(No Model.)

S. A. REEVE.

APPARATUS FOR UTILIZING LIQUID OR GASEOUS FUEL FOR POWER.

No. 588,178. Patented Aug. 17, 1897.

Fig. 1.

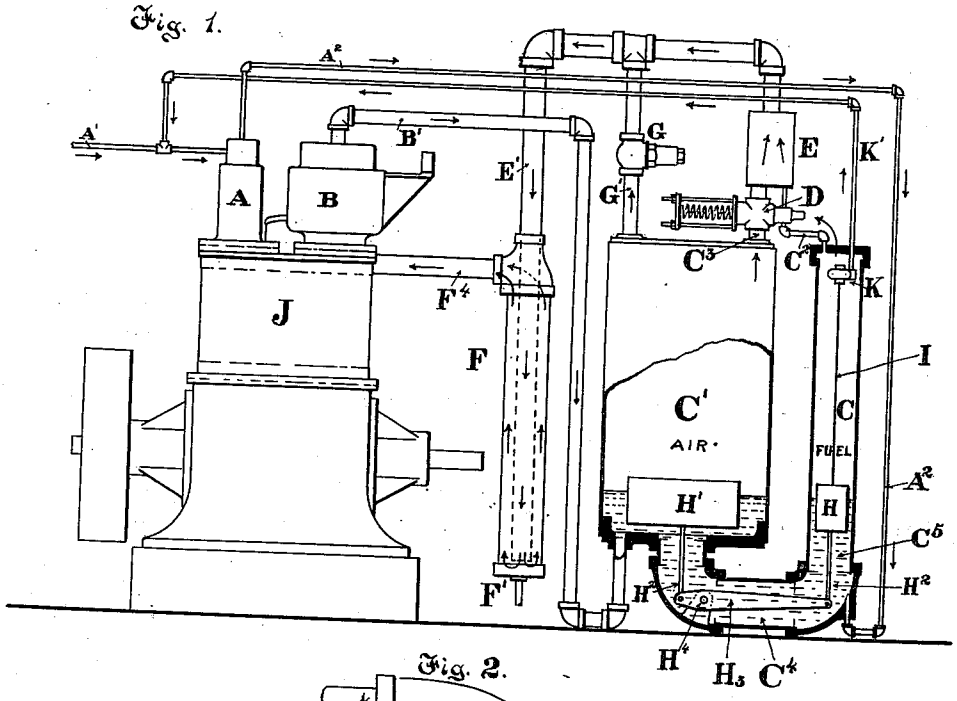
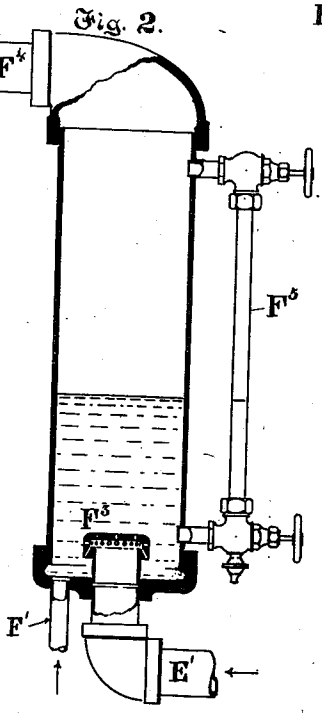
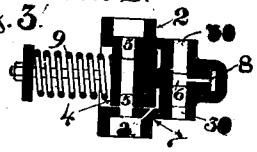


Fig. 2.



Valve D.

Fig. 3.



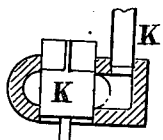
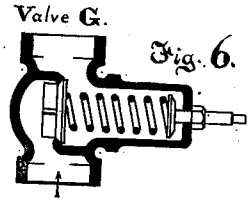


Fig 4.

Valve G.

Fig. 6.



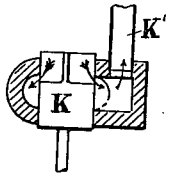


Fig. 5.

Witnesses:
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UNITED STATES PATENT OFFICE.

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APPARATUS FOR UTILIZING LIQUID OR GASEOUS FUEL FOR POWER.

SPECIFICATION forming part of Letters Patent No. 588,178, dated August 17, 1897.

Application filed December 16, 1894. Renewed January 16, 1897. Serial No. 619,498. (No model.)

To all whom it may concern:

Be it known that I, SIDNEY A. REEVE, of Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Apparatus for Utilizing Liquid or Gaseous Fuel for Power, of which the following is a specification.

This invention relates to gas or liquid fuel engines in which a mixture of air and fuel is continuously burned in a combustion-chamber connected with the working cylinders of the engine; and it consists in certain improvements, hereinafter described and claimed, having for their general objects, first, the control of the proportion of fuel and air admitted to the combustion-chamber, so that the relative quantities of fuel and air shall not materially vary, and, secondly, the automatic and uniform reduction of the fixed gases resulting from the combustion to a predetermined working temperature before they enter the working cylinders of the engine.

Of the accompanying drawings, forming a part of this specification, Figure 1 is a diagrammatic view illustrating a suitable arrangement of the parts of an apparatus embodying my invention. Fig. 2 represents a section on line 2 2 of Fig. 1. Figs. 3, 4, 5, and 6 represent detached views of parts of the apparatus hereinafter referred to.

In the drawings, A represents a compressor or pump adapted to force into a reservoir C a constant quantity of fuel, which may be either gaseous or liquid, the part A being a compressor when gaseous fuel is used and a pump when liquid fuel is used.

As the apparatus hereinafter described is designed with reference to the use of gaseous fuel, I will hereinafter call the part A a "compressor," although I do not limit myself to an apparatus organized to use gaseous fuel and may modify the apparatus so that it will utilize liquid fuel without departing from the spirit of my invention.

The compressor A is supplied with fuel by a pipe A′, and supplies it to the reservoir C through a pipe A^2.

B represents an air-compressor which receives atmospheric air through a suitable inlet and supplies it through a pipe B′ to a reservoir C′.

The compressors A and B may be of any suitable construction and may be operated by power applied in any suitable way, and as my invention does not relate to the construction and mode of operation of the compressors I do not illustrate their construction or the means for actuating them.

The reservoirs C and C′ are provided, respectively, with outlets C^2 and C^3, through which their contents pass through a proportioning-valve D to a combustion-chamber E, where combustion is continuously carried on, the valve D being of such construction as to supply the fuel and air in such proportion, whatever the quantity may be, as to insure perfect combustion. The valve D here shown comprises a casing 2, having an air-passage 3 and a fuel-passage 3^a and a sliding valve 4, having corresponding passages 5 6. Portions of the air and fuel passing through the valve have access through ports 7 8 to faces on the valve and tend to close the valve, the tendency varying with the pressure of the air and fuel and being exerted against the pressure of a spring 9. This construction of proportioning-valve is one of a number which may be employed, and I do not limit myself thereto.

The combustion of the mixture of fuel and air produces a mixture of nitrogen, carbonic acid, and superheated steam, which is conducted through a conduit E′ to a cooling-chamber hereinafter described and from the latter to the working cylinders of the engine.

It is essential to complete combustion of the mixture of fuel and air that the proportion of said elements admitted to the combustion-chamber be closely controlled, and to this end the pressures in the reservoirs C and C′ must not be allowed to differ in any great degree from each other, however much the pressure of either may vary. In other words, any considerable variation in the pressure in either reservoir should be accompanied by a corresponding variation in the pressure in the other reservoir. To this end I provide a tube or passage c^4, connecting the lower portions of said reservoirs, said passage being filled with a body of liquid C^5, such as water, which extends into the lower portions of the reservoirs and constitutes a liquid seal which prevents the mixture or osmose of the stored fuel and

air and stands at different levels in the two reservoirs when the pressure in one exceeds that in the other. I utilize this difference in level to practically equalize pressure in the two reservoirs. This equalization may be effected by the coöperation with the liquid seal of any suitable devices adapted to be operated by the rise and fall of the liquid seal to either release the excess of pressure from the reservoir containing it or to admit an additional supply to the reservoir needing it, or both. The equalizing devices here shown comprise a valve K in the fuel-reservoir, a float H in the fuel-reservoir connected with said valve by a rod I, a float H′ in the air-reservoir, and a lever H^3, pivoted at H^4 in the passage C^4 and connected by rods H^2 H^2 with the floats H H′, each float being proportionate in volume to the volume of the reservoir containing it, while each arm of the lever H^3 is inversely proportional to the volume of the float with which it is connected. The valve K controls a supplemental outlet or by-pass K′, extending from the fuel-reservoir C to the supply-pipe A′, so that when said valve is opened fuel will escape from the reservoir to the supply-pipe, thus reducing the pressure in the reservoir.

The arrangement of the valve K as here shown is such that when the pressure is substantially alike in both reservoirs the valve will occupy the position shown in Fig. 4, closing the by-pass K′, and when the level of the liquid in the reservoir C is lowered by an excess of fuel-pressure the valve will be depressed, as shown in Fig. 5, thus opening the by-pass until the fuel-pressure is reduced to substantially that of the air-pressure in the reservoir C′, when the valve will be raised to its closed position. The air-pressure therefore acts to control the fuel-pressure, so that there can be no material variation between the pressure of the air and fuel, although they may vary simultaneously to any extent without operating the valve K.

The liquid seal between the two reservoirs, acting to prevent an excess of pressure in either reservoir, and therefore closely controlling the proportion of fuel and air admitted to the combustion-chamber, is an important feature of my invention.

In further carrying out my invention I provide for the regulation of the pressure of the compressed air in the reservoir C′ by the pressure of the products of combustion in and beyond the combustion-chamber by means of a supplemental outlet or by-pass G′, connecting the reservoir C′ with the conduit E′, and a lightly-confined safety-valve G in said by-pass, the chief object of such regulation being the maintenance and control of a difference in pressure between the air-reservoir and the combustion-chamber, upon which difference depends the velocity and quantity of flow of air and fuel into the combustion-chamber. In order that the proportion between the air and fuel may be controlled, this difference, just mentioned, must be several times greater than the maximum difference between the reservoirs of air and gas. In other words, if it is found impossible to maintain the pressures in the two reservoirs within less than two ounces of each other both of them must be at least one pound above the pressure in the combustion-chamber in order that the proportion between the air and fuel flowing into the combustion-chamber may be certain within close limits of variation. It will be seen, therefore, that I make the pressure in or beyond the combustion-chamber the controlling factor and cause the pressure in the air-reservoir to follow this at a distance of at least one pound higher by means of the valve G. It will also be seen that by means of the liquid seal I cause the fuel-pressure to closely follow the air-pressure. I find in practice that the fuel-pressure follows the air-pressure at a distance of not more than two ounces above or below.

Another object of the regulation of the air-pressure by the pressure of the products of combustion is the utilization as a working fluid of any excess of compressed air which may be on hand—that is to say, excess over the amount needed for combustion. The advantages of such utilization are as follows: First, the avoidance of the necessity for compressing an amount of air proportional to the load momentarily imposed on the engine, it being sufficient with this machine to always compress an amount sufficient for the maximum capacity and load for which the engine is designed. Under any lighter load there would result an excess of compressed air, which I utilize by discharging it into the products of combustion; secondly, the partial cooling of the products of combustion to the desired working temperature by the addition of a working fluid (compressed air) more economical than steam.

My invention further includes novel means for reducing the temperature of the mixed gases resulting from the combustion of the fuel and air to a predetermined degree of working temperature suitable for the working cylinders of the engine.

The combustion of the mixture of a hydrocarbon fuel and air produces a mixture of fixed gases, which, as already stated, includes superheated steam and usually nitrogen and carbonic acid, the gases being at or above the temperature and pressure of superheated steam. It is necessary to reduce this temperature to the predetermined degree of working temperature before introducing the gases into the working cylinder; and to this end it has been proposed to inject into the gases some diluent, such as water or air, a jet or stream of the diluent being introduced into the moving current of combined gases while they are on their way to the engine. It is impossible, however, to meet in this way the constantly-varying conditions as to quantity and temperature of the flow of the h

gases, so that the reduction of the gases to a uniform working temperature by the injection of a diluent into it is not feasible. This part of my invention has for its object to automatically meet the said varying conditions and to supply the gases to the engine at a uniform and practically unvarying working temperature; and to this end I pass the heated gases from the combustion-chamber continuously through a body of water contained in a chamber F, which receives said gases from the conduit E' and discharges them to the engine through a conduit F^4, the latter being above the maximum water-level in the chamber F. The volume of water in the chamber F is in excess of the maximum quantity which the heated gases are able to evaporate.

The manner of and means for passing the gases through the water may be variously modified. I prefer to divide the stream of gases into small jets beneath the surface of the water by means of a perforated cap F^3 on the discharging end of the conduit E', so as to divide the gases into a large number of small bubbles, which rise to the surface and separate from the water at their will. The essential feature is that there shall be present in a suitable receptacle or cooling-chamber a body of water sufficiently large to be in excess of the maximum amount which the gases are able to evaporate. It is evident that no water could exist in such a cooling-chamber at a temperature higher than that of saturated steam of the pressure existing therein at any given time. Therefore the hot gases entering the body of water and passing through it must be somewhat cooled down by the water, and must thereby evaporate a portion of the water. It is further evident that the gases cannot possibly be cooled to a temperature lower than that at which the water evaporates in the cooling-chamber unless cold water is supplied to the chamber faster than the hot gases can vaporize it and carry it away, in which case the cooling-chamber would be gradually filled with water to overflowing and the process therefore would not be continuous. The cooling-chamber should therefore be so designed and operated as that, first, the hot gases shall be so finely divided and forced to pass through the water through a path of such length that they shall have ample time to give up to the water all of their heat above the temperature of saturation, and, secondly, the cooling-chamber shall be supplied with water in only such amount as will keep the water-level approximately constant. These two conditions of design being fulfilled, the temperature of mixed permanent gases and steam cannot vary preceptibly above or below that of saturated steam of the pressure existing in the cooling-chamber. I thus avoid the varying results which have attended all attempts heretofore to cool the hot gases by injecting into the gases water, air, or any other diluent. In all such attempts the effort has been to supply the diluent in just such a quantity as will reduce the temperature to the desired point from instant to instant, but without the employment of any accumulation of the cooling agent to automatically meet the constantly-varying conditions as to quantity and temperature of the flow of the hot gases. The distinctive feature of this part of my invention is therefore the employment of an accumulation of the cooling agent and the consequent uniform and automatic reduction of the gases to the desired working pressure.

It is evident that while the amount of entering water must be regulated within certain limits in order to prevent the cooling-chamber either overflowing or running dry, yet the amount of water present has no influence over the temperature of the issuing gases, no matter in what quantity or at what temperature they enter, if only the smallest permissible amount be present or exceeded. In fact, it might be found preferable to make the cooling-chamber comparatively large and to fill it only periodically.

Suitable means should be employed to supply the water at a relatively warm temperature—say not lower than 150° Fahrenheit. The cooling-chamber has a supply-pipe F', which may be controlled by automatic means, so that it will be opened when the water falls below a given level and closed when the water rises to the maximum height desired. A glass gage-tube F^5 may be provided to indicate the height of water in the chamber.

The gases coming from the cooling-chamber F consist of a mixture of nitrogen, carbonic acid, and saturated steam under a pressure approximating the initial pressure to which they were compressed and under which the entire system must operate. This mixture of gases is expanded in the regular working cylinders of any type of steam or vapor engines. The diagram represents a Westinghouse standard automatic steam-engine J.

I claim—

1. The combination of a combustion-chamber, an air-reservoir and a fuel-reservoir both connected with said chamber, a liquid-sealed connection between said reservoirs, and pressure-releasing devices coöperating with the liquid seal whereby an excess of pressure in one of the reservoirs may be released.

2. The combination of a combustion-chamber, an air-reservoir and a fuel-reservoir both connected with said chamber, a supplemental outlet or by-pass connected with one of the reservoirs, a liquid-sealed connection between said reservoirs, a valve controlling said by-pass, and connections between the valve and the liquid seal whereby the valve is opened by a displacement of the seal caused by an excess of pressure in one of the reservoirs.

3. The combination of a pump or compressor adapted to supply a constant quantity of fuel, a fuel-reservoir connected with said pump and provided with a primary or

normal outlet, a supplemental outlet or by-pass connecting said reservoir with the source of fuel-supply, a valve in said by-pass, and automatic valve-operating means through which an excess of pressure in the reservoir acts to open the valve and reduce the pressure.

4. The combination of a fuel pump or compressor; an air-compressor; reservoirs connected with said compressor, each reservoir having a primary or normal outlet; a supplemental outlet or by-pass connecting the fuel-reservoir with the source of fuel-supply, a liquid-sealed connection between said reservoirs, a valve controlling said by-pass, and connections between the valve and the liquid seal whereby the valve is opened by displacement of the liquid seal caused by an excess of pressure in the fuel-reservoir.

5. The combination of a combustion-chamber, a conduit leading therefrom for the products of combustion, an air-reservoir and a fuel-reservoir connected with the combustion-chamber, a supplemental outlet or by-pass connecting the air-reservoir with said conduit and provided with a yielding valve adapted to release into said conduit any excess of air-pressure over the pressure of the products of combustion in the conduit, a supplemental outlet or by-pass connecting the fuel-reservoir with the source of fuel-supply, a liquid-sealed connection between the two reservoirs, a valve controlling the by-pass or supplemental outlet of the fuel-reservoir, and connections between the valve and the liquid seal whereby the valve is opened by an excess of pressure in the fuel-reservoir.

6. The combination of a combustion-chamber, an air-reservoir and a fuel-reservoir both connected with said chamber, means for supplying gaseous fuel and air to said reservoirs under pressure and for proportioning the pressure in said two reservoirs, an engine, and a cooling-chamber having its interior connected with the combustion-chamber and with the engine, and containing a body of water.

7. The combination of a combustion-chamber, an air-reservoir and a fuel-reservoir both connected with said chamber, means for supplying gaseous fuel and air to said reservoirs under pressure, an engine, and a cooling-chamber having its interior connected with the combustion-chamber and with the engine, and containing a body of water.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 8th day of December, A. D. 1894.

SIDNEY A. REEVE.

Witnesses:
C. F. BROWN,
WILLIAM QUINBY.