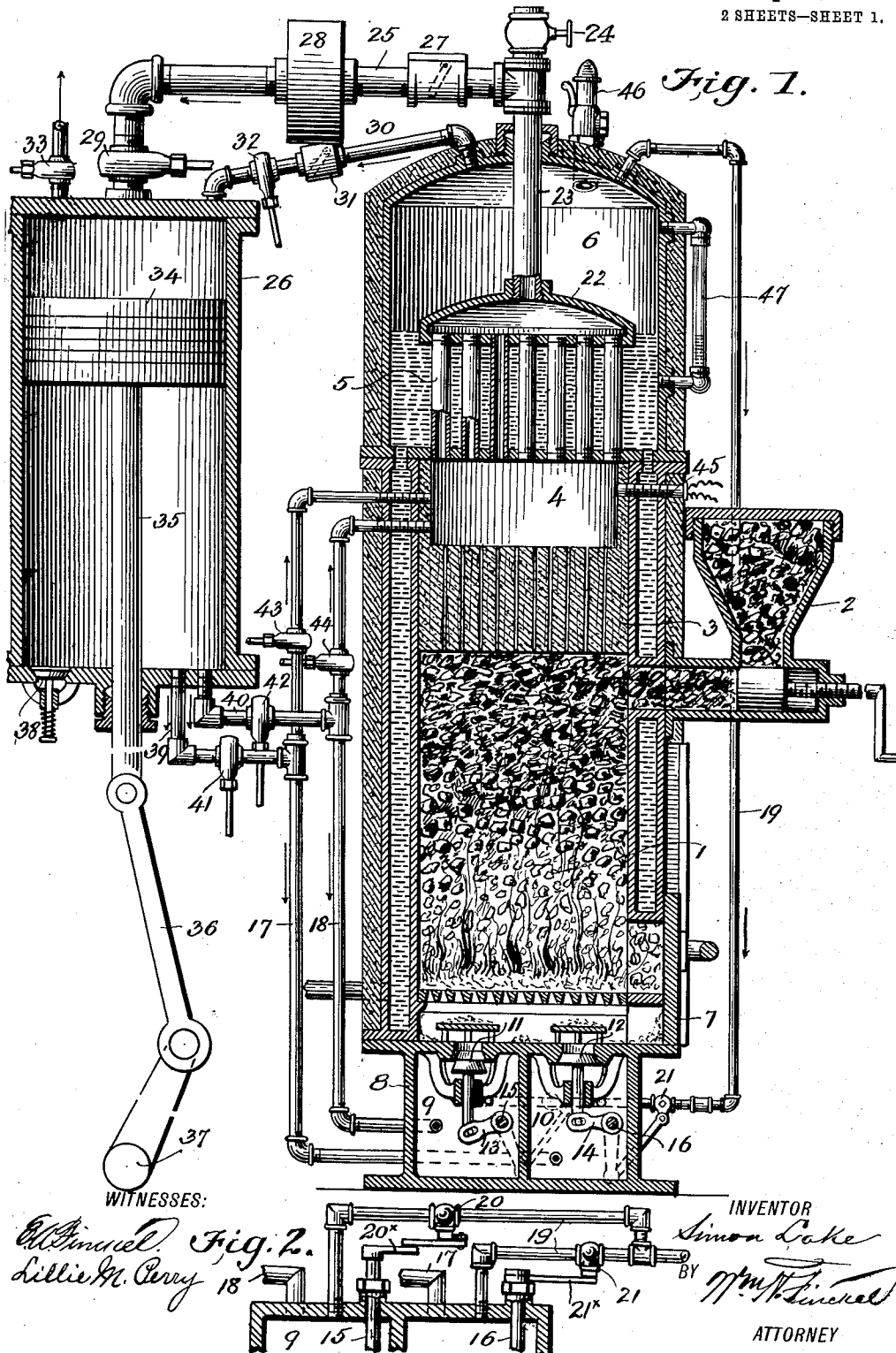


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HEAT ENGINE PLANT.
APPLICATION FILED NOV. 28, 1908.

933,080.

Patented Sept. 7, 1909.

2 SHEETS—SHEET 1.



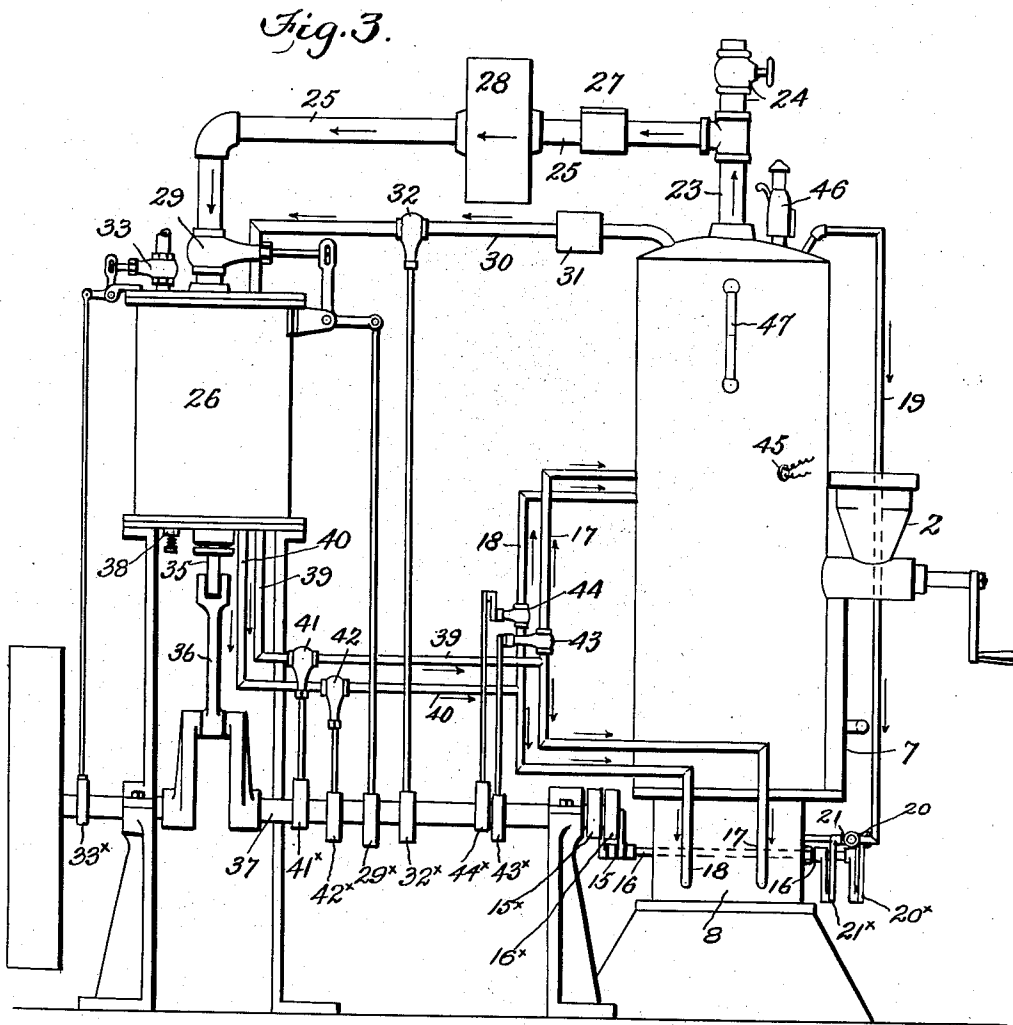
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UNITED STATES PATENT OFFICE.

SIMON LAKE, OF BRIDGEPORT, CONNECTICUT.

HEAT-ENGINE PLANT.

933,080.

Specification of Letters Patent.

Patented Sept. 7, 1909.

Application filed November 28, 1906. Serial No. 345,553.

To all whom it may concern:

Be it known that I, SIMON LAKE, a citizen of the United States, residing at Bridgeport, in the county of Fairfield and State of Connecticut, have invented a certain new and useful Improvement in Heat-Engine Plants, of which the following is a full, clear, and exact description.

This invention relates to apparatus for the utilization of heat in the generation of power.

In the case of a steam boiler, heat is utilized as power only as it is found in the steam itself, but otherwise the heat is lost. On the other hand, in a gas engine and producer system, the gas generated in the producer is utilized in the engine and the heat generated in the producer is lost in the cooler.

The present invention is designed to utilize both the gases arising from combustion of suitable agents and steam generated by the heat thereof, and these are used in conjunction or not, as elected, as the power fluids in the same apparatus.

As one means of carrying the invention into effect, I utilize a gas-producing chamber and a combustion chamber arranged in connection with a steam-boiler, and these elements connected with a working cylinder or engine supplying compressed air or air under pressure to the gas-producing chamber from separate air compression chambers and to the combustion chamber, and in such way that while compressed air is being accumulated in one compression chamber, it is being discharged into the gas-producing chamber from another, and the heat from the combustion chamber is used to make steam, and is further utilized as power in the engine along with, or independent of, the steam generated in the boiler.

In the accompanying drawings, illustrating the invention, in the several figures of which like parts are similarly designated, Figure 1 is a vertical section of one form of the apparatus embodying the invention. Fig. 2 is a horizontal section showing a portion of the compressed air chambers and air and steam feed-pipes. Fig. 3 is a diagrammatic view illustrating one installation of the apparatus.

The power fluid generator comprises a gas-producing chamber 1, of any approved construction, and operating on the base-burning principle, and fed by a stoker 2, or

any other suitable automatic or hand-operated mechanism, or kept supplied with fuel, such as coal, in any other suitable way. It is designed to keep this gas-producing chamber practically full of fuel in incandescence at its base and in a state of more or less complete combustion throughout.

Above the gas-producing chamber is a filter 3, of any suitable refractory material, such as porous clay or other suitable substance, or substance made porous in any approved way, and above this filter or within it is a combustion chamber 4, and over this combustion chamber is a fire-flue steam-boiler 5, having a steam dome 6. As shown, the boiler may be extended as a water-jacket surrounding the gas-producing chamber, and, if necessary, the whole structure may be incased in a sheathing of non-conducting substance, to prevent loss of heat by radiation. The gas-producing chamber may be provided with a sliding or other door 7, for cleaning and other usual purposes.

Beneath the gas-producing chamber, is a base 8, divided into any number, preferably two, chambers 9 and 10, in which are arranged valves 11 and 12, which afford communication between the said chambers and the gas-producing chamber. These valves are mounted upon crank-arms 13 and 14, fast to rock-shafts 15 and 16, which rock-shafts are actuated alternately by any suitable mechanism. As indicated in Fig. 3, said rock-shafts 15 and 16 may be operated by rocking connections 15* and 16*, respectively, on the engine shaft.

The respective air-chambers are connected with the combustion chamber 4 by means of pipes 17 and 18, and these air-chambers, 9 and 10, are also connected with the steam dome 6 by means of a pipe 19 having in its air-chamber connections, valves 20 and 21, which may be operated by crank-connections 20* and 21*, with the rock-shafts 15 and 16, substantially as shown in Figs. 2 and 3, so as to open and close with the air-valves 11 and 12 as they are alternately actuated.

The combustion chamber and fire-flues are covered by a tight head 22 from which leads a pipe 23 which has a starting valve 24, and this pipe has a lateral pipe connection 25 leading into one end of the engine or working cylinder 26. The pipe 25 has in it a check-valve 27 to prevent reflux from the cylinder, and it also has a filter 28 to catch any tarry substances or other solid products

of combustion carried up from the combustion chamber, and this pipe 25 also has in it a valve 29, operated through suitable connections by an eccentric 29* on the engine shaft, for controlling admission to the cylinder. A pipe 30 connects the steam dome 6 and upper end of the cylinder and is provided with a check-valve 31 to prevent reflux of pressure from the cylinder, and is also provided with a controlling valve 32, operated by eccentric 32* on the engine shaft. The cylinder is provided at its upper end with an exhaust valve 33 operated through suitable connections by an eccentric 33* on the engine shaft. Within the cylinder is a piston 34 having a stem 35 connected by a pitman or crank-rod 36 with a crank-shaft 37 by which the power is utilized.

In the lower end of the cylinder is an air intake valve 38, and also leading from this end are outlet pipes 39 and 40 connecting respectively with the pipes 17 and 18, and having respectively the cut-off valves 41 and 42, operated by eccentrics 41* and 42* on the engine shaft. The pipes 17 and 18 are provided respectively with cut-off valves 43 and 44, also operated by eccentrics 43* and 44* on the engine shaft.

The apparatus is shown as vertical and this specification is drawn accordingly, but the invention is not thus limited.

The operation is as follows:—Fuel, such as coal, is introduced into the gas-producing chamber and the stoker then closed, the valve 24 and door 7 opened, and the valves 29 and 32 closed by turning the engine shaft to the proper position. The fire is then started and the door 7 closed. Air is supplied to the gas-producing chamber by a hand-blower, or by any other suitable means, to produce a draft, the products of combustion passing out through valve 24. When the generation of gas and steam is well under way, the valve 24 is closed, and the engine shaft revolved in any suitable manner, as by hand, and a sufficient quantity of compressed air is forced through the generator to the cylinder to aid in starting the engine without load.

It is intended to run the engine a few minutes without load either by hand or by the aid of the compressed air and hot gases, until the temperature in the combustion chamber is raised sufficiently to ignite the charge, or steam generated sufficiently, to run the engine. Assuming that this condition has been reached and steam is being generated in the boiler, then upon each down stroke of the piston, caused by the pressure of the products of combustion and steam, air which has previously been drawn in by the piston through the valve 38 is discharged through either one or the other of the pipes 17 or 18. It must be borne in mind that the valves 41 and 42, which con-

trol the flow of air from the cylinder to the air-supply chambers 9 and 10 are operated alternately, by their oppositely arranged eccentrics 41* and 42*. That is, on one down stroke, the valve 41 is opened and the valve 42 closed, and on the next succeeding stroke the valve 42 is opened and valve 41 closed, admitting the air, which may be compressed, as desired, into either one or the other of the chambers 9 or 10, alternately, and simultaneously the products of combustion enter the working cylinder above the piston. The piston now returns on the up stroke, drawing in a fresh supply of air below the piston and discharging the products of combustion from above the piston through exhaust pipe valve 33, which is opened at the proper time by its eccentric 33*. At any desired position on this up stroke the air-valve in chamber 9 or 10, depending upon which air-supply chamber has been charged with the compressed air, is opened, admitting the air to flow through the bed of fuel and carry the gases generated thereby into the combustion chamber or furnace 4. At the proper time, regulated by the oppositely arranged eccentrics 43* and 44*, a sufficient quantity of air, from its proper chamber 9 or 10, is also admitted into the combustion chamber 4 by opening valve 43 or 44. An electric spark or carbon may be used to ignite the gases in this chamber until the chamber becomes sufficiently heated to produce self-ignition. The temperature of the air which has found its way through the bank of fuel and the filter 3 has been very materially raised. Ignition of the gases still further increases the pressure, so that by the time the piston has reached the top of its stroke, a considerable pressure has been created on the interior of the generator, sufficient, at least, to run the engine without load. When the piston reaches the top of its up stroke, valve 29 is opened, admitting the heated air and products of combustion to the top of the cylinder, forcing the piston down at the next down stroke and charging, in turn, the other air-chamber when the various operations already described are repeated, and the piston forced down on the next succeeding stroke. During this operation, steam is being generated, as above stated, and valve 32 being opened simultaneously with valve 29, admits a quantity of steam above the piston, which also assists in doing work, in the same manner as in an ordinary steam engine. Valve 32 is so operated by its eccentric 32* as to supply steam for a portion only of the stroke. If the steam pressure is greater than the pressure of the hot gases, the gases will not leave the generator until the steam has been expanded down to a pressure which will permit of the gas entering through its respective pipe. Back flow, or reflux of the steam from the

cylinder to the generator is prevented by check valve 27 in the gas pipe. On the other hand, if the gas pressure is greater than the steam pressure, check valve 31 in the steam pipe will prevent the back flow or reflux of the gases to the steam dome of the generator. It will thus be seen that the engine is, alternately, either a steam engine or a gas engine, or a combination of both. Valve 29 remains opened until the completion of the down stroke. It is intended to reduce the pressure in the apparatus down practically to atmospheric pressure by every down stroke. Every down stroke of the piston is a power stroke. The air which is drawn in below the piston is alternately compressed in the two air-supply chambers 9 and 10, where it is released at the proper time to escape up through the apparatus and be ready to give power on the opening of valve 29. The air flows up through the fuel and combustion chamber during the down stroke until the pressure is reduced to atmosphere within the cylinder.

Automatic devices may be provided, as previously stated for the purposes of supplying the fuel and taking away the ashes. In this instance I have shown a simple hand device for this purpose. Fuel is first put into the hopper where it drops down into the cylindrical portion of the hopper and is then forced into the gas-producing chamber by the piston and screw, as shown. The fire starts in at the bottom and as the fuel is burned, the body of the fire keeps working its way up to the top of the gas-producing chamber. Suitable inspection places may be provided to determine the height of the fire within the gas-producing chamber. When the fuel is nearly all consumed, the door 7 may be opened and steam admitted into the combustion chamber 4, which, by its pressure, will drive the fuel and ashes down into gas-producing chamber, where the ashes may be readily removed through the opening provided for cleaning purposes. Better results are obtained by mixing a certain quantity of steam, or water, with the air flowing through the generator, the fuel being brought to incandescence. The admission of a certain quantity of water produces water-gas in a well-known manner. The steam is introduced in the manner shown in Fig. 2. The pipe 19 connects with the steam drum and branches are led to each of the chambers 9 and 10. The valves 20 and 21 and their operating connections may be adjusted to operate in unison with the valves 11 and 12, so as to admit the desired quantity of steam into the apparatus, along with the inflowing air. The furnace may be supplied with a safety valve 46, and the usual water-gage 47.

What I claim is:—

1. A gas-producing chamber, means to

supply air artificially to said gas-producing chamber at intervals, a combustion chamber communicating with said gas-producing chamber, means interposed between the gas-producing chamber and the combustion chamber to filter the gases generated in said gas-producing chamber as they pass therefrom to the combustion chamber, means for igniting the gases in the combustion chamber, an air supply for the combustion chamber, a fire-flue steam-boiler arranged next to the combustion chamber, a working cylinder, and independent means for admitting the products of combustion and steam separately or together into the working cylinder.

2. A base-burning gas-producing chamber, means to feed air under pressure from below into said chamber in regulated quantities, a combustion chamber communicating with the gas-producing chamber and into which the gases are admitted, a filter interposed between the gas-producing chamber and the combustion chamber, an air supply for the combustion chamber, means to ignite the mixture of gases and air in said combustion chamber, a fire-flue steam-boiler arranged next to said combustion chamber through which pass the products of combustion from said chamber, a working cylinder, separate pipes leading thereinto from the combustion chamber and steam-boiler, and means for effecting the opening and closing of said pipes.

3. An engine cylinder, a piston therein, working fluid inlets to said cylinder on one side of the piston, means to admit air on the other side of the piston, which air is compressed on the working stroke of the piston, a power fluid generator, comprising in a unitary structure a gas-producing chamber, a combustion chamber communicating with said gas-producing chamber, and a steam-boiler, connections to supply the compressed air from the cylinder to the gas-producing chamber and combustion chamber, and connections for supplying the products of combustion and steam, either or both, to the working fluid inlets of the engine cylinder.

4. A heat engine plant, comprising a power fluid generator including a base-burning gas-producing chamber, air-chambers beneath the same, valves in said air-chambers for admitting air under pressure to said gas-producing chamber, means to open said valves alternately, a combustion chamber communicating with the gas-producing chamber, an air supply therefor, and means for igniting the mixture of air and gases in said combustion chamber to convert them into highly heated products of combustion, and a steam-boiler exposed to the heat of the gas-producing chamber and highly heated products of combustion, combined with an engine communicating with the power

fluid generator and actuated by the fluid agents produced therein and supplying air under pressure to the power fluid generator.

5. The combination of a power fluid generator, comprising a gas-producing chamber, and a combustion chamber communicating with said chamber and to which the gases generated in the gas-producing chamber pass to be mixed with air and ignited, with a steam-boiler, an engine, connections between the combustion chamber and boiler and one end of the engine cylinder, whereby the products of combustion and steam are utilized as power to drive the engine, and connections between the gas-producing chamber and combustion chamber and the other end of the engine cylinder, whereby the engine is utilized to supply compressed air to the gas-producing chamber and the combustion chamber.

6. A heat engine plant, comprising a power fluid generator, having a gas-producing chamber, a combustion chamber communicating with said chamber, a steam-boiler having fire-flues communicating with said combustion chamber, and independent compressed air chambers beneath the gas-producing chamber, valves interposed between these chambers and the gas-producing chamber, and means for alternately opening the said valves to admit the contents of their respective chambers into the gas-producing chamber, combined with an engine communicating with said power fluid generator and deriving its power from the combustion chamber and boiler, connections between said engine and generator for furnishing compressed air to the air-chambers and to the combustion chamber, and valves interposed between the engine and the air chambers and combustion chamber to control the supply of compressed air.

7. A heat engine plant, comprising a power fluid generator, having a gas-producing chamber, a combustion chamber communicating with said chamber, a steam-boiler having fire-flues communicating with said combustion chamber, and independent compressed air chambers beneath the gas-producing chamber, valves interposed between these chambers and the gas-producing chamber, means for alternately opening the said valves to admit the contents of their respective chambers into the gas-producing chamber, and a steam supply to said chambers, combined with an engine and air compressor communicating with the combustion chamber and steam-boiler and deriving its power therefrom, and valved connections between

the said air compressor and the combustion chamber and compressed air chambers beneath the gas-producing chamber to control the supply of air to said chambers.

8. The combination of a gas-producing chamber, a combustion chamber communicating with said chamber, air-chambers arranged beneath the gas-producing chamber, and a cylinder and piston, one end of the cylinder being connected with the air-chambers and adapted to act as a compressor to alternately supply air to the air-chambers, and the opposite end of the cylinder being the power end and communicating with the combustion chamber, valves arranged in the air-chambers to control the admission of air through the fuel in the gas-producing chamber, means for supplying air to the combustion chamber to produce a combustible mixture, and valves controlling the communication between the combustion chamber and the power end of the cylinder, whereby a supply of air is forced through the fuel and gas generated and then ignited in the combustion chamber and utilized in the power end of the cylinder.

9. The combination with a power fluid generator, comprising a gas-producing chamber, and a combustion chamber arranged above and communicating with said gas-producing chamber, of an air compressing means, means for intermittently and independently conducting a supply of air therefrom to the gas-producing chamber and to the combustion chamber, and means for utilizing the products of combustion from the combustion chamber for operating the air-compressing means.

10. The combination with a power fluid generator, comprising a gas-producing chamber, air-chambers communicating with the gas-producing chamber, a combustion chamber communicating with the gas-producing chamber, and a steam-boiler having fire-flues communicating with the combustion chamber, of an air-compressing means for supplying air to the air-chambers and the combustion chamber, and means for utilizing the products of combustion from said combustion chamber and the steam from said boiler for operating the air-compressing means.

In testimony whereof I have hereunto set my hand this 26 day of November A. D. 1906.

SIMON LAKE.

Witnesses:

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