ROCKET PROPULSION UTILIZING HYDROCARBON, SULFATE TURPENTINE, NITRIC ACID, AND SULFURIC ACID OR OLEUM

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Fig. 1.

Fig. 2.

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This invention relates to a reaction propulsion method, and more particularly to a method for generating power by ejecting a stream of combustion products at high velocities. Rocket propulsion of the type used for propelling airplanes is the most important field in which this method of propulsion is employed at the present time, although the invention in its broader aspects is not limited to this field.

Modern rocket motors of the type now in use to give an accelerated take-off or accelerated speeds in airplanes consist of a suitable housing provided with pairs of jets adapted to inject a fuel and an oxidant, respectively. The combustion of these two materials creates a mass of hot, burning gases which are ejected at high velocity through a suitable orifice, the reaction from this ejection providing the propulsive force. Such motors are of great potential value in assisting the take-off of seaplanes, since additional power is needed to overcome the skin friction of the water against the hulls of such planes. They are also of great value in assisting the take-off of heavily loaded land planes, since it is well-known that only a fraction of the power of a modern airplane is used in flight, as compared with that necessary to lift the plane from the ground under ordinary take-off conditions.

In order to assist the take-off of airplanes it is of utmost importance to have a rocket fuel which will ignite immediately and with certainty, as the plane would be almost certain to crash if the rocket motor failed to fire. For this reason a self-igniting fuel mixture is greatly preferred to one which must be ignited by a spark or by compression, as in ordinary internal combustion engines. It is a principal object of the present invention to provide a reaction propulsion method which is both instantaneous in action and certain in character, so that power failure is reduced to a minimum.

We have found that the terpenes as a class are particularly well suited for use as fuels for use in rocket motors, either when used alone or in admixture with other fuels. The terpenes are hydroaromatic compounds containing at least one double bond and they are capable of igniting spontaneously upon admixture with strong nitric acid in the proper ratios. They are compounds of low freezing point that are soluble in gasoline, fuel oil and mixtures thereof, and can therefore be used as igniting agents in cheaper fuels such as gasoline and other aliphatic hydrocarbons if desired. Although the hydroaromatic alcohols such as alpha and beta terpineol and similar monocyclic terpene alcohols and ketones may be employed, we prefer to use the terpene hydrocarbons such as the pinenes, terpinolene, terpinen-5-dipentene, and mixtures such as ordinary turpentine oil, sulfate turpentine and the like. Our invention in its broader aspects therefore includes the generation of rocket power by igniting a terpene with an oxidant such as strong nitric acid or nitric acid-containing mixtures, while the terpene hydrocarbons and mixtures such as turpentine constitute preferred fuels. Sulfate turpentine is particularly useful because of its low cost and ready availability.

Although any suitable oxidant may be employed in conjunction with the terpenes for the development of rocket power, the most reliable results are obtained with oxidants containing strong nitric acid, and particularly with mixtures of strong nitric acid and sulfuric acid or oleum. Bleached nitric acid having a strength of about 95% HNO₃ will function as an oxidant for terpenes and terpene mixtures, but much better results are obtained with nitric acid of about 96-99.8% HNO₃ or with fuming nitric acid containing not more than 8-10% of water. Still better results are obtained when 20-30% of sulfuric acid monohydrate (H₂SO₄) or about 1-30% of oleum are dissolved in strong nitric acid and the resulting solution is used as the oxidant.

The efficacy of the terpenes as igniting agents and fuels in the generation of rocket propulsion can be demonstrated by a cup test in which suitable quantities of the oxidant are poured into a 4-inch evaporating dish containing the igniting agent. Upon adding quantities of 10-14 parts by volume of strong nitric acid to 7 parts of the terpenes an immediate bright flash is obtained with a time lag of about 0.25 second, accompanied by violent combustion with evolution of an intense bright flame. Cup tests with ordinary wood turpentine, with sulfate turpentine consisting principally of alpha pinene and with dipentene and other representative terpenes have shown that in all cases a spontaneous ignition followed by violent combustion is obtained upon addition of 95% or stronger nitric acid or of mixtures thereof with sulfuric acid or oleum.

Although the terpenes may be employed as such as self-igniting fuels in the generation of rocket power, they may also be employed in the form of solutions in gasoline, Diesel oil, benzene, toluene and the like with a considerable saving in the fuel cost. The effectiveness of such solutions is shown on the attached drawing, wherein Fig. 1 is a graph showing the results of cup tests per-
formed on solutions of sulfate turpentine in 91 octane gasoline and Fig. 2 is a similar graph showing the results of tests with sulfate turpentine dissolved in Diesel oil.

Referring to Fig. 1 it will be seen that a prompt ignition with a time lag of less than 2 seconds is obtained when as little as about 15% of turpentine is added to gasoline, provided an oxidant containing both 95% or stronger nitric acid and sulfuric acid or 20% oleum is employed. About the same results are obtained with either sulfuric acid or oleum and with either 95% nitric acid or with 99.5% nitric acid, but in all cases the time lag before ignition is further reduced by increasing the quantity of turpentine in the gasoline to 20-40%. When 95% nitric acid is used alone it is necessary to employ about 45-50% of turpentine in the gasoline to obtain prompt and reliable ignition.

The behavior of turpentine in Diesel oil is somewhat similar to its behavior in gasoline, but a wider variation in behavior towards different oxidants is found. Referring to Fig. 2, it will be seen that prompt ignition with a time lag of 1.5 seconds or less is obtained when slightly more than 20% of turpentine is added, providing a mixture containing very strong nitric acid and 15% of oleum is used as the oxidant. When a similar oxidant is prepared from 99% nitric acid it is necessary to add about 35% or more of turpentine to the Diesel oil and approximately the same result is found when sulfuric acid is substituted for the oleum. When straight 95% HNO₃ is used the Diesel oil should contain more than 50% of turpentine to obtain reliable ignition.

From the foregoing it will be seen that the process of our present invention consists in generating an ignited propulsive charge by combining a fuel comprising a terpene, and preferably a terpene hydrocarbon or hydrocarbon mixture such as sulfate turpentine with an oxidant capable of igniting and burning the fuel. For use in rocket motors the oxidant preferably comprises strong nitric acid, and the best results are obtained when sulfuric acid or oleum in amounts of about 10% up to about 15-30% of the weight of the oxidant are added to strong nitric acid. The terpenes as a class will ignite rapidly and spontaneously upon admixture with these oxidants in the proper ratio, and a strong propulsive force is obtained by ejection of the burning charge at high velocity. The ratio of oxidant to fuel will depend upon the type and strength of the oxidant used and also on the type of fuel. The terpenes may be used as fuel or they may be dissolved in an aliphatic hydrocarbon fuel to function as an igniting agent therefore, but in the latter case at least 15-25% of the terpenes should be used with the strongest oxidants and more than 50% should be present when weaker oxidants such as 95% nitric acid are used. Alternatively, the motor may be started by the use of a straight terpene or a rich mixture thereof with other fuels and then operated with an aliphatic hydrocarbon fuel or with a similar fuel containing considerably smaller quantities of the terpenes as igniting agents.

What we claim is:

1. A rocket propulsion method which comprises injecting into a combustion chamber a fuel comprising a volatile aliphatic hydrocarbon having at least 15–25% of a terpene hydrocarbon dissolved therein together with an oxidant comprising nitric acid containing about 10–30% of a member of the group consisting of sulfuric acid and oleum whereby an ignited propulsion charge is formed, and ejecting the burning charge at high velocity.

2. A rocket propulsion method which comprises injecting into a combustion chamber a fuel comprising a volatile aliphatic hydrocarbon having at least 15–25% of sulfate turpentine dissolved therein together with an oxidant comprising nitric acid containing about 10–30% of a member of the group consisting of sulfuric acid and oleum whereby an ignited propulsive charge is formed, and ejecting the burning charge at high velocity.

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