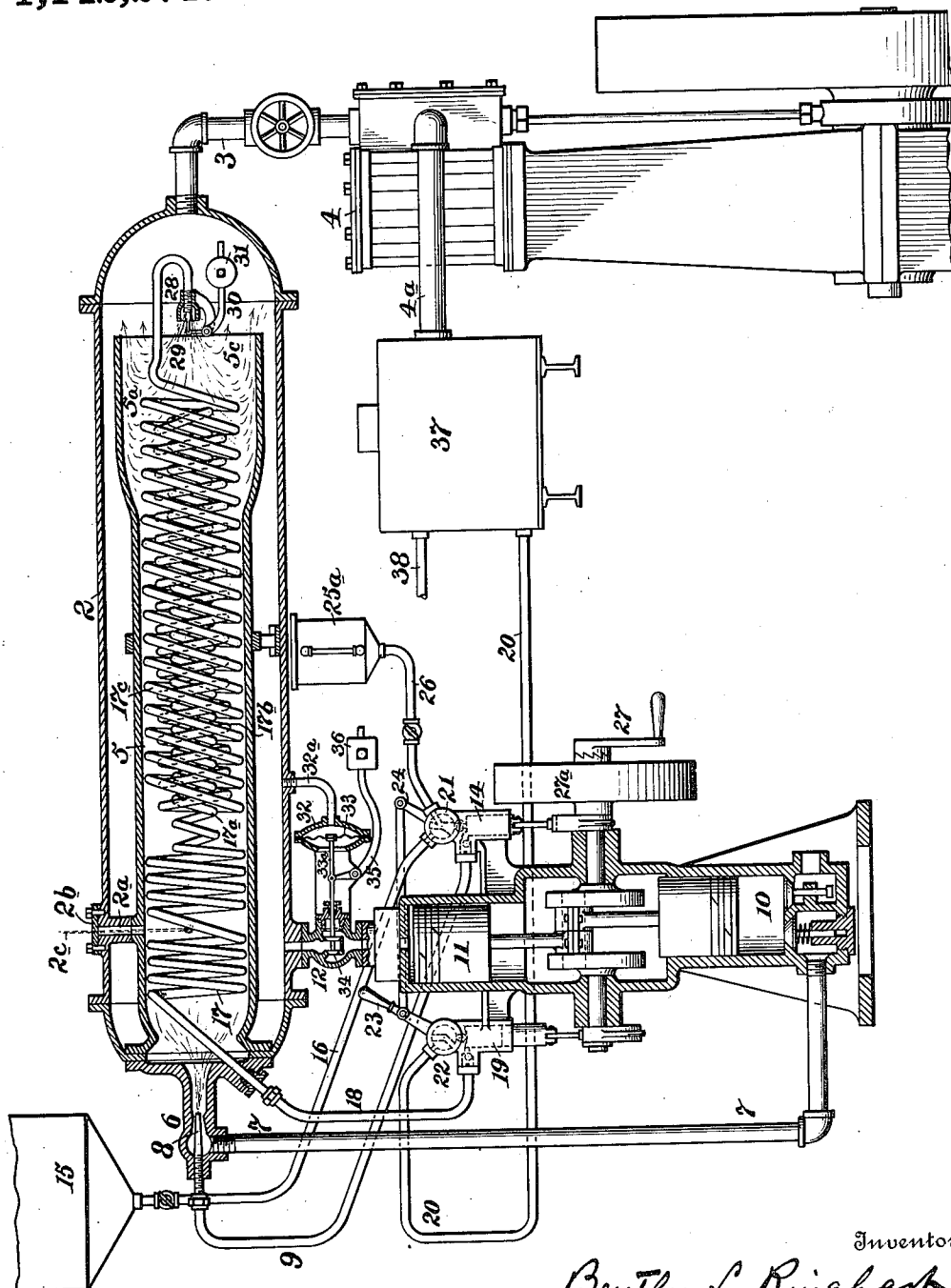


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METHOD AND MEANS FOR THE GENERATION OF COMPOUND MOTIVE FLUID.
APPLICATION FILED APR. 18, 1913.

1,142,271.

Patented June 8, 1915.



Witnesses

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METHOD AND MEANS FOR THE GENERATION OF COMPOUND MOTIVE FLUID.

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Specification of Letters Patent.

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Application filed April 18, 1913. Serial No. 761,884.

To all whom it may concern:

Be it known that I, BENTLEY L. RINEHART, citizen of the United States, and resident of Philadelphia, county of Philadelphia and State of Pennsylvania, have invented an Improvement in Methods and Means for the Generation of Compound Motive Fluids, of which the following is a specification.

The object of my invention is to provide a method and means for the generation of compound motive fluid for operating engines, whether of the reciprocating, rotary or turbine type, whereby the production of associated operating vapors and gases may be generated at an exceedingly low cost as compared with the ordinary methods of generating steam, wherein the water is vaporized by the use of fuel separated therefrom by the interposed boiler plates forming the shell, fire-box, flues and tubes.

The two main objects of my invention are, to produce a motive medium at low cost and to provide a method and apparatus for so doing which shall be inexpensive and occupy small space.

A secondary, yet important, feature of my improvement is due to the fact that there is but small danger from explosion, notwithstanding that the apparatus may be employed to rapidly generate enormous volumes of steam and gases.

Broadly considered, my invention comprehends the method and means for the production of a mixture of steam and gases from water and a suitable hydrocarbon fluid, by subjecting the latter to combustive process, preferably under high pressure, and utilizing the heat so produced to vaporize the water and convert it into steam at high temperature and corresponding pressure to that under which the combustive gases are generated.

By my improved method, the water is converted into a finely subdivided heated spray and the hot spray instantly converted into steam by direct contact with the products of combustion at high temperature and pressure, thereby utilizing the entire available thermal units of the heated gases for the transforming of the water into steam and raising the said steam to the high degree of temperature which is desired in the apparatus to enable the carbon-dioxid and other gases, resulting from the combustive process, to retain their high temperature so as to op-

erate expansively when employed, associated with the steam, in the engine.

Furthermore, it will be understood that, as the products of combustion are required to mix with the steam and the compound mixture of vapor and gases pass to the engine, it is essential that the products of combustion shall be clean. To secure this result, I employ a special method and means for producing a combustion of the hydrocarbon fuel in exactly the right proportions to convert it all into a gaseous state, and especially is this possible without carbon deposition, because of the exceedingly high temperature under which the gases are produced at the initial moment of their production. The temperature under which the gases are produced may be increased or decreased to the desired extent by adjustment of the apparatus which supplies the generator with the hydrocarbon fuel and air, said suitable devices operating automatically maintain the temperature and pressure within the generator at any predetermined condition desired.

As the method of generating the heat within the generator is a chemical one, and when carried on with a fuel of uniform composition, is one which operates under exact chemical laws, it is evident that, by accurately controlling the admission of the hydrocarbon fluid and also of the air, perfect combustion can be secured with the production of the maximum number of heat units per gallon of fuel, so that the manner of generating the heat is highly economical; and moreover, the use of this heat so generated in transforming the hot water vapor into high temperature steam by direct contact therewith, is also economical in the highest degree as a mode of transferring heat from the fuel to the water. Moreover, every unit of heat provided is utilized as far as possible in such a rapid manner that enormous volumes of steam and gas may be generated with an apparatus relatively small to what would be required in generating the same available motive energy under the old and still common manner of generating steam in boilers.

As the quantity of liquid fuel, the air for its combustion and the amount of water to be vaporized in a given time, are all matters which are accurately predetermined and decided upon, it follows that the process and method employed is automatic, irrespective of the amount of steam and gases which the

generator is required to generate in a given period of time, the automatic supply of these various substances, fuel, air and water, being increased or decreased proportionally in accordance with the consumption of the generated products of the apparatus.

The method herein described is very useful in cases where automatic generation of motive fluid is required as in the operation of automobiles in which economy of fuel is important; but the method is equally available for the operation of large powers such as those of steam-ships, electric power plants and large operations where steam engines are now employed. The fact, that the generator may automatically vary the volume of steam and gas produced (at predetermined and constant pressure) in a given time, to suit the variable duty of the engines, makes the method and apparatus especially useful in all cases where the consumption of power is variable. It will further be understood, the method is so responsive that, within a few moments, a comparatively dormant condition of the apparatus can be brought to one of great activity with a maximum production of steam, a capacity which would be especially available in naval vessels in active service.

In view of the fact that the generation of the motive fluid is rapidly accomplished and obviates the necessity of employing any boiler reservoir of large capacity such as is ordinarily required in steam boilers and especially those used in turbine work, it becomes necessary in maintaining the pressure substantially constant, to accurately and automatically govern the supply of fuel, air and water to the generator, and to retard the supply of these elements whenever there is a tendency to increase the pressure above the predetermined maximum amount.

My invention also consists of apparatus in which to carry out the method of operation above outlined, the said apparatus being fully described hereinafter in connection with the drawings, in which is shown, diagrammatically (largely in section), an elevation of apparatus embodying my invention. 2 is the generator shell for temporarily holding the mixed steam and gases, and these may be supplied to any suitable steam engine, 4, by pipe 3, controlled by throttling or governing devices, as is customary in steam engine practice. Within the shell 2 is arranged the combustion chamber, comprising the tubular part 5 secured at one end to the shell 2 and open at the other end within the generator, said open end preferably enlarged as at 5^a, for purposes to be later described.

The closed end of the combustion chamber 5 is provided with the nozzle 6 for supplying the fuel for generating the heat, said fuel consisting of suitable hydrocarbons and air, the former preferably in liquid form

such as refined or crude petroleum. This nozzle 6 connects with an air pipe 7 receiving compressed air from the air compressor or pump 10. This air compressor 10 is operated by an engine 11, operated by the steam and gases generated within the generator 2. These steam and gases are supplied to the engine through a controlling valve 12, which operates automatically to cause the pump to deliver more or less air as the pressure conditions of steam and gases within the generator may dictate. This valve will be more fully described hereinafter.

The nozzle 6 also has an oil nozzle 8 for delivering the hydrocarbon fuel as a spray, to enable it to be more fully associated or mixed with the air passing through the nozzle 6. The oil or hydrocarbon fuel is supplied to the nozzle 8 by a pipe 9 and pump 14, also operated by the engine 11. The source of oil or hydrocarbon fuel is the tank 15, from which it is supplied to the pump by pipe 16 and the valve 21 controls the supply of this oil or hydrocarbon fuel to the pump.

25^a is a small auxiliary or starting tank for holding gasolene or other highly volatile hydrocarbon fluid which is supplied to the pump 14 by pipe 26. The valve 21 is so constructed and arranged that it may supply gasolene from tank 25^a or oil from tank 15 to the pump 14, but preferably not both at the same time. The gasolene is employed only at starting the generator, to secure the initial heat for heating the coils 17 and whereby a sufficient volume of gas (with or without steam) may be generated to operate the engine 11; after the engine automatically operates, the contents of the tank 15 are supplied to the pump.

Within the combustion chamber 5, are arranged the coils of pipe through which the water is circulated and heated before being sprayed from the nozzle 28 at the terminal of said pipe. These coils at the water receiving end are coiled of a diameter which substantially fills the interior diameter of the chamber 5, as shown at 17, and thereby act as a water cooled lining to protect the metal walls of the combustion chamber and prevent them from melting under the high temperature which is produced. The coils, for about one-quarter of the length of the combustion chamber, are as above described and are then continued through the chamber for the remainder of their length as a coil 17^a of small diameter, then returned upon itself in a coil 17^b of medium diameter, and finally returned again in an outer coil 17^c substantially filling the diameter of the combustion chamber 5 except where it is enlarged at 5^a near the open end 5^c. The extreme end of the coil terminates in the nozzle 28, which is directed inward toward the coils so as to spray the hot water into the open and

enlarged end of the combustion chamber and toward the outflowing hot products of combustion. The spray may be adjusted to suit the requirements by providing a valve or plug 29 which is pressed into the nozzle by a lever 30 and weight 31 thereon. The pressure of the water causes it to flow outward around the plug or valve piece and form a fine spray, and this may be adjusted as to fineness by adjusting the weight 31 on the lever 30. I have here described the form of spray nozzle I prefer, but I do not restrict myself to any form of device for causing the water to be sprayed or vaporized at or about the time it is projected into the hot outflowing gases or products of combustion from the enlarged end 5^a of the combustion chamber.

The form or arrangement of the coils may be varied, as I do not limit myself to any special construction of such coils; in fact, the heating of the spray water, from which the steam is to be generated may be heated in any suitable manner, under the broader understanding of my invention.

As shown, by way of example, the feed water is delivered by a pump 19 and pipe 18 to the coils 17 of the combustion chamber, above described. The water may be supplied to the pump by a pipe 20, and as shown this pipe may receive its supply from the feed water heater 37, of any suitable construction. The cold water may be supplied to the feedwater heater by a pipe 38, and be heated by the exhaust steam and hot waste gases from the engine 4, delivered into the heater through the exhaust main 4^a. In this manner, a very large portion of the heat units passing from the engine in uncondensed steam and expanded gases carrying caloric, may be recovered by the feed water, thereby reducing the amount of fuel required to be supplied to the generator.

A valve 22, having an operating handle 23, may be employed for shutting off the water supply to the pump 19 when starting the apparatus with the preliminary heating with the gasolene, at which time it is not desired to retard the initial heating by injection of feed water spray. Instead, the coils 17 are heated to a high degree by the combustion of the gasolene or gas mixture, and then the water is turned on and caused to burst into steam when it enters the hot coils, giving a quick available steam pressure and volume for operating the engine 11 when starting to raise the pressure to the normal high pressure required. To effect this action, I prefer to connect the valves 19 and 21 by a link 25, said link connected at one end to the handle 23 of valve 19 and at the other end to the arm 24 of the valve 21. By this arrangement, it will be seen that when the gasolene is supplied to the pump 14 for use in the generator, the water

is shut off from the pump 19; and when water is supplied to pump 19, the oil from the tank 15 is supplied to pump 14, this being the time when the water supply is especially needed.

The air pump 10, water pump 19 and fuel pump 14, are shown connected as one mechanism operated by the engine 11, so that by carefully predetermining the exact quantities of each of these materials required for the carrying out of the method of generation of the steam and gas, the apparatus will operate automatically with the highest efficiency. Of course, it is not at all necessary that these three pumps shall be constructed as one machine, as it will suffice that the requisite regulated amounts of each of these materials shall be supplied in any suitable or convenient manner. In the construction shown, I have provided the engine 11 with a hand crank 27 by which to operate the pump until the gasolene, burning with the air, has generated a working pressure and sufficiently heated the coils to insure the generation of the steam. The engine 11 will respond as soon as there are sufficient heated gases or steam or both to operate it, so that the hand operation is only a preliminary and temporary matter. Of course, this engine may be operated at the start by any other motor, such as an electric motor or an auxiliary gasolene or explosive motor by simply belting it to the fly wheel 27^a, such detail being in no way material to the real invention.

Referring to the automatic speed controlling valve 12, I provide a pressure chamber 32 in communication with the generator chamber by a pipe 32^a, said pressure chamber 32 having a diaphragm 33; to the diaphragm I connect a valve stem 33^a which operates a balanced valve piece 34, the diaphragm acting to close the valve to shut off the supply of steam and gas to the engine 11; and to the valve stem I connect a pivoted lever 35 having an adjustable counterbalance weight 36 to move the valve piece to open the valve to supply steam and gas to the engine. The weight 36 is set to operate the apparatus at any pressure desired and the automatic valve 12 will thereafter cause the engine 11 to be operated so as to insure the supply of air, oil and water to the generator, in just sufficient quantities to maintain that pressure. Any other suitable automatic control valve or device may be used in place of that shown to control the engine 11.

To enable the apparatus to be started, I provide the following means for igniting the gases in the combustion chamber. The generator has an igniting aperture 2^a opening through it and closed on the outside by a cap 2^b. When the gasolene and air mixture is forced into the generator, it is made

to impinge upon a bit of spongy platinum on the end of a rod 2^c (indicated in dotted lines) which heats in the gases and spontaneously ignites the mixture; the rod is then withdrawn and the cap 2^b secured in place. The coils 17 may be separated slightly, as shown, to enable the platinum sponge and its rod to be inserted within the coil to a central position in the combustion chamber. It is manifest that any other manner of igniting these combustible gases may be employed, such for example as the ordinary electric spark used in gasoline or explosive engines generally. I prefer, however, to use the platinum sponge and then remove it because of the high temperature maintained within the combustion chamber.

The enlarged end 5^c of the combustion chamber provides greater space for the admixture of the water spray and hot gases, as well as for the greatly increased volume due to the generation of the steam. The enlargement also allows the escape of the gases and steam from the combustion chamber to a point beyond the nozzle as soon as the heat of the gases has generated the steam, so that new portions of gas and water spray may be brought into intimate contact. The impinging of the water and steam upon the outflowing gases insures a quicker transference of heat than if they were mixed or brought into contact in any other way. The shape of the combustion chamber may be greatly varied, to suit the requirements of commercial practice.

The apparatus which I have illustrated, is to be understood as diagrammatic or academical, for the purpose of disclosing the essential features required for the carrying out of my invention, for in commercial practice the various parts of the apparatus would be especially designed for the duty required of it and consequently the details may be greatly varied under all of the usual liberties accorded to good engineering practice.

I will now briefly describe the operation of the apparatus: The valves 21 and 22 being in the positions shown, the hand crank 27 is rotated to operate the air compressor 10 and the fuel pump 14. Gasolene is drawn from tank 25^a and forced through pipe 9 and sprayed from the nozzle 8; and at the same time compressed air is forced through the pipe 7 through the nozzle 8. The combustible mixture passes into the combustion chamber 5, where it is ignited by the platinum sponge 2^c (or otherwise). The heat generated heats the coils 17 and all the other coils connected with them. The platinum sponge is withdrawn and the opening 2^a sealed by the cap 2^b. The gases produced will soon increase in pressure sufficiently to operate the engine 11 and thereby dispense with the necessity of operating the crank 27.

When the gasolene from tank 25^a is about consumed, the valves 21 and 22 are shifted, to supply oil from tank 15 to the pump 14 and water to the pump 19, by which latter it is forced into the hot coils 17, 17^a, 17^b and 17^c, to be heated and sprayed from the nozzle 28. The apparatus then continues to operate automatically. The hot water from nozzle 28 is sprayed into the outrushing hot gases from the combustion chamber 2 and is, by the heat of said gases, converted into steam at high pressure and temperature. The heat of the gases (products of combustion) is partly given up to the water spray to be absorbed as latent heat to convert the water into steam at the pressure of the generator and to produce a balance in the temperature of the gases and steam, the temperature of the latter being sufficiently high to enable the final temperature of the gases of the resultant mixture to be capable of use expansively for operating pistons or rotors of engines.

The burning of the air and hydrocarbons in the generator under high pressure insures a very intense temperature and this is utilized, first: in heating the water in the coils preferably almost to vaporizing point, and second: transforming the spray into steam with enormous rapidity, the temperature and pressure of the steam being a function of the temperature of the gases of combustion and the volume of the water converted into steam relatively to the volumes of air and fuel supplied to the generator.

The high pressure mixture so generated may be supplied to an engine of any suitable construction of reciprocating, rotary or turbine types, and the supply of the gases and steam is insured in the proper or requisite quantities, by the control of the engine 11, this being regulated by the automatic valve 12. This valve 12 throttles the supply of motive gases and steam to the engine 11, whenever the pressure of the generator exceeds a predetermined amount, and vice versa. The waste or exhaust products from the engine may pass by the exhaust pipe 4^a to the feed water heater 37, in which some of the heat of the exhaust products may be absorbed in the feed water which is delivered by the pump 19 to the generator coils, to add to the economy of the process.

As the thermal value of hydrogen is 34462 as against 7000 to 8000 for carbon (coke and coal) when burned with oxygen, and as against 2400 for carbonic acid, when burned to carbonic acid, and as the more important hydrocarbons of crude oil are marsh gas with a thermal value of 13063, oiliant gas with a thermal value of 11858, it is evident that there is an enormous available capacity by my process for producing and transferring heat to the water in the act of generating high pressure steam at a rapid rate with a

small apparatus and at relatively low cost. Furthermore, as the process is one in which the combustion is made to take place at high pressure (100 pounds or over, as desired), the density of these hydrocarbon gases is greatly increased at time of combustion over what it would be in the atmosphere and consequently the temperature obtained is greatly increased. When hydrogen is burned under a pressure such as would make the density of its product equivalent to that of carbonic acid at atmospheric pressure, the same volume of compressed gas would give an intensity of temperature approximately a great many times that of the carbonic acid; and it is because of this power of regulating the temperature within the generator and producing available heat units by regulated combustion within a confined space sufficient to generate the large volumes of steam required by direct contact of the water spray with the high temperature products of combustion, that the effectiveness and efficiency of my process are secured.

As conduction of heat through steel boiler walls is dispensed with, the conversion of water into steam becomes possible with almost the speed of explosion, but without any of the dangers thereto. The white hot products of combustion meeting the highly heated water in fine spray, produces spontaneous steam generation in the myriads of water particles in rapid succession; and as the heat temperature is maintained constant, irrespective of the volume duty of steam required, the apparatus is automatic to the highest degree.

As the hydrocarbon constituents of the oil fuel are hydrogen and carbon, the action of the air therein is to produce carbonic acid and steam mixed with nitrogen so that the final mixture which passes to the engines is the same but enormously augmented by the steam which is produced from the water.

The carbonic acid and nitrogen are not condensible and hence, if the expansive power of these gases is to be utilized, it will be best to also rely upon the expansive force of the steam, above atmospheric pressure, in the engine. The heat of the waste gases from the engine and the latent heat of the steam may be given up subsequently in the feed water heater, to return part of the waste heat to the feed water.

While the steam may be used below atmospheric pressure in a condensing engine, the necessity of rapid lowering of the heat of the carbonic acid and nitrogen, mixed with it, will mitigate to a material extent against such condensation, when the condensing medium is expensive. The low cost of producing a mixture of steam and products of combustion and the facility of its production at high pressure and under perfect control, enables it to be used expan-

sively above atmospheric pressure with highly efficient results, so that the apparent loss by the difficulty of using the steam by condensation, as heretofore commonly practised, is not a real one, especially as there is a great saving in costly condensing apparatus and the expense of operating it.

I have described my process and an example of an apparatus in which it may be carried into use, but I do not restrict myself to the details of either, as these may all be varied or modified without departing from the spirit of the invention.

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

1. The herein described method of generating a mixture of steam and gases and utilizing them as a motive force for a prime mover, which consists in supplying to a closed chamber carbonaceous materials and air in accurately measured and controlled quantities to produce perfect combustion, forcing the said combustion to take place under high pressure and thereby producing an exceedingly high temperature, utilizing a portion of the high temperature products of combustion for heating a confined body of water to a condition to give it a pressure considerably in excess of the pressure of the products of combustion in the closed chamber, delivering the said heated body of water in the form of spray into the heated products of combustion within the closed chamber in a continuous manner and causing the liberation of the water under the excessive pressure to cause the water to burst into great subdivision in the presence of the heated products of combustion, whereby the subdivided water is instantly converted into steam at a temperature and pressure lower than the temperature and pressure of the water before being liberated, supplying the steam and mixed gases to the prime mover in accordance with the requirements thereof, and controlling the volumes of the products of combustion and steam generated wholly by the variations in the conjoint pressures under which the same exist within the closed chamber and independently of the speed of the prime mover.

2. The herein described method of generating a mixture of steam and gases to be used as a motive force for engines, which consists in generating products of combustion under high pressure and temperature in a closed chamber, employing the said highly heated products of combustion under pressure to produce large volumes of steam within the chamber by raising measured quantities of water in a confined state to a higher pressure than that of the products of combustion and steam contained in the chamber and at a higher temperature than the steam contained in the said chamber,

causing the said water under its highly heated condition and under its high pressure to be injected into the chamber and thereby to be converted into a state of spray or great subdivision at a lower temperature and pressure, and bringing said spray into intimate contact with the products of combustion within the chamber, and thereby instantly converting the subdivided water or spray into steam at the pressure of the products of combustion and at a less pressure and lower temperature than that under which the water was heated.

3. The herein described method of generating a motive fluid for operating engines and prime movers, which consists in generating a high temperature and pressure within a closed chamber by forcing into said chamber air and combustible fuel in predetermined in definitely measured proportions bearing constant and definite relation to each other and independent of the prime mover, supplying feed water to the heat of the products of combustion while shielded from direct contact therewith and generating thereby a pressure in excess of that in the chamber and producing from said feed water a highly heated finely divided spray of water under high pressure within the closed chamber, and intermingling the hot products of combustion and water spray to spontaneously convert the spray into steam at high pressure and temperature.

4. The herein described method of generating a motive fluid for operating engines and prime movers, which consists in generating a high temperature and pressure within a closed chamber by forcing into said chamber air and combustible fuel in predetermined mechanically measured proportions bearing constant and definite relation to each other and independent of the prime mover, supplying feed water to the heat of the products of combustion while shielded from direct contact therewith and producing from said feed water a highly heated finely divided spray of water under high pressure within the closed chamber, intermingling the hot products of combustion and water spray to spontaneously convert the spray into steam at high pressure and temperature, supplying the high pressure mixture of steam and hot gases to a prime mover, and varying the amount of measured quantities of air, fuel and water under the control of the pressure of the steam and products of combustion generated and wholly independent of the variations in the speed of the prime mover.

5. The herein described method of generating a motive fluid for operating engines and prime movers, which consists in generating a preliminary high temperature and pressure within a closed chamber independent of control by the engine or prime mover

by forcing into said chamber air and combustible fuel in predetermined measured proportions by hand operation, utilizing the pressure so produced for automatically forcing into the said closed chamber air, fuel and water in predetermined mechanically measured relative proportions bearing definite and constant relations to each other and producing a spray of water under high pressure within the closed chamber, intermingling the hot products of combustion and water spray to convert the spray into steam at high pressure and temperature, and automatically varying the amount of the air, combustible fuel and water admitted into the closed chamber under the control of variations in the pressure therein while maintaining their relative proportions.

6. The herein described method of generating a mixture of steam and gases to be used as a motive force for prime movers, which consists in forcing into a closed chamber definitely measured relative quantities of air and fuel and thereby generating products of combustion under high pressure and temperature in said closed chamber, producing large volumes of steam by the heat of the said products of combustion by forcing measured quantities of water in confined condition about the products of combustion and thereby raising the water to a higher temperature and pressure than that of the steam to be generated therefrom, converting the confined water into a state of high subdivision at a lower temperature by spraying it into the hot products of combustion within the closed chamber containing the lower pressure and thereby causing said water spray to be spontaneously converted into steam and intimately commingled with the products of combustion, and drawing off the mixed gases and steam and utilizing them in the operation of the prime mover.

7. The herein described method of generating a mixture of steam and gases to be used as a motive force for prime movers, which consists in generating products of combustion under high pressure and temperature in a closed chamber, causing said products of combustion to flow through the closed chamber in one direction, heating measured volumes of water in a confined condition by said hot products of combustion and raising the water to a higher pressure than the gases and steam to be generated within the closed chamber, producing from the said highly heated water volumes of steam by injecting the said water in the form of spray into the products of combustion in the opposite direction to their normal direction of flow whereby the water is spontaneously lowered in pressure to produce steam at the pressure of the products of combustion, and causing the steam and gases of the products of combustion to flow

out of the zone of the injected water and be delivered to the prime mover.

8. The method of generating a mixture of steam and gases at high temperature for use expansively, which consists in burning oil and air in definitely measured relative quantities under high pressure and producing a current of highly heated gases in one direction thereby, and injecting in the opposite direction and into the heated gases a spray of water or vapor thereof and thereby converting it into steam at an equally high pressure and a relatively high temperature.

9. In an apparatus of the character described, a prime mover, in combination with a generator chamber, a nozzle for supplying the chamber with air and fuel, pumps for directly supplying air and fuel in definite relative measured quantities to the nozzle and also water to the chamber, means independent of the prime mover to operate the pumps, and means controlled by the pressure of the gases within the chamber for controlling the speed of the pumps while maintaining the relative proportions of the air, fuel and water to maintain a substantially constant pressure within the chamber.

10. In an apparatus of the character described, a prime mover, in combination with a generator chamber, a nozzle for supplying the chamber with air and fuel, pumps for directly supplying air and fuel in definite relative measured quantities to the nozzle, a pump for directly supplying water to the chamber in mechanically measured quantity, means independent of the prime mover to operate the pumps, and means controlled by the pressure of the gases within the chamber for simultaneously controlling the speed of the pumps while maintaining the relative proportions of the air, fuel and water to maintain a substantially constant pressure within the chamber.

11. In an apparatus of the character described, the combination of a generator vessel having a combustion chamber within the vessel and opening into it, a coil of pipe within the combustion chamber and adjacent its walls and terminating at its open end in a spraying device directed toward the interior of the chamber, means for directly delivering air and fuel into the combustion chamber in definitely measured relative quantities and in opposed direction to the open end of the water coil to produce substantially perfect combustion, a pump for delivering water directly to the coil in relatively measured quantities, and means for regulating the measured supply of the air, fuel and water without changing the relative proportions of each.

12. In an apparatus of the character described, the combination of a generator vessel, a tubular combustion chamber within the vessel and having one end opening into

it, a coil of pipe within the combustion chamber and lining its walls and terminating at its open end in a spraying device directed toward the interior of the chamber, mechanical means for directly delivering air and fuel into the combustion chamber at a part most distant from its open end in definitely measured relative quantities to produce substantially perfect combustion, a pump for directly delivering water to the coil in definitely measured quantities, devices controlled by the pressure within the generator vessel for automatically and simultaneously controlling the said means and pump for varying the quantities of air, fuel and water while maintaining their relative proportions to compensate for variable quantities of the mixture of gas and steam withdrawn from the vessel from time to time, and a prime mover operated by the steam and gases and independent of the means and pump for measuring the air, fuel and water.

13. In an apparatus of the character described, the combination of a prime mover a generator vessel to supply steam to the prime mover having a combustion chamber within and opening into it, a coil of pipe within the combustion chamber and terminating at its open end in a spraying device directed toward the interior of the chamber, pumps for directly delivering air and fuel into the combustion chamber in mechanically measured relative quantities to produce substantially perfect combustion, a pump for directly delivering water to the coil in definite measured quantities, an engine wholly independent of the prime mover for operating the several pumps, means for supplying the mixture of steam and gases of the generator vessel to the engine to operate it, and an automatic valve for controlling the supply of mixture of steam and gases to the engine and independently of the steam and gases supplied to the prime mover controlled by the pressure within the generator vessel.

14. In an apparatus of the character described, the combination of the generator vessel, a combustion chamber within the vessel and opening into it, a coil of water pipe within the combustion chamber and forming a water tube lining thereto to protect its side walls and its end discharging into the combustion chamber, a nozzle for air and oil directed into the combustion chamber within the space bounded by the coils, means for supplying the oil and air to the nozzle in relatively measured quantities under pressure, a pump for delivering water to the coil under pressure, means for controlling the means and pump for supplying the oil, air and water in quantities to maintain a substantially constant pressure within the generator vessel, and an engine connected with the generator vessel for receiving the

mixture of gases and steam generated therein and transforming the energy into work.

15. In an apparatus of the character described, the combination of a generator vessel, a coil of water pipe within the vessel and discharging therein, a pump for forcing air into the vessel, a pump for forcing oil into the vessel, a pump for forcing water into the coil, a source of oil, a source of volatile hydrocarbon fluid, a valve for controlling the supply of water to the water pump, a valve for connecting the oil pump with either the source of volatile hydrocarbon fluid or with the source of oil, and connecting means between the valves for shutting off the water when the oil pump is receiving volatile hydrocarbon fluid and vice versa.

16. In an apparatus of the character described, the combination of a generator vessel, a coil of water pipe within the vessel and discharging therein, a pump for forcing air into the vessel, a pump for forcing oil into the vessel, a pump for forcing water into the coil, an engine for operating all of the pumps, a pipe for supplying the engine with steam and gases from the generator vessel, an automatic valve device for varying the speed of the engine controlled by the pressure within the generator vessel, a source of oil, a source of volatile hydrocarbon fluid, a valve for controlling the supply of water to the water pump, a valve for connecting the oil pump with either the source of volatile hydrocarbon fluid or with the source of oil, and connecting means between the valves for shutting off the water when the oil pump is receiving volatile hydrocarbon fluid and vice versa.

17. In an apparatus of the character described, a prime mover, in combination with a closed generator chamber having communication with the prime mover, means for supplying air and fuel to the generator chamber, mechanically operated pumping devices for directly measuring and forcing air and fuel into the chamber in definitely measured relative quantities to produce combustion, a mechanically operated pump for directly supplying water to the closed generator chamber in mechanically measured quantities, means to superheat the water before being discharged into the generator

chamber to bring it to a pressure greater than the pressure within the generator chamber, means to liberate the water in a state of subdivision and cause it to be projected into the products of combustion within the chamber whereby the water is lowered in pressure and transformed instantly into steam, and means independent of the prime mover to operate the pumps whereby the supply of air, fuel and water to the generator is controlled independently of the prime mover.

18. In an apparatus of the character described, a prime mover, in combination with a closed generator chamber having communication with the prime mover, means for supplying air and fuel to the generator chamber, mechanically operated pumping devices for directly measuring and forcing air and fuel into the chamber in definitely measured relative quantities to produce combustion, a mechanically operated pump for directly supplying water to the closed generator chamber in mechanically measured quantities, means to superheat the water before being discharged into the generator chamber to bring it to a pressure greater than the pressure within the generator chamber, means to liberate the water in a state of subdivision and cause it to be projected into the products of combustion within the chamber whereby the water is lowered in pressure and transformed instantly into steam, means independent of the prime mover to operate the pumps whereby the supply of air, fuel and water to the generator is controlled independently of the prime mover, and means controlled by the pressure of the gases and steam within the generator chamber for simultaneously controlling the pumps to vary the quantities of the air, fuel and water, while maintaining substantially their relative proportions and thereby maintain a substantially constant pressure within the generator chamber irrespective of the quantities of the gases and steam, variable or otherwise, consumed by the prime mover.

In testimony of which invention, I hereunto set my hand.

BENTLEY L. RINEHART.

Witnesses:

R. M. KELLY,
E. W. SMITH.