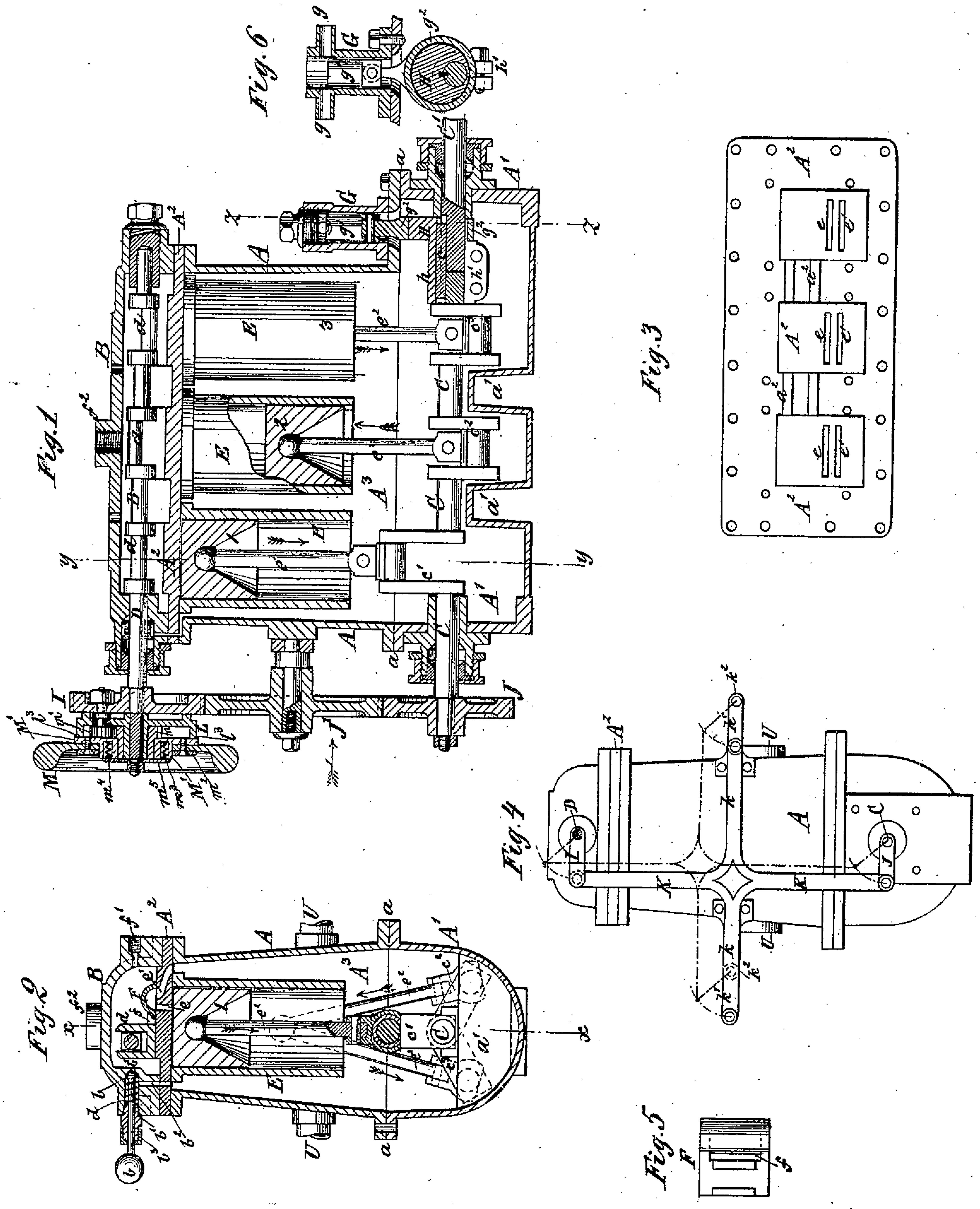
(No Model.)

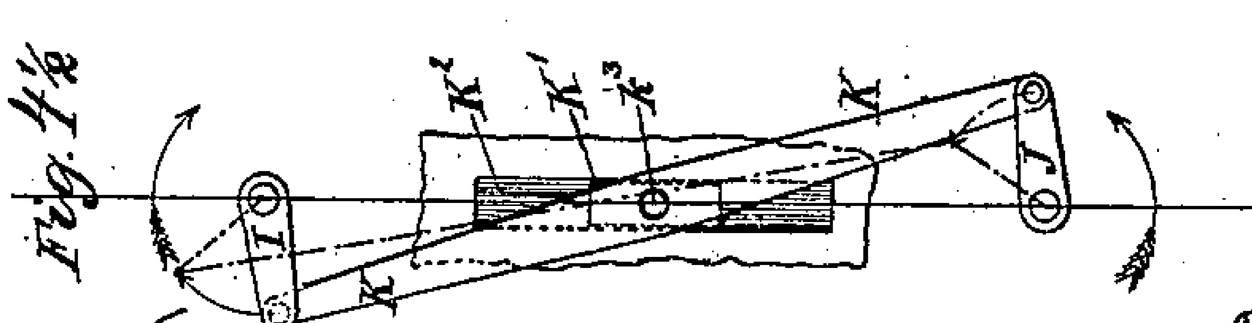
2 Sheets—Sheet 1.

F. W. OFELDT.

GAS ENGINE.

No. 356,419. Patented Jan. 18, 1887.





WITNESSES:

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ATTORNEY

(No Model.) 2 Sheets—Sheet 2.

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Fig. 11

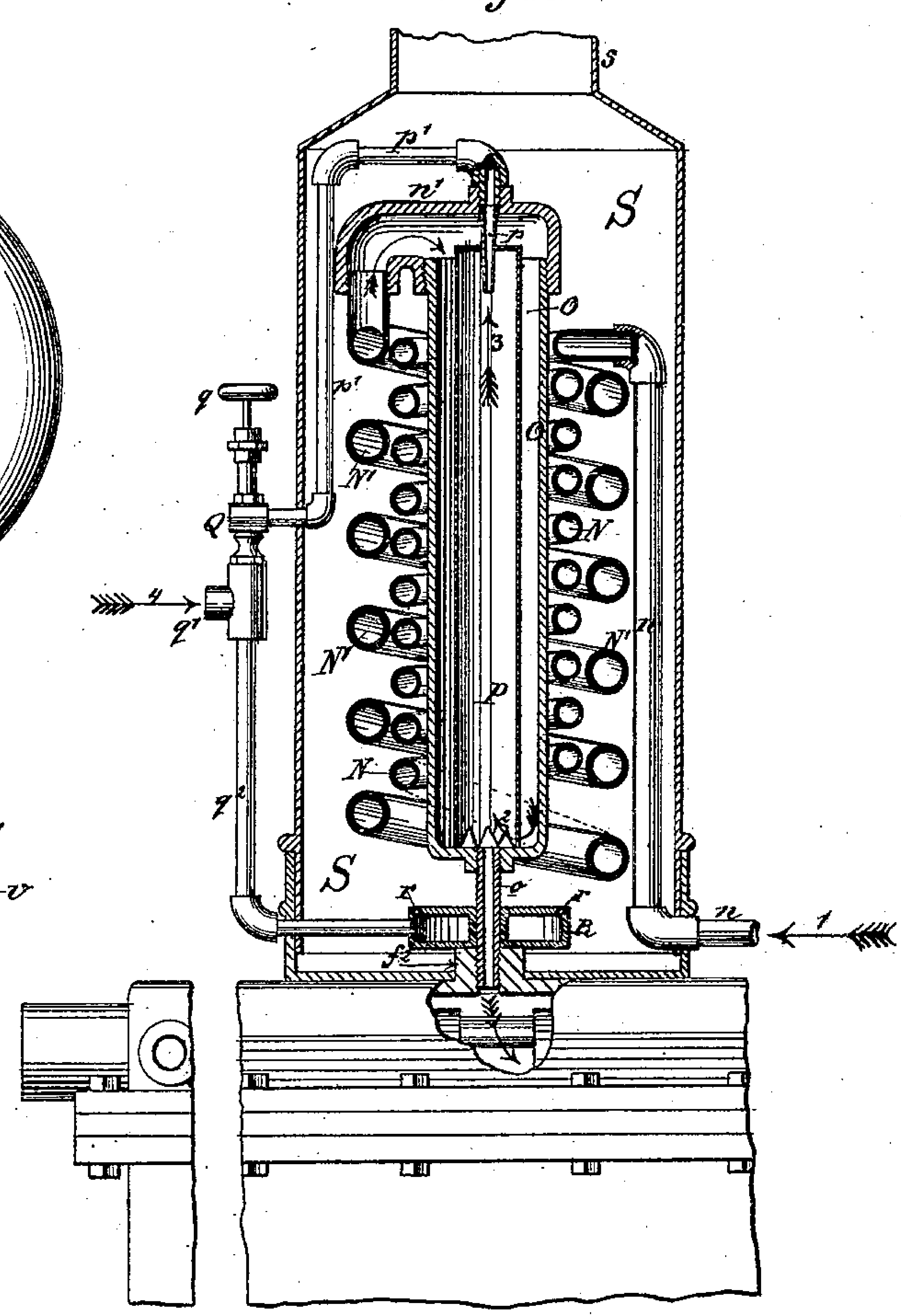


Fig. 7

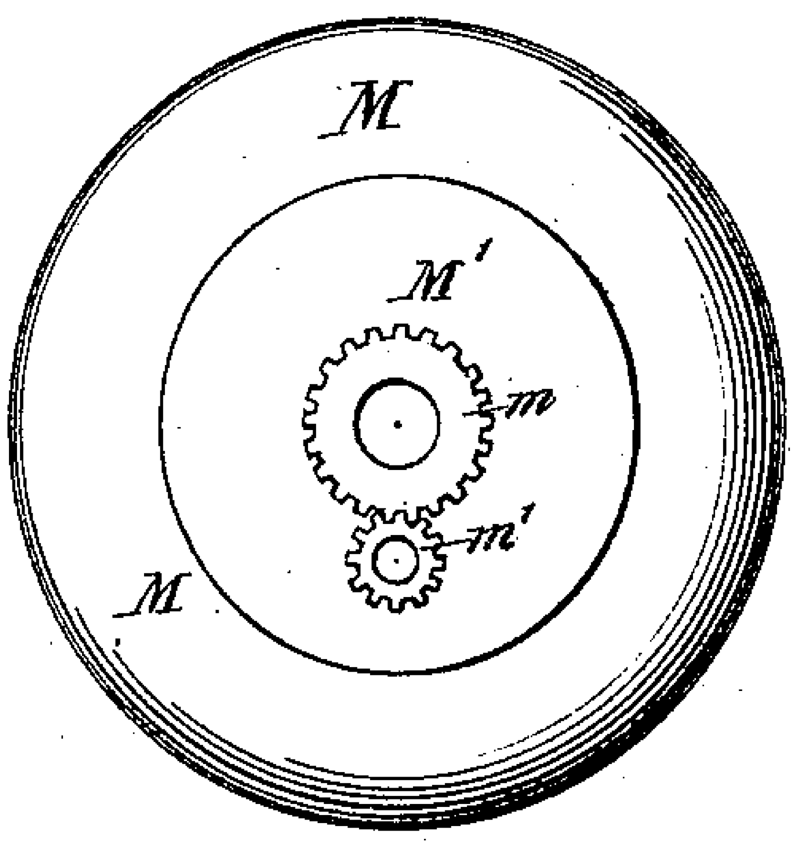


Fig. 8

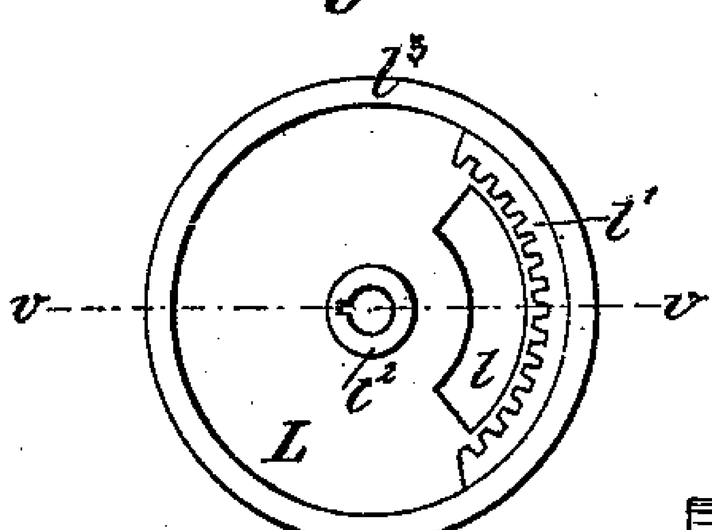


Fig. 9

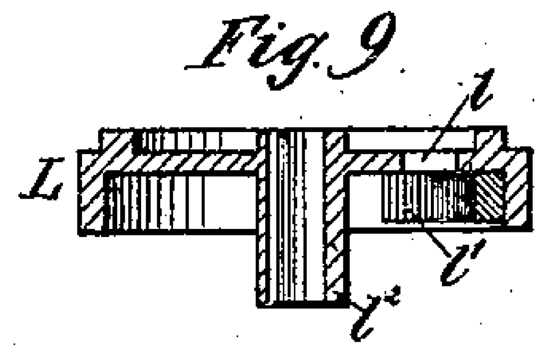


Fig. 10

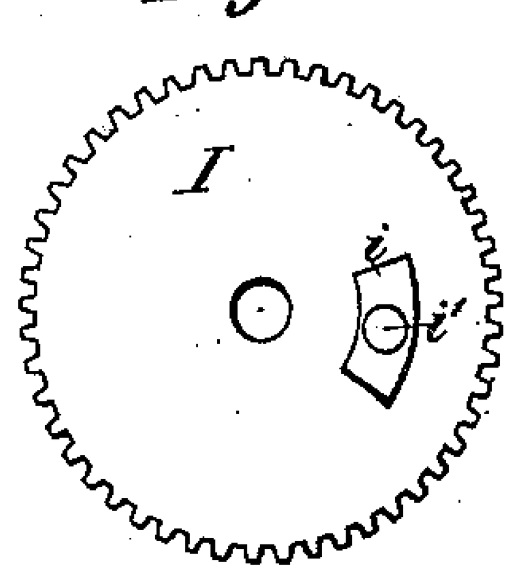


Fig. 12

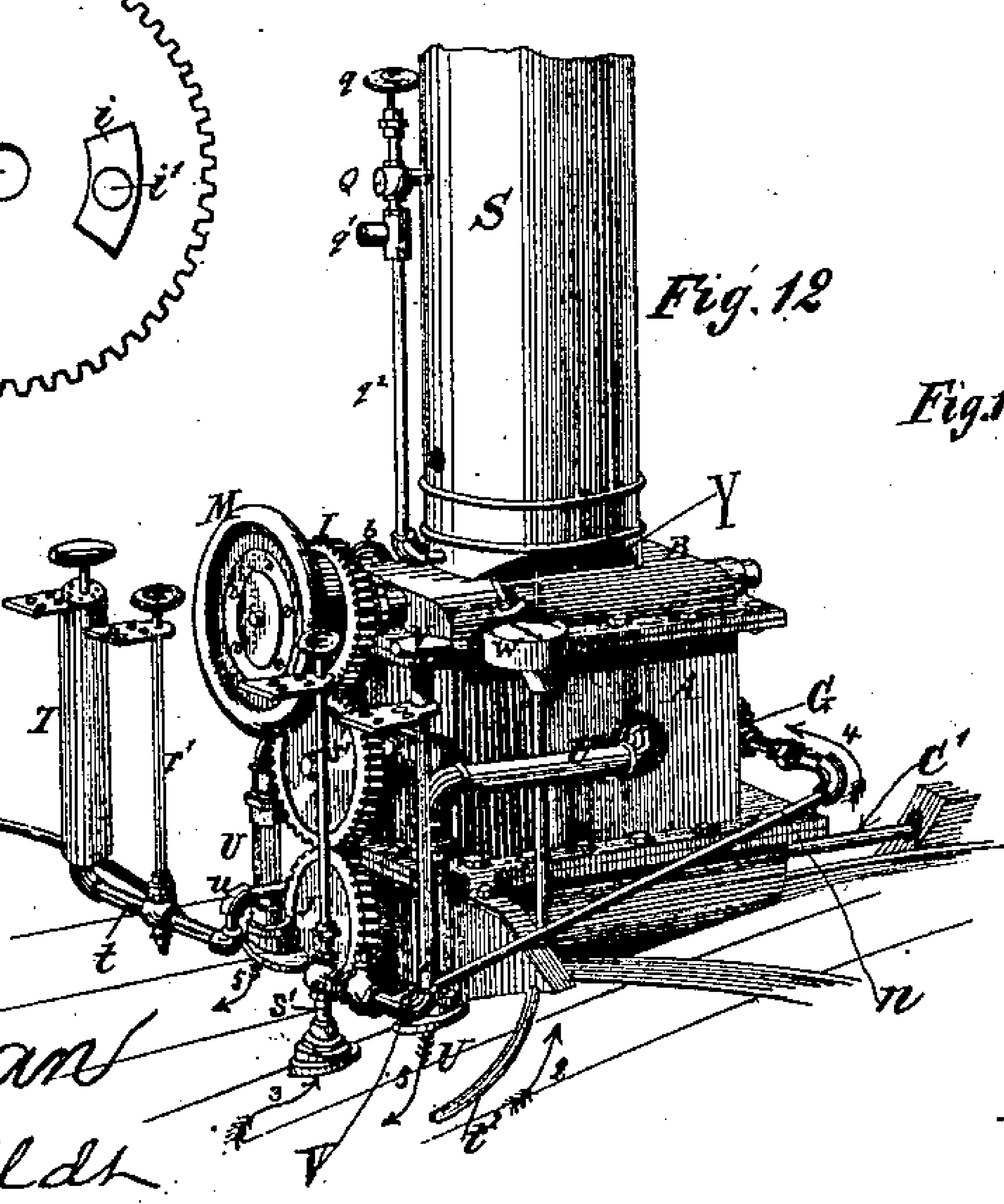
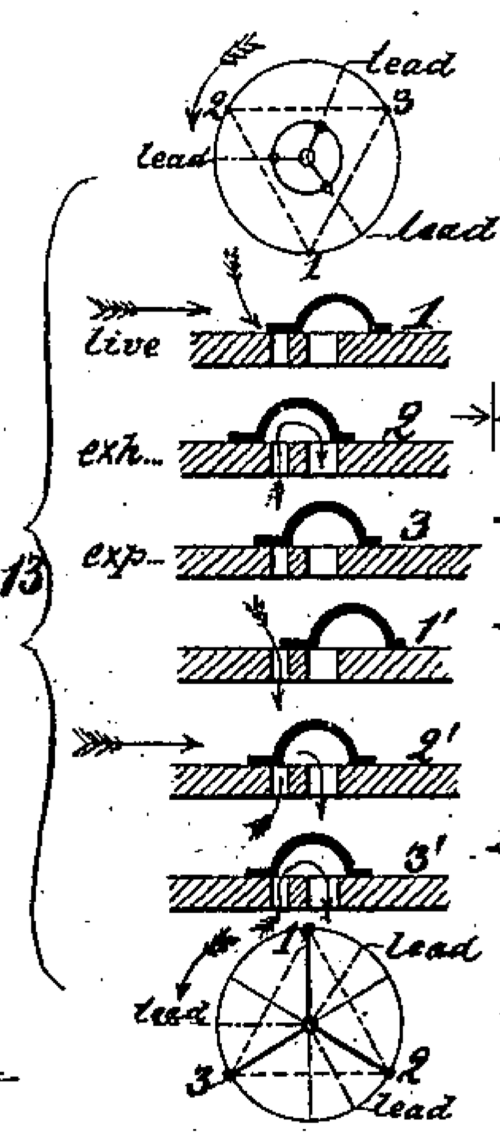


Fig. 13



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UNITED STATES PATENT OFFICE.

FRANK W. OFELDT, OF NEW YORK, ASSIGNOR TO THE GAS ENGINE AND POWER COMPANY, OF NEW YORK, N. Y.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 356,419, dated January 18, 1887.

Application filed June 25, 1886. Serial No. 206,190. (No model.)

To all whom it may concern:

Be it known that I, FRANK W. OFELDT, a citizen of Sweden, and a resident of New York, in the county and State of New York, have invented a new and useful Improvement in Gas-Engines, of which the following is a specification.

The invention relates, generally, to gas-engines of that class in which a liquefiable gas is used expansively, then condensed, then returned, and by heating again converted into gas, and thus used over again indefinitely—such matter as, for instance, sulphide of carbon or naphtha being suitable for the purpose.

The invention relates more especially to an engine in which the heat necessary for converting the liquid into gas is obtained by the combustion of a portion of the said gas itself, as shown in my previous Patent No. 279,270, dated June 12, 1883.

The object of my present invention is to provide certain improvements in the construction of the engine described in the aforesaid patent, with a view to make it more compact, avoiding the effect of the dead-point of the stroke, locating its parts conveniently for manipulation, facilitating the control of the slide-valves for regulating the speed and the forward and reverse movement of the engine, so as to adapt it particularly well for use to run the propeller of a launch, boat, or other vessel, and also to transmit noiselessly the necessary positive movement from the main shaft to the valve-shaft.

The invention will be hereinafter fully described, and specifically pointed out in the claims, reference being had to the accompanying drawings, in which—

Figure 1 represents a side elevation of my improved gas-engine, mainly in section, taken on the line *x x* of Fig. 2. Fig. 2 is a vertical cross-section of the same, taken on the line *y y* of Fig. 1. Fig. 3 is a plan view of the valve-chest face, showing the surfaces on which the slide-valves work. Fig. 4 is an end view of the engine, showing my improved device for communicating motion from the main shaft to the valve-shaft. Fig. 4½ shows a modification of the same. Fig. 5 is a top view of one of the valves detached. Fig. 6 is a vertical section of the oil-pump, main shaft, and eccentric, the section being taken on the line *z z* of Fig. 1. Fig. 7 is an inside view of the hand-wheel of the reversing-gear, showing its central and intermediate pinions. Fig. 8 is a side view of the slotted cog-segment into which the pinion of Fig. 7 gears. Fig. 9 is a cross-section of the same on the line *v v*. Fig. 10 is a side view of the wheel or crank which carries the block and stud of the intermediate pinion, which work in the slot and segment shown in Fig. 8. Fig. 11 is a sectional elevation of the chimney and the retort by which the gas is generated, the same being shown in position on the engine proper. Fig. 12 is a perspective view of the engine and chimney seen toward the side and rear of a boat or launch, in which it is indicated as being placed. Fig. 13 is an explanatory view of the relative positions of the slide-valves and valve-cranks corresponding to the positions of the pistons indicated in Figs. 1 and 2.

Like letters of reference indicate like parts in the several figures.

A is a hollow frame or box-shaped casting which incases the engine, its lower portion, A′, being made somewhat in the shape of a trough, bolted by flanges at *a*, to the middle portion, and extending longitudinally so much farther rearward than the middle portion as to leave room for placing the oil-pump vertically above the main shaft. On top of the said middle portion is bolted the valve-chest face or slide-plane A^2, on which the slide-valves work, and on top of the said plate or plane A^2 is bolted a hollow cover, B, which forms the valve-chest or valve-chamber.

From the bottom of the trough A′, which also serves as the base or bed plate of the engine, project upward cross-partitions *a′*, which serve as rests for pillow-blocks or bearings of the main shaft C, which is arranged horizontally in and is coupled to and in line with the propeller-shaft C′ by a key or spline, *c*, within the hub of the oil-pump eccentric, as will be further described. The shafts C C′ have bearings in the ends of the lower part, A′, in stuffing-boxes, as shown in Fig. 1, and from the front end of the shaft motion is transmitted to a valve-shaft, D, for operating the slide-valves. The said valve-shaft is arranged above and parallel with the main shaft C, longitudinally of the valve-chest B, and has its bearings in the ends of the same, the front end of the valve-shaft projecting through a stuffing-box above the main shaft C, as in Fig. 1. The shaft D is further steadied from lateral deflection by resting in jaws or pillow-blocks a^2, cast upon the slide-plane A^2.

The piston-cylinders E are three in number, open at their lower ends, and closed at their upper ends by being bolted through flanges to the under side of the plate A^2, the only communication from the valve chest to the cylinders being through the inlet-port *e*, which port, when the slide-valve is in the position shown in Fig. 2, forms communication between the cylinder and the exhaust by way of the exhaust-port *e'*, which is also formed in the plate A^2.

The main shaft C has three cranks, c' c^2 c^3, which by pitmen e^2 are connected to the corresponding pistons, numbered 1 2 3. The cranks c' c^2 c^3 are arranged at an angle to each other of one hundred and twenty degrees, or set as three radii dividing a circle in three equal parts.

The valve-shaft D has three cranks, *d*, for regulating the throw of the valves, and which are also arranged at an angle of one hundred and twenty degrees to each other, to correspond with the cranks of the pistons and cylinders whose valves they are to regulate, and are preferably set a little in advance of the lower cranks, so as to give lead to the valve and thereby effect a free exhaust and an end cushion on the upstroke of the pistons, and a cut-off for utilizing the gas expansively on the downward stroke of the pistons.

The ends of the piston-rods or pitmen are ball-shaped, and simply lodge in corresponding sockets in the pistons, a firmer connection not being needed, inasmuch as the working pressure is always upon the pistons on the downstroke only.

By arranging the crank-shafts C D parallel with each other, the cylinders vertical, and the valve-plane horizontal, it will be seen that the motion of the slide-valves is at right angles to the motion of the pistons and to the axis of the shafts, thereby facilitating the advantage of a comparatively large and rapid movement of the valve at the end of the stroke of the piston when the movement of the latter is slow and small, and thereby also enabling a quick opening and cut-off of the inlet-port, as well as of its communication with the exhaust-port into the exhaust-chamber A^3, which is simply the interior of the hollow frame or casing A.

The slide-valves F (see Figs. 2 and 5) are each provided with two parallel upright lugs, forming a guide-jaw, in which is fitted a square slide-block bored through horizontally to receive the corresponding crank-pin of the valve-shaft D.

f is the induction-opening of the valve, which, when above the port *e*, admits the live or pressure vapor from the valve-chest to the cylinder. Between the lips of the valve is the ordinary arch or channel, which, when in the position shown in Fig. 2, forms communication between the port *e* and the exhaust-port *e'*

In the diagrams in Fig. 13 the relative positions of the cranks of the valve-shaft and those of the main shaft are shown, respectively, in the circles above and below the valve-port sections, and the first three of these latter indicate the corresponding positions of the respective valves in accordance with the positions of the pistons 1 2 3 in Figs. 1 and 2, and, for convenience of comparison, are marked with the respective numbers on the pistons, the arrows indicating the direction of the motion.

It will be seen that the cylinder of piston 1 is about to receive live pressure-gas and the piston about to start on the downstroke. No. 2 has started on the upstroke and is exhausting No. 3, which is at the same elevation as No. 2, but yet, moving downward, has its inlet-port *e* closed by the valve, and is impelled by the expansion of the inclosed or cut-off vapor.

The three last or lowest valve-port sections in Fig. 13 indicate the relative positions of the valves at the end of one-fourth revolution. The valves of Nos. 1 and 2 are moving in directions opposite to those before. Piston No. 1 is half-way on the downstroke and its valve has cut off. No. 2 is about three-fourths of its way on the upstroke and is yet exhausting, and No. 3 has started on its upstroke and is also exhausting.

The pistons are all single-acting—namely, on the downward stroke only—and each in turn is moved upward by the downstroke of the others; but their active paths—*i. e.*, effective to turn the cranks—lap one another, whereby the rotary motion produced is unaffected by the dead-points, and continues uniform without the use of a fly-wheel.

The automatic oil-pump is arranged, as before stated, upon the rear end of the trough A', above the main shaft C, and in line with the row of cylinders E, in a manner to cause no lateral projections on the frame.

G is the pump-cylinder shown in Fig. 6, with the cap removed and provided near its upper end with oppositely-placed nipples *g*, for the attachment of inlet and outlet valves (not shown in the drawings except at G in Fig. 12) and oil-pipe *n*, leading from the tank to the retort. The pump-piston is an ordinary solid plunger, *g'*, which is connected by an eccentric-strap, g^2, to an eccentric, H, which has a long hub, *h*, split along one side and provided with lugs *h'*, by which and bolts through the said lugs it is tightly clamped around the adjoining ends of the main shaft C and the propeller-shaft C', the aforesaid key *c* being fitted in a corresponding groove in the hub *h* and in the two shafts, thus securing the three together, as plainly shown in Figs. 1 and 6.

At opposite sides through the valve-chest are horizontal openings $f' b'$, the former for attaching thereto a pressure-gage, W, (see Figs. 2 and 12,) and the latter for the safety-valve. The channel b' has a seat at its inner end to receive the valve b, whose stem works in a stuffing-box, b^3, a spiral-spring, d', (of suitable strength to yield when the pressure of safety is exceeded,) being put upon the valve-stem and interposed between the said stuffing-box and the valve proper, b. A vertical channel, b^2, connects the channel b' with the exhaust-chamber A^3 and the condenser, so that when under an excess of pressure the safety-valve b opens, the overheated gas passing direct through the channels $b' b^2$ from the valve-chest to the condenser, until safe pressure is restored.

The motion from the main shaft C is transmitted to the shaft D from a crank or wheel, J, upon the former shaft, and a crank or wheel, I, upon the latter, and an intermediate cog-wheel, J′, or bar K. In Figs. 1 and 12 the motion is shown as transmitted by cog-wheels, the intermediate wheel, J′, being mounted to turn upon a stud secured to the frame A; but as the gear-wheels, although they work very satisfactorily, make some noise during their movement, I have devised other means (see Figs. 4 and 5) for transmitting the motion. The upper and lower cranks, I J, are connected by a bar, K, (see Fig. 4,) which has one or more lateral extensions, k, whose ends are connected by cranks k', of the same length as the cranks I J, to stationary pins or pivots k^2, around which the said cranks revolve. By this construction it is easily understood how the cog-wheels may be dispensed with and, nevertheless, positive movement obtained, the effect of the third (and, still better, the fourth) crank and pivot being to afford steadiness in the movement and always keep the bar K in a vertical position.

In Fig. 4½ is shown a modification in which the steadiness of movement may be obtained without cog-wheels and without the lateral arms k. This is done by pivoting the center of the bar K to a pin, k^3, secured to a parallel piece or block, K′, fitted to slide in a vertical slot, K^2, on the frame A. When this modification is used, the upper and lower cranks, I J, must turn in opposite directions, instead of both turning in the same direction, as they do when the device shown in Fig. 4 is used, and when the cog-wheels are used.

In order to regulate the slide-valves so as to stop and start and reverse the movement of the engine, I have provided the following means: The crank or wheel I is free to turn upon the valve-shaft D, and to it is secured a block, i, which is of size and shape adapted to fit and slide in a circular slot, l, in another wheel, L, which latter wheel is rigidly secured or keyed on the shaft D. Upon the block i is a pin, i', on which is mounted, free to turn, a pinion, m', which gears in a cog-segment, l', within the rim of the wheel L, and also with a larger pinion, m, whose hub is bored and fitted to turn freely upon the elongated hub l^2 of the said wheel L. Upon the hub of the said toothed wheel m is secured a hand-wheel, by which the gears are manipulated. This consists of a disk with wooden rim M, which is fastened by screws through a metallic ring, m^2, to a metallic central disk, M′, the latter being that portion of the hand-wheel by which it is secured upon the hub of the aforesaid wheel m. The central disk, M′, has sockets m^3, in which there are spiral springs m^4. The said sockets are covered and the springs compressed from the outside by a metallic disk, m^5, which, by a nut screwed upon the outer threaded end of the valve-shaft D, is forced against the said springs, thereby also pressing the central disk, M′, of the hand-wheel against the adjoining rim l^3 with sufficient friction to cause the said wheels to turn together uniformly, as if they both were fastened upon the valve-shaft, until sufficient force is applied to the hand-wheel to overcome the said friction.

When the parts shown in Figs. 7 to 10 are together, as in Fig. 1, and the engine started, the motion imparted to the wheel or crank I is in turn imparted by the latter to the wheel L, keyed upon the valve shaft, by the block i upon the wheel or crank I′, which, when having traveled to the end of the circular slot l in the wheel L, carries the latter with it to revolve the shaft D and operate the slide-valves.

If it is desired to reverse the engine, it is only necessary to turn the hand-wheel M, (or hold it back a little against the motion of the engine,) so that by means of the cog-wheel m, pinion m', and cog-segment l', the wheel L will advance on the motion of the crank or wheel I, so that the block i lodges against the opposite end of the circular slot l, thereby turning the valve-shaft D, and consequently reversing the valves, and thereby the engine.

By turning the wheel M so that the block i be moved to about the middle of the slot l the valves will get in such position that the engine will instantly stop, one of the pistons then being at the end of its stroke and the other piston, having both pressures on to counteract each other.

The combustion-chamber S is arranged upon the valve-chest, as in my previous patent, its arrangement being shown in Figs. 11 and 12, the central nipple, f^2, upon the top of the valve-chest serving to attach the pipe from the vapor-chamber. The feed-pipe n from the oil-pump and naphtha-tank enters the lower end of the combustion-chamber. (See arrow 1 in Fig. 11.) It then runs upward and connects with the upper end of a pipe, N, which is coiled, as shown in the said figure, and the lower end of which again connects with a pipe, N′. This latter is of larger size and is coiled in an opposite direction to the pipe N and surrounds the coil of the latter pipe. The outer coiled pipe, N′, is connected at its upper end by a casting, n', (in about the shape of a reverted elbow-joint) with the presuretube or vapor-chamber O, which from there continues downward centrally through the inner coil, N, and is closed at its lower end, with the exception of a central pipe, *o*, by which it is connected to the aforesaid nipple f^2, leading to the valve-chest. Within the tube O is a tube, P, of smaller diameter. This rests with its open lower end upon the bottom of the tube O, and is partly cut out at its edge where it joins the tube O, leaving openings at arrow 2. The upper end of the tube P is closed, except having a central perforation, through which a downward-tapering tube, *p*, is inserted, whose upper end is threaded from the inside into a nipple on the aforesaid casting n', to which nipple is threaded from the outside a coupling of a pipe, *p*, connecting the tube P with the injector Q. It will be seen that the tapering pipe or tube *p* serves two purposes—by its taper to make a tight joint without extra packing in the end of the tube P, and at the same time to retain the said tube in an upright position centrally within the tube O, so as to make the annular space between them uniform.

The injector-valve *q* serves to stop, start, and regulate the flow of the gas from the pipe p', which thence by the pipe q^2 is conveyed to the burner R, a vent-coupling, q', to admit air, forming the connection between the injector and the pipe q^2.

The burner R is simply an annular casting held in place by being arranged to surround the pipe *o* and rest upon the nipple f^2 of the valve-chest. The upper surface of the burner R is provided at its circumference with a series of outward-flaring holes, through which the flame throws against the coils and other parts of the retort for heating the oil and reverting it into gas.

By this construction it will be seen that the oil entering in the direction of arrow 1 through the pipe N' to the retort first passes downward through the entire inner coil, N, thence upward through the entire larger pipe, N', (the said pipe being increased in diameter, so to, as near as possible, correspond with the increased volume of the oil as it is converted into gas first of lower and then of higher grade or less density,) thence down into the tube O, and through the annular space between the said tube and the inner tube, P. Thence the greater portion and the denser portion of the gas enters through the openings at the bottom edge of the inner tube, P, and through the pipe *o* to the steam-chest, and thence through the cylinders. At the same time a portion of the highest grade of the gas, or that which has the least density, passes up, as indicated by arrow 2, into the inner tube, P, and thence in the direction of arrow 3 into the pipe p' to the injector, in passing through which latter, owing to its velocity, it draws air in the direction of arrow 4 through the vent q', and thus charged with air passes illuminating-gas into the burner R.

Draft for the burner R is provided by side openings, V, at the lower end of the combustion-chamber, (see Fig. 12,) and the gas of combustion passes up through the smoke-stack *s* on the upper end of the combustion-chamber S, as in my previous patent.

The manner of starting the engine will be understood with reference to Fig. 12, in which, however, the condensing oil-tank is not shown. By the hand-pump T air is forced through the pipe *t*, three-way cock r', and pipe t' in direction of arrow 1 to the oil-tank. A portion of the oil thereby vaporized returns through the pipe t^2 in direction of arrow 2 to the retort. The upper end of the pipe t^2 is perforated, so that by igniting the gas issuing therefrom a flame is started to heat up the retort. The oil-valve s' is then opened and the oil hand-pump is worked a little to pump oil from the tank in the direction of arrows 3 and 4, through the pipe *n* to the retort. When the latter has been sufficiently heated by the flame from the aforesaid pipe t^2, the oil, converted into gas, passes through the pipe p', injector Q, and pipe q^2 to the burner R, drawing air through the vent q' to keep up the flame. The action then continues automatically and the engine may be started.

The aforesaid three-way cock r' is for the purpose, also, of connecting the air hand-pump T with a pipe, *u*, which leads to a whistle, and at the same time cutting off the connection between the pipes t t', so that the air from the hand-pump will rush to the whistle instead of to the oil-tank.

U are the exhaust-pipes by which the exhaust-chamber A^3 is connected to the condensing oil-tank, the exhaust vapor issuing in the direction of arrow 5, Fig. 12.

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

1. In an engine worked by the pressure of an expansive gas, the combination of three cylinders having single-acting pistons, a driving-shaft having three cranks connected to the rods of the said pistons and radiating from the driving-shaft at angles to each other of one hundred and twenty degrees, a valve-shaft receiving rotary motion mediately from the said driving-shaft and having cranks set at angles to each other corresponding to those of the drive-shaft cranks, and slide-valves reciprocated by the rotation of the said valve-shaft cranks to regulate the inlet and outlet of gas to the said cylinders, substantially as and for the purpose set forth.

2. In an engine worked by the pressure of an expansive gas, the combination of working-cylinders arranged in the same axial plane and having single-acting pistons, a driving-shaft arranged in the same axial plane as the cylinders and having cranks radiating at angles to each other and connected to the rods of the said pistons, a valve-shaft arranged parallel with and rotated mediately by the said driv-

ing-shaft and having cranks set at angles corresponding to those of the driving-shaft cranks, and slide-valves reciprocated transversely or at right angles to the axial plane of the cylinders by the rotation of the said valve-shaft cranks to regulate the inlet and outlet of gas to the said cylinders, substantially as and for the purpose set forth.

3. In an engine having cylinders connected to cranks radiating at angles from the driving-shaft, and a valve-shaft having similar cranks and arranged parallel with the said driving-shaft, the combination, with the said drive-shaft and valve-shaft, and with cranks J I, secured upon the same, of a bar, K, pivoted to the said cranks and provided with a pivotal support intermediate to the said shaft for transmitting motion from the said drive-shaft to the valve-shaft, substantially as specified.

4. In an engine having cylinders connected to cranks radiating at angles from the driving-shaft, and a valve-shaft having similar cranks and arranged parallel with the said driving-shaft, the combination, with the said drive-shaft and valve-shaft, and with cranks J I, secured upon the same, of the bar K, pivoted to the said cranks and provided rigidly with one or more lateral arms, k, pivoted to a crank of the same length as the cranks of the said shafts, said crank being movable around a fixed pin or stud, substantially as specified, to transmit motion from the drive or main shaft to the valve-shaft.

5. In an engine worked by the pressure of an expansive gas, the combination of the box-frame A, forming the exhaust-chamber of the engine, vertical piston-cylinders E, and horizontal crank-shafts C, arranged in the same axial plane within the said exhaust-chamber, the valve-chest B, arranged above the said cylinders, and having ports e e', connecting it, respectively, with the said cylinders and exhaust-chamber, the valve-shaft D, arranged in the said valve-chest above and parallel with the main shaft C, and provided with cranks d and slide-valves F, and operated mediately from the said main shaft, and the feed-pump G, arranged in the axial plane of the said cylinders and shaft E C, and having plunger g', operated by an eccentric, H, upon the said main shaft, substantially as hereinbefore set forth.

6. In an engine worked by the pressure of an expansive gas, the combination of the box-frame A, forming the exhaust-chamber of the engine, and having its lower part, A′, extending endwise a distance beyond the upper portion, A, vertical piston-cylinders E and horizontal crank-shafts C, arranged in the same axial plane within the said exhaust-chamber, the valve-chest B, arranged above the said cylinders, and having ports e e', connecting it, respectively, with the said cylinders and exhaust-chamber, the valve-shaft D, arranged in the said valve-chest above and parallel with the main shaft C, and provided with cranks d and slide-valves F, and operated mediately from the said main shaft, the feed-pump G, arranged upon the extended lower portion, A′, in the axial plane of the said cylinders and shaft E C, and having plunger g', operated by an eccentric, H, upon the said main shaft, and a shaft, C′, meeting endwise the shaft C, and coupled to the latter by means of the hub h, key c, and clamping-lugs h' of the said eccentric H, substantially as specified.

7. In an engine operated by the alternate vaporization and liquefaction of a substance, the combination, with the exhaust-chamber A^3 and the piston-cylinders and shafts E C, arranged within the said chamber, and with the valve-chest and valves B F, arranged above the said chamber, of the channel b', having branch channel b^2, forming direct communication between the valve-chest and exhaust-chamber, and the safety-valve b, closing against the seat in the said channel b' at a point between the valve-chest and the said branch channel b^2, substantially as and for the purpose set forth.

8. In an engine worked by the pressure of an expansive gas, and having valve-shaft D, operated mediately from the main or driving shaft C, the crank or wheel I, free to turn upon the said valve-shaft by motion imparted from the said main shaft, and provided with a stop-block, i, with pin i', and a pinion, m', upon the said pin, the wheel L, keyed upon the said valve-shaft, and provided with a slot, l, to receive the said block, and a toothed segment, l', to gear with the said pinion, and a wheel, m, movable upon a hub, l^2, of the fixed wheel L, to gear with the said pinion m' for advancing the movement of the said wheel L, and thereby of the valve-shaft relatively to the loose wheel or crank I, in order to regulate the valve movement for stopping, starting, and reversing the engine, substantially as specified.

9. In an engine worked by the pressure of an expansive gas, and having valve-shaft D, operated mediately from the main or driving shaft C, the crank or wheel I, free to turn upon the said valve-shaft by motion imparted from the said main shaft, and provided with a stop-block, i, with pin i', and a pinion, m', upon the said pin, the wheel L, keyed upon the said shaft and provided with a slot, l, to receive the said block, and a toothed segment, l', to gear with the said pinion, and the wheel m, secured to a hand-wheel, M, and movable upon the hub l^2 of the said wheel L, the said wheel L having flange l^3 in contact with an adjoining surface of the hand-wheel, and the said hand-wheel being provided with sockets m^3, having inclosed springs m^4, and the end of the said valve-shaft being provided with a disk, m^5, and a nut to press the said disk against the said springs to produce friction between the said hand-wheel and the fixed wheel L, substantially as set forth.

10. In an engine for utilizing as a motive

power a liquid convertible into combustible vapor at a comparatively low temperature, the combination, with a vapor-generating retort communicating with the valve-chest and working-cylinder of the engine, a combustion-chamber inclosing the retort, and a pipe connecting it with the valve-chest, a burner for heating the retort, a supply-pipe leading to the burner, an injector opening into the supply-pipe, and a pipe connecting the retort or vapor-generator with the injector, of a tube or chamber, P, encircled by the said retort, the said tube having openings around its lower edge, and connected by a pipe through its closed upper end with the supply-pipe to the injector, for the purpose of bringing gas of the highest grade and least density to the burner, substantially as specified.

11. The combination, with the valve-chest, working cylinder or cylinders, and oil-pump of the engine, and with the feed-pipe, the gas-pipe, injector, burner-supply pipe, and combustion-chamber, substantially as described, of the retort formed of an inner tubular chamber, O, coiled pipe N, surrounding the said chamber, and a larger pipe, N′, surrounding the said chamber and coil N, and wound in opposite direction to that of the said smaller coil N, and the reverted elbow-joint *n′*, the said coil N N′, joint *n′*, and chamber O forming continuous connection from the feed-pipe *n* to the pipe *o*, connecting the retort to the valve-chest, all constructed and arranged substantially as hereinbefore set forth.

In testimony that I claim the foregoing as my invention I have signed my name, in presence of two witnesses, this 6th day of May, 1886.

FRANK W. OFELDT.

Witnesses:
A. W. ALMQVIST,
HELMER WESTIN.