No. 673,993. Patented May 14, 1901.

H. L. ARNOLD.

COMBUSTION MOTIVE FLUID GENERATOR.

(Application filed Feb. 17, 1900.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 3.

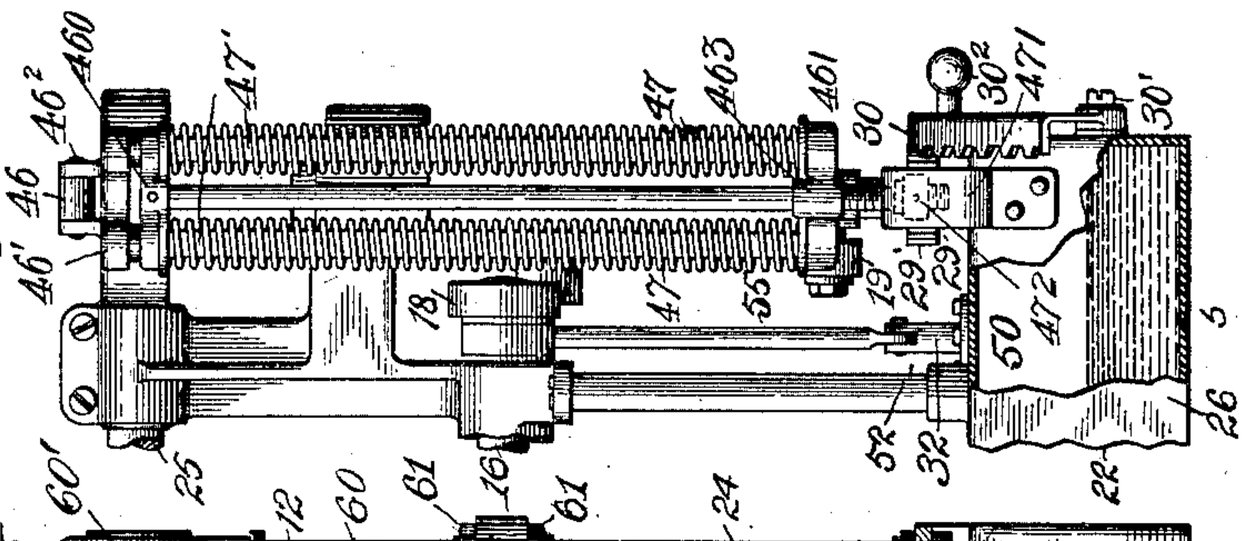


Fig. 2.

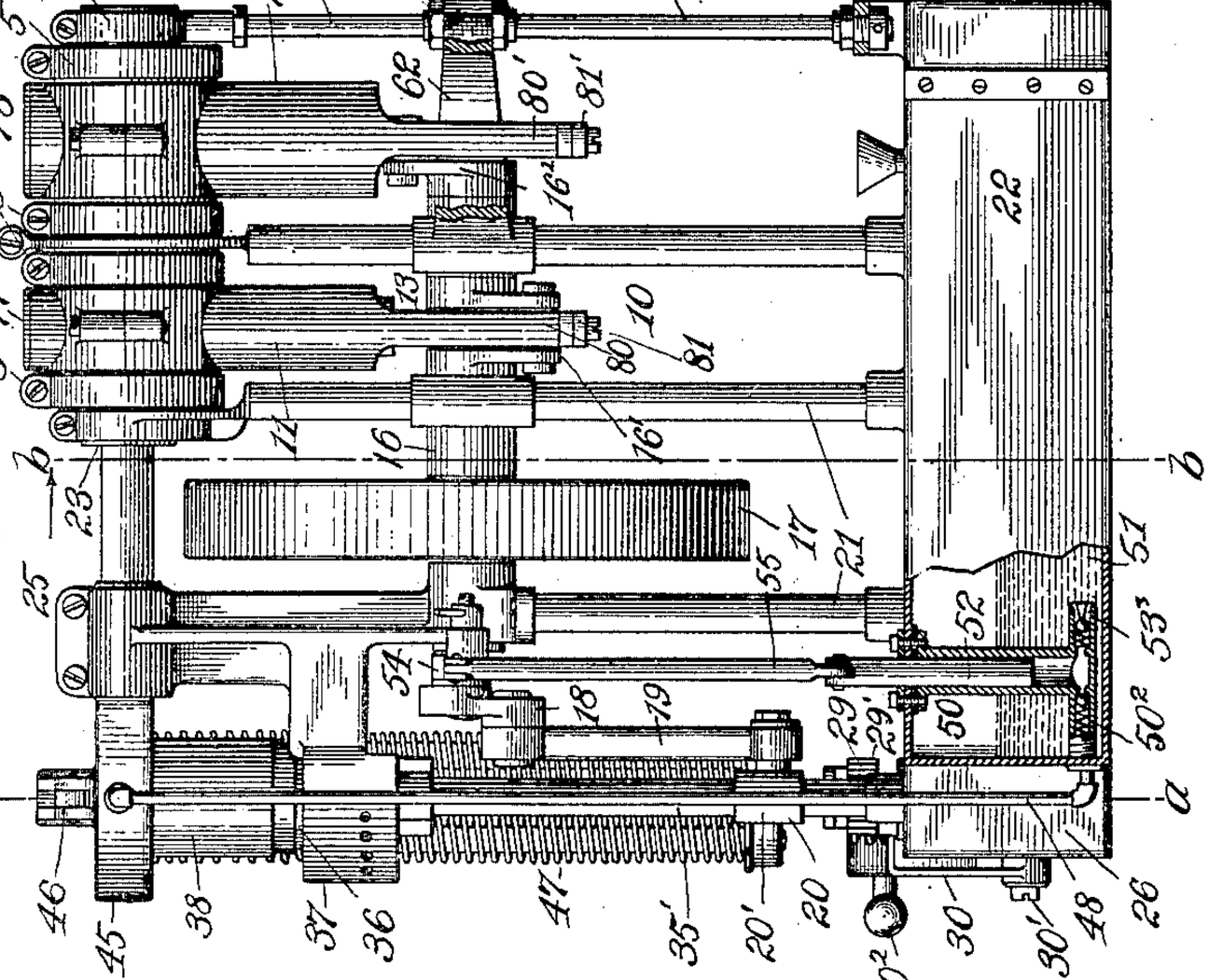
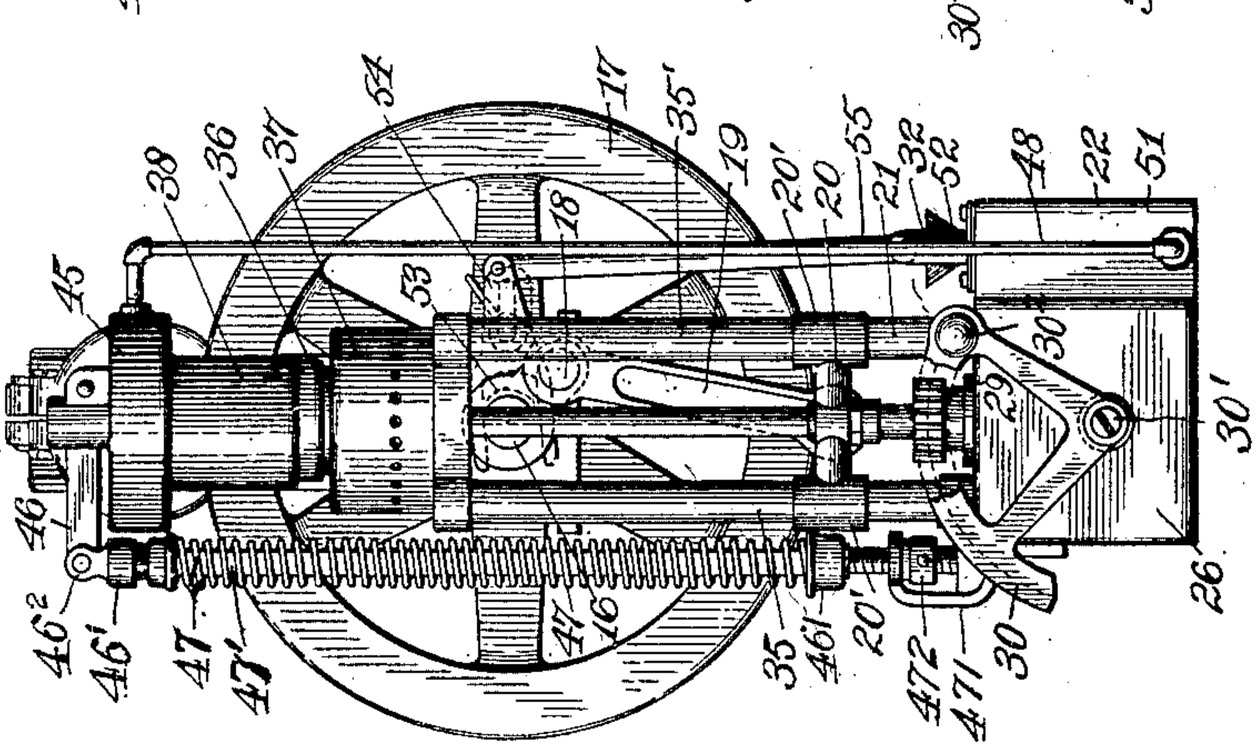


Fig. 1.



Witnesses:
C. W. Smith
R. F. Whittman

Inventor:
Horace L. Arnold
By his Attorney
F. A. Richards.

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Fig. 4.

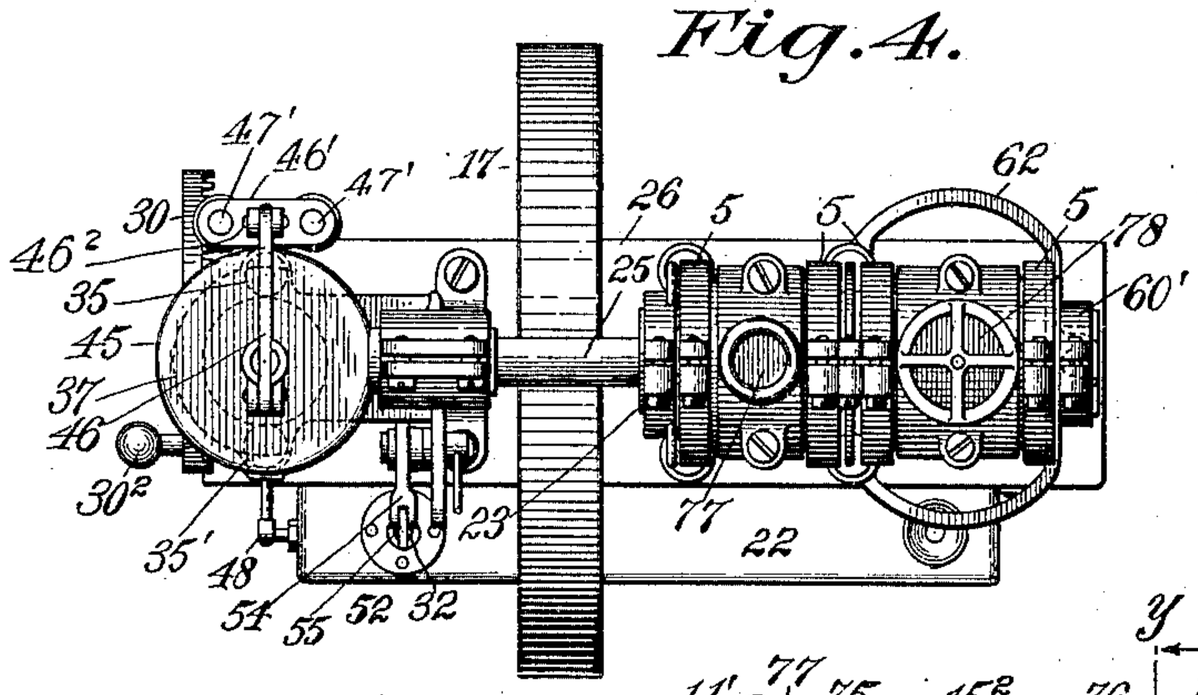
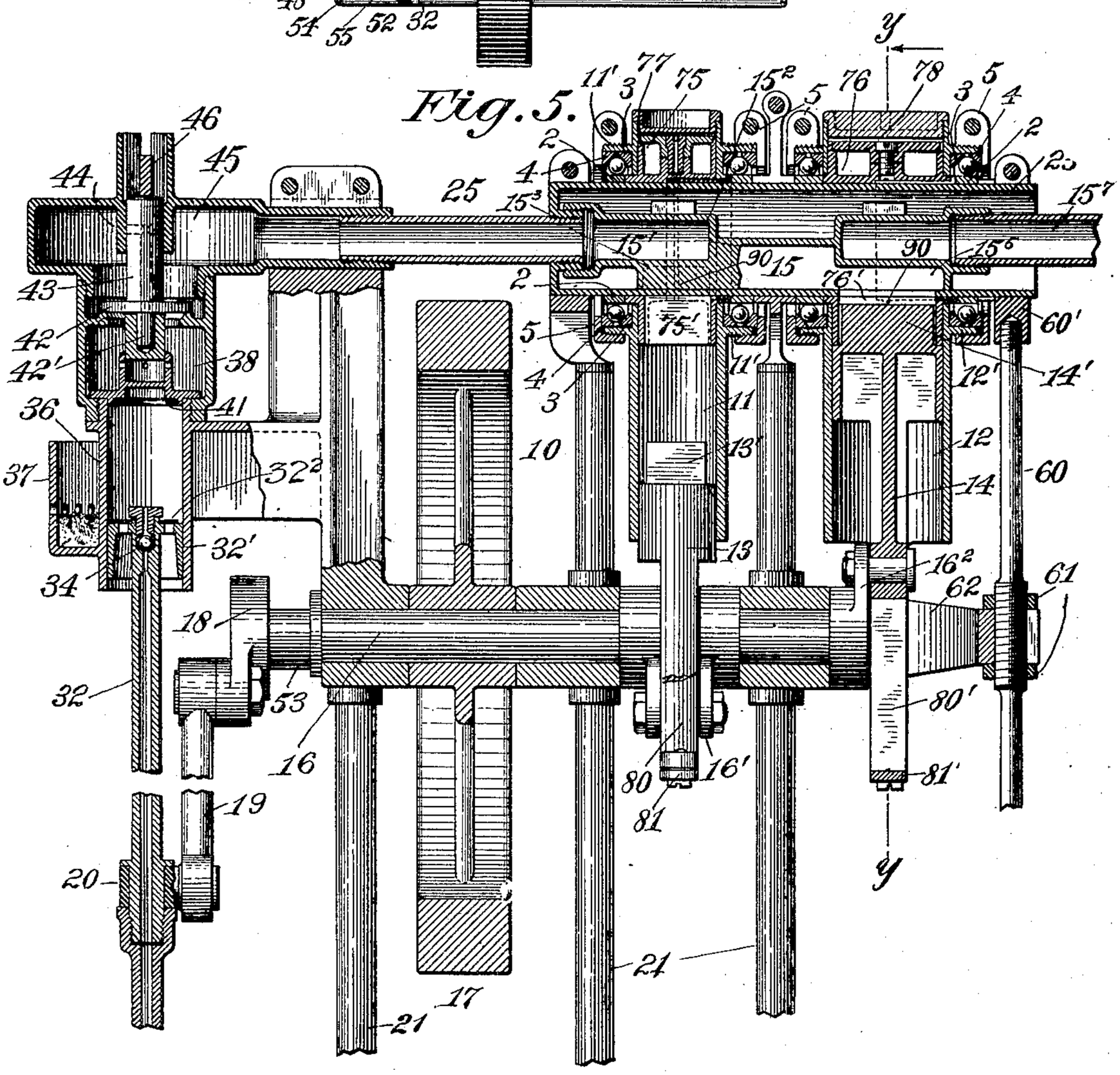


Fig. 5.



Witnesses:
C. W. Smith
R. F. Pittman

Inventor:
Horace L. Arnold
By his Attorney
F. A. Richards.

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H. L. ARNOLD.

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(No Model.) 4 Sheets—Sheet 3.

Fig. 6.

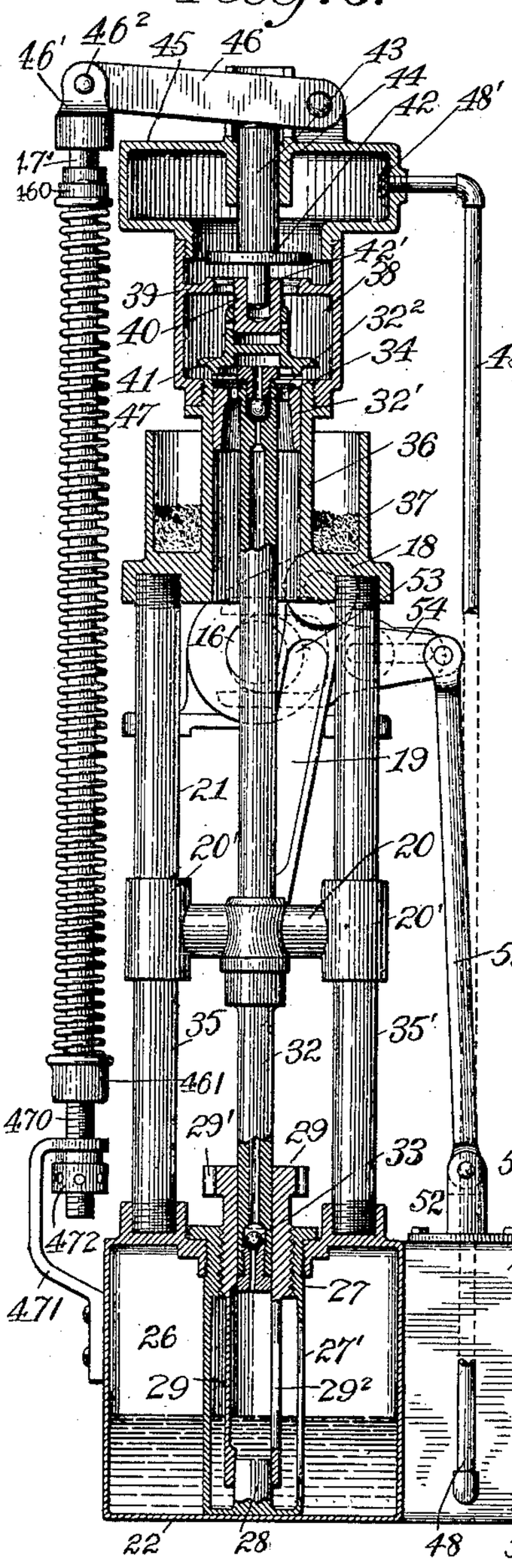


Fig. 7.

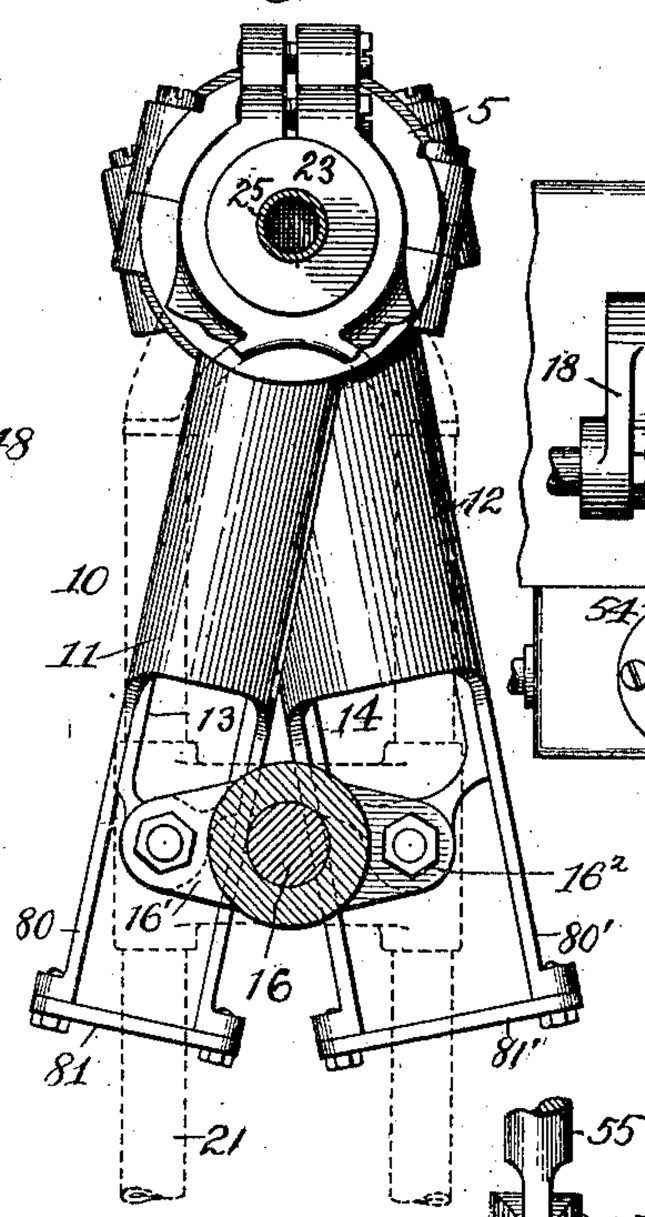


Fig. 8.

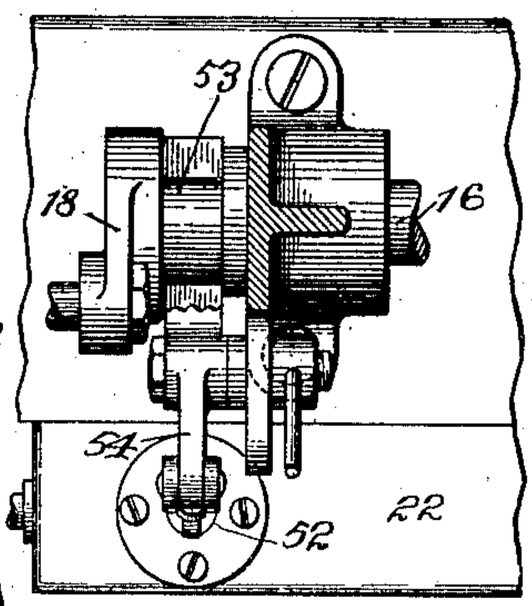
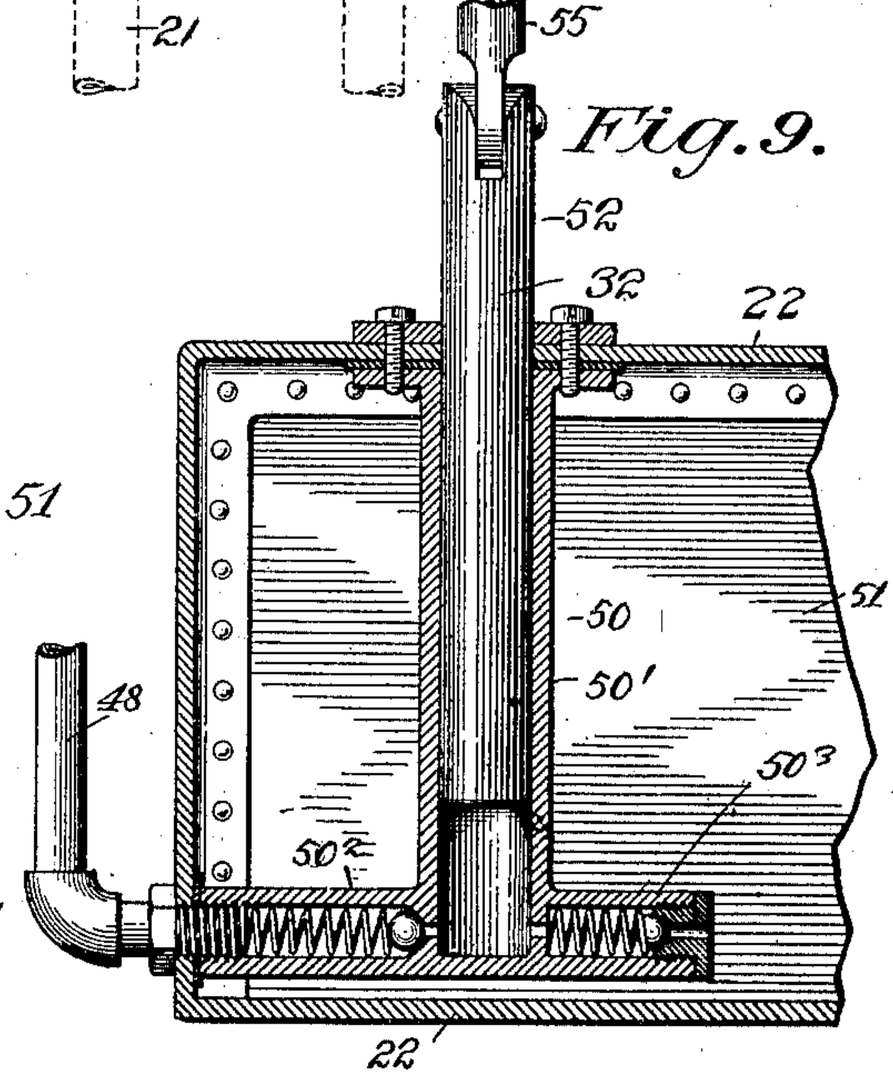


Fig. 9.



Witnesses:
C. W. Smith
R. H. Pittman

Inventor:
Horace L. Arnold
By his Attorney
F. A. Richards.

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(No Model.) 4 Sheets—Sheet 4.

Fig. 10.

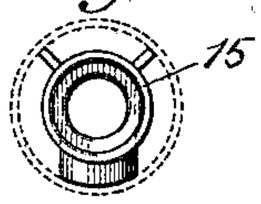


Fig. 11.

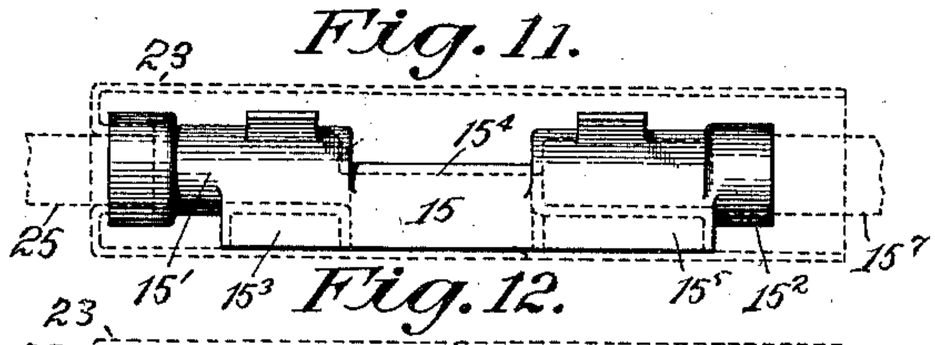


Fig. 12.

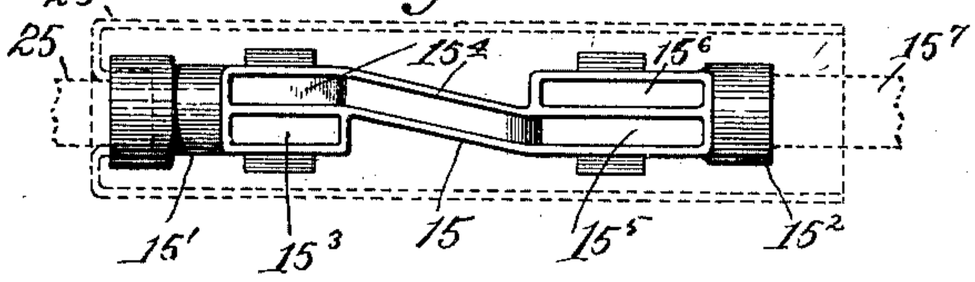


Fig. 13.

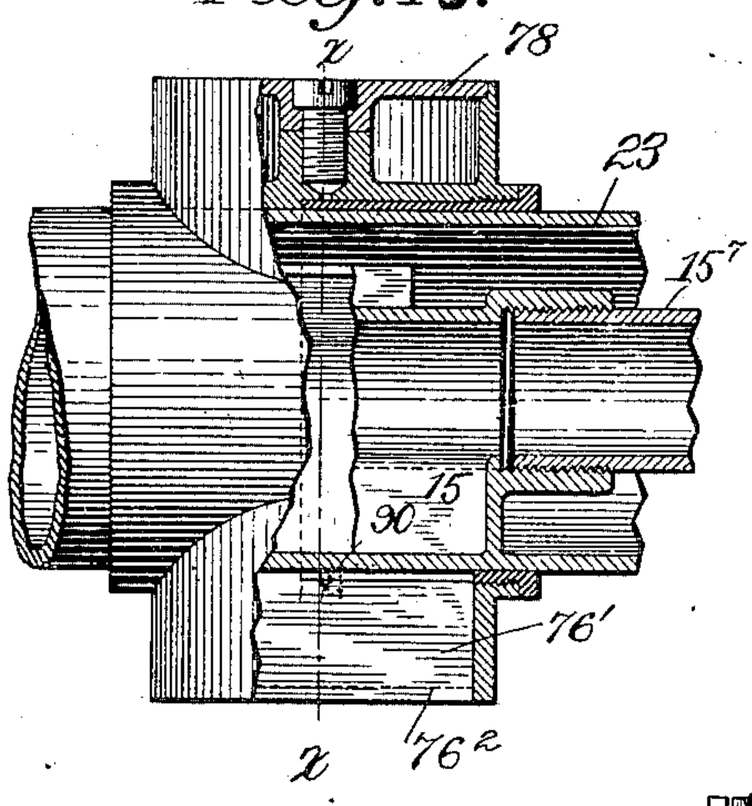


Fig. 14.

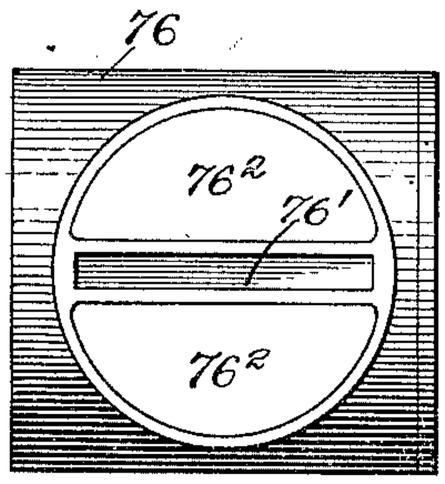


Fig. 15.

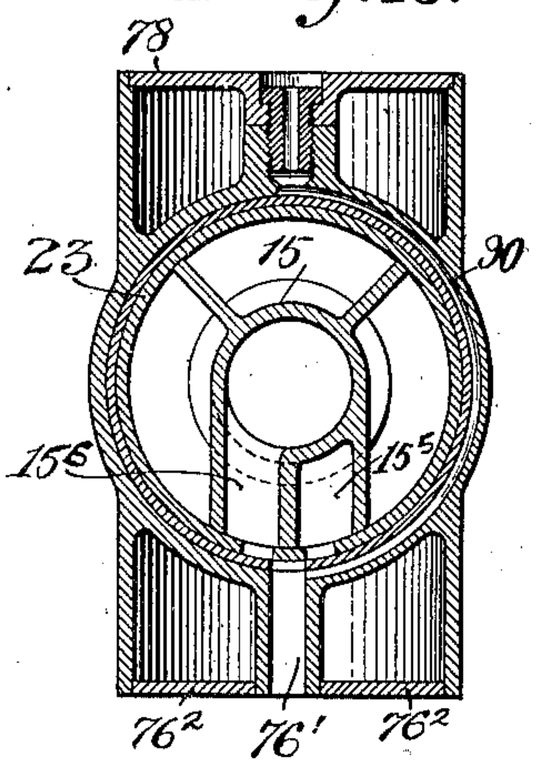
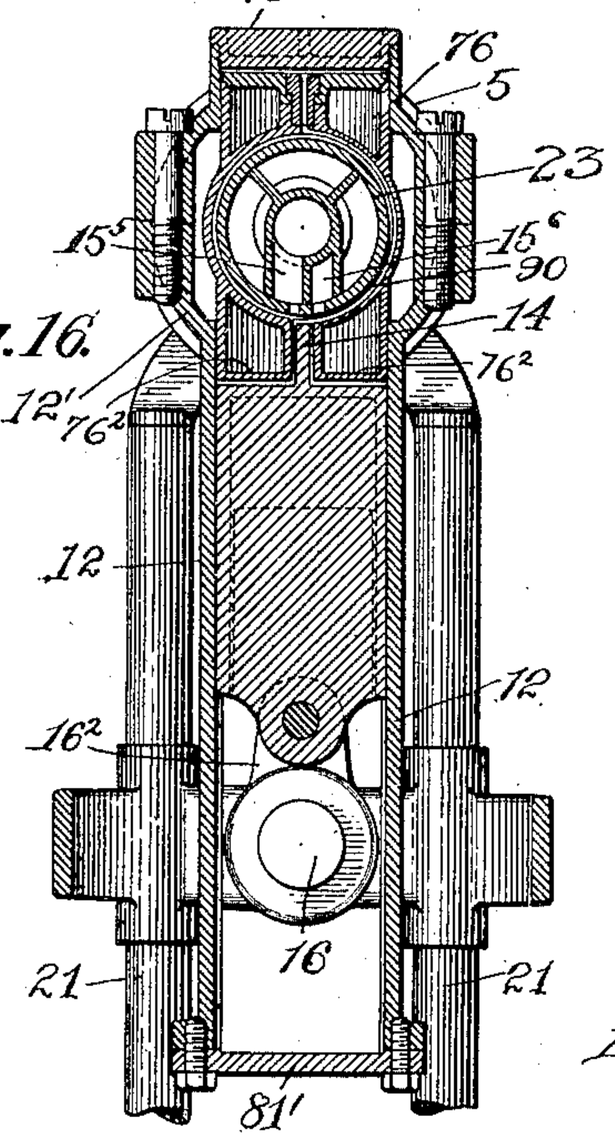


Fig. 16.



Witnesses:
C. W. Smith
A. D. Pittman

Inventor:
Horace L. Arnold
By his Attorney
F. A. Richards.

UNITED STATES PATENT OFFICE.

HORACE L. ARNOLD, OF BROOKLYN, NEW YORK, ASSIGNOR TO JOHN A. HILL, OF MANHATTAN, NEW YORK, N. Y.

COMBUSTION MOTIVE-FLUID GENERATOR.

SPECIFICATION forming part of Letters Patent No. 673,993, dated May 14, 1901.

Application filed February 17, 1900. Serial No. 5,575. (No model.)

To all whom it may concern:

Be it known that I, HORACE L. ARNOLD, a citizen of the United States, residing in Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Vapor-Generating and Motive-Fluid-Producing Means for Motors, of which the following is a specification.

This invention relates to pressure-supplying means for motors, and more particularly to those kinds of motors in which the motive fluid is generated by the combustion of liquid or gaseous fuel, although it is not limited thereto. In motors of this kind the gases or products of combustion are generally delivered directly to the motor at an excessively high temperature, and consequently the valve mechanism and other metallic parts thereof are apt to deteriorate, owing to the fact that it is impossible to keep them properly lubricated, and are soon cut, worn, and burned out and have to be replaced by others, causing heavy expense and vexatious delay. Various means have been devised for overcoming this trouble, and among these may be mentioned the common use of cooling devices—such as water-jackets, coils, &c.—for keeping the parts at such a temperature that they may be lubricated; but these devices have either been wholly or partially inoperative to accomplish the result desired or their employment has caused too rapid a cooling effect, followed by a corresponding loss in energy of the motive fluid. By all authorities it is admitted that when such devices are employed a large proportion of the heat of the expanded gases is abstracted by the cooled cylinder-walls and other parts of the motor, and consequently only a small proportion is retained and converted into useful effect. Primarily my invention relates to means for preventing this loss of energy in the motive fluid and for keeping said fluid at a temperature sufficient to drive the motor without interfering with the proper lubrication thereof; and it has for its object the provision of means for accomplishing this and other purposes, as will be hereinafter described.

In the accompanying drawings, Figure 1 is an end view of a motor with my invention applied thereto. Fig. 2 is a side elevation, partially in section. Fig. 3 is a detail, partially in elevation, of part of the opposite side of the motor. Fig. 4 is a plan view. Fig. 5 is a longitudinal vertical section of the motor and its accessories, certain parts being broken away. Fig. 6 is a section on line *a a*, Fig. 2, looking in the direction of the arrow. Fig. 7 is a section on line *b b*, Fig. 2, looking toward the right. Fig. 8 is a detail showing the means for actuating the pump for supplying water to the chamber containing the expanded gases. Fig. 9 is a partial section of one end of the water-tank, showing the pump well and plunger. Figs. 10, 11, and 12 are detached end, plan, and side views, respectively, of the ported distributing device for conveying the motive fluid to the motor. Fig. 13 is an elevation, partially in section, of one of the cylinder-valves detached. Fig. 14 is a bottom plan view of said valve. Fig. 15 is a vertical cross-section taken on line *x x*, Fig. 13; and Fig. 16 is a transverse vertical section on line *y y*, Fig. 5, looking in the direction of the arrow.

Like characters refer to similar parts throughout the several views.

My invention is shown applied to a compound engine or motor of the character set forth in my application filed April 2, 1898, No. 676,211; but it is distinctly to be understood that it is not limited to such use, for it may be employed with any suitable motor, that shown and hereinafter described being merely utilized for purposes of illustration.

In the drawings the motor is designated in a general way by 10, and comprises high and low pressure cylinders 11 and 12, respectively; pistons 13 and 14, respectively, working in said cylinders; ported pressure-conveying means, (designated in a general way by 15;) a crank-shaft 16, mounted in bearings of the motor-frame; two cranks 16′ 16^2, to wrist-pins of which the pistons 13 and 14 are respectively connected; a fly-wheel 17, carried by said crank-shaft; a crank 18, the wrist-pin of which is connected by a pitman 19 with a cross-head 20 for operating a feed-pump plunger; a skeleton framework, shown formed of separated tubes or rods 21; a base

22; a top tubular connection 23, and a brace-rod 60, uniting said connection 23 and said base.

Communicating with the ported distributing device 15 for conveying the motive fluid to the motor is a conduit 25 in communication with means for generating the motive fluid to be employed, and this generating means will hereinafter be described.

Base 22 of the motor-frame is shown constituting a receptacle having tanks for containing both the fluid to be vaporized and water to be employed in connection with the vaporizing and combustion devices, as will be hereinafter described; but these tanks may be separate from said base and otherwise located, if desired. Preferably located at one end of said base 22 is a fluid-tank 26 for containing the petroleum or other suitable hydrocarbon to be used, and in this tank 26 is a well or cylinder 27, having a longitudinal slot 27′ and carrying a piston 28 at its lower end, which coöperates with the barrel of a ported pump-cylinder 29, shown adjustably connected with the well or cylinder 27, a threaded connection being preferably employed and equipped with means whereby one of said cylinders may be adjusted with reference to the other to vary the amount of oil or other fluid delivered by the pump as desired. At one end this pump-cylinder is provided with a gear 29′, which is intermeshed with a cog-segment 30, shown pivoted at 30′ to the base, equipped with a knob or handle 30^2, by which it may be manipulated, and said cylinder 29 is slotted at 29^2 to permit the entrance of fluid thereto. Other means, however, may be substituted for those described for adjusting the pump-cylinder and the piston-cylinder within the tank with reference to each other without departure from this invention, and usual automatic connections may also be provided whereby when the motor runs too fast the amount of liquid fuel delivered to the combustion devices may be regulated to reduce the speed thereof, and when it runs too slow a reverse action may also automatically take place.

As will be obvious, when the pump-cylinder 29 is lowered within the well 27 the piston 28 will fill more of the space in said cylinder, and consequently a less amount of liquid will be supplied by the pump, and when the cylinder 29 is raised a greater amount of liquid will be contained therein and the pump will supply a larger quantity thereof to the combustion devices. By the means described the amount of fluid supplied may be nicely regulated and charges containing any desired quantity of such fluid may be readily fed to the combustion devices.

Fitted in pump-cylinder 29 is a tubular plunger 32, having a valve 33 at one end opening upward and a valve 34 at the opposite end for controlling the supply of hydrocarbon or other fluid to the combustion devices. This plunger is connected to a cross-head 20, driven by the crank 18 on crank-shaft 16, and said cross-head is equipped with sleeves 20′, having sliding engagement with guide-rods 35 35′, which rods also serve to brace the framework and to sustain the parts thereof. At one extremity the pump-plunger is provided with a ported piston 32′, the ports of which are covered on the forward stroke of said piston by a disk valve 32^2, which prevents the leakage of gas through said ports; but on the reverse stroke of said piston this valve will be lifted by the air compressed on such stroke, which will rush through the ports and commingle with the charge of liquid fuel fed by the pump-plunger into a cylinder 36, in which the charge is compressed and ignited, said cylinder being partially surrounded by a brazier 37, containing a suitable wick supplied with a small amount of liquid fuel. Any suitable charge-igniting device may be employed, the brazier being shown merely as a convenient appliance for this purpose. Connected to or forming a part of this cylinder 36 is a combined combustion and pressure-retaining chamber 38, having a diaphragm 39, from which projects a piston 40, rigid with such diaphragm, which coöperates with the chamber of a valve 41 to constitute a dash-pot therefor, said valve being normally seated over the opening between the cylinder 36 and said chamber 38. Located over an opening in the diaphragm of said chamber 38 is a valve 42, having a stem 42′, which extends into a chamber in the dash-pot piston 40. At one side said valve is equipped with a projection 43, moving in a suitable guide 44 of a chamber 45, which constitutes a reservoir for the expanded gases or products of combustion as they leave the combustion and pressure-retaining chamber 38. This valve 42 may be loaded in any suitable manner—as, for instance, by a lever 46, connected to adjustable spring-actuating devices 47, by which the pressure of the valve may be nicely regulated. These springs loosely surround rods 47′, the latter being attached at their upper ends to a cross-head 46′, pivoted at 46^2 to lever 46, and at their lower ends said rods are connected to a cross-head 461, having an eye 463, sleeved upon a rod 470, depending from a cross-head 460, against the under side of which the upper ends of said springs bear. At its lower end rod 470 is threaded and passes loosely through an opening in the arm of a bracket 471, attached to the base 22, and upon this threaded portion of said rod a nut 472 is placed, by the adjustment of which the tension of the springs may be regulated. When the valve 42 is lifted, the stem thereof bears against and raises lever 46, and the rods 47′ being connected to cross-head 46′, pivoted to said lever, it follows that cross-head 461 will be raised (its eye 463 slipping over rod 470) and that the springs 47 will be compressed against the under side of cross-head 460, and when the excess of pressure has passed out of the chamber 38 the valve 42 will be imme-

diately forced to its seat by the connections just described.

Connected with the chamber 45 is a conduit 48, communicating at one extremity with a barrel of a pump, (designated in a general way by 50,) said pump being located in a water-tank 51 of the hollow base 22. The plunger of this pump is designated by 52 and may be driven by any suitable means, that shown being a cam or eccentric 53, mounted on the shaft adjacent to the crank 18 for actuating the pump-plunger 32. This cam operates between a fork of a lever 54, pivoted to the framework and connected at its end remote from the cam with a pitman 55, articulated to the pump-plunger 52. At its upper end conduit 48 will preferably be provided with a rose or other suitable spray nozzle 48′ for delivering water in the form of spray into the chamber 45. The barrel 50′ of pump 50 has two branches at its lower end, 50^2 and 50^3, in which are mounted suitable valves for controlling the supply of liquid to the pump and its emission therefrom through the conduit 48.

It is to be understood that the invention is not limited to the use of a pump of any kind, for water may be delivered to the chamber 45 in any desired manner—for instance, by a connection from a main or other suitable source of supply.

Tube 23 at the top of the frame serves as a trunnion for the motor-cylinders 11 and 12 and also as a receptacle and support for the distributing device 15, which may be integral therewith, the latter having at one end a chamber 15′, in communication with the conduit 25, leading from the reservoir 45 and terminating at its opposite end in an abutment 15^2. Communicating with chamber 15′ is a port 15^3, in line with a passage in trunnion-tube 23 for conveying the motive fluid to the high-pressure cylinder 11, the exhaust from said cylinder being delivered into a port or passage 15^4, leading to an admission-port 15^5 of the low-pressure cylinder 12, which cylinder exhausts through passage 15^6 and pipe 15^7 to the atmosphere. Prolongations 80 80′ of the engine-cylinders, connected at one end by ties 81 81′, form guides for the piston extensions, which are connected with the wrists of the cranks 16′ 16^2. Integral valve-faces might be formed on the cylinders; but in such case they would be subjected to undesirable wear, and to prevent this a separate valve 75 76, respectively, is introduced in each cylinder and is seated in the bore thereof and in an extension of said bore on the opposite side of the trunnion-tube 23, the opposite end of each of said extensions being fitted with a head 77 78, respectively, the result being a short closed cylinder of the same diameter as the working cylinder and extending on the side of the trunnion-tube opposite the crank. In shape each of these valves conforms to that of two cylinders crossing each other, the interior of one of these cylinders being fitted to slide on the trunnion-tube and the two exterior portions of the intersecting cylinder being fitted in the cylinder-bore and its closed extension, as above described.

At its upper end each working cylinder is divided transversely in the horizontal plane of the axis of the trunnion-tube and the parts are secured together in such a manner that one part may be removed to permit the valve to be placed in position on the trunnion-tube, and when said valve is introduced two of the ends thereof form short plugs or pistons seated in the cylinder-bore and its extension, so that the valve will partake of the vibrating motion of the cylinder.

Each valve 75 76 is provided with a single port 75′ 76′, respectively located to communicate at the proper time with the supply and exhaust ports in the trunnion-tube, and a passage 90, Fig. 15, is formed in the wall of the valve for establishing communication at all times between both ends of the valve, whereby the pressure is always the same on each end and the valve is balanced or placed approximately in equilibrium.

To reduce clearance to a minimum, the cylinder extension-heads are made to just afford a clearance to the valve extensions, and both the upper and lower valve extensions have heads 75^2 76^2 secured to them, and also to accomplish this result the pistons 13 and 14 of the high and low pressure cylinders 11 and 12 are provided with projections 13′ 14′, respectively, which nearly fill the ports in the valves when the pistons are at the limit of their forward strokes. (See Fig. 16.)

A cylindrical lateral projection 11′ 12′ is located on each working cylinder on each side of its bore and at right angles thereto and surrounds the trunnion-tube 23, leaving an annular space between said tube and the internal surface of said projection sufficient to sustain a preferably three-point ball-bearing consisting of a ball-track 2, mounted on the trunnion-tube, an inner stationary ball-cup member 3, and outer adjustable ball-cup member 4, and an interposed series of balls, adjustment being effected by a flanged split ring 5, threaded on the exterior of said cylinder projection and provided with a pinch-screw to retain the adjustment, all as shown in Fig. 5. At its right-hand end the crank-shaft 16 is splined to receive the low-pressure crank 16^2, said crank being secured thereon by any suitable means—as, for instance, a set-screw (not shown)—and the high-pressure cranks may be secured to the shaft in the same manner. At its left-hand end crank-shaft 16 carries the pump-plunger-operating crank 18, said crank being secured to the shaft in any well-known manner.

As illustrated, the high and low pressure cranks are set at one hundred and eighty degrees apart, and the crank for operating the fluid-feed-pump plunger and the charge-compressor piston is set to have forty-five degrees effective angular advance when the high-

pressure crank reaches the end of its working stroke; but these cranks may be disposed in any other angular relation, if desired.

To secure a stable support for the right-hand end of the trunnion-tube 23, (see Figs. 2 and 5,) a screw-brace 60, having a split eye or sleeve 60′, surrounding the extremity of said tube and attached at its lower end to the base 22, is provided, and the intermediate portion of this brace is fitted with nuts 61 for supporting the outer end of a bowed extension 62, (see Fig. 4,) which is connected in any suitable manner to the right-hand end of one of the crank-shaft bearings.

In operation my improved mechanism works as follows: A small charge of liquid fuel is first placed in the brazier 37, partially surrounding the cylinder 36, if an igniting device be employed, and this charge is ignited and the flame thereof soon brings said cylinder to a high heat. The motor is then operated to cause the pump-plunger 32 and charge-compressing piston 32′ to deliver a charge of liquid fuel mixed with air to said cylinder 36 and to compress the same between the end of said piston and the valve 41. Combustion immediately takes place and the vapors or gases generated thereby attain sufficient tension to lift the valve 41 and escape into the pressure-retaining and combustion chamber 38, where the combustion of said charge is completed, and after attaining sufficient tension in said chamber the gas or vapor lifts the valve 42 and escapes into the reservoir or chamber 45, into which a spray of water from tank 51 is delivered by the pump 50. This water immediately flashes into steam and by this change of condition absorbs heat from the expanded gas or vapor in the reservoir or chamber 45 and reduces the temperature of the same to a condition fit to enter a working cylinder of the motor, and from the chamber 45 the compound motive fluid, consisting of the gas or vapor and steam formed by vaporization of the water, passes through the transmission pipe or conduit 25 and into the chamber 15′ of the distributing device 15, by which it is delivered to the high-pressure cylinder 11 and operates the piston thereof to cause the movement of the crank-shaft. From this cylinder it is delivered by the connections described to the low-pressure cylinder and from thence escapes to the atmosphere.

One of the advantages of this improvement is that the amount of air introduced into the cylinder 36, in which the charge is compressed and ignited, may be of minimum quantity, since the volume of air augmented by the gases of combustion is further increased in the chamber 45 by a volume of steam produced in said chamber by the vaporization of the water injected therein. By this means the temperature of the gases is reduced between the combustion-chamber and the motor to prevent heating said motor at a point where the lubrication will be ineffective, and at the same time a compound motive fluid is obtained having a composition adapted for operating the motor mechanism in the best manner and for lubricating the surfaces of the pistons and valves, so that they will always operate correctly.

A further advantage in the use of a compound motive fluid of the kind described resides in the fact that it may be employed expansively or with a cut-off in a manner common in steam-engines, and consequently will accomplish more work than the usual motive fluid supplied by the combustion of a charge of fuel.

Many details of my invention may be variously modified without departure therefrom, and the invention is not limited to the location or arrangement of the parts shown and described. For instance, the reservoir-chamber 45, in which the heat from the gases produced by combustion is absorbed by water injected into said chamber, may be located at a different distance from the combustion and vapor-generating devices, if desired, and may be connected therewith in a different manner; so, too, the location of the water and liquid-fuel feeding pumps is immaterial, and these pumps may be replaced by those of a different type without departing from this invention.

As above stated, the kind of motor shown is simply for exemplification of the invention, and the invention is not limited thereto, as it may be used with any form of motor suitable for the purpose.

No claim is herein made to certain parts of the vapor-generating and combustion devices, as these constitute the subject-matter of my application filed February 17, 1900, Serial No. 5,576.

Having described my invention, I claim—

1. In mechanism of the class specified, the combination with a chamber in which the charge is compressed and ignited, of means operative to feed a charge to said chamber and to compress said charge therein; a pressure-retaining chamber communicating with the chamber in which the charge is compressed and ignited; a reservoir in communication with said pressure-retaining chamber; and means for injecting water into said reservoir.

2. The combination, with a feed-pump, of a cylinder in which the charge delivered by said pump is compressed and ignited; a piston working within the cylinder and having ports for the admission of air thereto, said piston being actuated by the plunger of the feed-pump; a pressure-retaining chamber; a valve between said chamber and the cylinder; a reservoir communicating with said chamber; and means for injecting water into the reservoir.

3. The combination, with a cylinder in which a charge is compressed and ignited, of a piston operative within said cylinder; means for feeding said charge to the cylinder; a pressure-retaining chamber; a valve located be-

tween the cylinder and said chamber; a reservoir communicating with the pressure-retaining chamber; means for injecting water into said reservoir; and a conduit leading from the reservoir to a motor.

4. The combination, with a cylinder in which the charge is compressed and ignited, of a piston operative therein and having a tubular piston-rod; means for forcing a charge of fuel through the piston-rod and piston and into the cylinder; a pressure-retaining chamber; a valve between said chamber and said cylinder; a reservoir; means for injecting water into the reservoir; a valve between the reservoir and said pressure-retaining chamber; and a conduit leading from the reservoir to a motor.

5. In mechanism of the class described, the combination, with a compressing-cylinder, of means for heating the same to ignite the charge; a pump-plunger having a charge-compressing piston working within said cylinder; a pressure-retaining chamber; a valve between said chamber and the compressing-cylinder; a reservoir communicating with said pressure-retaining chamber; a loaded valve normally covering the opening between said chamber and said reservoir; means for injecting water in the form of spray into said reservoir; and a conduit for conveying the compound fluid generated in said reservoir to a motor.

6. In mechanism of the class described, the combination, with a cylinder in which the charge is compressed and ignited, of means for supplying a mixed charge of air and liquid fuel to said cylinder and for compressing the same directly therein; a pressure-retaining chamber; a valve in said chamber for normally closing the opening therein communicating with the cylinder; a reservoir or chamber having a valve; a water-supply pipe for injecting water into said reservoir; and a pump for forcing water through said pipe.

7. The combination, with a cylinder in which the charge is compressed and ignited and with means for feeding a charge of liquid fuel thereto and for compressing the same directly therein, of a pressure-retaining chamber; a valve for closing the outlet to said chamber; a reservoir in communication with said chamber; a tubular connection for supplying water to said reservoir; a pump for forcing water through said connection; means for actuating said pump; and a conduit for conveying the compound motive fluid generated in said reservoir to a motor.

8. The combination, with means for compressing and igniting a mixed charge of liquid fuel and air, of a pressure-retaining chamber; valves for closing the inlet and outlet openings to said chamber; a reservoir constituting an extension of said chamber; means for conveying a supply of water to said reservoir for cooling and thereby reducing the temperature of the vapor contained therein; and a conduit for conveying the compound motive fluid, consisting of steam and vapor, to the working cylinder of a motor.

9. In mechanism of the class specified, the combination, with means for generating vapor from a mixed charge of liquid fuel and air, comprising a feed-pump, of a liquid-fuel tank having a longitudinally-slotted well or cylinder carrying a piston at its lower end, and a slotted barrel for said feed-pump adjustably secured in said well or cylinder.

10. In mechanism of the class specified, the combination, with means for generating vapor from a mixed charge of liquid fuel and air, comprising a feed-pump, of a liquid-fuel tank having a longitudinally-slotted well or cylinder carrying a piston at its lower end; a slotted barrel for said feed-pump adjustably secured in said well or cylinder and adapted to regulate the amount of fuel fed by said pump, said pump-barrel having a gear on its upper end; and a cogged segment pivotally attached to the outside of said tank and meshing with said gear.

11. The combination, with a cylinder and a brazier for heating the same, of a tubular pump-plunger having a perforated piston at its upper end, the piston working in said cylinder; a liquid-fuel-supply chamber coöperating with said plunger; a pressure-retaining chamber communicating with said cylinder; a valve controlled by a dash-pot for normally closing the opening between said chamber and cylinder; a reservoir communicating with said pressure-retaining chamber; a loaded valve for controlling the efflux of the products of combustion from the pressure-retaining chamber to said reservoir; a pipe through which water is injected into said reservoir; a pump for forcing water through said pipe; a conduit communicating with the reservoir and the working cylinder of a motor; and means actuated by the motor for driving the pump.

12. The combination, with a motor-frame, of a cylinder; means for supplying a charge of liquid fuel to said cylinder; a charge-compressing piston movable within the cylinder and having ports for the admission of air thereto; means for operating said piston; a valve closing the end of the cylinder communicating with a pressure-retaining chamber; a pressure-retaining chamber communicating with and extending from the cylinder; a valve normally closing the pressure-delivery end of said chamber; a reservoir communicating with the pressure-retaining chamber; means for injecting water into said reservoir; and a conduit connecting the reservoir with a motor.

13. The combination, with a cylinder, of a perforated piston operative to compress a charge in said cylinder; a valve for closing the perforations in the piston during its charge-compressing stroke; a tubular piston-rod; a fluid-pump cylinder with which said piston-rod coöperates; a pressure-retaining chamber extending from and in line with the

cylinder; a valve intermediate the cylinder and the pressure-retaining chamber; a reservoir extending from and in line with the pressure-retaining chamber; a valve intermediate said reservoir and chamber; means for injecting water into said reservoir; a motor; and a conduit connecting the reservoir and the motor.

14. The combination, with a cylinder, of a piston having a perforated head and reciprocatory to compress the charge in said cylinder; a valve located over the perforations in the piston-head; a tubular pump-plunger projecting from said piston; valves carried by said plunger; a pump-cylinder with which the pump-plunger coöperates; means for actuating the pump-plunger; a pressure-retaining chamber connected to and in line with the cylinder in which the charge is compressed; a valve intermediate said cylinder and chamber; a reservoir connected to and in line with the pressure-retaining chamber; a valve located between said reservoir and chamber; a pipe for conveying water to said reservoir; a motor; and a conduit connecting the motor with the reservoir.

HORACE L. ARNOLD.

Witnesses:
FRED. J. DOLE,
C. H. WEED.