No. 864,830. PATENTED SEPT. 3, 1907.

H. CHARLES.

EXPLOSIVE ENGINE.

APPLICATION FILED FEB. 10, 1905.

3 SHEETS—SHEET 1.

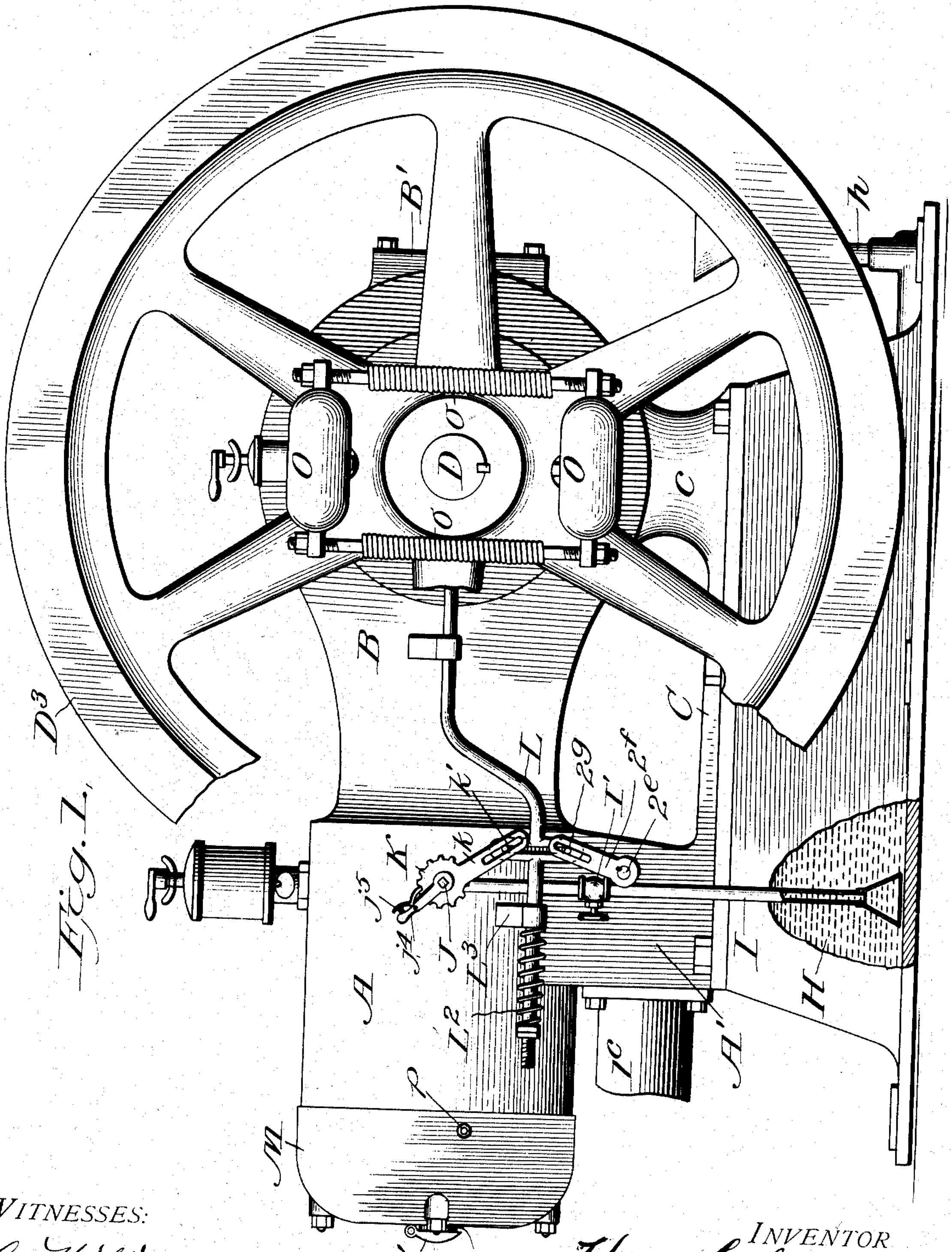

Fig. 1.

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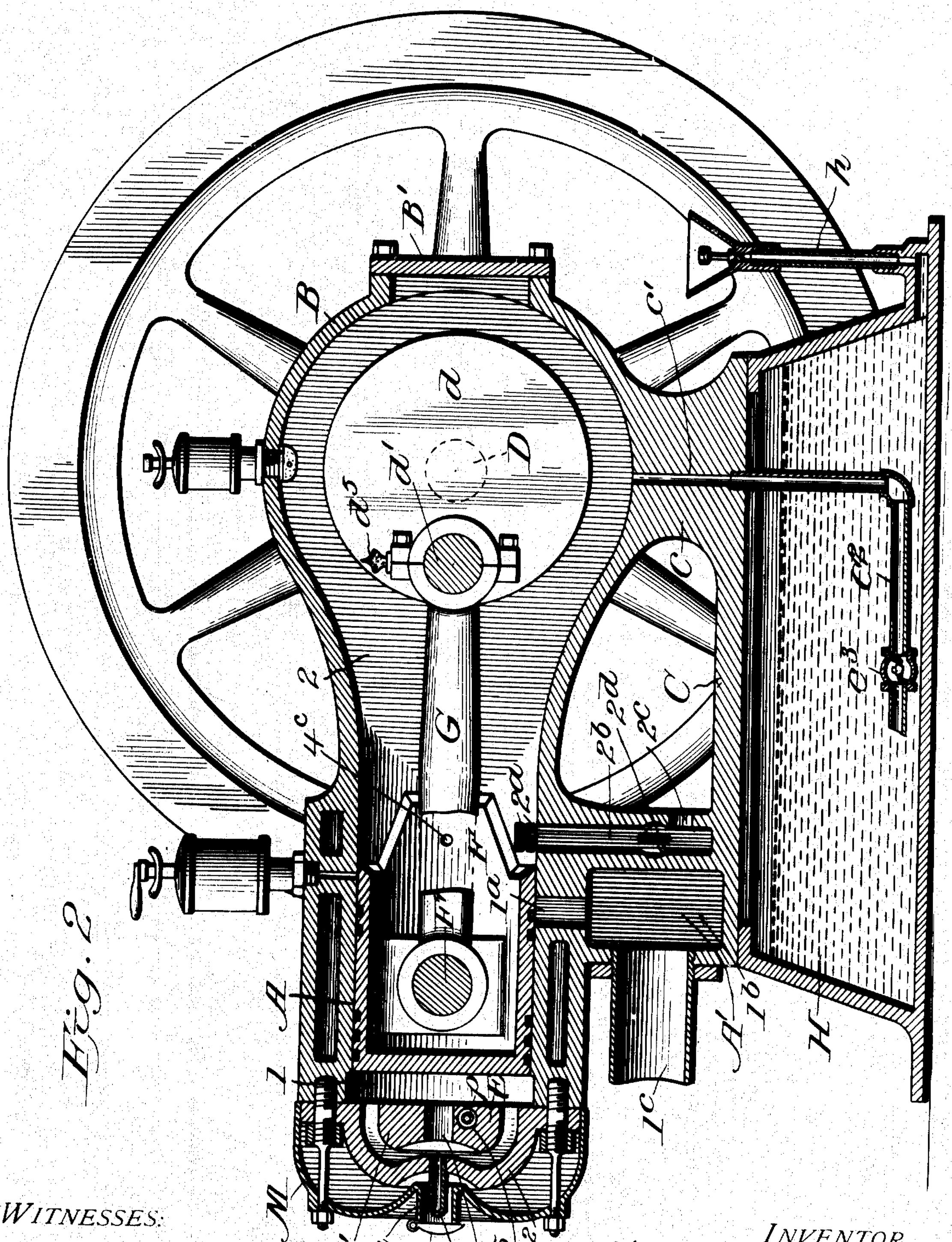

Fig. 2

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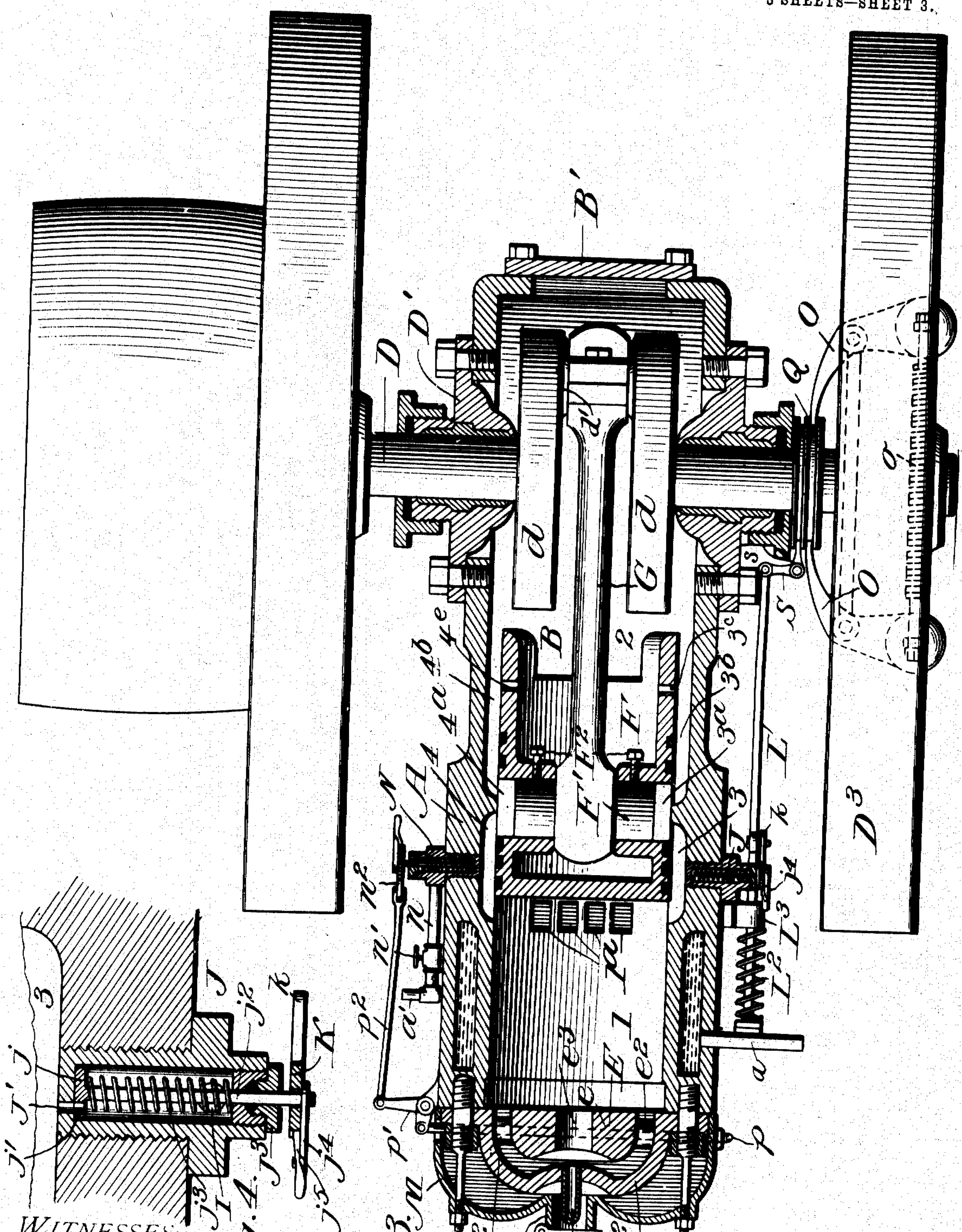

Fig. 4.

Fig. 3.

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UNITED STATES PATENT OFFICE.

HOMER CHARLES, OF RAPID CITY, SOUTH DAKOTA.

EXPLOSIVE-ENGINE.

No. 864,830. **Specification of Letters Patent.** **Patented Sept. 3, 1907.**

Application filed February 10, 1905. Serial No. 245,096.

To all whom it may concern:

Be it known that I, HOMER CHARLES, of Rapid City, in the county of Pennington and State of South Dakota, have invented certain new and useful Improvements in Explosive-Engines; and I hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, which form part of this specification.

This invention is an improvement in explosive engines, operative with any of the usual explosive mixtures, but particularly designed to use liquid-hydrocarbons such as petroleum or gasolene.

The object of the present invention is to make a very simple, compact and economical engine, capable of operating for long periods without perceptible wear; easy of regulation, reversible at will; and operating upon the two-cycle principle so as to give the greatest efficiency.

In the engine the main piston serves as the working and pump-piston, and also as the main valve for regulating the admission of air to the compression chamber, the fuel and water to the vaporizing chambers, the admission of explosive mixtures to the working-chamber, and the exhaust from said chamber. I also provide means for regulating the admission of air and oil or fuel so that the explosive mixtures will be practically uniform in quality, although varied in quantity, which means is controlled by a governor and enables the engine to be operated at a practically constant and uniform speed regardless of variations in the load. I also provide novel means for automatically regulating the temperature of the igniting head, or working-chamber, so that the explosive mixture will not be prematurely ignited; and by the novel construction and method of operating my engine the dangers and annoyances of "back-firing" are obviated and the engine rendered exceedingly sensitive to the action of the "governor".

The various novel features and combinations of parts embraced within the invention are summarized in the claims hereinafter enumerated, and in order to impart fully and clearly the operation and construction of a practical one-cylinder engine embodying the invention I refer to the accompanying drawings and describe the same in detail as follows—

In the drawings—Figure 1 is a side elevation of the complete engine partly broken. Fig. 2 is a longitudinal vertical section thereof. Fig. 3 is a longitudinal horizontal section thereof. Fig. 4 is a detail sectional view of the oil inlet-valve.

The cylinder A containing the working or explosive chamber 1 and the housing B for the crank-shaft, are preferably cast integral with a base-plate C connected to the cylinder by a hollow leg A′, and to the housing by a leg *c*, so as to support the cylinder, preferably in exactly horizontal position; when the base is horizontal. The housing incloses the crank *d* of the main shaft D, said crank being preferably formed by disks and connecting wrist-pin *d′*, for the purpose of reducing the air capacity of the crank-chamber, which forms the pump-chamber 2 of the engine, and is air-tightly closed on all sides, the bearings of the main-shaft in the sides of the chamber being stuffed to prevent leakage of air. Access can be had to the pump-chamber 2 through openings in its sides and end, the side openings being closed by the journal-bearing plates D′ of the main-shaft, and the end opening by a plate B′ all securely bolted to the housing as shown. Access can be had to the working-chamber by removing the head E thereof.

The working and pump-chambers are separated by the piston F which is connected to the crank-shaft by a pitman G, one end of which is directly connected to the crank-wrist-pin *d′*, and its other end to a pin F′ secured in a transverse opening in the piston by bolts F^2, or other convenient manner, doing away with any piston-rod and guides.

The pumping and working-chambers have no direct communication, but formed in the walls of the casing and housing, intermediate the pump and working-chambers, are mixing-chambers or recesses 3 and 4, which are normally closed by the piston so as to be out of communication with either the pump or working-chamber, but when the piston is at or near the end of its working (inward air-compressing) stroke, and after the exhaust ports have been uncovered, are momentarily put in communication with the working-cylinder, by the piston slightly uncovering the ends of the chambers 3 and 4 as in Fig. 3;—and at same time said chambers 3 and 4 are momentarily put into communication with pump-chamber 2, by means of ports or passages 3^a 4^a in the walls of the piston, which at that time establish communication between the inner ends of chambers 3 and 4 and channels or ports 3^b 4^b, opening into the pump-chamber as shown in Fig. 3.

The exhaust ports 1^a are arranged near the inner end of the working-chamber, so as to be uncovered by the piston just before the chambers 3 and 4 are opened thereby, and will be closed by the piston just after said chambers are closed. The exhaust ports all communicate with a common passage 1^b in the leg A′ from which the waste products can escape through a pipe 1^c to any desired point of discharge. Air is admitted into the pump-chamber only through ports 2^a, connecting with a common passage 2^b in leg A′, into which air is admitted through an opening 2^c, and a valve 2^d is placed in said passage to regulate the admission of air therethrough.

Preferably the engine is mounted upon a fuel reservoir of which base-plate C forms the top, and said reservoir is preferably air-tight, so that pressure can be accumulated therein sufficient to insure the proper feed of fuel to the vaporizing chamber 3 with which it communicates through a pipe I, as shown in Figs. 1 and 3.

The admission of oil from pipe I into the chamber 3 is controlled by a suitable regulating and controlling valve J preferably like that shown in Fig. 4, and a cut-off valve I′ may be arranged in pipe I to cut off oil entirely, when the engine is shut down.

The regulating valve J preferably consists of a hollow casing connected with pipe I, and screwed into an opening in the side-wall of the engine, communicating with chamber 3. In the inner end of this casing is a small aperture J′, which is controlled by a disk-valve j having an aperture j' adapted to register with aperture J′. Disk j is fixed on a stem j^2 which extends outside the casing through a suitable stuffing box J^3, and a spring j^3 is interposed between the stuffing box and disk so as to seat the latter closely against the head. On the projecting end of the stem is hung a notched plate K, having a depending arm k adapted to be connected to the governor as hereinafter explained. Fixed on the outer end of the stem j^2 is a hand-lever j^4, provided with a catch j^5 adapted to engage the notches in the plate K, and lock the valve thereto. By varying the engagement of the hand-lever and plate, the apertures in disk j can be thrown more or less in or out of register with aperture J′, and thus regulate nicely the admission of fuel or oil into chamber 3; and by shifting plate K the register of the said apertures can be varied without disturbing the adjustment of the valve relative to the plate.

On the stem 2^e of the air valve 2^d is fixed an arm 2^f which extends toward and is connected to the sliding bar L hereinafter referred to. The air-valve 2^d and the oil or fuel valve J are preferably arranged at the same side of the engine and are both connected to the governor, and they are so relatively adjusted that the amount of oil admitted into the mixing-chamber 3 is directly proportionate to the amount of air admitted into the pump-chamber, so that the explosive mixture used in the working-chamber will be substantially uniform in composition at all times, although the quantity thereof admitted into the working-chamber be varied, and, as hereinafter explained, the quantity of the explosive mixture admitted into the working-chamber depends upon the amount of air admitted into and compressed in the pump-chamber. I have found this feature of maintaining the uniformity of the explosive mixture most essential to the successful economical operation of an explosive engine, and this method enables the engine to be controlled even more quickly than a steam engine can be, and renders it even more sensitive to the action of the governor, as hereinafter explained.

It will be observed by reference to Figs. 2 and 3 of the drawings that the head E is chambered so as to leave a central portion or mass e which is practically separated from the outer portion or shell E^2, but connected therewith by stays e^2. This part e has a central aperture e^3 directly opposite a tube e' fixed in a small aperture in the shell E^2 of the head, said tube being closed at its outer end. The gases can circulate around this mass e and then into the tube e'. The mass e becomes very hot and will retain its heat for a long time and in practice the temperature of mass e remains at such a high point that when the gases are compressed, by the return stroke of the cylinder and forced into contact with this mass e, they will be ignited by its heat the instant the pressure on the gases is relaxed, which occurs when the piston reaches the end of its return stroke and makes the slightest forward movement. So long as the engine is in operation this mass e is maintained at the desired temperature by the heat of the burning gases in the working-chamber. When it is desired to start the engine the tube e' may be heated in a very few moments by a torch applied to the exterior thereof, to cause ignition of the gases admitted into the working-chamber, thereafter the retained heat in the mass e is sufficient to ignite the gases as described. The mass e will retain its high temperature for a long time after the engine has stopped, as much as 15 to 30 minutes, under ordinary conditions, and being isolated from the shell E^2 it does not part with its heat so rapidly as the shell. As a further protection against loss of heat, the shell may be inclosed in a casing M which is attached to the head as shown and is provided with a central tube m surrounding the projecting tube e' and having its end closed by door m' through which access can be had to tube e' to heat the latter when necessary.

Oil may be supplied to mixing-chamber 4 in the same manner as it is supplied to chamber 3 if desired, but I prefer to use chamber 4 for the purpose of moistening a portion of the air admitted into the explosive chamber, by mixing it with steam or hot water which is admitted into chamber 4 through the valve N preferably constructed like the valve J above described and is automatically controlled as hereinafter described.

Just sufficient water or steam is admitted into chamber 4 to provide additional explosive elements in the mixture and to regulate the temperature of the burning gases so that if the temperature rises above the desired point more water or steam is admitted and if it falls below the desired point the supply of steam or water is lessened. In practice I have found that this enables me to regulate and maintain the temperature of the igniter at the desired point so that there will be no danger of premature ignition of the gases in the working-chamber, and consequent hammering and shock attendant upon such premature firing.

The valve N may be connected to any suitable steam or water supply, and as shown in the drawing, it is connected by pipe n with a pipe a' leading from the water-jacket of the cylinder A, the water being supplied to said jacket from a pipe a. The pipe n may be provided with a cut-off valve n' if desired. The valve N is adjusted to supply the proper amount of water or steam to the chamber 4 required for the normal operation of the engine, and it may be automatically regulated by means of a thermostatic regulator which will increase or diminish the supply according to the temperature of the igniting head E. For this purpose a thermostatic tube or rod p is passed through an opening e^5 in the head E, said rod or tube being formed of a composition of metals which will cause expansion or contraction of the rod by heat. One end of this rod is fixed, and the other end is connected to the short arm of an amplifying lever p' the long arm of which is connected by a rod p^2 with a short crank-arm n^2 on the stem of the valve N, (see Fig. 3).

If the temperature rises the expansion of the rod causes more or less opening of the valve N. If the temperature falls below the desired point the contraction of the rod causes an increased closing of the valve and thus the supply of water or steam to chamber 4 is automatically regulated. This feature, I find in practice, is a very valuable one in connection with the engine.

I have shown in the drawings one form of governor for regulating the oil and air supply in the manner above described, this governor consisting of centrifugally acting weighted levers O O, pivoted on the fly-wheel D^3 attached to the shaft D on the opposite side of the shaft and connected by controlling springs *o* in the usual manner; the inner arms of said levers engage a sliding collar Q splined on the shaft, and a groove in said collar is engaged by the short arm of a bell-crank-lever S pivoted on a bracket *s* attached to the casing and the other arm of lever S is connected to the sliding bar L above referred to. This bar has its rear end supported in a guide L^3 attached to the cylinder or casing, and is normally retracted by means of a spring L^2 shown in the drawings. The plate *k* controlling the oil-valve is adjustably connected with bar L in any suitable manner as by a slot and pin, as shown at *k'*, and the arm 2^f of the air-valve 2^d is similarly connected to the bar L by a pin and slot as shown at 2^g. The result is that if the bar L is moved by the governor or by the spring L^2 the air-valve 2^d and the oil-valve J are simultaneously shifted and when the oil supply is reduced the air supply is also reduced and vice versa, so that the explosive mixture utilized in the engine will be practically of constant uniformity whether the amount of such mixture be greater or less. The amount of mixture used in one explosion in the working-chamber depends upon the amount of air just previously admitted into the pump-chamber; the greater amount of air admitted the greater the compression will be; and the lesser the amount of air admitted the lesser the compression will be thereon. The wrist-pin may be lubricated by means of a wiping lubricator d^5 as indicated in the drawings; the oil may be supplied to the reservoir H through a filling tube *h* provided with a suitable stopple as indicated in the drawings.

Operation: The piston on its inward, or working-stroke under the action of the expanding gases in the working-chamber, first cuts off the air inlet to the pump-chamber and then compresses such air therein, meanwhile keeping the mixing-chambers 3 and 4 entirely closed. The air, it will be observed, is admitted into the chamber 2 without admixture with any explosive. As the piston nears the end of its inward stroke it uncovers the exhaust ports 1^a allowing the burned gases to escape therethrough to the atmosphere, and immediately thereafter communication is established between the mixing-chambers and the working-chamber and simultaneously the ports in the piston establish communication between the pump-chamber and the mixing-chambers, whereupon the air in the pump-chamber rushes violently through the mixing-chambers taking up the small modicums of fuel therein, atomizing it and rushing therewith into the working-chamber. As the piston starts on its return stroke it first closes communication between the mixing-chambers and the pump and working-chambers and keeps the mixing-chambers closed and isolated; it then also closes the exhaust ports 1^a and during the remainder of the non-working stroke of the piston the explosive mixture which has been admitted into the working-chamber is compressed.

I find it desirable to so proportion the ports and the parts that the explosive mixture shall be compressed to a very high extent, say about 70 pounds, by the time the piston reaches the end of its return stroke. As the piston passes the dead center the compression is slightly lessened, whereupon explosion occurs. I have found in practice that so long as the explosive mixture is under increasing pressure it will not explode without direct ignition, but that as soon as the pressure begins to relax it will ignite or explode very readily with comparatively low heat, and owing to this fact I am enabled to successfully use an igniting head or hot plate, which I shall hereafter describe for igniting the gases, doing away with any direct flame or sparking apparatus. As soon as the gases are ignited the piston is driven forward and the cycle of operations above described is repeated. Before the ignition occurs, however, and just as the piston nears the limit of its return stroke communication is momentarily established between the mixing-chambers 3 and 4 and the pump-chamber 2 through small relief ports 3^c and 4^c in the sides of the piston, as shown in Figs. 2 and 3. These relief ports are for the purpose of reducing the pressure of the gases which happen to be confined in the mixing-chambers during the return stroke of the piston. The pressure in the mixing-chambers is therefore reduced to atmospheric pressure before the piston starts on its return stroke, and this reduction of pressure in the mixing-chambers facilitates the introduction of fuel thereinto, as hereinafter explained.

It will be observed by reference to Fig. 2 that on the return stroke the piston passes considerably in the rear of the air-ports 2^a and consequently to this extent produces rarefaction of the air in the chamber 2 which causes an inrush of air through said ports into said chamber and hastens the reduction of the pressure in the mixing-chambers 3 and 4. On the forward stroke the air in pump-chamber 2 is confined by the closing of the ports 2^a and then is compressed by the further forward movement of the piston, and I purposely make the chamber 2 small in area so as to obtain a considerable degree of pressure on the air during this forward stroke of the piston. It will be observed that I do not admit into the pump-chamber 2 any gases, or explosives, or oil, simply using it as an air-pump-chamber, and by so doing there is no possibility of any "back-firing", or retarding explosion, which is so common a defect in engines wherein explosive mixtures are compressed in the pump-chamber. If any oil happens to get into chamber 2 from the lubricating apparatus, it is drained therefrom into the reservoir through the aperture *c'* which may be connected at the bottom with a pipe c^2 and provided with a check valve c^3 on its lower end, which is below the surface of the oil in the reservoir. By reason of this communication between the pump-chamber and the reservoir a pressure will be maintained in the reservoir equal to that in the pump-chamber, and this pressure is utilized to feed the oil through pipe *i* to chamber 3, and as the pressure in this chamber at the time the oil is fed therein is not above atmospheric pressure no difficulty is experienced in feeding the proper amount of fuel thereinto and no special pumping apparatus is required to maintain the supply of oil. The air rushing through the mixing-chambers 3 and 4 at the moment communication is established between them and the pump and explosive chambers, sweeps up the small quantities of oil and water admitted into said chambers and vaporizes the same forming an explosive mixture; thus the non-explosive air escaping from the pump-chamber is converted into an explosive mixture when it enters the working-chamber, and the resultant mixture is so thorough that perfect combustion is realized when the gas is ignited.

In practical operation I have used engines like that shown in the drawings with a consumption of less than one quart of oil per horse power per four hours on full load, and have not experienced any difficulty from clogging deposits. The engine operates practically noiseless as the greatest amount of explosive mixture admitted at any one time, even when ignited, reduces to almost atmospheric pressure by the time the piston reaches the end of its working-stroke.

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

1. In an explosive engine, the combination of the working-chamber, the pump-chamber, a mixing chamber intermediate the pump and working chambers, and through which the air is passed from the pump-chamber to the working-chamber, means for normally isolating said mixing-chamber from the other chambers, and means for venting said chamber to reduce any retained pressure therein before the oil is admitted thereto, substantially as described.

2. An explosive engine, having a working-chamber, a pump-chamber, mixing-chambers intermediate the pump and working-chambers, means for admitting liquids or fuels into said mixing chambers, and a piston common to and working between the working and pump-chambers, and adapted to establish communication between the mixing-chambers and the pump and working-chambers when at the end of its working stroke, and to isolate the mixing-chambers at other times; with means for relieving the confined pressure in the mixing-chambers before they are again placed in communication with the pump and working-chamber.

3. In an explosive engine, a working-chamber, a pump-chamber, a piston common to both chambers, a mixing-chamber intermediate the working and pump-chambers, normally isolated from both chambers by the piston,—and a port in the piston adapted to establish communication between the pump and mixing chambers when the piston permits communication between the mixing-chamber and working-chamber, and a second port in the piston adapted to relieve pressure in the mixing-chamber before the compression stroke is commenced.

4. In an explosive engine, a working-chamber, a pump-chamber in line therewith, a piston between and common to both chambers, a mixing-chamber in the walls of the cylinder at a point intermediate the pump and working-chambers and normally isolated from both chambers by the piston, means for admitting oil to said mixing-chamber, a port in the piston for relieving pressure in the mixing-chamber before the compression stroke of the piston, and a second port in the piston whereby communication is established between the pump and working-chambers through the mixing-chamber when the piston permits communication between the mixing and working-chambers.

5. In an explosive engine, the combination of a working-chamber, exhaust ports therefrom; a pump-chamber, direct air-inlets thereto, and non-communicating passages in the walls of said chambers respectively connecting with the working-chamber and with the pump-chamber; with a piston also constituting a valve controlling said exhaust and air-ports, and provided with a recess in its side adapted to establish communication between said passages when the piston is at the end of its working stroke, and means for admitting fluid into the passages to be vaporized by the rush of air from the pump to the working-chambers, substantially as described.

6. The herein described engine, comprising a working-chamber, and a combined crank-case and pump-chamber, a piston between and working in said chambers and forming the main valve, exhaust ports from the working-chamber controlled by said piston, air-inlet ports to said pump-chamber also controlled by said piston, adjacent passages in the walls of the cylinder respectively communicating with the working-chamber and the pump-chamber, and a recess in the side of the piston adapted to establish communication between said passages after the exhaust port is opened and when the piston has about reached the end of its working stroke; with means for admitting liquids into the mixing-chambers to be vaporized by the inrush of air from the pump to the working-chamber, and means for igniting the explosive mixtures after the piston has completed its return stroke, substantially as described.

7. The herein described explosive engine, comprising a working-chamber, a pump-chamber, two isolated mixing-chambers in the walls of the engine intermediate the working and pump-chambers, an air-inlet to the pump-chamber, exhaust ports from the working-chamber, a piston common to said working and pump-chambers and controlling the ports, a fuel reservoir communicating with the pump-chamber, an oil supply-pipe for conducting oil from the reservoir to one of the mixing-chambers, and a valve for the oil supply, means for supplying water to the other of the mixing chambers, said piston having ports for simultaneously establishing communication between the two mixing-chambers and the pump-chamber after the piston has opened communication between the two mixing-chambers and the working-chamber; and an igniter in the working-chamber, substantially as and for the purpose described.

8. The herein described explosive engine, comprising a working-chamber, a pump-chamber, an isolated mixing-chamber in the walls of the engine intermediate the working and pump-chambers, inlets to the pump-chamber, exhaust ports from the working-chamber, and a piston common to said working and pump-chambers and controlling the ports, and adapted to establish communication between the pump and working-chambers through the mixing-chamber; with a fuel reservoir communicating with the pump-chamber, an oil supply pipe for conducting oil from the reservoir to the mixing-chamber, a valve for the oil supply, a valve for the air supply, means for simultaneously actuating the oil and air-valves to maintain a constant relative proportion of elements in the explosive mixture, and an igniter in the working-chamber, substantially as and for the purpose described.

9. An explosive engine comprising working and pump-chambers in opposite ends of its casing, and a piston working between said chambers and controlling their ports and having recesses in its sides, passages respectively connecting with the working and pump-chambers, and adapted to be intermittently put into communication with each other by the recesses in said piston, and means for admitting oil or combustible elements to the said passages; with valves for controlling the admission of elements to said passages, a valve for regulating the admission of air to the pump-chamber, and connections between the air and oil-valves whereby they can be simultaneously varied to maintain approximate uniformity of explosive mixture, substantially as and for the purpose described.

In testimony that I claim the foregoing as my own, I affix my signature in presence of two witnesses.

HOMER CHARLES.

In presence of—
LILLIAN E. WITHAM,
ARTHUR E. DOWELL.