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Turner

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[54] **ELECTRICALLY CONTROLLED SOLID ROCKET IGNITION SYSTEM**

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

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[52] **U.S. Cl.** .....**102/49.7,** 102/70.2 A, 60/39.82 E, 60/256

[51] **Int. Cl.** **F42c 19/12**

[58] **Field of Search** .....102/39, 49.7, 70.2 A, 102; 60/256, 39.82 E

[56] **References Cited**

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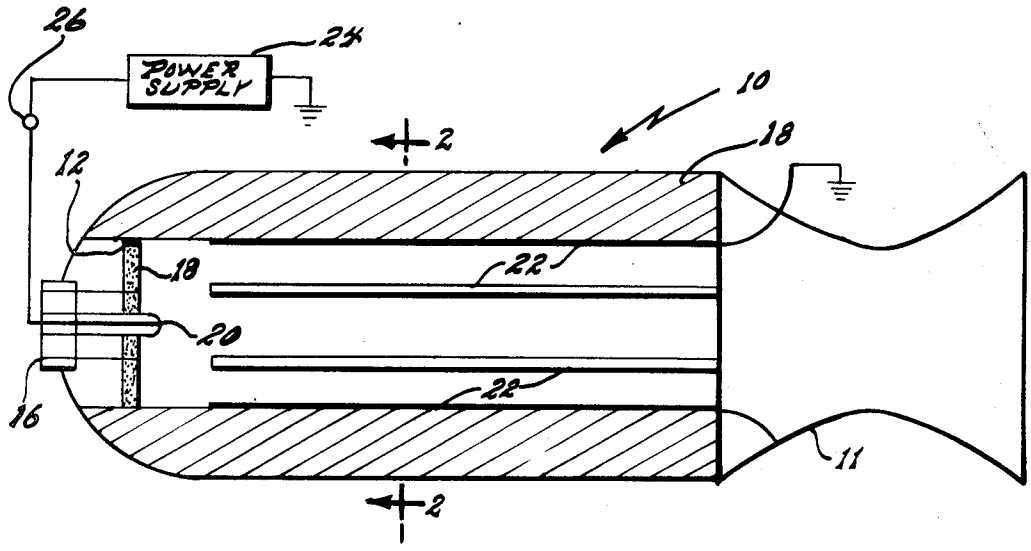
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[57] **ABSTRACT**

An electrically controlled solid rocket ignition system including a resistance wire initiator for igniting pyrotechnic material. After ignition, a high voltage is applied between forward and aft electrodes which are positioned on or near the surface of the propellant. This produces an electrostatic field which permits controlled movement of heated ions and/or electrons from the flame zone to the remaining unignited surface of the propellant. Ignition delay time can thereby be precisely controlled.

1 Claim, 2 Drawing Figures



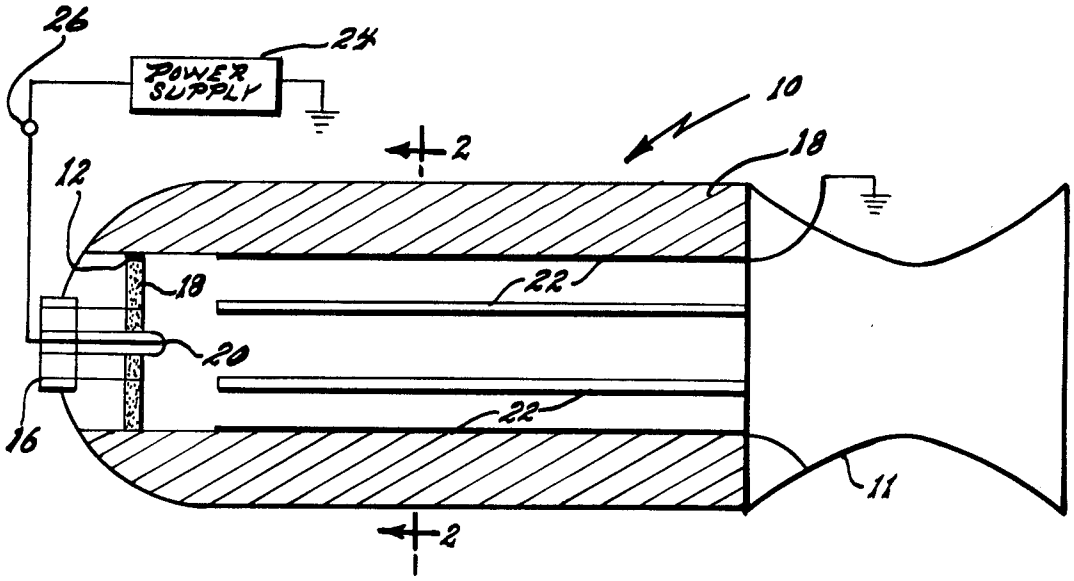


FIG. 1

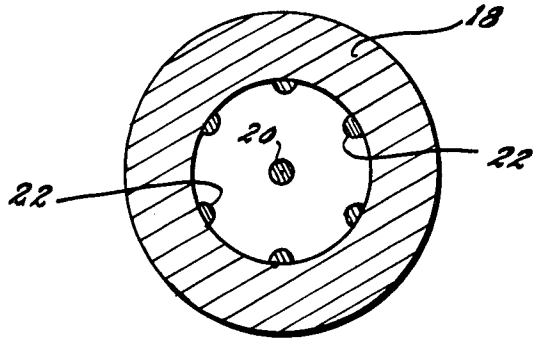


FIG. 2

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ELECTRICALLY CONTROLLED SOLID ROCKET IGNITION SYSTEM

BACKGROUND OF THE INVENTION

The present invention relates to a solid rocket ignition system, and more particularly to a system which permits command control of ignition delay time in a solid rocket motor by controlling the rate of flame spread over the surface of the unignited propellant.

In the standard pyrogen type igniter, hot gases are propelled into the internal body of the propellant grain and onto its surface. In this system, there is no efficient means for precisely controlling delay time. Irregularities of density within the body of the propellant grain offer difficulties in controlling ignition rate and flame spread. The capability of varying ignition delay time as desired is not available in the currently available pyrogen ignition systems.

Then there is, of course, the always present fact that the pyrogen igniters add weight.

SUMMARY OF THE INVENTION

The object of the present invention is, therefore, the provision of an ignition device for solid rocket motors which will allow the propulsion system a constant ignition delay time, regardless of the temperature of the rocket fuel.

A further object of the invention is to decrease the necessary weight of the missile by eliminating the need to mount a large power supply on board the missile, and permit the power supply to be ground-mounted or to be positioned on a flying launch platform.

A further object of the invention is the provision of an ignition system wherein the control of flame spread rates is so effective that difficulties usually experienced in slots and other such areas are eliminated, and flame spread proceeds.

The system of the invention consists of a resistance wire initiator installed at the forward end of an internally ported solid rocket of any given design or internal geometry. The device of the invention is capable of being modified. More sophisticated initiators can be substituted for the resistance wire which is disclosed herein for purposes of disclosure and examplification. Connections for the resistance wire are made through an adaptor of high dielectric material, such as micarta (phenolic or epoxy impregnated linen). The resistance wire circuit is consumable and is vaporized immediately after the pyrotechnic material has ignited. A high voltage is then applied between forward and aft electrodes. The electrodes are positioned on or near the surface of the propellant. An electrostatic field is thus produced between fore and aft electrodes, causing a force to be exerted on certain charged particles (positive ions, negative ions and electrons) within the flame zone. The resulting motion of these charged particles is primarily dependent upon magnitude and direction of the applied field force, and can be controlled by external electrical circuitry. Movement of heated ions and electrons from the flame zone along the surface of the unignited propellant which causes an increase in the resulting flame spread rate. There are several mechanisms which operate to modify the rate of flame spread. For example, (1) increased heat transfer to unignited surfaces by heated positive ions which move from flame zone to unignited surface of negative polarity; (2) increased heat transfer to unignited surface by the drag of heated, non-charged particles along with heated positive ions as described in (1); (3) increase in localized chemical reaction at the negative electrode by altering equilibrium concentration of species; (4) control dissipation of electrical energy into the surface of unignited propellant surface due to electronic conduction along propellant surface.

The power supply is connected externally and can be disconnected immediately upon ignition by means of quick disconnect mechanisms. This eliminates the need to mount a large power supply on board the missile and permits the power supply to be ground mounted or remain with a flying launch platform.

The power supply is a high voltage, low amperage unit which operates for the very short time interval only, and is associated with ignition delay of the rocket motor.

Many variations of design and configuration are possible which will enhance flame spread. Reversal of polarity will cause similar but less useful effects. The changes in electrode geometry, which are possible, give greater flexibility to the system. However modified, the governing principle employed in this ignition system is the controlled movement of heated ions and electrons from the flame zone along the unignited propellant surface, using electrostatic field forces developed within the rocket motor by means of an externally mounted power supply.

These and other advantages, features and objects of the invention will become more apparent from the following description taken in connection with the illustrative embodiment in the accompanying drawing.

DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic longitudinal sectional view of a rocket with the device of the invention installed therein; and

FIG. 2 is a schematic cross-section taken on the line 2—2 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An internally ported solid propellant rocket body is represented generally by the numeral **10** and the nozzle by the numeral **11**.

The ignition system comprises a resistance wire initiator **12** installed at the forward end. It is to be understood that the invention is not limited to the specific geometry shown. The showing of the initiator is exemplary only. Other more sophisticated initiators can be employed.

A resistance wire **12** is described herein only for purposes of discussion.

The connections for the resistance **12** are made through forward adapter **16** which may be made of high dielectric material such, for example, as micarta which is phenolic or epoxy impregnated linen.

The resistance wire circuit is consumable and is vaporized immediately after pyrotechnic material **18** has been ignited.

A high voltage is then applied between forward electrode **20** and aft electrodes **22**. The aft electrodes **22** are positioned on or near the surface of the propellant grain **18**.

It has been determined that the aft electrode wires have no observable effect upon the flame spread rate in the absence of an electrostatic field.

An electrostatic field is then produced between electrodes **20** and **22** which causes a force to be exerted on certain charged particles (positive ions, negative ions and electrons) within the flame zone.

The resulting motion of these charged particles is primarily dependent upon the magnitude and direction of the applied field force and can be controlled by external electrical circuitry. Movement of heated ions and electrons from the flame zone along the surface of the unignited propellant causes an increase in the resulting flame spread rate by one or more of several mechanisms. For example, (1) increased heat transfer to unignited surface of negative polarity; (2) increased heat transfer to unignited surface by drag of heated, non-charged particles along with heated positive ions as noted above; and (3) increase in localized chemical reaction at the negative electrode by altering equilibrium concentration of species; (4) control dissipation of electrical energy into the surface of unignited propellant due to electronic conduction along propellant surface.

The power supply **24** is connected externally and can be disconnected immediately upon ignition by means of quick disconnect **26**. This eliminates need to mount a large power supply on board the missile and permits supply to be ground mounted or remain with a flying launch platform.

The power supply **24**, indicated in FIG. **1**, is a high voltage, low amperage unit which operates for the very short time interval associated with ignition delay of the rocket motor.

Although the invention has been described with reference to a particular embodiment, it will be understood to those skilled in the art that the invention is capable of a variety of alternative embodiments within the spirit and scope of the appended claims.

I claim:

1. In a solid propellant rocket motor ignition system, means for varying and controlling the ignition delay time thereof comprising a hollow cylindrical propellant grain having an exposed internal surface, a plurality of aft electrodes positioned along the exposed surface of said propellant grain and extending forward from the rearward end thereof, a forward electrode positioned in the central forwardmost end of said rocket motor and extending rearwardly along the central axis of said rocket motor, a pyrotechnic material positioned around the base of said forward electrode, initiator means in contact with said pyrotechnic material for producing ignition thereof, and an electrical power supply operatively connected between said forward and aft electrodes for applying an electrostatic field therebetween and causing a force to be exerted on charged particles within the flame zone thereby producing motion of the charged particles proportional to the magnitude and direction of the applied field force resulting in a corresponding variation in the rate of flame spread along the surface of the propellant grain.

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