June 13, 1967 E. W. BRADSHAW, JR 3,324,656

TEMPERATURE CONTROLLED IGNITER

Filed May 4, 1964

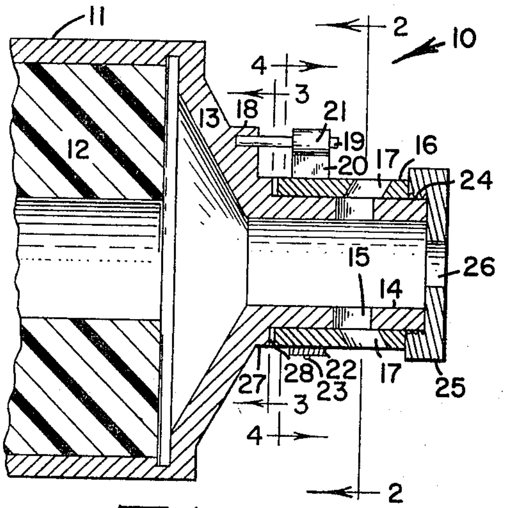

Fig. 1

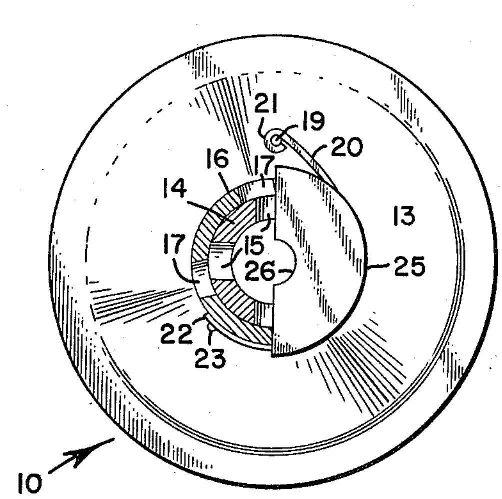

Fig. 2

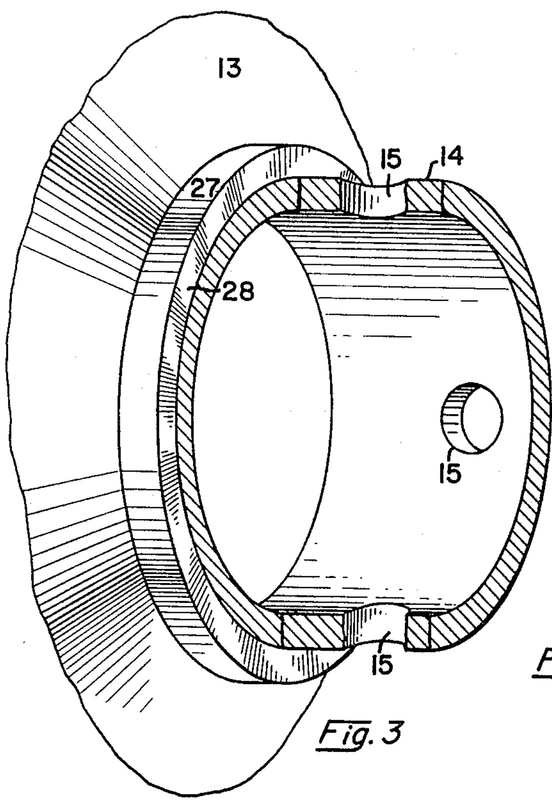

Fig. 3

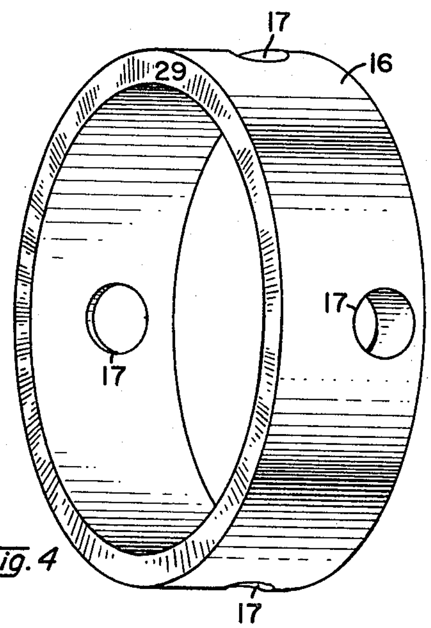

Fig. 4

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3,324,656

Patented June 13, 1967

3,324,656

TEMPERATURE CONTROLLED IGNITER

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Filed May 4, 1964, Ser. No. 364,705
6 Claims. (Cl. 60—39.82)

This invention relates to temperature controlled igniters for solid propellant rocket motors and, more particularly, to igniters that are controlled by the variations of temperature that occur in the solid propellant of a solid propellant rocket motor.

It is a well known fact that, at high temperatures, solid propellants have higher burning rates and are easier to ignite, whereas at low temperatures, the opposite condition exists. The rate of the burning of the igniters is also at a maximum at high temperatures. Thus the rate of energy release from the igniter is at a maximum when propellant ignition energy requirements are at a minimum.

It is an object of this invention, therefore, to provide a temperature controlled igniter that will reduce "over-ignition" or high pressure peaks at high temperatures and "under-ignition" at low temperatures.

Thus by controlling the energy output of the igniter relative to the temperature of the motor, more uniform and reproducible rocket motor ignition characteristics will be provided.

Also the igniter embodying the present invention will solve the mismatch problem of motor ignition by continuously reversing the energy output rate versus the temperature relationship.

Another object of this invention, therefore, is to provide a temperature controlled igniter that includes a variable throat, the variations of which are controlled by temperature effects on a bimetallic spring.

From a ballistic standpoint, the rate of energy release from an igniter can be readily controlled by regulating the burning rate; and this can be achieved by varying the chamber pressure through variations of the throat area through which the igniter exhausts.

It is a well known fact that the igniter is initiated by an electrically-actuated squib and that the combustion of the pyrotechnic material in the igniter furnishes the energy for the ignition of the solid propellant in the rocket motor. Since the chamber pressure varies in the rocket motor, such variation has its effect on the burning rate of the pyrotechnic in the igniter. Thus by controlling the throat area of the igniter, the burning rate of the igniter can be maintained at a level that will furnish optimum ignition energy for the rocket motor regardless of the temperature variations in the rocket motor.

With the above and other objects and advantages in view, the invention consists of the novel details of construction and arrangement of parts more fully hereinafter described, claimed and illustrated in the accompanying drawings in which:

FIGURE 1 is a longitudinal, sectional view of the throat area portion of a temperature controlled igniter embodying the instant invention.

FIGURE 2 is an end view of FIGURE 1, partially in section, on the line 2—2 of FIGURE 1 showing the bimetallic spring that, through temperature variations, controls the throat area of the temperature controlled igniter.

FIGURE 3 is an enlarged, detailed, fragmentary, sectional view of the throat area of FIGURE 1 on the line 3—3 thereof, and

FIGURE 4 is an enlarged perspective view of the rotary diffuser with parts removed taken substantially on the line 4—4 of FIGURE 1.

Referring more in detail to the drawings wherein like parts are designated by like reference numerals, the reference numeral **10** is used to generally designate a temperature controlled igniter embodying the instant invention.

The igniter **10** comprises a tubular body **11** in which is cast a pyrotechnic material **12**, which in conventional practice is ignited by an electrically-operated initiator, such as an electrically-actuated squib which is not shown.

The tubular body **11** includes an integral aft end **13** that merges into an integral throat portion **14** which, as shown in FIGURE 3, is provided with a plurality of radially-disposed ports **15**. Mounted for controlled rotation on the throat portion **14** in circumjacent relation thereto is a diffuser ring **16** which is provided with a plurality of radially-disposed, canted ports **17**, as shown in FIGURE 4. The axis of the ports **15** of the throat portion **14** is at right angles to the longitudinal axis of the throat portion **14**, while the axis of the ports **17** of the diffuser ring **16** is canted at an angle both to the longitudinal axis of the diffuser **16** and the axis of the ports **15**.

The aft end **13** of the body **11** is provided with a reinforcing boss **18** in which is rigidly secured an anchor pin **19**; and a bimetallic spring **20** is secured at one rolled end **21** thereof to the anchor pin **19**, the opposite end **22** thereof being secured to the diffuser ring **16** by an anchor fastener **23**.

The outer end of the throat portion **14** is provided with external threads **24**, and threadably secured to the throat portion **14** by means of the threads **24** is a closure cap **25** that is provided with a fixed orifice **26**.

An annular shoulder **27** is provided on the aft end **13** of the body **11** in circumjacent integral relation to the throat portion **14** where it projects from the aft end **13**; and the face of the shoulder **27** is provided with a plurality of relatively-spaced, radially-disposed serrations **28**. In like manner, the face of the diffuser ring **16** that opposes the serrated face of the shoulder **27** is also provided with a plurality of relatively-spaced, radially-disposed serrations **29**. The serrations **28** and **29** are adapted to be inter-engaged to prevent anti-clock rotation of the diffuser ring **16** in relation to the throat portion **14** during igniter operation. The engaged serrations **28** and **29**, however, do not prevent the clockwise rotation of the diffuser ring **16** that is caused by the effect of temperature changes on the bimetallic spring **20**.

In the operation of the igniter **10** with the primary exhaust of the igniter **10** emitting through the orifice **26**, the ports **15** in the throat portion **14** will be restricted at operating pressures over a given temperature range by means of the bimetallic spring **20**; but when there is an abnormal rise in temperatures which will affect the bimetallic spring **20**, the diffuser ring **16** is then slightly rotated so that the ports **15** and **17** will move into alignment with each other to increase the throat venting area which will result in decreasing the energy release of the igniter **10**.

During operation, the canted ports **17** have a tendency to produce a resultant force that will attempt to move the diffuser **16** in an axial direction. Thus, with the serrations **28** and **29** engaged and the bimetallic spring **20** in normal position, no rotation of the diffuser ring **16** is possible. When the igniter is not in operation, the bimetallic spring **20** is affected by a rise in temperature; and then the diffuser ring **16** will be slightly rotated to align the ports **15** and **17**. Consequently, with the serrations **28** and **29** engaged during operation, no rotation of the diffuser ring **16** is accomplished. Prior to igniter operation, the bimetallic spring **20** has adjusted the port area as is necessary to fulfill the necessary ignition characteristics that are necessary to properly ignite the solid propellant in the rocket motor as required by operational conditions.

Thus any change in chamber temperature will alter the burning rate of the igniter **10**. Therefore, when the burning rate of the propellant in the rocket motor is at a maximum, the venting area of the throat portion **14** of the igniter **10** will also be at its maximum, conversely, for optimum burning rate of the propellant at low temperatures, the venting area of the throat portion **14** should be at a minimum. Consequently, by controlling the venting area of the throat portion **14** by means of temperature effects on the bimetallic spring **20**, the burning rate of the pyrotechnic material **12** in the igniter **10** can be maintained more nearly constant, thus delivering ignition energy at a more constant rate regardless of the temperatures involved. In this manner, the control of the ignition energy from the igniter **10** will directly influence the peak pressure which the rocket motor experiences during the ignition phase.

It is believed that, from the foregoing description, the operation and construction of the temperature controlled igniter will be apparent to those skilled in the art; and it is to be understood that variations therein may be made provided such variations fall within the spirit of the invention and the scope of the appended claims.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A temperature controlled igniter comprising a body portion, a throat portion at one end of and integral with said body portion, said throat portion having radially-disposed ports therein, said throat portion having an open end, a closure cap having a fixed orifice therein secured to said open end, a diffuser ring having radially-disposed ports therein mounted for rotation on said throat portion, and temperature controlled means mounted on said throat portion and connected to said diffuser ring for controlling the rotation of said diffuser ring such that said diffuser ring ports change registry with respect to said throat ports with changes in atmospheric temperature.

2. A temperature controlled igniter, as in claim **1**, wherein an ignitable pyrotechnic material is cast into said body portion.

3. A temperature controlled igniter, as in claim **1**, wherein said temperature controlled means comprises a bimetallic spring having one end fixed to said throat portion and one end fixed to said diffuser.

4. A temperature controlled igniter, as in claim **3**, wherein an anchor pin is rigidly secured in said body and said bimetallic spring has one end thereof contoured to engage said anchor pin and an anchoring fastener mounted in said diffuser ring secures the opposite end of said bimetallic spring to said diffuser ring.

5. A temperature controlled igniter, as in claim **1**, wherein the ports in said diffuser ring are canted at an angle in relation to the ports in said throat portion.

6. A temperature controlled igniter, as in claim **1**, wherein an annular shoulder is provided on said body in circumjacent integral relation with the throat portion, the face of said shoulder is provided with a plurality of relatively-spaced, radially-disposed serrations; and the face of said diffuser ring that opposes said shoulder is also provided with a plurality of relatively-spaced radially-disposed serrations whereby when said serrations are in engagement with each other anti-clockwise rotation of said diffuser ring is prevented.

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