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IGNITION SYSTEM FOR SOLID FUEL CHARGES

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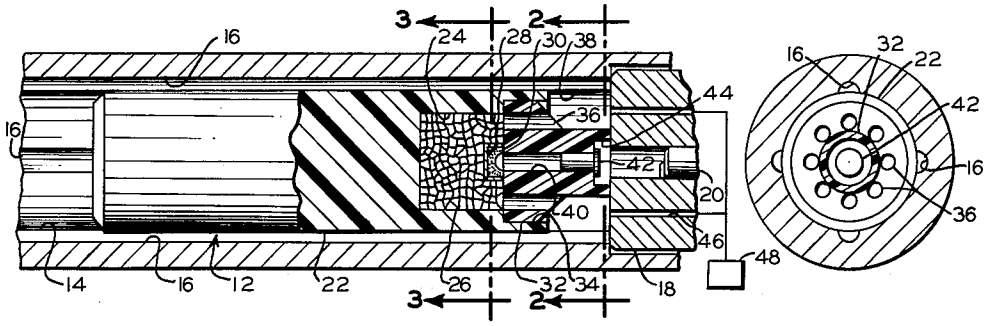

Fig. 1

Fig. 2

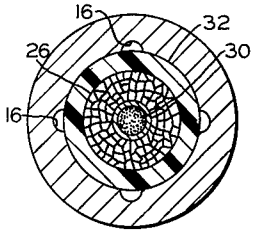

Fig. 3

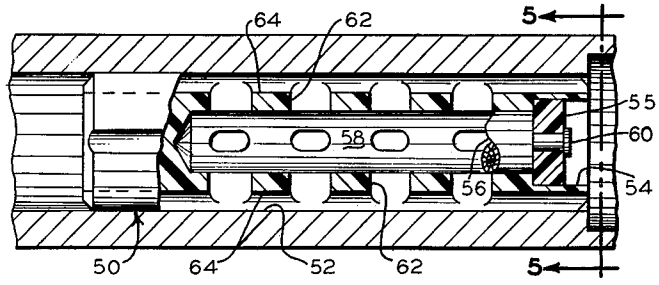

Fig. 4

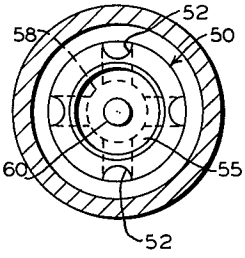

Fig. 5

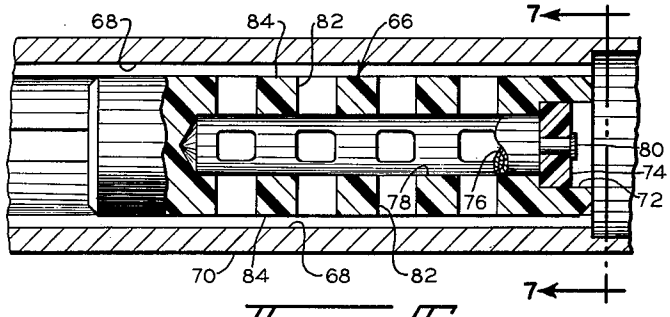

Fig. 6

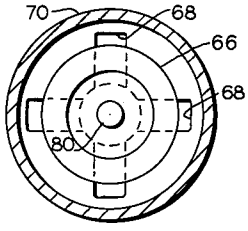

Fig. 7

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IGNITION SYSTEM FOR SOLID FUEL CHARGES

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This invention relates to ignition systems for solid fuel charges such as those which are used in rocket engines.

Solid fuel charges employed in rocket engines must be strong and rigid, have high impact strength, and have reasonable resistance to weathering, moisture, petroleum products, weak acids, salt air, and the like. Such charges also must not be sensitive to shock or vibration and must be difficult to ignite in order to be transported, stored, and used without danger of premature ignition or explosion. On the other hand, the charges must be capable of being ignited with 100 percent assurance, without possibility of failure. Consequently, an ignition system for the charges must subject them to high temperatures for relatively long periods of time to assure their ignition.

The present invention provides an ignition system for a solid fuel charge, which system assures ignition thereof by concentrating a large amount of heat upon relatively small portions of the charge for a period of time. In accordance with the invention, an igniting charge is located centrally in one end of a solid fuel charge with passages extending longitudinally of the charge at the periphery thereof and with additional passages connecting the longitudinally-extending passages with a chamber containing the igniting charge. When the igniting charge is ignited, heat therefrom is distributed through these passages so as to be supplied to portions of the solid charge from both the igniting charge chamber and the longitudinally extending passages. Thus, portions of the fuel charge receive heat from two sides thereof and for as long as the igniting charge burns. This concentration of heat supplied from multiple points enables even the most difficult materials to burn, the heat being applied from at least two points causing a substantial reduction in heat dissipation over that ordinarily occurring with only a single point of heat application. The heat-distributing passages, by carrying off combustion gases from the igniting charge chamber, also relieve pressure in that chamber and enable more complete combustion to take place therein.

It is, therefore, a principal object of the invention to provide a more reliable ignition system for solid fuel charges.

Another object of the invention is to provide an ignition system for solid fuel charges in which a plurality of passages extend from a secondary igniting charge for distributing heat therefrom to a plurality of portions of the charge and for relieving pressure at the igniting charge.

Still another object of the invention is to provide an improved ignition system in which heat is applied to portions of a solid fuel charge from at least two different points.

Other objects and advantages of the invention will be apparent from the following detailed description of preferred embodiments thereof, reference being made to the accompanying drawings, in which:

FIG. 1 is a view in longitudinal vertical cross section of a combustion chamber in which is located a solid fuel charge according to the invention, part of the charge being broken away to show portions of an ignition system embodied therein;

FIG. 2 is a view in lateral cross section of the charge and chamber shown in FIG. 1, taken along the line 2—2 of FIG. 1;

FIG. 3 is a view in lateral cross section taken along the line 3—3 of FIG. 1;

FIG. 4 is a view in longitudinal vertical cross section of a combustion chamber in which is a modified fuel charge employing a modified ignition system embodying the principles of the invention, with part of the charge being broken away and with parts in cross section;

FIG. 5 is a view in lateral cross section taken along the line 5—5 of FIG. 4;

FIG. 6 is a view in longitudinal vertical cross section of a combustion chamber and charge according to the invention with a part broken away and with parts in cross section; and

FIG. 7 is a view in cross section taken along the line 7—7 of FIG. 6.

Referring to the drawings, and more particularly to FIG. 1, a solid fuel charge 12 containing an ignition system according to the invention, is located in a combustion chamber 14 having a plurality of longitudinally extending passages or grooves 16 spaced uniformly around the periphery thereof. At the forward end of the chamber 14, toward a nose (not shown) of a rocket in which the charge and chamber are employed, is a bolt 18 which is moved longitudinally in a known manner to charge the chamber 14 and to supply additional fuel charges thereto as each previous charge burns, when the rocket is used with a plurality of charges. A firing pin or striker 20 is located centrally within the bolt and can be fired by any suitable, known mechanism.

The fuel charge 12 includes a cylindrical body 22 of solid fuel which can be of many suitable types. One particularly suitable fuel from which the cylinder 22 can be made includes 75 percent cellulose nitrate with 10.7–11.2 percent nitrogen, and 25 percent camphor. This material is of a plastic nature, has high impact strength, and requires a high ignition temperature, over 320° F. The percent of nitrogen in the cellulose nitrate can be varied and additional material such as dehydrated wood particles can be added to the fuel in order to produce slower burning thereof. Located centrally in the fuel body 22 and at an end thereof is an igniting chamber 24 containing a secondary igniting charge 26. A combination of sulphur, lamp black, potassium nitrate, magnesium powder, and particles of the solid fuel has been found to be suitable for the secondary charge 26, with cellulose nitrate lacquer being used as a binder. The secondary charge 26, in turn, has a recess 28 located centrally at the rear thereof, which recess contains a primary igniting charge 30, uncoated cellulose nitrate powder in rodlet form being suitable for this purpose.

An insert 32 is held in an end recess 34 at the rear of the cylinder 22 and can also be made of the same solid fuel employed in the cylinder 22, the insert 32 being separable from the cylinder 22 for the purpose of positioning the secondary charge 26 and the primary charge 30 in the chamber 24. The insert 32 has a plurality of short connecting passages 36 located in a circular pattern and connecting the secondary igniting charge 26 with another connecting passage or combustion space 38 located between the insert 32 and the bolt 18. A central opening 40 in the insert 32 contains a percussion cap 42 at the rear thereof, which caps extends into an indentation 44 in which the striker 20 is received.

When the charge 12 is in proper location in the chamber 14 and is to be ignited, the striker 20 is driven forwardly into the recess 44, striking and exploding the percussion cap 42. This ignites the primary igniting charge 30 which burns and immediately ignites the secondary igniting charge 26. Heat from the secondary charge 26 is transferred to the adjacent portions of the cylinder 22 and highly heated gases of combustion pass through the connecting passages 36 and 38 to the longitudinal grooves 16 adjacent the periphery of the charge cylinder 22.

Heat is thus transferred to the inner, rear portion of the charge 22 adjacent the recess 24 from the charge 26 and also to the outer, rear portion from the combustion gases flowing through the grooves 16. This double concentration of heat assures ignition of the rear portion of the fuel charge and also initiates combustion of the periphery of the cylinder 22 toward the end nearer the exhaust nozzle of the chamber 14.

If desired, gas for supporting additional combustion in the rear space 38 can be supplied through supply ports 46 in the bolt 18 from a suitable source 48. This gas, which can be compressed air or oxygen, for example, supports secondary combustion of the gases issuing from the igniting charge 26 and thereby enables additional heat to be supplied to the periphery of the cylinder 22 as the gases travel through the passages 16.

Referring to FIGS. 4 and 5, a modified fuel charge 50 is adapted for use in a combustion chamber similar to the chamber 14 but without the grooves 16, the charge in this case having its own grooves. The charge 50 includes a plurality of longitudinally extending passages or grooves 52. A centrally located recess 54 at the rear of the charge holds an insert 55 which is made of the same material as the rest of the charge 50 but is removable so that an igniting charge 56 can be placed in a central ignition chamber 58. The igniting charge 56 is located adjacent a percussion cap 60 located in the insert 55.

When the cap 60 is struck by a striker such as the striker 20 of FIG. 1, it ignites the charge 56. Gases of combustion from the charge 56 pass through connecting passages 62 to the longitudinally extending passages 52 and flow toward an exhaust nozzle at the rear of a chamber in which the charge 50 is located. Portions 64 of the charge 50 receive heat from the charge 56 in the central recess 58 and also from the combustion gases flowing through the longitudinally extending passages 52. These portions 64 also receive heat from the connecting passages 62, thus being heated from four sides in this instance. This assures ignition of the portions 62 and, hence, subsequent combustion of the over-all charge 50.

Referring more particularly to FIGS. 6 and 7, a charge 66 is basically similar to the charge 50 but longitudinal extending passages 68 are located in a combustion chamber 70, rather than in the charge itself. The charge 66 includes a rear recess 72 containing an insert 74 which is positioned in the recess after an igniting charge 76 is placed in a central ignition chamber 78.

The insert 74 positions a percussion cap 80 concentrically with the charge 76, which cap, when exploded by a suitable striker, ignites the charge. Combustion gases from the charge 76 flow outwardly through connecting passages 82 and through the longitudinally-extending passages 68 in the chamber 70. Portions 84 of the chamber 66 thereby receive heat directly from the charge 76 and also from the heated combustion gases in the passages 82 and 68.

Various modifications of the above described embodiments of the invention will be apparent to those skilled in the art and it is to be understood that such modifications can be made without departing from the invention, if such modifications are within the scope and tenor of the accompanying claims.

I claim:

1. A solid fuel charge and ignition system for a rocket engine comprising an elongate body of solid fuel, an ignition chamber centrally located laterally of said body, an igniting charge in said chamber, an end recess in said body adjacent said ignition chamber, an insert in said recess closing off said ignition chamber, means forming a plurality of grooves extending longitudinally of said fuel body and spaced around the periphery thereof, a plurality of connecting passages in said fuel body connecting said chamber with said longitudinal groove means, and means held by said insert for initiating combustion of said igniting charge.

2. A rocket engine comprising an elongate body of solid fuel, an ignition charge chamber centrally located laterally of said body, an igniting charge in said chamber, an end recess adjacent said chamber, an insert of solid fuel in said recess, and means held by said insert for initiating combustion of the igniting charge, wall means forming a combustion chamber in which said body is located, a plurality of grooves extending longitudinally of the body and spaced around the periphery thereof, said grooves being formed in one of said wall means and said body, and a plurality of connecting passages connecting the ignition chamber with said longitudinal grooves.

3. A rocket engine according to claim 2 and means for supplying a combustion-supporting gas to combustion gases issuing from the igniting charge, before said combustion gases reach said longitudinal grooves.

4. A rocket engine comprising a generally cylindrical, elongate body of solid fuel, an ignition charge chamber located axially of said body and nearer one end thereof than the other, an igniting charge in said chamber, an end recess in said body adjacent said ignition charge chamber, an insert of solid fuel held in said recess, and means held by said insert for initiating combustion of said igniting charge, wall means forming a combustion chamber in which said body is located adjacent the inner surface thereof, a plurality of grooves extending longitudinally of the body, over a substantial portion of the length thereof, and spaced uniformly around the periphery thereof, said grooves being formed in one of said wall means and said body, and a plurality of connecting passages connecting the ignition chamber with said longitudinal grooves.

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