United States Patent

[11] **3,613,583**

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[73] Assignee **The United States of America as represented by the Secretary of the Air Force**

[54] **ALTITUDE-COMPENSATED HYBRID INFRARED FLARES**
1 Claim, 3 Drawing Figs.

[52] **U.S. Cl.** **102/37.8,** 102/35, 60/251
[51] **Int. Cl.** **C06d 1/10**
[50] **Field of Search** ..... 60/220, 264, 251, 261, 35.6 RS; 102/37.8, 35

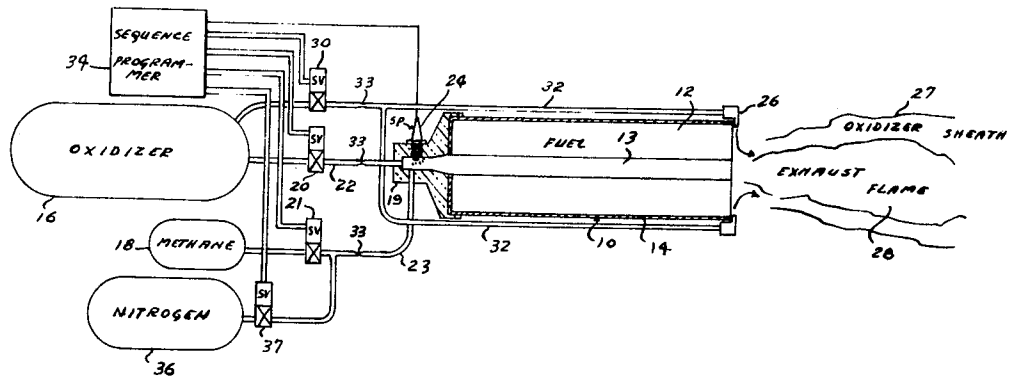
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ABSTRACT: A hybrid infrared flare is ignited by first igniting a methane-oxidizer mixture with a spark which in turn ignites the fuel grain. Burning is sustained by a continuous flow of oxidizer through the upstream oxidizer injector. Oxidizer is also supplied at the downstream end of the flare to provide an oxidizer sheath around the exhaust flame so that the oxidizer mixes with the fuel-rich exhaust products of the flare to enhance the infrared output regardless of the altitude at which the flare is located. Nitrogen is supplied at the upstream end of the flare to quence combustion between burns when the flares are used in multistart operation.



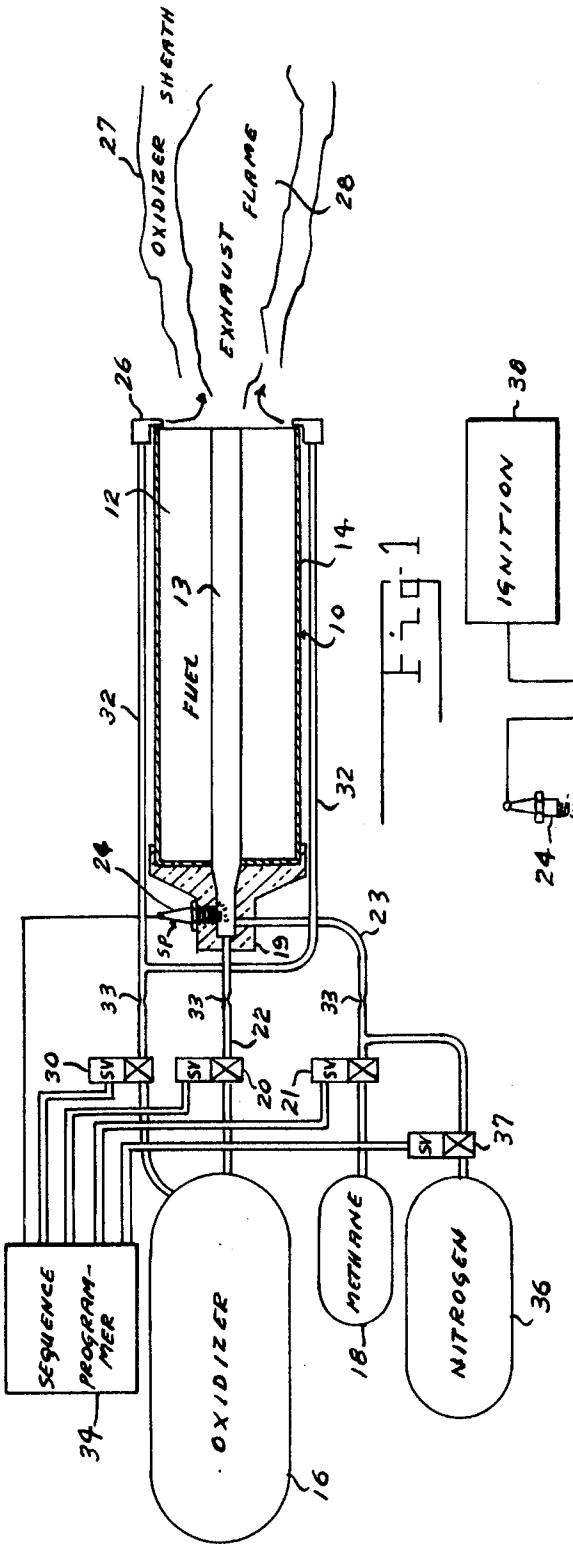


FIG. 1

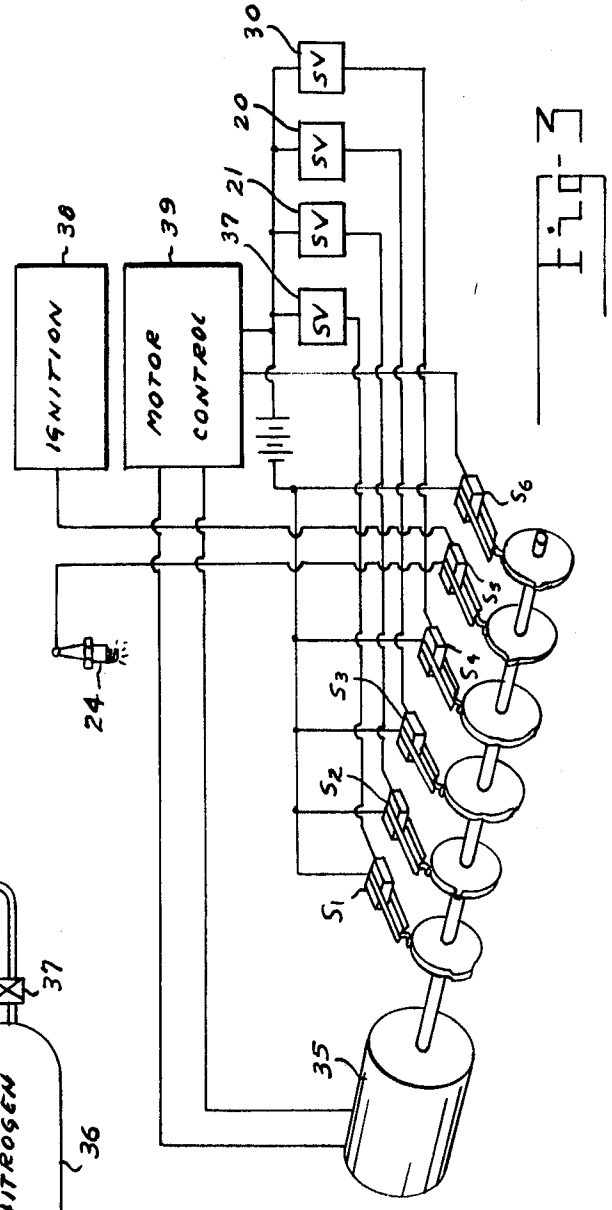


FIG. 2

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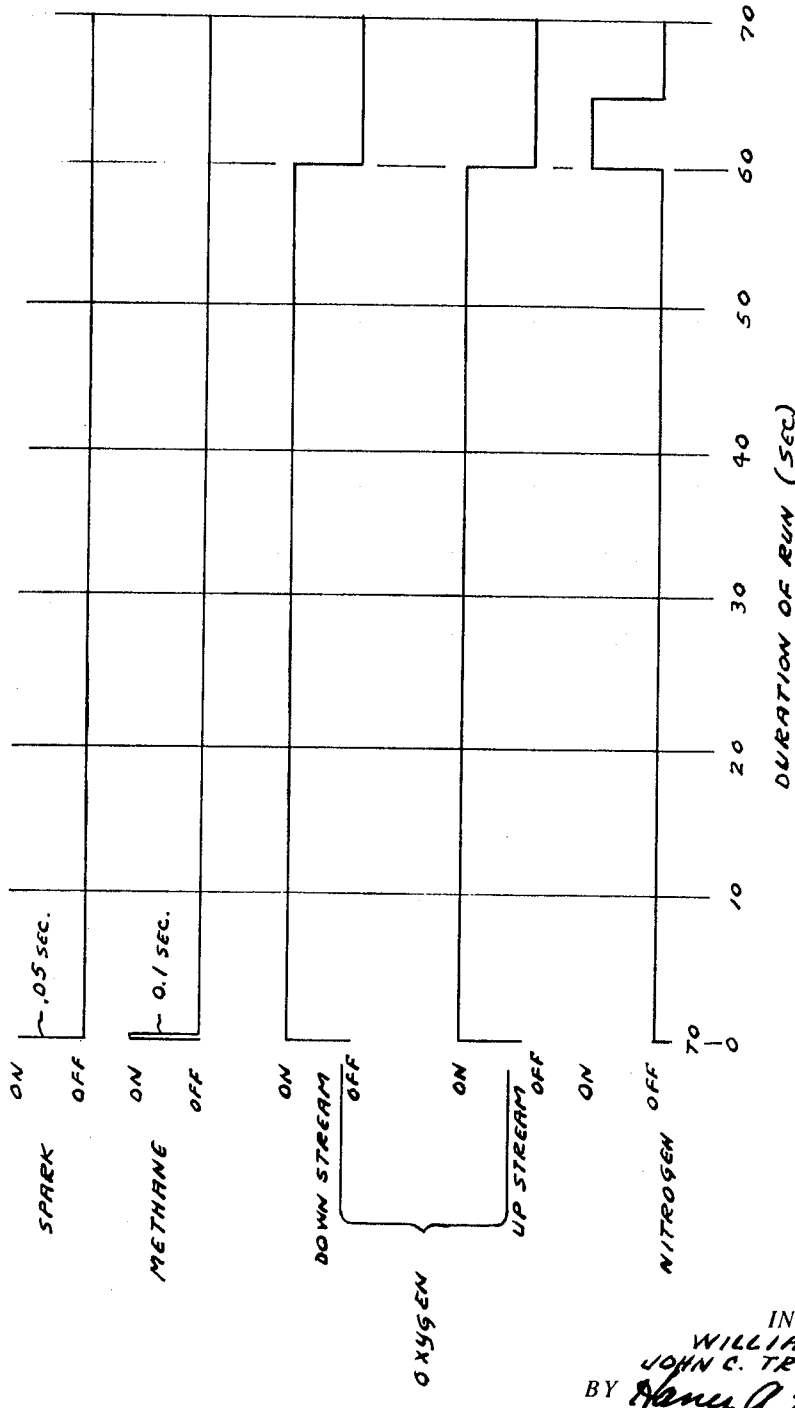


Fig. 2

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ALTITUDE-COMPENSATED HYBRID INFRARED FLARES

BACKGROUND OF THE INVENTION

Hybrid flares depend upon afterburning of the fuel-rich exhaust for enhancement of infrared output. Fuel-rich exhaust operation makes the hybrid flares altitude sensitive since afterburning in the atmosphere is altitude dependent because of rarefied conditions at higher altitudes.

SUMMARY OF THE INVENTION

According to the invention, an oxidizer is injected downstream of the flares to provide an oxidizer sheath around the flare exhaust flame so that the oxidizer mixes with the fuel-rich exhaust products to provide the afterburn, thus compensating for altitude sensitivity induced by rarefied ambient conditions at higher altitudes. Nitrogen may be supplied at the forward end of the flare to quench the combustion at the end of a burn, when the flares are used in multistart operation.

IN THE DRAWING

FIG. 1 is a schematic diagram of a hybrid flare according to the invention;

FIG. 2 shows one possible operating sequence for the flare of FIG. 1; and

FIG. 3 is a schematic of a programmer which may be used with the device of FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

Reference is now made to FIG. 1 of the drawing wherein reference number **10** shows an infrared flare having a fuel grain **12** with a central port **13** which is located within a support housing **14** made of a material such as aluminum. The fuel grain may be made of a material such as carboxy-terminated polybutadiene.

An oxidizer such as oxygen or hydrogen peroxide from supply **16** and a fuel such as methane from fuel supply **18** are supplied to the upstream injector **19** under the control of solenoid valves **20** and **21** in lines **22** and **23**, respectively. A spark igniter **24** ignites the fuel and oxidizer which, in turn, ignites the fuel grain **12**. To make the flare substantially altitude insensitive, oxidizer is also supplied to downstream injector **26**. The injector **26** is an annular manifold with an annular nozzle in the form of a slit or holes to provide a sheath of oxidizer **27** around the exhaust flame **28**. The manifold **26** is supplied with oxidizer from supply **16** through solenoid valve **30** and conduits **32**. A separate oxidizer supply may be provided for supplying a different oxidizer such as dinitrogen tetroxide to the manifold **26** if desired. Mass flow control of the fuel and oxidizer is provided by means of conventional sonic chokes **33**. The sequence of operation is controlled by sequence programmer **34**. One type of programmer which may be used is shown in FIG. 3, wherein cam-operated switches S_1, S_2, S_3, and S_4 act to control the operation of solenoid valves **37**, **21**, **20**, and **30**, respectively. When the motor **35** starts, switches S_2, S_3, S_4, and S_5 are closed to energize solenoids **20**, **21**, and **30** and to energize the spark igniter **24** from the ignition circuit **38**. The motor may be started either by a ground signal to the motor control **39**, or the motor control **39** may include a timer to start the motor a predetermined time after the flare is launched. The flare launching system forms no part of this invention and therefore is not shown. The motor control could also include a timer to restart the motor **35** at predetermined intervals. Switch S_6 may be used to stop the motor after one sequence of operation or the stop signal could come from a ground control signal or from the timer within motor control **39**. The sequence programmer shown is only for illustration purposes and it is to be understood that any programmer may be used that provides the desired operation, for example, the series **60** solid-state sequential programmer, by Tempo Instruments, Inc. may be used.

Nitrogen from supply **36** may be supplied through the methane line **23** to the upstream injector **19** through solenoid valve **37** to quench the combustion between burns for multistart operation.

In one possible sequence of operation as shown FIG. 2, the motor **35** is started in a manner indicated above. At time T_0 the solenoid valves **20** and **21** are energized to supply oxidizer and methane to the upstream injector and at the same time the igniter is energized to ignite the fuel which, in turn, ignites the fuel grain. The oxidizer continues to flow, after the methane fuel stops flowing, to support burning of the fuel grain. Also at T_0, oxidizer is supplied to the downstream injector **26** and continues for the full period of the burn. The oxidizer from injector **26** provides an oxidizer sheath around the exhaust flame **28** to support afterburning of the fuel-rich mixture at all altitudes. At the end of the desired burn the oxidizer is shut off and nitrogen is supplied to the upstream injector to quench combustion within the fuel grain port.

The operating sequence given is merely illustrative as other operating sequences may be used, for example, an altitude sensor operating a second solenoid valve could be provided in series with valve **30** to permit a flow of oxidizer from the downstream injectors only above a certain predetermined altitude.

There is thus provided a hybrid infrared flare in which the afterburn is substantially altitude insensitive.

We claim:

1. A hybrid infrared flare comprising a fuel grain having a hollow central port, a first oxidizer injector at one end of said fuel grain; means for supplying an oxidizer to said first oxidizer injector; means for supplying a small amount of fuel to said first injector; means for igniting the fuel and oxidizer within said first injector to thereby ignite the fuel grain which burns with the oxidizer to form an exhaust flame at the end of said port remote from the first injector; means, at the other end of said fuel grain, for providing an oxidizer sheath around the exhaust flame of said flare and means for supplying nitrogen to said first injector for quenching the combustion a predetermined time after combustion is initiated.