

Aug. 26 , 1924.

1,506,322

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METHOD AND MEANS OF PRODUCING HEAT

Filed Dec. 5, 1919

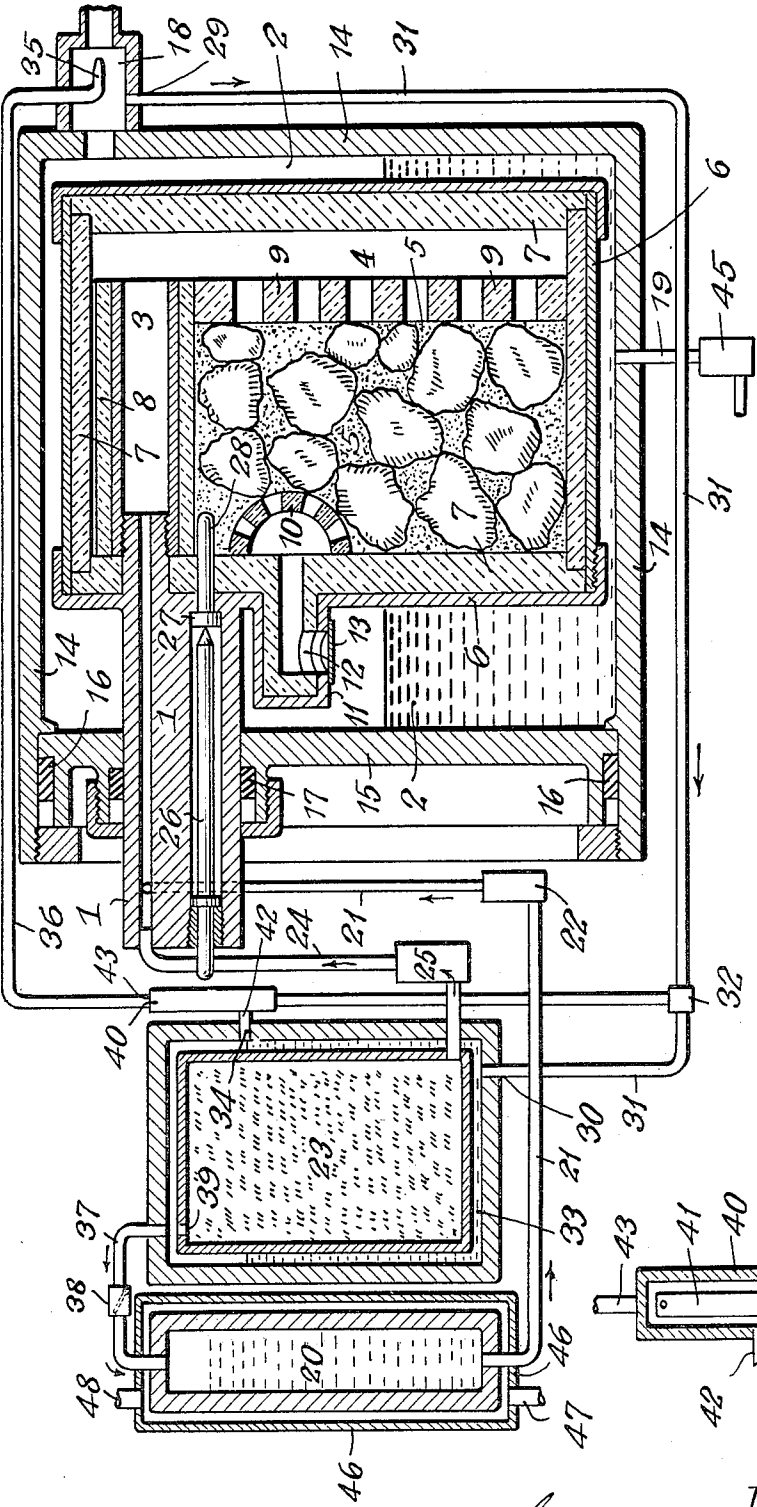


Fig. 1.

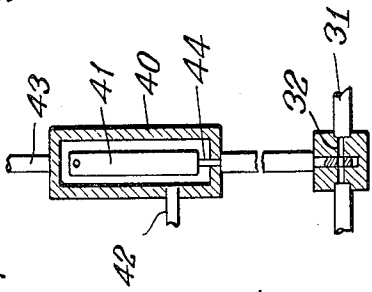


Fig. 2.

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UNITED STATES PATENT OFFICE.

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METHOD AND MEANS OF PRODUCING HEAT.

Application filed December 5, 1919. Serial No. 342,832.

To all whom it may concern:

Be it known that I, JOHN HUGH O'NEILL, a citizen of the United States, and residing at Springfield, Missouri, have invented certain new and useful Improvements in Methods and Means of Producing Heat, of which the following is a specification, and is an elaboration and a continuation of the methods disclosed in my application No. 269,268, filed January 2, 1919, for method and means of generating power.

Application No. 269,268, relates to the use of gas, or a liquid which yields when dissociated by heat combustion supporting gas, which furnishes one element of a combustion. The other element is metal or metals or other material located in a combustion chamber while the gaseous or liquid combustion supporting gas is admitted in governed quantity. Or both elements, fuel and combustion sustainer are admitted simultaneously in governed quantity. But there is a very important class of oxygen carriers or carriers of other combustion supporting gases which are solid at ordinary temperatures but can be liquefied by heat or by solution or by both and therefore can then be readily pumped or forced by other means in a governed or continuous manner so as to support a governed or continuous combustion as desired. These solids will thus fulfill all the functions of a comburent which is normally in a liquid or gaseous state.

It is obvious that when comburents such as peroxide of nitrogen, peroxide of hydrogen, nitric acid, sulphuric acid, hydrochloric acid, water or any of the various solutions or mixtures of combustion supporting gas carriers, which are liquid at ordinary temperatures are used, the heating arrangement may be omitted. Also if a fuel such as a liquid hydrocarbon is used which is liquid at ordinary temperatures the heating arrangement is omitted without departing from the spirit of my invention of maintaining a combustion away from atmospheric air as disclosed in this and the previous application.

The present invention relates to an improved method of using solids carrying oxygen or other combustion sustaining gas or gases such as metallic oxides, or metal or halogen compounds, chlorates, chlorides, sulphates, metallic salts, nitrites, nitrates,

metallic nitrates or ammonium nitrate, etc., which can be liquefied by heat or by solution or by both, for furnishing in whole or in part oxygen or other combustion supporting gas or gases to sustain the combustion of a fuel, which fuel may be any liquid or any material that can be liquefied by heat or by solution or by both, that combines with oxygen or other combustion supporting gases with the production of heat away from atmospheric air.

This invention has many uses among which are the production of higher temperatures than can be obtained by utilizing air to sustain combustion of a hydrocarbon or other carbon since the volume of inert gas will be much less in the case of many oxygen carrying solids than in the case of air in which the inert nitrogen is a very large proportion, and since metals can be used as fuels which give very high heats of combination.

Furthermore, the combustion can be carried on in such regulated manner as to produce a reducing or oxidizing flame or neutral or other atmosphere such as nitrogen gas or hydrogen gas or a mixture of nitrogen and hydrogen or nitrogen and carbonic oxides or hydrogen and carbon monoxide or chlorine or mixtures of chlorine and hydrogen, or steam, or mixtures of steam, nitrogen and carbonic oxides, etc., furthermore, since these solids may be first liquefied and then introduced into the combustion chamber simultaneously with the liquid or liquefied fuel and since the expansion from the liquid to the gaseous state takes place in the combustion chamber it is clear that the combustion can be conveniently carried on under pressure.

The gaseous waste products and vapors of combustion can be used as a motive fluid, this fluid can be regulated in temperature by means of water, either by mixing the water with the oxygen or other gas carrying material or by mixing it with the fuel, or with both, or by mixing with water vapor raised by the conduction of heat through the walls of the combustion chamber to the water, or by direct mixture of the gases and vapors with the water, or by blowing the gases and vapors over the surface of the water, or by spraying the water into the hot gases and vapors either in the combustion chamber or in the duct leading therefrom,

or by any convenient combination of said or other means. This produces a gas-steam mixture for motive fluid. It is, of course, clear that the waste gases can be kept separated from the steam and cooled by surface contact with a heat transferring wall and then be rejected without mingling with the steam or other vapor.

It has been established that a nitrated hydrocarbon can be burned in somewhat regulated manner as a self combusting body, such as a colloidal nitro compound. I have discovered that a nitrate, oxide, chlorate, sulphate or metallic-salt-thermit mixture, in which the fuel metal or metal alloy and the comburent are intimately mixed, may be burned in a manner regulated by the selection of the elements and the adding of water. But in both these cases difficulty has been encountered in making the regulation accurate and safe from irregular effects; due to the fact that both the fuel and the oxygen carrier are in molecular combination, or in intimate mixture, so that the reaction propagates with an uncertain speed especially under pressure.

This invention provides a method and means for carrying a solid oxygen carrier or other comburent; of liquefying the same, and of introducing it and the fuel separately into the combustion chamber, thus making possible the close regulation and safe production of heat which may be used for producing motive fluid, or for heating crucibles in a suitable furnace, or for producing desired gas or gases, or for any other desirable application of heat. This invention provides a most suitable method of producing power for driving submerged automobile torpedoes and submarines, since no gases need to be carried in compressed form with their accompanying heavy containers, usual leakage, and risk of rupture. In addition the fuel also may be carried in solid form, as sulphur, phosphorus, grease, wax, sugar, shellac, carbonaceous compounds, liquefiable by heat or solution or both, or metals, or metal alloys with sufficiently high heats of combination to give a positive result; these and others may be liquefied and introduced in regulated manner with a carrier of oxygen or other comburent.

The highest heats of combination, the highest furnace temperature, and the highest power output per unit of weight are obtained by the reaction between liquid or solid but liquefiable oxygen carriers and alkali metals, or alkali-earth metals, which may be liquefied and introduced into a combustion chamber or furnace in regulated amount and manner.

While many different comburents or carriers of combustion supporting gas or gases such as oxids of metals, chlorates, sulphates, nitrites and nitrates are liquefiable by heat

or solution or by both, and many fuels are either liquid or liquefiable by heat or solution and all come within the limits of my method of keeping elements separate until reaching the combustion chamber, one reaction will suffice as an example. Ammonium nitrate (NH_4NO_3) and alcohol ($\text{C}_2\text{H}_5\text{OH}$) is such an example. When these are properly heated and introduced into a combustion chamber through a gas generating, self-heated tube or by other exposure to heat, they react with a heat value of 1200 calories per gram or 2160 B. t. u. per pound of combined materials, which will allow for vaporizing a large quantity of water in reducing the product of combustion to a usable temperature. Thus a motive fluid is provided in much greater quantity, weight and space considered, than that obtained at present from the combustion of compressed air and alcohol. Ammonium nitrate with alkali-metal or alkali-earth-metal or alloys thereof as fuel gives still higher heat values. For bringing this system into operative condition, a calculated amount of thermit may be used for initial heating and this may be ignited by any of the usual methods such as the electric spark or the percussion. For instantaneous delivery of power from a cold system, a nitrate thermit may be used. This is particularly rapid because the gaseous waste products which are nitrogen, or mixtures of gases such as nitrogen, hydrogen, and steam, are immediately available in large quantity as motive fluid.

This invention consists primarily in the method and apparatus for producing heat by first liquefying the oxygen carrier or other comburent, or the fuel, or both, and then separately and simultaneously introducing them in regulated quantities into a suitable combustion chamber.

It further consists in solid comburents or oxygen carriers such as ammonium nitrate (NH_4NO_3), nitrates of lithium, rubidium, potassium, barium, strontium, sodium, boron, calcium, magnesium, aluminum, iron, etc., peroxides of potassium, sodium, calcium, magnesium, barium, strontium, lithium, heptoxide of manganese, chlorates, sulphates, nitrites, etc. mixed in any proportion and liquefied by heat or solution or both.

It further consists in the fuels used, such as alcohols, gasoline, animal, vegetable and mineral oils and greases, hydrocarbons, ethers and esters, etc., which can be liquefied and carried under pressure, acetone and solutions of acetylene in acetone, benzene, naphtha, sulphur, phosphorus, wax, sugar, shellac, glucose, etc., metals of high heat of combination, lithium, rubidium, potassium, barium, strontium, sodium, boron, calcium, silicon, magnesium, aluminum, etc.,

separately or in the innumerable mixtures and alloys which may be desirable for special reasons.

It further consists in the arrangement of apparatus for introducing the elements of combustion, in the regulation and disposal of the combustion products, in the types of combustion chambers or furnaces, in the means of bringing the system immediately to operating heat and condition, and in the application of these cycles to metallurgical, industrial, scientific and power purposes.

Obviously the fuels, combustants and cycles can be varied and combined in many ways without departing from the spirit of my invention, one form of which is illustrated in the accompanying drawing to assist in the better description of the process.

Referring to Fig. 1, 1 is a conductor through which the several elements of combustion are carried through the steam chamber 2 into the generating tube 3 from which they pass to the distributing space 4 to the combustion area 5. This cavity is partially filled with particles of refractory material for the purpose of obtaining surface combustion. 6 is the combustion chamber shell of metal, of comparatively light section since the pressures are equalized within and without. 7 is the refractory lining of the same. 8 is the refractory cover for the generating tube 3, and 9 and 10 are perforated refractory walls. 11 is a refractory lined lug for furnishing outlet 12 for products of combustion. 13 is a water-tight cover easily ruptured by heat or pressure. 14 is the boiler shell. 15 is a removable boiler head attached with gland joint 16. Through this removable head 15 is passed the conductor 1 packed by gland packing 17. 18 is the outlet for the motive fluid and 19 is the water inlet.

Alcohol carried in the fuel container 20 flows to the conductor 1 by means of a pipe 21 and pump 22. Ammonium nitrate or other suitable combustant is carried in the tank 23 from which it reaches the conductor 1 by means of the pipe 24 and the pump 25.

To start combustion the firing pin 26 is driven against the percussion cap 27 which ignites the ignition powder 28. All or part of the space between the refractory particles in the combustion area 5 is filled with nitrate thermit which is ignited by the powder 28 and immediately the following reaction takes place: $(\text{Mg}(\text{NO}_3)_2 + 6\text{H}_2\text{O}) + (\text{Mg} + \text{Al}) = \text{MgO} + \text{N} + \text{H}_2\text{O} + \text{Al}_2\text{O}_3$ of which the N and H_2O are a hot mixture of nitrogen and steam which are cooled to a usable temperature after passing the outlet 12 by contact with stored water in space 2. Residue gases and steam pass around the combustion chamber shell 6 to the outlet 18. At 29 steam at boiler pressure is taken off and supplied to the combustant tank at 30 by means

of the pipe 31 through the temperature-controlled valve 32.

The tank 23 is surrounded by a jacket 33 in which the steam condenses until the water reaches the outlet 34 at which level it is maintained by an aspirator 35 connected by the pipe 36.

When the steam enters the space 33 the ammonium nitrate begins immediately to liquefy. The pipe 37 communicates pressure to the fuel tank 20 through the automatic check valve 38; and a port at 39 permits steam or nitrogen to equalize the pressure in the tank 23. The thermostat 40, better illustrated in Fig. 2, closes the valve 32 when the temperature in the tank 23 equals or exceeds a predetermined temperature.

In Fig. 2, 41 is a piece of metal of greater coefficient of expansion than the case 40. Steam enters at 42 from the cavity 33 and leaves for the aspirator 35 at 43. A rod 44 connected to the metal 41 operates the valve 32 in the steam line 31.

When immediately after ignition, the hot thermit gases rush through the boiler space 2, producing the required steam pressure, the steam passes through the pipe 31 to the cavity 33, the ammonium nitrate melts and is pumped by the pump 25 to the tube 3. The pump 22 pumps alcohol to the tube 3 where it vaporizes and mixes. This mixture of gases thus maintains the combustion in the chamber 5. The gases of their combustion also pass through the port 12 into the steam chamber 2 and on to the prime mover (not shown) through the outlet 18.

The pump 45 feeds water to the boiler through the pipe 19. The jacket 46 surrounding fuel container 20, provides a steam space through which live or exhaust steam may be circulated entering through inlet pipe 47 and discharged through pipe 48. In case a metal is used as fuel which melts at a higher temperature than the live steam, a separate thermit charge or other means of applying heat may be used to bring it to the molten state.

The pumps 45, 22 and 25 may be operatively connected to the prime mover, in which case they will supply in correctly proportioned predetermined amounts, the oxygen, the fuel and the water.

What I claim is:

1. The method of producing heat away from atmospheric air which consists in liquefying ammonium nitrate, mixing the same with alcohol in predetermined proportions, and vaporizing and burning the mixture.

2. The method of producing heat away from atmospheric air which consists in applying heat to liquefy a normally solid combustant material which is adapted to support combustion of a fuel, feeding said liquefied combustant and a liquid fuel in pre-

determined proportions into a vaporizing compartment which is heated by the combustion of the vaporized comburent and fuel and burning the mixture in a combustion chamber.

3. The method of producing heat away from atmospheric air, in which a self-burning material first is ignited to bring a system into operative heat and condition and thereafter sustaining the heat by the combustion of a liquid fuel and a normally solid comburent which has been liquefied by heat, both elements being pumped from separate sources into a heated vaporizing compartment located in a combustion chamber to form a combustible vapor and passing said vapor from the vaporizing compartment to the combustion chamber and there burning it.

4. The method of producing heat in a combustion chamber isolated from atmospheric air which consists in starting combustion with a nitrate thermit and subsequently feeding from separate sources predetermined quantities of a fluid fuel and a liquefied oxygen carrier and vaporizing the mixture to form a combustible vapor passing the latter to a combustion chamber to sustain the combustion therein, said oxygen carrier being normally solid but having heat applied to it to liquefy it, said vaporizing means being heated by the combustion of the vapors issuing from it.

5. The method of producing heat in a combustion chamber isolated from atmospheric air which consists in starting combustion by igniting a charge of nitrate thermit, applying the heat of the gaseous products of the thermit reaction to fuel and to a normally solid comburent to liquefy the fuel to liquefy the comburent, then pumping at predetermined rate each element into a vaporizing compartment located in said combustion chamber, passing the vaporized fuel and comburent from said vaporizing compartment into said combustion chamber where they burn, the vaporizing compartment being heated by this combustion.

6. An apparatus for generating motive fluid away from atmospheric air, including a shell forming a boiler, a structure forming a combustion chamber located inside said shell and spaced away from it forming a water and steam space adapted to store an initial charge of a predetermined quantity of water in said water and steam space, a structure located inside said combustion chamber forming a vaporizing compartment and adapted to be heated by the com-

bustion in said combustion chamber, means for initially bringing the system into operative condition of temperature and pressure, a vent conduit from said combustion chamber into said water and steam space, an outlet for motive fluid from the upper portion of said water and steam space, a container for a comburent, a shell about said comburent container and spaced away from it forming a heating space, a connection for a part of the motive fluid from a motive fluid outlet to said heating space to heat and to liquefy the comburent in said container, a vent from said heating space into said comburent container to equalize the pressure in order to facilitate pumping the comburent, a discharge opening from said heating space for discharging condensed water and cooled gases, a connection from said discharge opening to an aspirator operated by the main flow of motive fluid said aspirator operating to circulate hot motive fluid to said heating jacket by withdrawing the cooled and condensed fluid, a container for liquid fuel, a pressure equalizing connection from said heating jacket to said fuel container, means for feeding at predetermined rate said liquefied comburent and fuel to said vaporizing compartment, means for supplying at predetermined rate water to said water and steam space.

7. An apparatus for generating motive fluid away from atmospheric air including a boiler, a motive fluid outlet, a comburent container, a shell about said comburent container forming a heating jacket, a connection for motive fluid supply from said boiler to said heating jacket, an outlet for cooled motive fluid from said heating jacket, a connection from said outlet for cooled motive fluid to an aspirator operated by the main current of motive fluid, a regulating valve on said connection for motive fluid supply to said heating jacket operating to stop or restrict the supply of hot motive fluid to said heating jacket, a thermostat in said connection from the heating jacket outlet to said aspirator adapted to be influenced by the temperature of the cooled motive fluid and operatively connected to said regulating valve so that when the temperature of the cooled motive fluid rises to a predetermined point the thermostat will operate to close or restrict the passage of hot motive fluid through said regulating valve.

In witness whereof, I have hereunto signed my name.

JOHN HUGH O'NEILL.