No. 647,651. Patented Apr. 17, 1900.

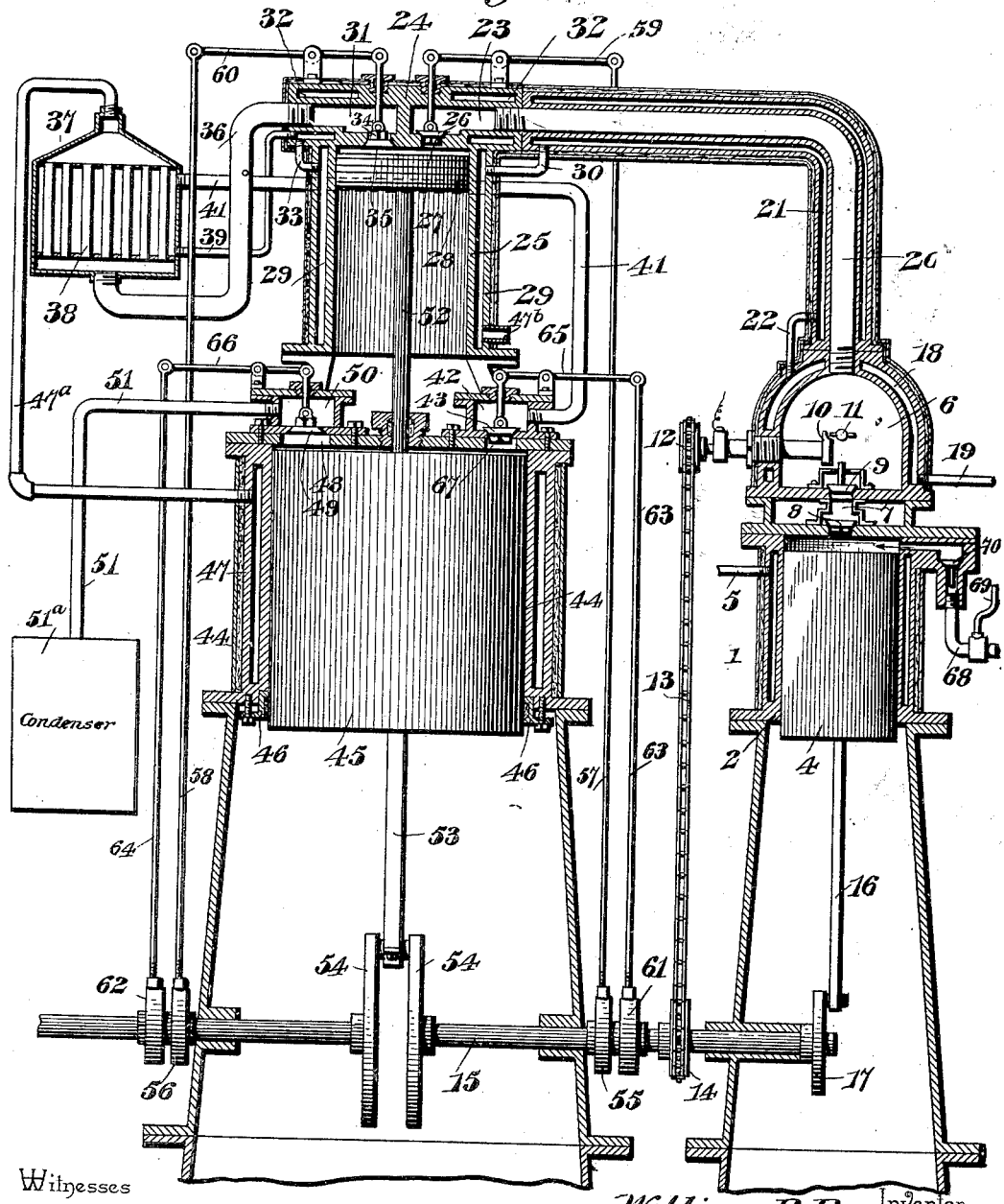
# W. R. DOW.

## GAS ENGINE.

(Application filed July 30, 1898.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.




Witnesses
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William R. Dow Inventor

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Fig. 3

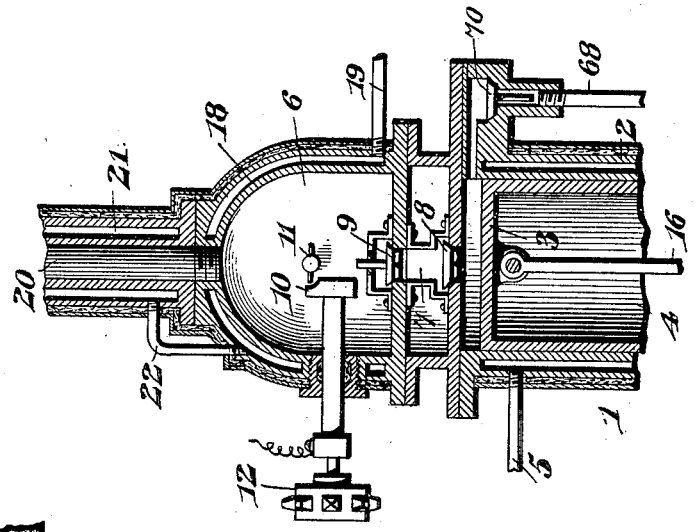
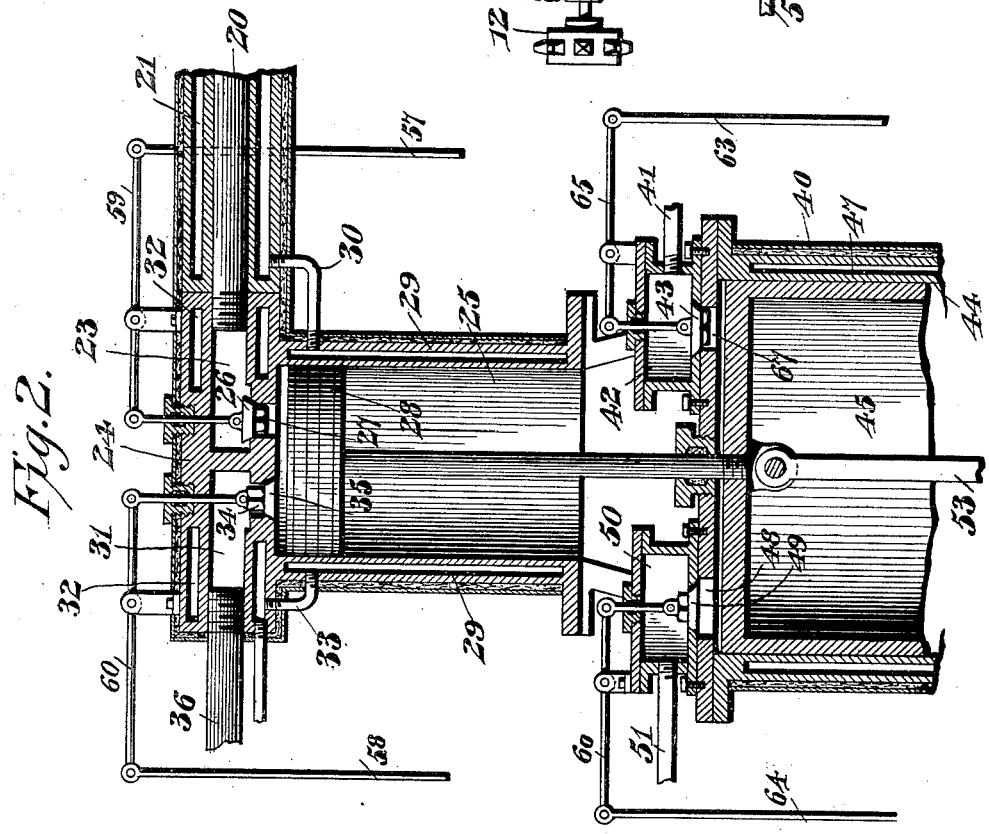



Fig. 2.

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# UNITED STATES PATENT OFFICE.

WILLIAM ROBERT DOW, OF BOULDER CREEK, CALIFORNIA.

## GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 647,651, dated April 17, 1900.

Application filed July 30, 1898. Serial No. 687,282. (No model.)

*To all whom it may concern:*

Be it known that I, WILLIAM ROBERT DOW, a citizen of the United States, residing at Boulder Creek, in the county of Santa Cruz and State of California, have invented a new and useful Gas-Engine, of which the following is a specification.

My invention relates to gas-engines, and has for one object to provide a construction and arrangement of parts whereby the exhaust heat, and that which is absorbed by the contents of the water-jackets, is utilized in connection with a heater or boiler for forming steam which is employed to assist in the operation of the piston.

Further objects and advantages of this invention will appear in the following description, and the novel features thereof will be particularly pointed out in the appended claims.

In the drawings, Figure 1 is a vertical sectional view of an engine constructed in accordance with my invention. Figs. 2 and 3 are detail sectional views, respectively, of the main cylinder and coöperating parts and the compressor with the connected explosion-chamber.

Similar numerals of reference indicate corresponding parts in all the figures of the drawings.

1 designates a compressor in the cylinder 2 of which operates a piston 3 of the single-acting type known as a "trunk-piston" and having a shell 4, the proper lowness of temperature being maintained by means of water admitted through an inlet 5. The compressor-cylinder communicates with an explosion-chamber 6 through a passage 7, fitted with check-valves 8 and 9, which open upwardly or toward the explosion-chamber, and arranged in the explosion-chamber is an electric igniter of the ordinary construction, including a rotary member 10 and a stationary member 11, said rotary member having its spindle provided with a sprocket-wheel 12, traversed by a chain 13, which extends to a similar sprocket-wheel 14 on the main or driving shaft 15. The pitman 16, which is connected with the piston 3, is actuated by a crank-disk 17, also carried by said shaft 15.

The explosion-chamber is jacketed, as shown at 18, and is interiorly supplied with water through a supply-pipe 19, and communicating with the explosion-chamber is a conveyer 20, also having a jacket 21, which is connected by means of an intermediate conductor 22 with the jacket 18, whereby water after passing through the jacket 18 is communicated to the jacket 21.

The conveyer 20 communicates with a valve-chamber 23, formed in a hollow head 24 of the main piston-cylinder 25, an inlet-valve 26 being seated in an inlet-port 27 in communication with said cylinder to allow the products of explosion in the chamber 6 to pass into the piston-cylinder to depress the driving or main piston 28. This main piston-cylinder is also provided with a jacket 29, which is in communication by a conveyer 30 with the jacket 21 of the conveyer 20, and the head 24, which is also constructed interiorly to form an exhaust-chamber 31, is provided with a water-jacket 32, which is in communication by a conveyer 33 with the jacket 29. Said exhaust-chamber is in communication with the interior of the cylinder 25 by means of an exhaust-port 34, in which is seated an exhaust-valve 35.

The exhaust-chamber 31 is in communication by means of an exhaust-conveyer 36 with a heater 37, having suitable means, such as boiler-tubes 38, for bringing the heated exhaust of the cylinder 25 into contact with water to raise the temperature of the latter, said tubes extending through a boiler-chamber which is preferably supplied with water by means of a conductor 39, which is in communication with the jacket 32 of the cylinder-head 24, and hence is supplied by the pipe 19 through the several jackets of the engine. In order to cause the absorption by the contents of the water-jackets of the maximum percentage of the heat thrown off by the several elements of the structure, the outer walls of said water-jackets are covered with layers 40 of a non-heat-conducting material, such as asbestos, and exteriorly of this asbestos layer is arranged a sheath of burnished metal, such as tin or the equivalent thereof, to reduce radiation to the minimum. Thus water is admitted to one of the series of water-jackets and thence passses through the several jackets, which are arranged in series for this purpose, until it reaches the

heater, where it is exposed to the exhaust-heat of the main cylinder, and consequently to the products of the explosion in the chamber 6. At this point the water is raised to a temperature sufficient to form steam, which is carried by a suitable conveyer 41 to an inlet-valve casing 42, which is in communication through a steam-inlet valve 43, and port 67 with a steam-cylinder 44, in which operates a trunk-piston 45. This piston operates through a stuffing-box 46, and the cylinder may be jacketed, as shown at 47, and supplied by the exhaust from the heater 37 through a conveyer $47^a$ in order to maintain the cylinder at such a temperature as not to cause a premature condensation of steam admitted thereto. In combination with the jacket is a final exhaust $47^b$ for the products of combustion after they have passed through said jacket. Also in communication with the cylinder 44 is an exhaust-port 48, having a valve 49, which when unseated allows communication with the exhaust-valve casing 50, this being in communication by a conveyer 51 with a condenser. (Not shown.) The piston 28 is connected by its rod 52 with the piston 45, and the latter is connected by a pitman 53 with a crank-disk or disks 54 on the main shaft. Also suitable eccentrics 55 and 56 are connected, respectively, by eccentric-rods 57 and 58 with levers 59 and 60, which are connected with the stems of the above-mentioned inlet and exhaust valves 26 and 35, respectively, and in the same way eccentrics 61 and 62 are connected, respectively, by rods 63 and 64 with levers 65 and 66, to which are connected the stems of the inlet and exhaust valves 43 and 49, which control the ports 67 and 48, respectively.

The cylinder of the compressor is supplied with a mixture of gas and air in the desired proportions by means of an air-supply pipe 68 and a gas-supply pipe 69, communicating at a common point with said cylinder by means of a port controlled by the check-valve 70, whereby during the downward movement of the compressor-piston gas and air in the proportions of about one to eight are drawn into the cylinder. During the upstroke of said piston this mixture of gas and air is forced under pressure into the explosion-chamber 6 through the valved passage 7, where it is exploded by means of the igniter. The pressure thus generated is now communicated through the inlet-tube to the valve-chamber 23 to the main cylinder 25 by the opening of the valve 26 at such times as pressure is desired in the said cylinder and of which the operation is under the control of the above-mentioned eccentric 55. Simultaneously with the admission of pressure from the explosion-chamber into the main cylinder 25 steam is admitted through the valve-port 43 into the steam-cylinder 44, and I preferably employ a steam-cylinder of much greater capacity than the other cylinders. When the pistons reach the limit of their downward stroke, the exhaust-valve 49 is open to the condenser, which is indicated in diagram at $51^a$ and may be of any preferred or ordinary construction, whereby the steam in the cylinder 44 is condensed to produce a partial vacuum, which forcibly raises the piston 45 by suction and with it raises the piston 48, thereby expelling the products of explosion from the cylinder 25 and forcing them through the conveyer 36 to the heater, the exhaust-valve 35 being obviously opened simultaneously with the valve 49. Thus it will be seen that the utilization of the products of the explosion in the operation of the piston 28 is wholly independent of the amount of explosion, and therefore it is only necessary to maintain by explosion a sufficient pressure in the explosion-chamber and communicating conveyer 20 to insure the prompt operation of the piston 28. This pressure is drawn from the explosion-chamber and applied to the piston 28 in the same manner as any other fluid-motive agent, and I have found in practice that the same can be controlled and that "back fire" may be prevented by the simple use of cooling means for the compressor. By maintaining the compressor-cylinder at a low temperature, as through the use of water admitted by the supply-pipe 5, each upward movement thereof projects into the explosion-chamber a quantity of compressed gas and air which is at a much lower temperature than the contents of the explosion-chamber, and hence materially cools the contents of said chamber, and as the last-admitted cool fluid remains at the bottom of the explosion-chamber, thus causing the heated fluid to leave the chamber first, it will be seen that it is constantly being replaced and that the portions of the apparatus contiguous to the compressor and the igniter are maintained at a temperature which renders the operation of the mechanism safe and efficient.

Various changes in the form, proportion, and the minor details of construction may be resorted to without departing from the spirit or sacrificing any of the advantages of this invention.

Having described my invention, what I claim is—

1. In an engine, the combination with jacketed gas and steam cylinders, pistons operating in said cylinders and connected for simultaneous movement, means for admitting gas and steam to the cylinders to apply pressure simultaneously to corresponding sides of said pistons, a condenser having valved communication with the steam-cylinder for receiving exhaust-steam therefrom, a valved exhaust in communication with the gas-cylinder, and adapted to be opened simultaneously with the establishment of communication between the steam-cylinder and the condenser, and a water-heater having a chamber in communication with the exhaust from the gas-cylinder, and also in communication with the jacket of the steam-cylinder, said jacket hav-

ing a final exhaust for the hot gases supplied to the steam-cylinder jacket from the water-heater, and the water-heater also having a water-chamber in communication with the jacket of the gas-cylinder, substantially as specified.

2. In an engine, the combination of jacketed gas and steam cylinders, pistons operating in said cylinders and connected for simultaneous movement, means for admitting gas under pressure to the gas-cylinder, a valved exhaust for the gas-cylinder, valved inlet and exhaust ports for the steam-cylinder, a condenser in communication with the exhaust of the steam-cylinder, a water-heater having a chamber in communication with the exhaust of the gas-cylinder, and also in communication with the jacket of the steam-cylinder, said jacket of the steam-cylinder being provided with a final exhaust-port for the hot gases supplied to the steam-cylinder jacket from the water-heater, and said water-heater also having a water-receptacle in communication with the jacket of the gas-cylinder, and with the inlet-port of the steam-cylinder, substantially as specified.

3. In an engine, the combination of jacketed gas and steam cylinders, pistons operating in said cylinders and connected for simultaneous movement, means for admitting gas under pressure to the gas-cylinder, a valved exhaust for the gas-cylinder, valved inlet and exhaust ports for the steam-cylinder, a condenser in communication with the exhaust of the steam-cylinder, a water-heater having a chamber in communication with the exhaust of the gas-cylinder, and also in communication with the jacket of the steam-cylinder, said jacket of the steam-cylinder being provided with a final exhaust-port for the hot gases supplied to the steam-cylinder jacket from the water-heater, said water-heater also having a water-receptacle provided with an outlet-conveyer in communication with the inlet-port of the steam-cylinder, and an inlet-conveyer in communication with the jacket of the gas-cylinder, and means for continuously supplying the jacket of the gas-cylinder with water, substantially as specified.

4. In an engine, the combination of jacketed gas and steam cylinders, pistons operating in said cylinders and connected for simultaneous movement, valved means for admitting gas under pressure to the gas-cylinder, said means consisting of an explosion-chamber and conveyer provided with a jacket in communication with that of the gas-cylinder, a water-supply pipe in communication with the jacket of the explosion-chamber, a valved exhaust for the gas-cylinder, valved inlet and exhaust ports for the steam-cylinder, a condenser in communication with the exhaust of the steam-cylinder, and a water-heater having a chamber in communication with the exhaust of the gas-cylinder, and also in communication with the jacket of the steam-cylinder, said jacket of the steam-cylinder being provided with a final exhaust-port for the hot gases supplied to the steam-cylinder jacket from the water-heater, and said water-heater also having a water-receptacle in communication with the jacket of the gas-cylinder to receive water therefrom, and with the inlet-port of the steam-cylinder to supply steam thereto, substantially as specified.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

WILLIAM ROBERT DOW.

Witnesses:

A. H. STAGG,

W. H. DOOL.