

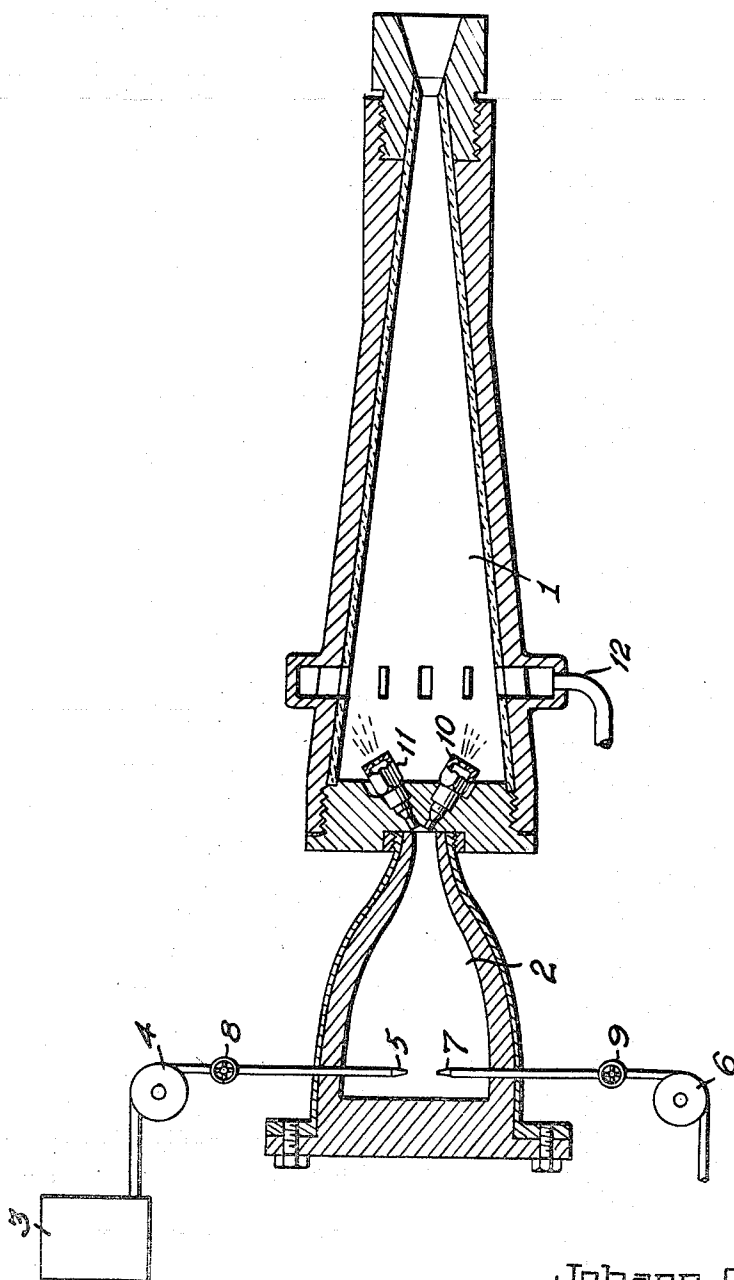
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J. G. TSCHINKEL

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SELF VAPORIZATION OF LIQUID FUELS BY PARTIAL OXIDATION

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INVENTOR.
Johann G. Tschinkel

BY

J. H. Church + O. Codier
ATTORNEYS

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SELF VAPORIZATION OF LIQUID FUELS BY PARTIAL OXIDATION

Johann G. Tschinkel, Huntsville, Ala., assignor to the United States of America as represented by the Secretary of the Army

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6 Claims. (Cl. 60—35.4)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described in the specification and claims may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

This invention relates to the vaporization of liquid fuels before their ignition.

The storage of gases is always expensive. At normal conditions of temperature and pressure they are very bulky and require excessive storage space. Furthermore there is a possibility of leakage or diffusion losses. On the other hand liquefied gases require good heat insulation to avoid high vaporization losses. If the gases are merely compressed, very heavy containers are required. It follows that it is cheaper to store a liquid than a gas under normal conditions.

Gaseous fuels, however have some advantages over liquid fuels in regard to combustion. Owing to their penetrability for example the oxidant can react with them more readily than with liquids. Usually therefore liquids are either evaporated or divided into a fine spray before ignition.

Evaporation requires a large amount of heat that must be supplied in a rather short time. A special case where an extremely short time is available for mixing, evaporation and combustion is found in ramjet propulsion units. The time requirement can be met more easily if the fuel is vaporized and preheated before injection.

It is therefore an object of this invention to provide a method for vaporizing a liquid fuel and preheating the gas before injection into the combustion chamber. Incorporation of a hypergolic material into a larger mass of relatively stable fuel will accomplish this result. Another object of the invention is consequently to provide a method for vaporizing a liquid fuel and heating the resulting gas by means of a hypergolic material added to the liquid. Phenylhydrazine in this application will serve as a hypergolic compound, that is one capable of igniting spontaneously upon contact with the proper oxidant. A third object of the invention is therefore the use of phenylhydrazine as a hypergolic agent to vaporize a larger bulk of relatively stable fuel and to heat the resulting gas. Other objects will be evident hereinafter.

The process of the present invention may be explained in general terms as follows:

A stable or diluting liquid fuel with phenylhydrazine dissolved therein is contacted with a peroxide such as hydrogen peroxide. Phenylhydrazine is hypergolic to such contact. The heat generated by the spontaneous reaction between the phenylhydrazine and peroxide is employed to vaporize the remaining liquid and to heat the gas formed. This gas is then injected into the main combustion chamber of whatever device the process is used with.

These hot fuel gases can be used in gas turbines employed with rockets. These turbines propel pumps, electric generators and the like and may be driven by combustible gases later burned after expansion in the rocket

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combustion chamber. In similar fashion better use has already been made of the hydrogen peroxide, employed in the turbines on rockets, by burning the decomposition products with the rocket fuel in the rocket combustion chamber. It may be noted that the peroxide used with the phenylhydrazine in the instant invention furnishes only a small part of the oxygen necessary for the complete combustion of the fuel.

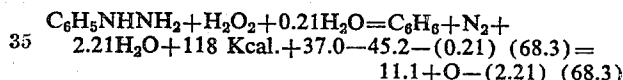
My invention may be more readily understood from the examples and the accompanying drawing which form a part of the specification. The drawing depicts schematically a vaporization chamber generally indicated at 2 having admission means indicated at 5 and 7 for the introduction of the fuel containing phenylhydrazine and the other hypergolic reactant respectively into the vaporization chamber. The vaporization chamber functionally communicates with a conventional combustion chamber generally indicated at 1. The fuel containing the phenylhydrazine contacts the peroxide compound which is hypergolically reactive with the phenylhydrazine. Upon contact and combustion of the hypergolic reactants, the fuel is vaporized without combustion thereof and is then introduced into the combustion chamber for reaction with an oxidizer for the combustion thereof.

The process which I have discovered is shown in more detail in the following two examples:

Example 1

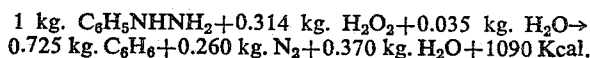
Isopropyl alcohol is here chosen as the stable fuel and is mixed with phenylhydrazine. The mixture is then contacted with hydrogen peroxide.

The exothermal reaction is:



The second line gives the heats of formation in Kcal. referred to 25° C.

The weights of these materials, referred to 1 kg. phenylhydrazine are:



Heating these reaction products to their boiling temperature at normal pressure requires

$$(0.725) (0.41) (55) + (0.37) (1.0) (75) = 44 \text{ Kcal.}$$

The vaporization at boiling temperature requires:

$$(0.725) (93) + (0.37) (540) = 267.5 \text{ Kcal.}$$

while the superheating of the vapor to 200° C. requires

$$\begin{aligned} (0.725) (0.37) (120) + (0.26) (0.248) (175) + \\ (0.37) (0.474) (100) = 61 \text{ Kcal.} \end{aligned}$$

717.5 Kcal. is thus available to heat up the stable fuel, isopropyl alcohol in this example. This alcohol dissolves phenylhydrazine as well as H₂O₂ and has a lower heat of vaporization and higher heat of combustion than ethyl alcohol. The heating, evaporation and superheating of one kilogram of isopropyl alcohol require

$$(0.65) (55) (160) + (0.45) (120) = 250 \text{ Kcal.}$$

2.87 (717.5/250) kg. isopropyl alcohol can thus be vaporized additionally.

The final hypergolic composition is:

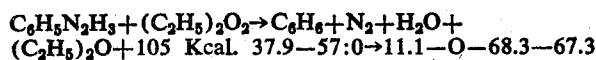
	Percent
1.0 kg. phenylhydrazine	23.53
2.9 kg. isopropyl alcohol	68.235
0.35 kg. 90% H ₂ O ₂	8.235

The lower heat of combustion of this combination is
 $H_L = (0.235) (7700) + (0.683) (7250) +$
 $(0.082) (280) = 6990 \text{ Kcal.}$

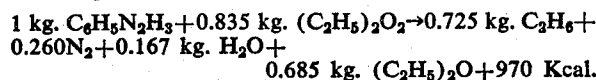
Example 2

In order to raise the heating value of the combination an oxidizer is chosen in which the active oxygen is bound to a combustible radical, diethyl peroxide for example. No data could be found on the heat of decomposition of diethyl peroxide to diethyl ether and oxygen but it is assumed to be about 10 Kcal./mol.

The oxidation may be formulated as follows:



The weight ratios are



Heating the reaction products to the boiling temperature requires 34.5 Kcal., vaporization at boiling temperature requires 216 Kcal. and superheating, 102 Kcal. 681 Kcal. remain to heat the stable fuel. Xylene is chosen as this stable fuel in this example. This fuel dissolves all the reaction partners and requires 150 Kcal./kg. for gasification at 200° C. The excess heat can thus be used to gasify $618/150 = 4.1 \text{ kg. xylene.}$

The reactive combination is composed of:

	Percent
1 kg. phenylhydrazine.....	16.85
4.1 kg. xylene.....	69.08
0.835 kg. diethyl peroxide.....	14.1

The lower heating value of the combination is:

$$H_L = (0.17) (7700) + (0.695) (9850) +$$

$$(0.14) (6650) = 9090 \text{ Kcal./kg.}$$

The heating value of the ether plus heat of decomposition of the peroxide was inserted as the heat of combustion of the diethyl peroxide.

For use in gas turbines, the reaction must be carried out at higher pressures and the gases superheated to higher temperatures through use of less diluent.

What I claim is:

1. In a process of vaporizing a normally stable liquid fuel taken from the class consisting of isopropyl alcohol and xylene, the step which comprises vaporizing a mixture consisting essentially of said fuel and phenylhydrazine by reacting said mixture with a peroxide compound taken from the class consisting of hydrogen peroxide and diethyl peroxide, said phenylhydrazine and peroxide compound being present in equivalent reaction proportions.

2. The process of vaporizing a liquid fuel without combustion thereof comprising reacting in a confined system a mixture consisting essentially of phenylhydrazine and a normally stable liquid fuel taken from the class consisting of isopropyl alcohol and xylene with a peroxide compound taken from the class consisting of hydrogen peroxide and diethyl peroxide, said phenylhydrazine and peroxide compound being present in equivalent reaction proportions for interaction therebetween.

3. The process of vaporizing a liquid fuel mixture without combustion thereof comprising reacting in a confined system a normally stable liquid fuel mixture consisting essentially of isopropyl alcohol and phenylhydrazine with hydrogen peroxide, said phenylhydrazine and peroxide compound being present in equivalent reaction proportions.

4. The process of claim 3 in which the amounts of phenylhydrazine and hydrogen peroxide are in the ratio of 1 to .35 by weight.

5. The process of vaporizing a liquid fuel mixture without combustion thereof comprising reacting in a confined system a normally stable fuel mixture consisting essentially of xylene and phenylhydrazine with diethyl peroxide in equivalent reaction proportions.

6. The process of claim 5 in which the amounts of phenylhydrazine and diethyl peroxide are in the ratio of 1 to .835 by weight.

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