above described, is discharged into a vessel, O, Fig. 9, from which the motor-cylinder or a pump for compressing the charge before it is conveyed to that cylinder draws its supply. To this vessel air may be admitted for diluting the inflammable mixture when more highly charged with hydrocarbon than is deemed desirable. For this purpose the vessel O is furnished with a self-acting valve, o, the latter opening against the resistance of a light spring, o', on a partial vacuum being created in the vessel O. The quantity of air admitted may be regulated by altering the tension of the spring by adjusting the nut o^2. The application of such a valve prevents the escape of vapor from the vessel O during those intervals when the inflammable mixture is not being withdrawn for use in the motor-cylinder. In some instances I substitute for the self-acting valve above described an adjustable shutter, whereby the inflow of air may be throttled and regulated to that adapted to the requirements of the engine.

When it is desired to control the passage of the benzoline from the tank M through the pipe m' to the mixing apparatus N in such a manner that the flow takes place intermittently, and approximately coincides with the eduction of the inflammable mixture from the vessel O to the compressor or motor-cylinder, I apply to the benzoline-pipe m' valve apparatus, which may be constructed as represented in the vertical and horizontal sections, Figs. 5 and 6, or may simply consist of a plunger or other suitable cut-off valve, worked from an eccentric or cam on the shaft E, and acting to alternately open and close the communication through the benzoline-pipe m'. I prefer, however, to subject the action of the benzoline-regulating valve to the control of a governor, as indicated in these figures and in Figs. 7 and 8, the former of these being a sectional elevation showing the governor-standard and driving-gear, and the latter a plan of the same. The governor is mounted in a framing, Q, formed on or attached to the bed-plate R of the engine, motion being imparted to the said governor through the toothed gears s s, pulley s', and driving-rigger s^2, from the crank-shaft D. An eccentric, p, Fig. 11, mounted on the shaft J, communicates by means of a rod, p', a vibratory motion to the link or links r, Figs. 5 and 6, the latter being pivoted at their upper ends. Each of the links r is formed with a slot in which slides a block, the latter being traversed by a pin connected by means of the bars r' r' with the cross-head r^2. This cross-head carries a plunger-valve, r^3, and may be furnished with a guide-stem, r^4, and spiral spring r^5. The plunger-valve r^3 works in a casing, r^6, having suitably-disposed inlet and outlet passages, r^7 r^8, for the benzoline. The block sliding in the slotted link or links r is capable of being raised or lowered by means of the spindle t, acting under the influence of the governor-balls t'. Thus, when the spindle t assumes its lowest position, aided, if necessary, by the weight t^2 or spring t^3, and the sliding block approaches the lower end or ends of the slotted link or links r, the stroke of the plunger r^3 approximates the throw of the eccentric; but when, on the speed of the engine becoming excessively accelerated, the governor-weights are extended, the spindle t raised, and the sliding block moved toward the upper or pivoted ends of the slotted links r, the stroke of the plunger r^3 is reduced to a minimum, and the flow of the benzoline is partially or wholly cut off, notwithstanding the continued working of the eccentric-rod p' and slotted links r.

For igniting the charge in the motor-cylinder, I prefer to employ the agency of electricity, the electrical circuit being completed and a spark produced at the proper moment by the means hereinafter described. It should, however, be understood that an inflammable or explosive mixture prepared as above specified may be ignited by means of an incandescent wire, or of a flame communicated to the charge at the proper moment from the exterior of the cylinder.

When using an electric spark or incandescent wire for igniting the charge, I employ apparatus such as represented in Figs. 11 and 11^a, for making and breaking the electric circuit. On some conveniently-situated reciprocating part of the engine—in the present instance the connecting-rod of the air-pump L—is mounted an insulated roller, k, preferably of copper, to serve as a connector. At one extremity of the reciprocating movement of the rod the insulated connector k arrives in contact either with two insulated flexible plates, k' k', or with two pivoted arms composed of copper or other conductive material, the connector thereupon serving to establish communication between the free ends of the plates or arms k'. A light caoutchouc ring may be passed around the flexible plates k', to provide against their becoming permanently thrust apart and displaced by the repeated action of the connector brought into contact with them in completing the circuit. The flexible plates or arms k' are respectively connected with the sparking apparatus or incandescent wire with which the motor-cylinder is furnished and with the coil and battery, the arrangements in these latter respects being of the usual character. The electric current may be derived from a battery or other available source.

For actuating the exhaust-valve a^2, I prefer the arrangement represented in Fig. 10. A reciprocating thrust-rod, u, is operated by an eccentric or cam, u', mounted on the shaft J. Opposite the outer extremity of the rod u is mounted a lever, v, pivoted at v', and furnished as to one arm with an adjustable stop, v^2, for the rod u to act upon, while the other arm of the lever v is engaged with or bears against the extremity of the stem of the exhaust-valve a^2. A spiral spring, v^3, may be advantageously applied to insure the prompt reseating of the valve. According to this construction and method of working, although the throw of the eccentric, and consequently the stroke of the thrust-rod u, remains constant, the proportion of the stroke communicated to the valve is rendered capable of ready variation by protruding or retracting the working-surface of the stop v^2.

The valve a', for admitting the inflammable charge to the cylinder A from the chamber O, may be mounted in the valve-chest a in a similar manner to that shown and described with reference to the exhaust-valve a^2, except that the inlet-valve may be self-acting. A similar method of arranging and working the valves is applicable for engines so designed as to admit of the piston making an effective stroke during each revolution, or two such strokes if the engine be double-acting. Under these circumstances the valve eccentric or cam p may be mounted upon and revolve at the same speed as the crank-shaft D.

For rendering an engine of the class hereinbefore specially referred to reversible, I provide means such as represented in the enlarged sectional plan, Fig. 11, and whereby the action of the mechanism operating the exhaust-valve, as also that of the mechanism operating the firing apparatus, may be varied in relation to the position of the crank. With this object and as regards the valve mechanism I mount the eccentric u' freely on the shaft J, and I provide the shaft or body u', secured thereto, with a driving-stop, u^3, as indicated in Fig. 12, which is a transverse section on the line x x, Fig. 11. The eccentric u' is furnished with a corresponding stop, u^4, for receiving motion. The stop u^3, formed on or attached to the shaft, is of such circumferential length and is so located relatively to the position of the crank that when revolving in one direction one driving-face of the stop u^3 bears against the stop u^4 appertaining to the eccentric and operates the rod u^5 to open the exhaust-valve a^2 at and during the proper period. Upon the shaft J being revolved in the reverse direction it makes a portion of a revolution ineffectively as regards rotating the eccentric u' before the opposite driving-face of the stop u^3 arrives against the opposite face of the stop u^4, whereupon the position of the eccentric u' in relation to the crank is adapted for working the engine in the reverse direction. Similar means for reversing are applicable in connection with the firing mechanism. Where, as in the present illustration, the electric contact-making instrument is attached to the pump-rod, I operate the crank-disk from which the pump is worked by means of clutch mechanism of a similar description to that above described for actuating the exhaust-valve eccentric. In the present instance, where spur-gearing is employed for communicating motion from the crank-shaft D to the secondary shaft J, and where the spur-wheel H is utilized as a crank-disk for working the pump and firing mechanism, the clutch mechanism is interposed between the teeth of the spur-wheel and the crank-disk. The crank-disk w is mounted upon and secured to the shaft J, and is provided with a stop, w', as indicated in Fig. 13, which is a transverse section on the line $y\ y$. The spur-wheel H is mounted freely upon the shaft J or upon a sleeve projecting from the back of the crank-disk, and is provided with a stop, w^2, for imparting motion through the stop w' to the crank-disk, and thus to the shaft J. The stops w' and w^2 are respectively proportioned and disposed according to the requirements of the firing apparatus relatively to the position of the crank, the play of the clutch being in this instance less than that appertaining to the exhaust-valve eccentric. The action of the firing apparatus must in either direction of the engine's rotation precede the opening of the exhaust-valve.

I may say here, by way of explanation, that I am aware that vaporizers having conical nozzles similar to that shown in Fig. 4 have before been employed. Means for controlling by an intermittently-operated valve the admission of the liquid hydrocarbon in this class of engines have also been employed, as well as governors for regulating the quantity admitted. These features I do not broadly claim.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The combination, with the body n of the vaporizer, provided with the gas-passage n' and the liquid-hydrocarbon passage n^2, stopped at its forward end by a plug, n^3, of the nozzle n^5 and the tube n^4, the latter extending through plug n^3, forward into the nozzle n^5, and backward into the passage n^2, substantially as and for the purposes set forth.

2. The combination, with the body n of the vaporizer, provided with the passages n' n^2, the latter stopped by a screw-plug, n^3, of the removable nozzle n^5 at the front end of the body n, the tube n^4, fixed in plug n^3, and extending forward into nozzle n^5, and backward into passage n^2, the union n^7, the plug or body n^8, screwed into union n^7, and the pipes m and m', fixed in said body and coinciding with the passages n' and n^2, respectively, substantially as and for the purposes set forth.

3. In a liquid-hydrocarbon engine, the combination, with the hydrocarbon-pipe m', of the plunger r^3, mounted to reciprocate in a casing or chamber, r^6, and to control the passage of the liquid through pipe m', the said chamber through which the hydrocarbon passes, the vibrating link or links r, means for vibrating said links through the medium of the engine, the governor-spindle t, provided with a slotted lower end coupled to a block which slides in slots in links r, said sliding block, and bars or rods r', which couple said plunger r^3 to said sliding block, whereby the vertical movement of the governor-spindle is caused to regulate the extent of movement of the said plunger, substantially as set forth.

4. In liquid-hydrocarbon engines where the inflammable charge is fired by electricity, the improved means, substantially as herein described, for making and breaking the electric circuit, the same consisting of an insulated connector mounted on any suitable reciprocating part of the engine and working in conjunction with two flexible or pivoted arms connected with the circuit.

5. The improved means, substantially as herein described, for rendering liquid-hydrocarbon engines reversible, such means consisting of a pair of clutches for working the exhaust-valve and firing apparatus, respectively, the construction and setting of the clutches in relation to one another and to the crank being such that in either direction of rotation the action of the firing apparatus precedes by a proper interval that of the exhaust-valve.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

JOHN JOSEPH REVELEY HUMES.

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