

W. HECKERT.
GAS ENGINE WITH COMBINED APPARATUS.
APPLICATION FILED OCT. 4, 1906.

920,056.

Patented Apr. 27, 1909.

2 SHEETS—SHEET 1.

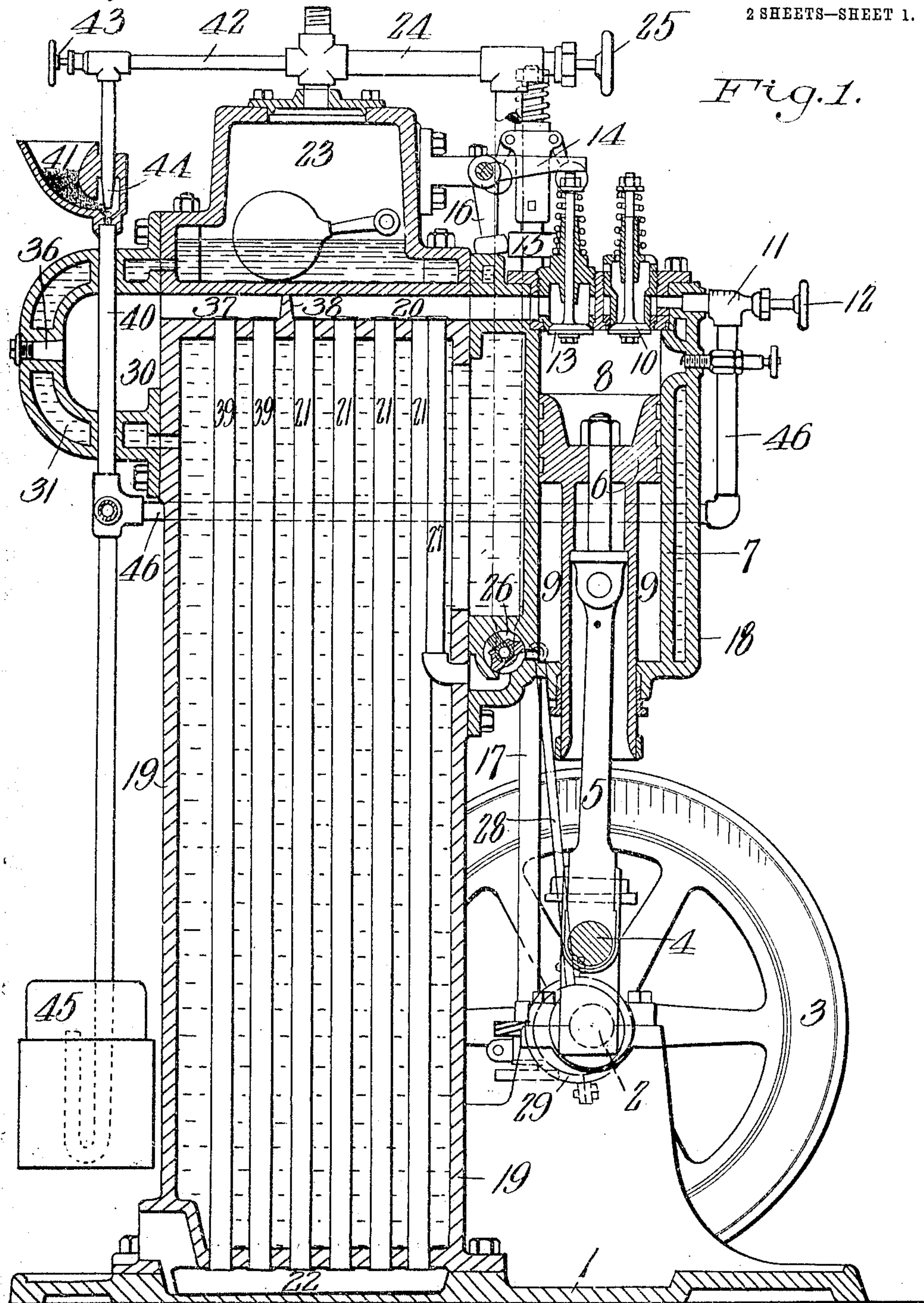


Fig. 1.

Witnesses
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Fig. 2.

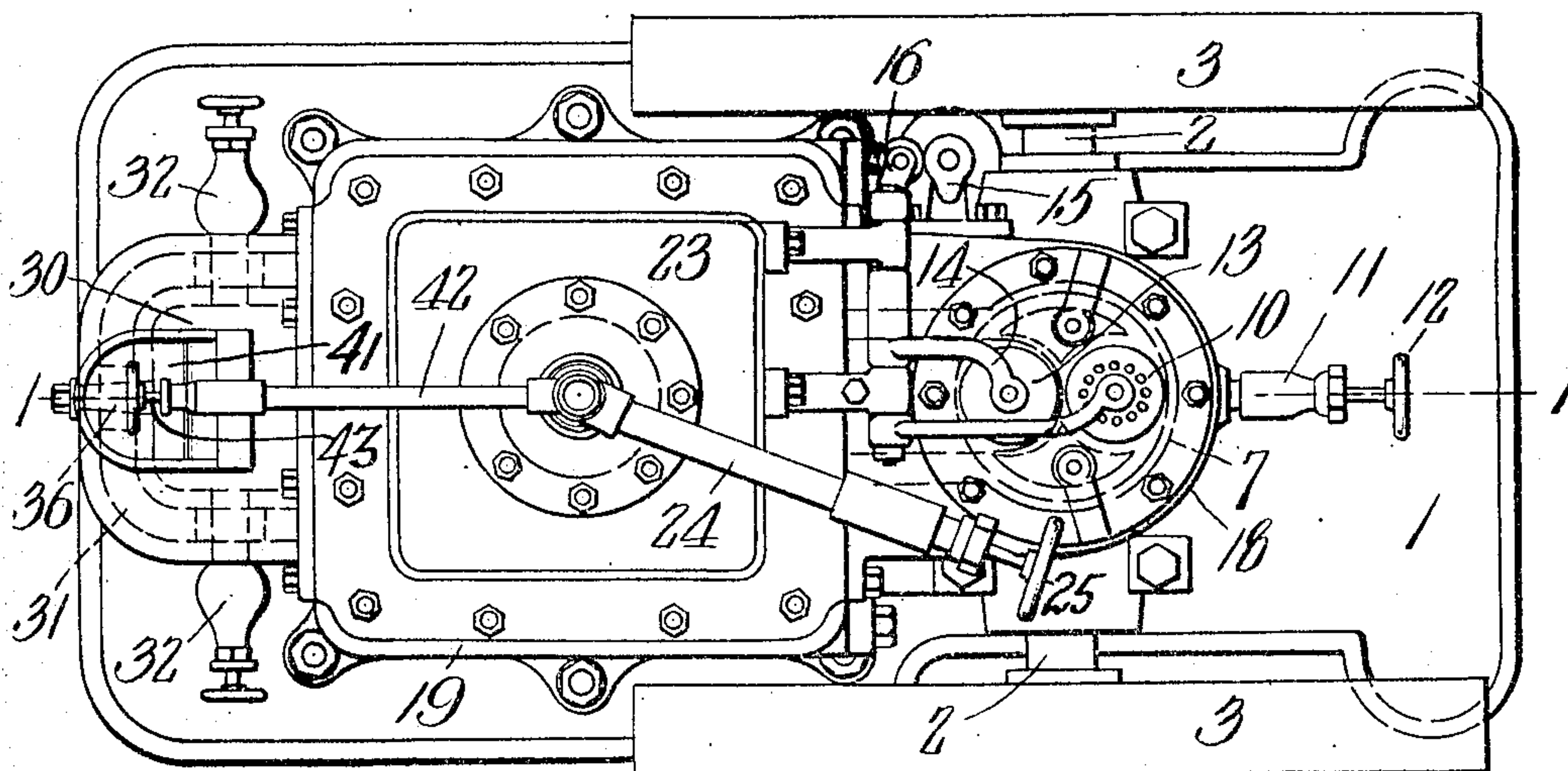
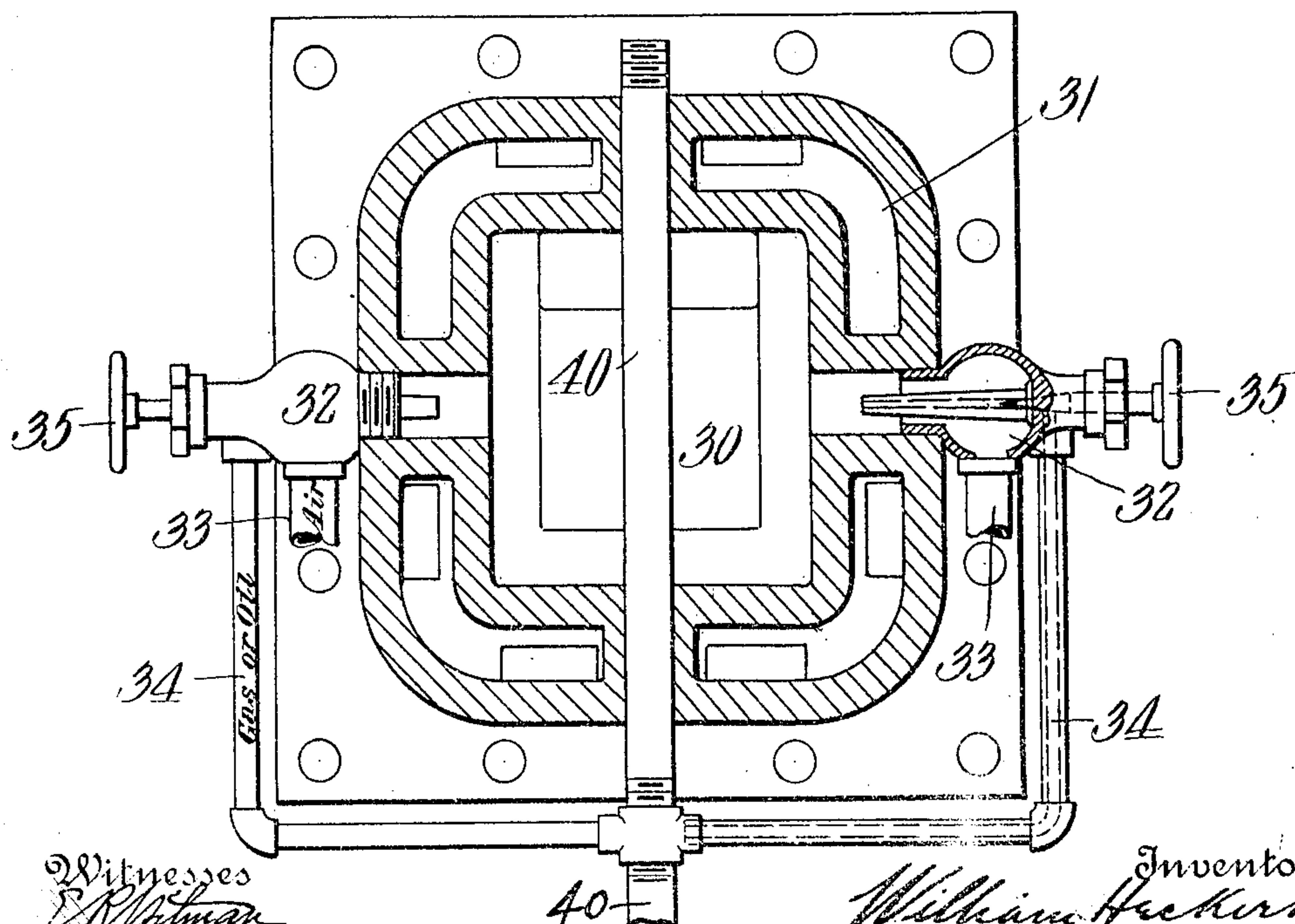


Fig. 3.



Witnesses
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UNITED STATES PATENT OFFICE.

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GAS-ENGINE WITH COMBINED APPARATUS.

No. 920,056.

Specification of Letters Patent.

Patented April 27, 1909.

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To all whom it may concern:

Be it known that I, WILLIAM HECKERT, a citizen of the United States, residing at Findlay, in the county of Hancock and State of Ohio, have invented certain new and useful Improvements in Gas-Engines with Combined Apparatus; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

One object of my invention is to provide an improved type of motor, of high power and efficiency, adapted for heavy work, either heating or power purposes, such as steam-heating, electric-lighting, pumping, locomotive, rolling-mill and steamship propelling.

More especially, my invention seeks to improve the construction and increase the efficiency of operation of combined gas and steam-engines having an associated boiler, and in which the heat derived from the combustion in the gas-engine is utilized for firing the boiler, for generating steam, for running the steam-engine or for other purposes.

A second object of my invention is to provide a supplemental firing means, independent of that afforded by the gas-engine, for internally firing the boiler and generating steam, to be used either independently of or conjunctively with the gas-engine as a heating or firing agency; and, further, to fully utilize the heat from both sources in a most economical and effective manner.

Another object is to utilize the supplemental firing agency as a means for starting the gas-engine, thereby obviating the difficulty, hitherto incident to gas-engines or combined gas and steam-engines, of requiring some exterior force to start them, and thus making the engine applicable to all kinds of heavy work, the same as the present steam-engine.

Still a further object is to provide, in conjunction with the supplemental firing agency, a gas-producing means for producing the combustible fuel for the supplemental firing agency, as well as for the gas-engine, or

for other additional purposes if desired; and, moreover, to obtain the production of gas from coal as well as other gasifiable material, thereby avoiding the restrictions to the use of oil as fuel.

For attaining these objects, together with such additional objects as are incidental to or included in the foregoing, a complete heat and power apparatus embodying all my improvements, comprises, in the main, first, a boiler in association with a combined gas and steam engine of the type known as the "trimotor" (see my U. S. Patents Nos. 708,637 and 764,808, dated Sept. 9, 1902, and July 12, 1904) wherein a gas-engine, steam-engine and boiler are united in one cylinder, the piston being propelled in opposite directions by the action of explosive gases on the one side and by the action of steam on the other side, and the cylinder being surrounded by a water-chamber constituting a jacket for the gas end of the cylinder and also serving as the boiler for generating steam to supply the steam end of the cylinder. In this case, the water-chamber or jacket surrounding the engine-cylinder constitutes a part of or is in communication with the main boiler; and, in addition to heating the water in said chamber or jacket by the heat of the explosions or combustions in the gas side of the engine-cylinder, the hot exhaust gases are conveyed off through a plurality of flues extending through the main boiler, so that the gas-engine practically constitutes a furnace for firing the boiler. Other similar flues, extending through the boiler are in communication with a supplemental firing or combustion-chamber, which is substantially surrounded by or inclosed in the boiler. In said firing or combustion-chamber, a suitable burner or burners is or are provided for delivering thereinto gas, oil, or other fluid combustible, which on being ignited likewise supplies hot gases for firing the boiler, as an independent agency from that afforded by the gas-engine. Through said supplemental firing or combustion-chamber extends a pipe or conduit, whose inlet end receives coal or other gasifiable substance,

while its outlet end is in communication with the gasometer; so, that, the gasifiable material in the conduit being exposed to the heat of the supplemental firing or combustion-chamber, generates gas in said pipe or conduit for supplying the gasometer. The gasometer, or the pipe or conduit, leading thereto, may be in communication with the gas-engine and with the burners in the supplemental firing-chamber, so as to supply the fluid combustible to both places; while the gas may also be supplied elsewhere for other uses if needed. The boiler has a surmounting steam-dome from which steam-pipes convey the steam for utilization. One steam-pipe extends to the steam side of the "trimotor", or combined gas and steam engine, for supplying the same with steam for propelling the piston; and thus makes provision for starting the motor prior to the starting of the gas-engine, since the steam generated in the boiler by firing with the supplemental firing device may be used for that purpose. Another steam-pipe leads to the aforesaid conduit which carries the gasifiable substance through the supplemental firing-chamber, whereby the coal or other gasifiable substance is forced by a steam-jet through said conduit.

Reference will now be had to the accompanying drawings, which constitute a part of this specification, and wherein is illustrated one practicable form of apparatus embodying my invention; it being understood however that the invention is susceptible of other embodiments and various changes in design, arrangement of parts, and details; so that I do not confine myself to this or any specific construction.

The invention will first be described with reference to said drawings, and then more particularly pointed out and defined in the appended claims.

Figure 1 is a central vertical section of the apparatus, taken on line 1—1 of Fig. 2. Fig. 2 is a top plan view of the same. Fig. 3 is an enlarged vertical section taken transversely through the burners of the gas-producer and firing device.

In said drawings, 1 denotes an engine-bed having bearings for an ordinary crank-shaft 2, shown provided with the fly-wheels 3. The crank 4 is connected by the pitman 5 with a piston 6, shown working in a vertically-arranged cylinder 7 above the crank-shaft. The piston 6 is propelled in opposite directions by the action of explosive or combustible gases on one side (here the upper side) and by steam upon the opposite side.

The numeral 8 denotes the combustion-chamber of the gas-engine and 9 indicates the steam-chamber.

The gas-engine may be of any appropriate construction. As shown, an explosive mix-

ture of gas and air is periodically admitted into the combustion-chamber 8 through the mixing-valve 10, the gas or fluid combustible being injected from the injector or nozzle 11, controlled by a valve 12, and the air for admixture therewith being taken through suitable openings in the casing or chamber of the said mixing-valve 10. As understood, an explosive charge or admixture is admitted to the combustion-chamber by the valve 10 during a reverse or down stroke of the piston, compressed on the forward or upward stroke, and ignited or exploded at the proper time by means of any suitable igniter, thus forcing back or propelling the piston on the second down stroke, while on the next upward stroke the expanded gases and products of combustion are exhausted through the exhaust valve 13. Said exhaust valve 13 is opened at the proper period by means of a tappet or presser-arm 14 caused to press down the valve-stem by the periodic action of a cam 15 on a roller-bearing arm 16 attached to the shaft or axis of said tappet; the cam 15 being affixed on a vertical shaft 17 geared with the crank-shaft to turn at a speed of one rotation to every two revolutions of the crank-shaft.

The engine-cylinder 7 has a surrounding water-jacket or casing 18, always filled with water, which besides jacketing the combustion-chamber of the gas-engine, serves also as a steam generator, the heat being furnished by the explosions or combustions in the gas-engine. Said water-jacket 18 is interiorly in communication with and forms a part of an upright boiler 19; in this instance the unitary casing of the engine-cylinder and its surrounding jacket being shown bolted to the side of the boiler, which in turn is mounted on the engine-bed 1. Water is supplied to the boiler, preferably at or near its bottom, by means of any suitable pump or injector, not shown. From the combustion-chamber of the gas-engine, the hot gases or products of combustion pass through the exhaust-valve 13 into a fire-space or passage 20, in the upper part of the boiler, and thence downwardly through a series of fire-flues or boiler-tubes 21 into a lower exhaust-passage 22. Thus the heat of the explosions and exhausted products of combustion is fully and effectively utilized, since the engine-cylinder itself constitutes an internal firing agency, besides which the hot exhaust gases therefrom pass at their highest temperature through the upper portion of the boiler, containing the hottest water, and thence pass downwardly at a diminishing temperature and give up their heat to the colder water. In other words, the highest temperature of the exhaust gases is applied to the hottest water above, and the lowest temperature of such gases to the coldest water in the bottom of the boiler; so

that the water in ascending is continuously and increasingly heated. Steam generated in the boiler rises to an uppermost steam-dome 23, from which a pipe 24, controlled by a valve 25, leads downwardly to a steam-valve 26 at the steam end of the cylinder. By means of said valve 26, steam may be admitted to and exhausted from the steam-chamber 9; the live steam being supplied through the pipe 24 as aforesaid, and the exhaust steam passing up through a tube 27 to the fire-space 20 and thence down through the flues 21 and out through the general exhaust 22. The steam-valve 26 may be of any appropriate type or construction, for example, a rocking or rotating valve, actuated through a connecting-rod 28 by an eccentric 29 on the crank-shaft.

Referring now to the supplemental-firing and gas-producing device, a water-jacketed firing-chamber 30 is arranged at or in the upper part of the boiler; its jacket 31 in this instance being shown bolted to the side of the boiler and having the water-space therein in communication with the water in the boiler. Said firing-chamber 30, shown enlarged in Fig. 3, is provided with two or more hydrocarbon burners 32, each having an air-supply pipe 33 and a gas or oil-supply pipe 34. As usual in such burners, the gas or oil is discharged through a nozzle extending through the air-chamber of the burner, the supply of gas or oil being regulated by a needle-valve 35. The said burners 32 can be lighted through an opening 36 in the firing-chamber, said opening being closed by a detachable screw-cap. The hot products of combustion pass from the firing-chamber 30 into the fire-space or passage 37, which is shown in line with the before-mentioned fire-space 20, and separated therefrom by a partition 38. From the fire-space 37, the hot products of combustion pass downwardly through a series of fire-flues or boiler-tubes 39 to the general exhaust 22 at the bottom of the boiler. Thus the heat from the supplemental firing device is utilized in the same perfect and effective manner already explained with reference to the heat from the products of combustion of the gas-engine. As to the respective numbers of the boiler-tubes 21 and 39, a desirable arrangement would be twenty-four tubes 21 for the hot gases from the gas-engine, and twelve tubes 39 for the hot gases from the supplemental firing-chamber; although of course the respective numbers of such tubes may be various.

A pipe 40 extends vertically through the center of the firing-chamber 30, in the focus of the heat of the said two or more hydrocarbon burners 32. At the upper end of said pipe 40, above the chamber 30, is a hopper 41 for receiving pulverized or ground coal, crude oil, or other gasifiable material. From the steam-dome 23 extends a steam supply-pipe

42, controlled by a valve 43, and having an injector or steam-jet 44 arranged in the hopper 41 in such manner as to force the ground coal or other material down through the pipe 40, wherein the said material is subjected to the intense heat within the firing-chamber 30 and is thereby gasified. A gasometer 45 is connected to the lower end of the pipe 40. A branch pipe 46 leads therefrom to the gas-feeding device 11 at the head of the gas-engine, and other branch pipes lead to the hydrocarbon burners 32; that is the fuel supply-pipes 34 of said burners 32 may derive their supply of gas from the pipe 40 or from the gasometer 45.

The operation of the supplemental-firing, gas-producing and engine-starting device is as follows: Assuming a gas supply in the gasometer 45, the valves of the burners 32 are opened and the gas in the firing-chamber 30 is lighted through the opening 36. In a short time the water in the jacket surrounding the firing-chamber and in the upper portion of the boiler will be heated and steam formed at high pressure in the steam-dome 23. If gas now be admitted to the mixing-valve 10 of the gas-engine, by opening the valve 12 of the gas-feeder or nozzle 11, and if the valve 25 of the steam-pipe 24 be opened to admit steam through the valve 26 to the steam-chamber 9 of the cylinder, the engine will start the same as any other steam-engine, under the impulse of steam admitted through the said valve 26. At the same time, the gas end of the cylinder will take in and compress a charge of gas which will be exploded in the usual way, thereby adding its impulse to the other side of the piston, and setting the gas-engine into operation. The engine having now been started, its operation will continue, the steam giving an impulse at each upward stroke of the piston and the explosion or combustion of the gas giving an impulse in the opposite direction at every second down stroke of the piston or every second revolution of the crank-shaft.

If desired, the supplemental-burners 32 may now be extinguished since the gas-engine will continue in operation, and the boiler will be fired by the heat from the gas-engine and from the products of combustion exhausted therefrom through the fire-flue or boiler-tubes 21. Or, if preferred, the supplemental-firing agency may be continued in operation, conjunctively with the firing afforded by the gas-engine, thereby increasing the capacity of the motor. As heretofore practiced with the "trimotor" or with a combined gas and steam-engine of the character disclosed herein, the waste heat from the gas end of the cylinder has caused the generation of a certain amount of steam for the steam end of the cylinder, reaching its maximum limit when a full charge of mixed gas and air is consumed in the gas end of the combined

motor. On the other hand, by the aid of my supplemental-firing device, any desired addition of steam and pressure can be given to the steam end of such motors. It is also
 5 evident that when such motors are used to heat and light buildings, the engine can be stopped at night or at any time, in which case the supplemental-firing device will keep up steam during the night to warm the
 10 building and start the engine again in the morning.

When it is desired to use coal as fuel, crushed or finely ground coal is supplied to the hopper 41, the burners 32 being in operation, thereby intensely heating the pipe 40.
 15 If the valve 43 now be slightly opened, the steam-injector 44 will carry mingled steam and crushed coal into the hot tube 40, wherein both the steam and carbon are de-
 20 composed into carbureted hydrogen gas, which will continue in its course down into the gasometer 45, and through the branch pipes 46 so as to supply the gas end of the gas-engine with heated gas as fuel, and in the
 25 same way supply the supplemental burners 32 with heated gas as the combustible for the supplemental firing device.

With present separate gas-producers, the residue of combustion usually passes away
 30 at a high temperature, wasting a large amount of heat, whereas, in my supplemental-firing and gas-producing device, after intensely heating the decomposing chamber, the hot gases enter into the boiler tubes
 35 39 in contact with the hottest water and descend as they cool off in contact with the coldest water through the general exhaust 22, thus recovering and utilizing the heat from such gases, in the same manner that the
 40 heat is recovered and utilized from the gas-engine.

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

45 1. In a gas-engine with combined apparatus, a steam-boiler in which are inclosed, and surrounded by the water therein, the cylinder of an internal combustion or explosion engine and also an independent fire-
 50 chamber, the latter having burners or firing means therein, and separate groups of fire-flues leading through the boiler one group from the said fire-chamber and the other from the combustion-chamber of the gas-
 55 engine for conveying off the hot products of combustion, all in a unitary structure, whereby the boiler is fired either independently or conjunctively by the gas-engine and said fire-chamber as a supplemental means.

60 2. In a gas-engine and combined apparatus, an upright steam-boiler having a fire-space in its upper portion and an exhaust space in its bottom, fire-flues connecting said spaces, and an internal combustion or explosion engine and supplemental firing device

both inclosed and surrounded by the water in said steam-boiler, and both arranged to discharge their hot products of combustion into said upper fire-space to descend through said
 70 flues to said bottom exhaust space.

3. The combination of a boiler having a steam-dome, fire-passages in its upper portion and a bottom exhaust passage, fire-flues or boiler-tubes connecting said fire and exhaust passages, a combined gas and steam
 75 engine, the explosion-chamber of the gas-engine being inclosed in the boiler and having its exhaust opening into one of said fire-passages, a supplemental firing-chamber also inclosed in the boiler and opening into
 80 the other fire-passage, a steam-valve in connection with the steam-engine, and a pipe for conducting steam thereto from said steam-dome.

4. In a gas-engine with combined apparatus, a steam-boiler in which are inclosed, and surrounded by the water therein, the cylinder of an internal combustion or explosion engine and also an independent fire-
 85 chamber, the latter having a burner or burners therein, fire-flues leading through the boiler from the said fire-chamber and from the combustion-chamber of the explosion-engine for conveying off the hot products of
 90 combustion, and a pipe or conduit for gasifiable material extending through said fire-chamber, being thereby exposed to the heat therein, and leading therefrom to the explosion-engine to supply the latter with hot gas
 95 for explosive mixture.

5. In a gas-engine with combined apparatus, a steam-boiler in which are inclosed, and surrounded by the water therein, the cylinder of an internal combustion or explosion engine and also an independent fire-chamber,
 100 the latter having a burner or burners therein, fire-flues leading through the boiler from the said fire-chamber and from the combustion-chamber of the explosion-engine for conveying off the hot products of combustion, and a pipe or conduit for gasifiable material exposed to the heat in said fire-chamber and communicating with said burners and with the explosion-engine, thus supplying said burners and the explosion-engine
 105 with hot gases.

6. In a gas-engine with combined apparatus, a steam-boiler in which are inclosed, and surrounded by the water therein, the cylinder of an internal combustion or explosion engine
 110 and also an independent fire-chamber, the latter having a burner or burners therein, fire-flues leading through the boiler from the said fire-chamber and from the combustion-chamber of the explosion-engine for conveying off
 115 the hot products of combustion, and a pipe or conduit for gasifiable material leading through said fire-chamber and having connection with the combustion engine, said pipe being provided exteriorly of the boiler with a hop-
 120
 125
 130

per for feeding ground coal or other crude fuel, and a steam-pipe leading from the boiler having a nozzle arranged to inject a steam-jet into said hopper to force the material through said pipe and to unite in the decomposition of the material for formation of gases.

In testimony whereof I affix my signature, in presence of two witnesses.

WILLIAM HECKERT.

Witnesses:

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JAS. M. SHEPARD.