

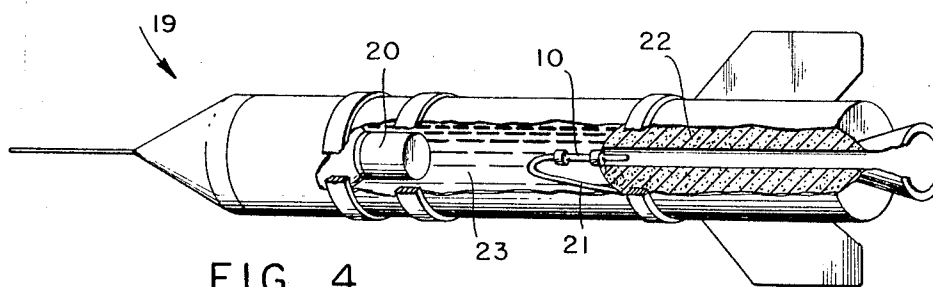
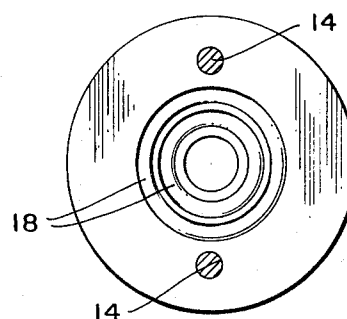
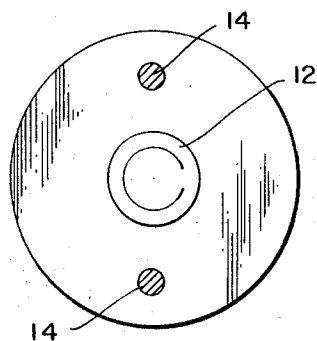
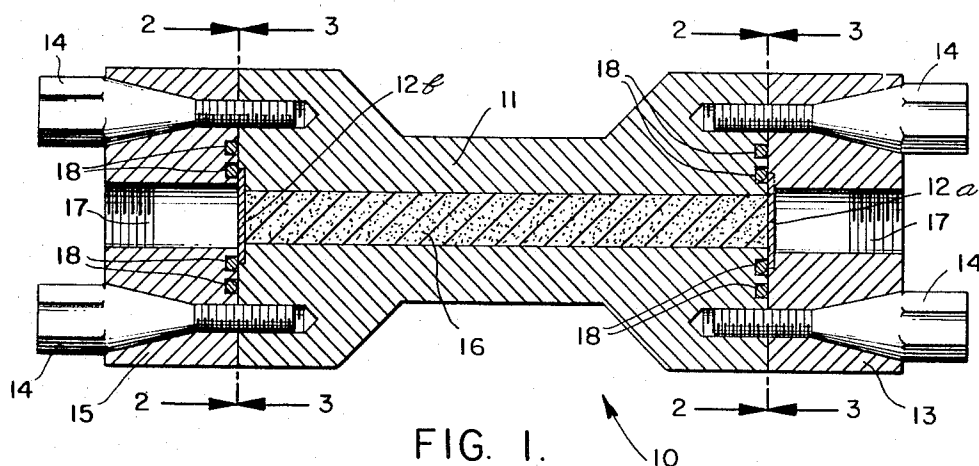
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HYPERGOLIC SLUG IGNITER

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HYPERGOLIC SLUG IGNITER

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2 Claims. (Cl. 60—251)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to a hypergolic igniter slug for rocket motors.

Previous methods and devices used in the ignition of hybrid motors were those utilizing black powder or any of the conventional pyrotechnic igniters. Improper timing of hybrid liquid injection and motor ignition has led to either quenching of the propellant or in certain cases to motor blow-up. Present methods using chlorine trifluoride ignition involve generally separating the chlorine trifluoride container from the non-hypergolic oxidizer system by injecting chlorine trifluoride from a separate tank into the motor or breaking a vial of chlorine trifluoride located inside the motor either by explosive or other means. The disadvantages here for hybrid motors is again timing since it is necessary to inject chlorine trifluoride and ignite the motor prior to oxidizer injection. The necessity for timing the injection will inevitably lead to a time lag between motor ignition and full hybrid thrust obtained when the oxidizer is injected. The general purpose of this invention is to provide an igniter slug which embraces all of the advantages of similarly employed devices and possesses none of the aforementioned disadvantages. To attain this, the present invention contemplates a unique igniter slug which avoids a time lag between ignition and full hybrid thrust obtained when the oxidizer is injected.

It is, therefore, an object of the present invention to provide an igniter for hybrid or liquid propellants which eliminates the need for timing ignition and liquid injection.

Another object is to provide an igniter for rapid ignition of solid propellants by a continuous rapid supply of oxygen to the grain.

A further object of the invention is the provision of a hypergolic igniter slug in the oxidizer line of a hybrid motor which assures quick start capability.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same become better understood by reference to the following detailed description when considered in connection with the following drawings in which like reference numerals designate like parts throughout the figures thereof wherein:

FIG. 1 is a longitudinal view of one embodiment of the slug igniter assembly;

FIG. 2 is a cross-sectional plan view taken along line 2—2 of FIG. 1;

FIG. 3 is a cross-sectional plan view taken along line 3—3 of FIG. 1; and

FIG. 4 is a schematic longitudinal view of a hybrid motor showing the slug assembly positioned in the oxidizer line.

Referring now to the figures, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in FIG. 1 the igniter slug assembly designated generally by numeral 10 which comprises a tubular container 11 and coupling means 13 and 15 secured in abutting relation thereto by appropriate means such as stud bolts 14. Container 11 is closed at the outlet end of a coined burst diaphragm or

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disk 12 and is provided at the inlet end with double grooves, generally designated by numeral 18 into which O-rings are fitted. The inlet end of coupling means 13 is closed with a coined burst diaphragm, generally designated by numeral 12a, and coupling 15 is provided at its outlet end with double grooves 18 into which O-rings are fitted. The burst diaphragm may be manufactured of nickel, copper, brass Inconel or other suitable material. Container 11 and coupling means 13 and 15 of the assembly were machined from stainless steel, but nickel, Monel, aluminum and copper are among some of the materials which may be used.

FIG. 2 is a cross-sectional plan view taken along line 2—2 of FIG. 1 showing the calibrated coined burst disk or diaphragm generally designated 12 which is mounted in the outlet end of container 11 and in the inlet portion of coupling 13.

FIG. 3 is a cross-sectional plan view taken along line 3—3 of FIG. 1 which shows that the inlet end of container 11 and the outlet portion of coupling means 15 are provided with double grooves generally designated by numeral 18 into which O-rings composed of Kel-F, Teflon or other suitable material are positioned.

In preparing the igniter slug assembly 10, container 11 which is closed at one end by diaphragm 12b is first filled with chlorine trifluoride or other hypergolic liquid 16 under low temperature. The outlet portion of coupling means 13 which is closed by a burst diaphragm 12a is positioned in abutting relation to the grooved end of container 11 in which O-rings have been mounted and then firmly secured by stud bolts 14 or other means so that a hermetic seal results. Coupling means 15 is firmly secured by stud bolts, or other means, to the other end of container 11 with its grooved portion in abutting relation to diaphragm 12b thereby sealing the container so that leakage will not occur. Coupling means 13 and 15 are provided with internally threaded ends 17 for connection to appropriate oxidizer and/or pressure lines.

In operation igniter slug assembly 10 is suitably mounted in the oxidizer line 21 as shown in FIG. 4 which is a schematic of a hybrid motor 19. Liquid oxidizer 23 which consists of inhibited red fuming nitric acid, perchloryl fluoride, nitrogen tetroxide, or other suitable oxidizers, is pressurized by release of an inert gas, such as nitrogen, from a pressurization package 20 positioned in the head end of the motor. The burst diaphragm or disks at each end of the slug assembly (12a and 12b) break at about 600 p.s.i. $\pm$ 150 p.s.i. With sufficient pressure both disks are ruptured forcing the chlorine trifluoride into the internal perforated portion of propellant grain 22 slightly in advance of the oxidizer. Rapid ignition of the propellant grain takes place which is fed by a continuous supply of oxidizer.

The amount of chlorine trifluoride necessary to ignite hypergolically the standard 12-inch motor was determined to be 75 cc. This quantity of chlorine trifluoride was loaded into a slug igniter, and it ignited the propellant with an 80 microsecond delay and a 1100 p.s.i. pressure peak which was 100 p.s.i. lower than predicted.

The type hypergolic material used in this device determines to a great extent the choice of metal for the container or casing. Hydrazine and chlorine trifluoride are the most widely used hypergolic materials in rocket motors. Chlorine trifluoride and chlorine pentafluoride are two of the most reactive chemicals known. They are the preferred materials for the igniter slug assembly because they are hypergolic with all fuels used in the rocket industry today. Other advantages include the following:

- (1) ignition is instantaneous, consistent, and reliable;
- (2) only a small quantity is required;
- (3) igniters are storable and liquid and can be in the manifold so that they burst with pressurization;

(4) it is not shock sensitive;

(5) it is thermally stable, non-flammable, but does support combustion.

Operating personnel should be thoroughly instructed concerning the hazards and the proper procedure involved in handling chlorine trifluoride and pentafluoride. The following information for handling this material is generally applicable. The corrosive resistance of all materials of construction used with chlorine trifluoride and chlorine pentafluoride depends upon the formation of a passive fluoride film. Therefore, before any equipment, lines, etc., are placed in service they must be thoroughly cleansed of all foreign matter, flushed with a non-aqueous degreasing and preliminary drying solvent such as acetone or trichloroethylene, thoroughly purged with a stream of dry nitrogen, and passivated. Where lines are not to be dismantled, pipe and fittings should be welded. Socket weld fittings are preferable since this type is easier to keep free of foreign matter, etc. These fluorides should be stored outdoors where it is protected from the weather, or in a well-ventilated room away from exposure to fire or direct heat. In this manner it may be safely stored for several years provided that the storage system is kept reasonably free from excessive heat and moisture. Clean neoprene gloves must be worn when directly handling equipment which contains chlorine trifluoride or has recently contained the same. Rubber gloves, aprons, face shields, etc., will serve for normal use and protect for a limited period of time.

The coined burst diaphragms were pressure tested by applying pressure to either side of the diaphragms to ascertain if variations existed by directional flow and configuration of diaphragm shapes. The units used in this device were all calibrated by this method and no noticeable difference was recorded by applying pressure to either side of the burst disks.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In a hybrid rocket motor including a liquid oxidizer, an oxidizer line, a pressurization package, and a solid propellant grain within said motor,

the improvement which comprises an igniter slug mounted in the oxidizer line adjoining the propellant grain, said slug comprising a casing provided with a bore therethrough, a coined burst diaphragm closure at one end and grooves with "O"-ring fittings at the open end;

chlorine trifluoride within said casing;

a coupling cap with a burst diaphragm at one end and internal threads at the other end; said cap adjoining the open end of said casing thereby creating a hermetic seal; and

a coupling means with grooves and O-ring fittings at one end and internal threads at the other end, said grooved end positioned in contiguous mating relation with the closed end of said casing,

whereby release of pressure from the pressurization package against the oxidizer line causes rupture of the disks forcing the chlorine trifluoride onto the propellant grain in advance of the oxidizer.

2. In a hybrid rocket motor which includes a liquid oxidizer, a solid propellant, a pressurization package and an oxidizer line for carrying the oxidizer to the grain,

the improvement which comprises an igniter slug mounted in the oxidizer line adjoining the propellant grain; said slug consisting of a casing provided with a bore therethrough, a coined burst diaphragm closure at one end and grooves with "O"-ring fittings at the open end;

a coupling cap with a burst diaphragm at one end and internal threads at the other end said cap adjoining the open end of said casing thereby creating a hermetic seal;

a coupling means with grooves and "O"-ring fittings at one end and internal threads at the other end, said grooved end positioned in contiguous mating relation with the closed end of said casing; and

a liquid which is hypergolic with said solid propellant within said casing

whereby rapid ignition of the propellant grain takes place when sufficient pressure is exerted on the oxidizer line to rupture both disks thereby forcing the hypergolic liquid onto the propellant grain in advance of the oxidizer.

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