Dec. 25, 1962 T. S. WHITSEL, JR 3,069,843

IGNITION OF SOLID PROPELLANTS

Filed May 29, 1958 2 Sheets-Sheet 1

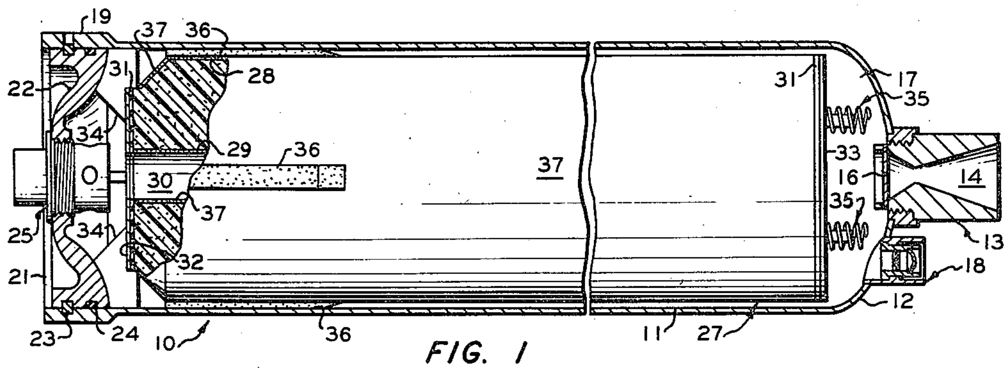

FIG. 1

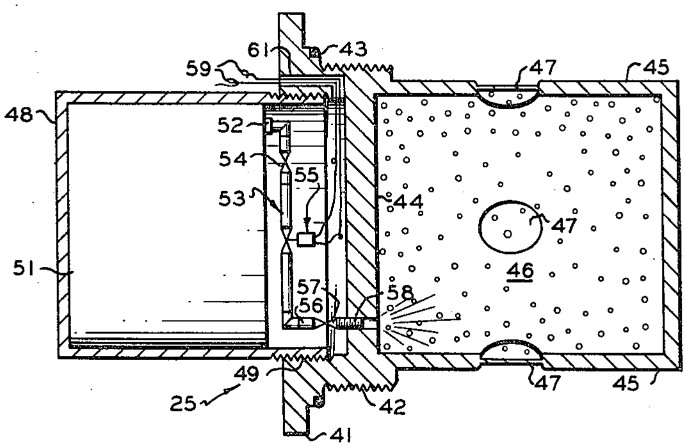

FIG. 2

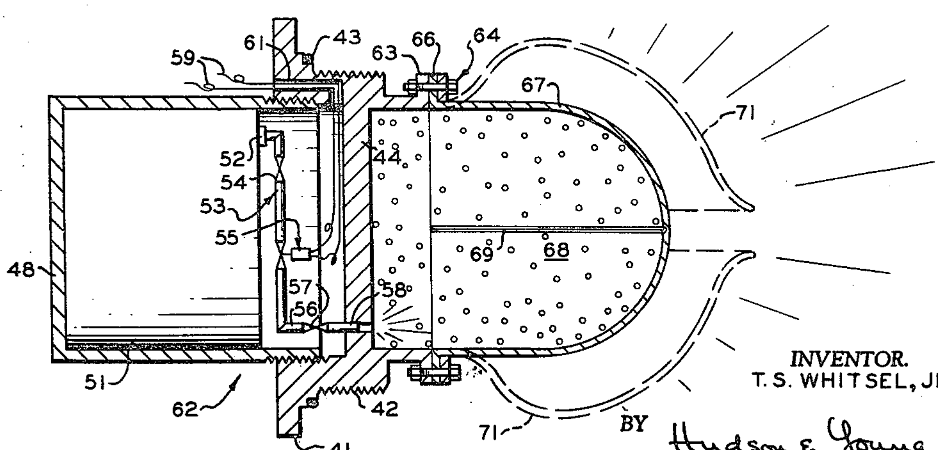

FIG. 3

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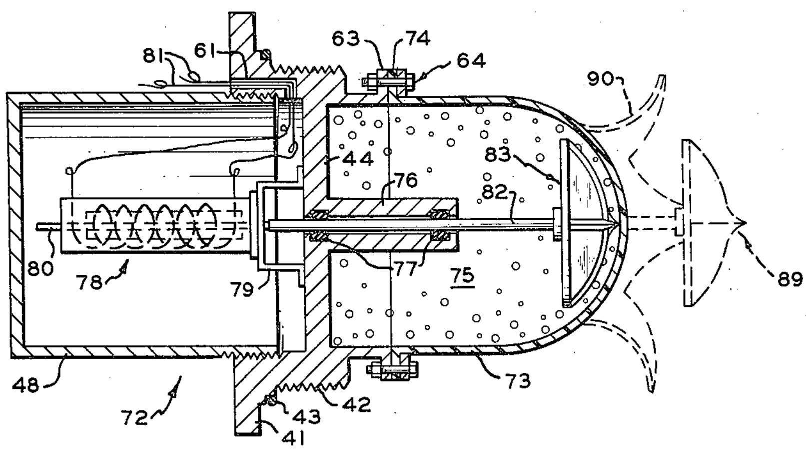

FIG. 4

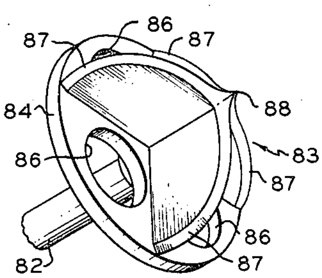

FIG. 5

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3,069,843
IGNITION OF SOLID PROPELLANTS

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9 Claims. (Cl. 60—35.6)

This invention relates to the ignition of solid propellants. In one aspect it relates to the ignition of solid propellants such as those propellants loaded in rocket motors employed to assist the take-off of aircraft. In another aspect it relates to novel ignition means employed to ignite solid propellants, especially those propellants of the composite type comprising a major amount of a solid inorganic oxidant and a minor amount of a binder. In another aspect it relates to a solid propellant charge having novel ignition means associated therewith. In another aspect it relates to solid propellant rocket motors equipped with novel ignition means.

Solid propellants, such as those loaded in rocket motors, are often of the composite type comprising a major amount of a solid inorganic oxidant, such as ammonium nitrate and/or ammonium perchlorate, and a combustible binder, such as asphalt, rubber and other tacky hydrocarbon-containing materials, which bond the oxidant particles into a solid grain, the binder also serving as a fuel. Recently it has been discovered that superior solid propellant mixtures of the composite type can be fabricated from a large proportion of a solid inorganic oxidant, such as ammonium nitrate and/or ammonium perchlorate, and a minor proportion of a rubbery copolymer of a conjugated diene and a vinylpyridine or other substituted heterocyclic nitrogen base compound, the copolymer serving as the binder. Solid propellants of this nature and a process for the production are disclosed and claimed in copending applications Serial No. 284,447 filed April 25, 1952, now Patent No. 3,003,861 and Serial No. 561,943 filed January 27, 1956, by W. B. Reynolds and J. E. Pritchard. This invention particularly concerns these solid propellants, although it is not necessarily limited thereto.

The aforementioned solid propellants are inherently difficult to ignite, especially where the solid oxidant employed is ammonium nitrate. Ammonium nitrate-binder propellants generally have a relatively high auto-ignition temperature (e.g. 600° F.). These propellants are highly susceptible to changes in pressure and a pressure of about 200 p.s.i. is usually necessary to sustain their combustion. The specific heats of these propellants are often high but their heat transfer coefficients are relatively low. Thus, in order to maintain steady ignition and combustion of these propellants, it is necessary to provide sufficient heat to maintain a hot zone (e.g. approximately ⅛" thick) below the burning surface.

Many of the powdered igniter charges, loaded in frangible plastic cups, bags, etc., heretofore employed for initiating the combustion of these propellants have been found wanting in certain respects. These igniter charges are often characterized by an explosive-type ignition and the shock or brisance thus produced often causes disintegration of the solid propellant. The ignition products produced are often scattered at random in the combustion chamber of the rocket motor and as a result all points of the burning surface of the propellant are not simultaneously and instantaneously ignited. Furthermore, since certain regions or portions of the propellant burning surface may be relatively remotely located in respect to the igniter, especially where complex grain geometries are utilized, these remote regions are very difficult to ignite at the same time other portions of the burning surface closer to the igniter are ignited, the remotely

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located portions of the burning surface being relatively inaccessible. As a consequence, many of these igniter charges will result in a relatively long ignition lag or delay and when severe may cause hangfires and/or misfires.

Accordingly an object of this invention is to improve the ignition of solid propellants. Another object is to provide novel ignition means for igniting solid propellants. Another object is to provide solid propellant rocket motors having novel ignition means associated therewith. Another object is to insure the simultaneous and uniform ignition of solid propellants and prevent the occurrence of hangfires and misfires. A further object is to provide ignition means characterized by its reliability, safety, and reproducibility. Other objects and advantages of this invention may become apparent to those skilled in the art from the following discussion, appended claims and drawing in which:

FIGURE 1 is a side elevational view, in partial section, of a rocket motor of the Jato type loaded with a grain of solid propellant and provided with novel ignition means;

FIGURE 2 is an enlarged side elevational view, in partial section, of the igniter illustrated in FIGURE 1;

FIGURE 3 is a view similar to FIGURE 2 illustrating a further embodiment of the novel igniter of this invention; and

FIGURES 4 and 5 are similar views illustrating a still further embodiment of the novel igniter of this invention.

Referring now to the drawing, in which like parts have been designated with like reference numbers, and initially to FIGURE 1, a rocket motor generally designated 10 is illustrated. Rocket motor 10 is in its simplest form a gas generator, or a jet propulsion device such as that employed to assist the take-off of aircraft and normally known as a Jato. Rocket motor 10 has a cylindrical casing 11, made of metal, plastic, or the like, having a reduced aft portion 12 that is provided with an axial opening into which a reaction nozzle generally designated 13 is threaded or otherwise secured. Nozzle 13 is of the DeLaval type and has internal restrictions so as to define a converging-diverging passage 14 through which combustion gases escape at high velocity. A blowout diaphragm or starter disc 16, which covers the inlet of passage 14, is designed so as to be ruptured or otherwise displaced and ejected through the nozzle passage when the pressure within combustion chamber 17 reaches a predetermined value, e.g., between 200 and 500 p.s.i. The reduced casing portion 12 can also be provided with one or more safety plug attachments 18 which is adapted to function at a predetermined chamber pressure so as to release excessive pressure from the combustion chamber 17, in a manner well known to those skilled in the art.

The head end of casing 11 can be in the form of an enlarged annular portion 19 and to this end is secured a closure member 21. A grain retaining assembly 22 is provided in the head end of the rocket motor and it can be secured to casing portion 19 by any convenient means, such as key means 23 and sealing ring 24. Closure member 21 and grain retaining assembly 22 can be provided with a common axial opening into which is threaded or otherwise secured a novel igniter generally designated 25.

A grain of solid propellant generally designated 27 is loaded within the combustion chamber 17. The specific grain illustrated in the drawing is cylindrical in shape and has an outer diameter somewhat smaller than the inner diameter of casing 11. Grain 27 is of the internal-external burning type by reason of an outer burning surface 28, and an inner burning surface 29 which nornally defines an axial perforation 30. The ends of grain 27 can be restricted by means of layers of restricting material 31, made of rubber or the like, which have axial openings in alignment with perforation 30. Grain retaining plates 32 and 33, having similar axial openings can cover the outside of the restricting material 31. Secured to the head retaining plate 32 can be a plurality of outer-extending prongs or legs 34 which are adapted to register with and are held in place by grain retaining assembly 22. The aft retaining plate 33 can have secured to its outer surface a plurality of spring means 35 which are adapted to come into contact and register with the inner wall of reduced casing portion 12. A plurality of resilient retaining pads 36, e.g. strips of sponge rubber or the like, can be positioned between the head portion of grain 27 and the adjacent portion of casing 11. It should be understood that although the specific grain retaining and supporting means shown in the drawings and described above are preferred, the invention is not limited thereto and the grain can be supported and retained by any other suitable means.

Both the outer burning surface 28 and inner burning surface 29 of grain 27 are coated with a novel, relatively thin layer 37 of finely divided or powdered pyrophoric metal.

It is to be understood that the utility of the improved ignition means (igniter 25 and pyrophoric metal layers 37) of this invention is not limited to the particular propellant grain 27 illustrated in FIGURE 1. It is within the scope of this invention to ignite any type of solid propellant charge, such as the external-burning type, the internal-burning type, the end-burning type, etc., the burning surfaces of which are completely or substantially coated with a layer of the aforementioned pyrophoric metal. Moreover, a rocket motor can be loaded with a plurality of propellant grains of these types and a plurality of igniters like 25 of FIGURE 1 can be utilized and positioned anywhere in the rocket motor in proximity to the burning surface of the propellant charge.

Referring now to FIGURE 2 of the drawing, together with FIGURE 1, there is illustrated in greater detail the igniter 25 of FIGURE 1. Igniter 25 is provided with an annular plug 41, a peripheral portion of which is provided with threads 42 adapted to mesh with similar threads in the grain retaining assembly 22 of FIGURE 1. An O-ring 43, or similar sealing means, is affixed to igniter plug 41 so as to furnish a gas-tight seal for the head end of the rocket motor 10. Igniter plug 41 has a central wall 44 to which is secured an integral or separable cylindrical, frangible pressure container 45 which together with wall 44 defines gas chamber 46. The cylindrical wall of pressure container 45 is provided with one or more flangible portions 47 adapted to rupture or otherwise fail when the pressure within chamber 46 reaches a predetermined pressure and thereby release a gas to the combustion chamber 17, said gas being spontaneously reactive with said pyrophoric metal 37.

A cylindrical cup or container 48 is suitably secured to the other side of igniter plug 41, for example by threads 49. A high pressure gas container 51 is disposed within cup 48 and is provided at its inner face with an inlet 52 to which is connected a flexible conduit 53. Conduit 53 is provided with a suitable valve 54 adjacent inlet 52 and another valve 55, such as a solenoid operated valve having electrical actuating wires 59 attached thereto. The latter pass through a passage 61 in igniter plug 41 and are adapted to be operatively connected to an external power source, such as a battery. The other end of conduit 53 is detachably connected to a conduit 56 having a valve 57 therein which is operatively connected to a passage 58 in wall 44.

During storage of rocket motor 10, a suitable closure member or dust seal (not shown) can be fitted in the threaded axial opening of grain retaining assembly 22 in place of igniter 25. When it is desired to arm the rocket motor 10 with the igniter 25, the dust seal can be removed and the igniter 25 substituted therefor. Prior to the insertion of igniter 25, the latter may be assembled as follows. With the cup 48 and valve conduit means 53 detached from igniter plug 41, a spontaneously reactive gas, such as fluorine, is injected into chamber 46 of pressure container 45 via conduit 56, valve 57 and passage 58. After injecting the spontaneously reactive gas into chamber 46 under sufficiently high pressure, valve 57 is closed and the lower end of valve conduit means 53 connected to conduit 56, followed by fastening cup 48 to igniter plug 41, the gas chamber 51 having previously been filled with a suitable pressurized gas by injection through the lower end of conduit means 53 at which time valves 54 and 55 are open. Following the igniter assembly, valves 54 and 57 are open and valve 55 closed. When it is desired to fire the rocket motor 10, solenoid valve 55 is opened by closing a suitable switch in a power source to which electrical wires 59 have been connected. Following the opening of valve 55, the pressurized gas in container 51 is allowed to escape via inlet 52, valve 54, conduit means 53, valve 55, conduit means 56, valve 57 and passage 58 into chamber 46, raising the pressure within the latter and causing flangible wall portions 47 to rupture when a predetermined pressure is reached within chamber 46. The resulting released spontaneously reactive gas then immediately escapes from chamber 46 through the resulting openings in container 45 at a high velocity and immediately fills combustion chamber 17. The released spontaneously reactive gas reacts with the layers 37 of pyrophoric metal on grain 27, thereby releasing exothermic heat which in turn causes the immediate, simultaneous, and uniform ignition of the outer burning surface 28 and inner burning surface 29 of the rocket grain. Since exothermic heat is released in close proximity to the entire burning surface of the grain, a hot zone below the burning surface is established and this insures complete ignition of the propellant. The resulting burning of the propellant material produces combustion gases which raise the pressure within the combustion chamber 17. When this pressure reaches a predetermined bursting pressure, starter disc 16 ruptures or otherwise fails and the propellant combustion gases are released at a high velocity via passage 14, thereby imparting thrust to the rocket motor 10.

Referring now to FIGURE 3, another embodiment of the igniter means of this invention is illustrated. This igniter generally designated 62 is in some respects similar to igniter 25 of FIGURE 1, with the following exceptions. Igniter wall 44 is provided with an annular flange 63 which is operatively connected by bolts 64 or the like to a peripheral flange portion 66 of a flangible pressure container 67, the latter together with wall 44 defining a chamber 68 which normally contains a spontaneously reactive gas under high pressure. The outer end of pressure container 67 can be rounded as shown and scored or otherwise weakened at 69. When the pressure within chamber 68 is raised to a predetermined bursting pressure, pressure container 67 fails or ruptures at 69, the wall of pressure container 67 then occupying the expanded position illustrated by broken lines 71. The spontaneously reactive gas is then released and completely fills the combustion chamber 17 of the rocket motor 10 of FIGURE 1. In other respects, igniter 62 is similar to the igniter 25 of FIGURE 1.

Referring now to FIGURES 4 and 5, a further embodiment of the igniter of this invention is illustrated. Igniter generally designated 72 is similarly provided with a cup 48 and a flangible pressure container 73, the peripheral edge or lip of which is in the form of a flange 74 and is connected by means of bolts 64 or the like to the end adjacent annular flange 63 of igniter wall 44. Container 73 and wall 44 define a chamber 75 which normally contains spontaneously reactive gas under high pressure. Igniter wall 44 is provided with an axial tubular extension

76 which extends within chamber 75, the extremities of the axial passage in extension 76 being provided with suitable seals 77 made of Teflon or the like. A suitable solenoid operated mechanism generally designated 78 is disposed within cup 48 and it can be supported therein by means of a suitable mount 79 which is fastened to the outer face of igniter wall 44. Suitable electrical wires 81 pass through passage 61 in igniter plug 41 and are operatively connected to solenoid mechanism 78. A suitable rod 82, preferably made of nonmagnetic material, passes through extension 76 and igniter wall 44, one end of the rod being operatively connected to an extension 80 of magnetic material which protrudes from mechanism 78 and is operatively actuated by the solenoid mechanism. The other end of rod 82 extends within chamber 75 and a suitable piercing means generally designated 83 is fastened to this end of the rod. As shown in detail in FIGURE 5, piercing means 83 comprises a disc 84 which can have a plurality of openings 86 therein. A plurality of curved wall members 87 are fastened to the outer face of disc 84 between the openings 86; the edges of walls 87 are in the form of cutting edges and can form a sharp point 88 at the outer extremity of their junction.

In operation, with igniter 72 fixed in position in rocket motor 10 of FIGURE 1, when it is desired to fire the rocket motor, a suitable switch in an external power source is closed and solenoid mechanism 78 energized. As a result, rod extension 80 is pulled within solenoid mechanism and rod 82 is pushed further into gas chamber 75 and the cutting edges of walls 87 pierce or cut the adjacent portions of frangible pressure container 73, the piercing means 83 then occupying the position shown by broken lines 89 and the adjacent portions of container 73 occupying the position shown by broken lines 90. The spontaneously reactive gas in container 73 is thus released and immediately completely fills the combustion chamber 17 of the rocket motor 10, the subsequent ignition and combustion of the propellant charge then taking place as described above.

It should be evident to those skilled in the art that various modifications and alternations of the ignited devices of this invention can be used to obtain the same results, and this invention is not limited to the specific igniter devices shown in the drawing and described hereinbefore. For example, the spontaneously reactive gas can be contained in other types of frangible containers such as vials or the like, and other means employed to release the pyrophoric gas from these other containers.

The finely divided or powdered pyrophoric metal coating the burning surface of the propellant charges of this invention include any of the metals which will spontaneously ignite with the reactive atmosphere produced in the rocket motor combustion chamber and generate sufficient exothermic heat to ignite the underlying burning surface of the propellant charge. Metals useful in the practice of this invention representatively include iron, zinc, cobalt, nickel, aluminum, magnesium, tin, tungsten, thallium, beryllium, cadmium, lead, tantalum, molybdenum, copper, cesium, chromium, columbium, electrolytic uranium, sodium, potassium, rubidium, strontium, barium, lithium and the like. These metals are applied in their finely divided form and generally have a colloidal size in the range between about 0.001μ and 1μ (μ is defined on page 2377, Handbook of Chemistry and Physics, 30th ed. (1946), Chemical Rubber Publishing Company). These powdered metals can be applied by any suitable means, such as rolling, etc., the uncured, somewhat tacky propellant grain in the powdered metal, and thereafter curing the coated grain, spraying the powdered metal on to the surface of the propellant, and like methods. The coating material will be applied in a relatively thin layer such that the exothermic heat of combustion of the coating material will be sufficient to raise the propellant burning surface to its auto-ignition temperature, preferably in an amount such that a hot zone of about 1/8" will

be established below the burning surface of the propellant.

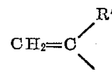
The spontaneously reactive gas preferred in the practice of this invention is fluorine. Because this gas is very reactive with most metals, the igniter components in contact with this gas, such as containers 45, 67, and 73, should be made of Monel or nickel, or the like and any packing or sealing material should be made of Teflon, or the like. This spontaneously reactive gas is kept under sufficiently high pressure in the ignited device, for example between 30 and 400 p.s.i. It is desirable to evacuate the combustion chamber of the rocket motor prior to ignition (e.g. to 0.5 p.s.i. or less), and in some cases the combustion chamber can be filled with an inert gas such as nitrogen. Where a pressurizing gas is used to raise the pressure of the spontaneously reactive gas container to its bursting point, any gas non-reactive with the spontaneously reactive gas can be utilized, such as high pressurized air or nitrogen. The amount of spontaneously reactive gas employed will depend upon the pressure desired within the rocket motor at the time the powdered pyrophoric metal is ignited, and to a lesser degree on the amount of pyrophoric metal used in the coating layers.

The solid propellants which can be ignited with the novel ignition means of this invention include any of those being fabricated, e.g., dual or composite base, mono-base, etc. The composite base propellants disclosed and claimed in said copending applications Serial No. 284,447, now Patent No. 3,003,861, and Serial No. 561,943 by W. B. Reynolds et al. will be readily ignited according to this invention and therefore are preferred. These preferred composite propellants are of the rubbery copolymer-oxidant type which is plasticized and worked into an extrudable mass at 130° to 175° F. The copolymer can be reinforced with suitable reinforcing agents such as carbon black, silica, and the like. Suitable oxidation inhibitors, wetting agents, modifiers, vulcanizing agents, and accelerators can be added to aid processing and to provide for the curing of the extruded grains of propellant at temperatures preferably in the range of 170° to 185° F. In addition, the propellant composition comprises a burning rate catalyst.

Oxidants which are applicable in the solid rocket fuel compositions of this invention include ammonium, alkali metal, and alkaline earth metal salts of nitric, perchloric, and chloric acids, and mixtures thereof. Ammonium nitrate and ammonium perchlorate are the preferred oxidants for use in the solid rocket fuels of this invention. Specific oxidants include sodium nitrate, potassium perchlorate, lithium chlorate, calcium nitrate, barium perchlorate, and strontium chlorate. Mixtures of oxidants are also applicable. In the preparation of the solid rocket fuel compositions, the oxidants are powdered to sizes preferably 10 to 300 microns average particle size. The amount of solid oxidant employed is usually a major amount of the total composition and is generally in the range between 50 and 90 percent by weight of the total mixture of oxidant and binder. If desired, however, less than 50 percent by weight of the oxidant can be used.

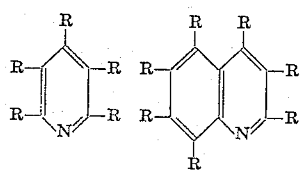
The copolymers preferably used as a binder are formed by copolymerization of a vinyl heterocyclic nitrogen compound with an open chain conjugated diene. The conjugated dienes employed are those containing from 4 to 6 carbon atoms per molecule and include 1,3-butadiene, isoprene, 2-methyl-1,3-butadiene, and the like. Various alkoxy, such as methoxy and ethoxy, and cyano derivatives of these conjugated dienes, are also applicable. Thus, other dienes, such as phenylbutadiene, 2,3-dimethyl-1,3-hexadiene, 2-methoxy-3-ethylbutadiene, 2-ethoxy-3-ethyl-1,3-hexadiene, 2-cyano-1,3-butadiene, are also applicable in the preparation of the polymeric binders of this invention. Instead of using a single conjugated diene, a mixture of conjugated dienes can be employed. Thus, a mixture of 1,3-butadiene and isoprene can be employed as the conjugated diene portion of the monomer system.

The polymerizable heterocyclic nitrogen bases which are applicable for the production of the polymeric materials are those of the pyridine, quinoline, and isoquinoline series which are copolymerizable with a conjugated diene and contain one, and only one,

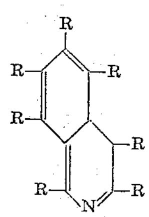


substituent wherein R′ is either hydrogen or a methyl group. This is, the substituent is either a vinyl or an alphamethylvinyl (isopropenyl) group. Of these, the compounds of the pyridine series are of the greatest interest commercially at present. Various substituted derivatives are also applicable but the total number of carbon atoms in the groups attached to the carbon atoms of the heterocyclic nucleus should not be greater than 15 because the polymerization rate decreases somewhat with increasing size of the alkyl group. Compounds where the alkyl substituents are methyl and/or ethyl are available commercially.

These heterocyclic nitrogen bases have the formula



or



where R is selected from the group consisting of hydrogen, alkyl, vinyl, alphamethylvinyl, alkoxy, halo, hydroxy, cyano, aryloxy, aryl, and combinations of these groups such as haloalkyl, alkylaryl, hydroxyaryl, and the like; one and only one of said groups being selected from the group consisting of vinyl and alpha-methylvinyl; and the total number of carbon atoms in the nuclear substituted groups being not greater than 15.

The vinyl heterocyclic nitrogen compound generally preferred is a monovinylpyridine or alkyl-substituted monovinylpyridine such as 2-vinylpyridine, 3-vinylpyridine, 4-vinylpyridine, 2-methyl-5-vinylpyridine, 2-ethyl-5-vinylpyridine, 2,4-dimethyl-6-vinylpyridine, and the like.

In the preparation of the copolymers, the amount of conjugated diene employed can be in the range between 75 and 95 parts by weight per 100 parts monomers and the vinyl heterocyclic nitrogen can be in the range between 25 and 5 parts. Terpolymers are applicable as well as copolymers and in the preparation of the former up to 50 weight percent of the conjugated diene can be replaced with another polymerizable compound such as styrene, acrylonitrile, and the like. The preferred, readily available binder employed is a copolymer prepared from 90 parts by weight of butadiene and 10 parts by weight of 2 - methyl - 5 - vinylpyridine, hereinafter abbreviated Bd/MVP. This copolymer is polymerized to a Mooney (ML–4) plasticity value in the range of 10–40, preferably in the range of 15 to 25, and may be masterbatched with 5–20 parts of Philblack A, a furnace black, per 100 parts of rubber.

The following empirical formulation or recipe generally represents the class of propellant compositions preferred for the preparation of the grains of propellant of this invention:

Table

Ingredient	Parts per 100 parts of rubber	Parts by weight
Binder	----------	5–25
Copolymer (Bd/MVP)	100	----------
Philblack A (a furnace black)	10–30	----------
Plasticizer	10–30	----------
Silica	0–20	----------
Metal Oxide	0–5	----------
Antioxidant	0–5	----------
Wetting agent	0–2	----------
Accelerator	0–2	----------
Sulfur	0–2	----------
Oxidant (Ammonium nitrate)	----------	75–95
Burning rate catalyst	----------	0–30

Suitable plasticizers useful in preparing these grains of propellant include TP–90–B; benzophenone; and Pentaryl A (monoamylbiphenyl). Suitable silica preparations include a 10–20 micron size range supplied by Davison Chem. Co.; and Hi-Sil 202, a rubber grade material supplied by Columbia-Southern Chem. Corp. A suitable anti-oxidant is Flexamine, a physical mixture containing 25 percent of a complex diarylamineketone reaction product and 35 percent of N,N′-diphenyl-p-phenylenediamine. A suitable wetting agent is Aerosol-OT (dioctyl sodium sulfosuccinate). Satisfactory rubber cure accelerators include Philcure 113; Butyl-8; and GMF. Suitable metal oxides include zinc oxide, magnesium oxide, iron oxide, chromium oxide, or combination of these metal oxides. Suitable burning rate catalysts include ferrocyanides sold under various trade names such as Prussian blue, steel blue, bronze blue, Milori blue, Turnbull's blue, chinese blue, new blue, Antwerp blue, mineral blue, Paris blue, Berlin blue, Erlanger blue, foxglove blue, Hamberg blue, laundry blue, washing blue, Williamson blue, and the like. Other burning rate catalysts such as ammonium dichromate, potassium dichromate, sodium dichromate, ammonium molybdate, and the like, can also be used.

The layer of restricting material can be made from any of the slow burning materials used for this purpose in the art, such as cellulose acetate, ethylcellulose, butadiene-methylvinylpyridine copolymer, GR–S, natural rubber, and the like.

Various modifications and alterations of this invention will become apparent to those skilled in the art without departing from the scope and spirit of this invention and it is to be understood that the foregoing discussion and drawing merely represent preferred embodiments of this invention and do not unduly limit the same.

I claim:

1. In a gas generator having a casing defining a combustion chamber, a solid propellant charge loaded in said chamber and having a burning surface, a relatively thin layer of finely divided pyrophoric metal subsantially covering said burning surface, confining means within said chamber adapted to confine a gas spontaneously reactive with said pyrophoric metal, and releasable means adapted to release said gas from said confining means to said chamber.

2. In a rocket motor having a cylindrical casing defining a combustion chamber and provided with a reaction nozzle at one end thereof, a solid propellant charge loaded in said chamber and having a burning surface, said charge comprising a major amount of a solid inorganic oxidant and a minor amount of a binder, a relatively thin layer of finely divided pyrophoric metal substantially covering said burning surface, a frangible container disposed within said chamber in proximity to said burning surface and adapted to normally confine a gas under pressure, said gas being spontaneously and exothermically reactive with said pyrophoric metal, and means to rupture said frangible container so as to release said gas in said chamber.

3. The rocket motor according to claim 2 wherein said gas is fluorine.

4. The rocket motor according to claim 2 wherein said pyrophoric metal has a size in the range between about 0.001μ and 1μ.

5. The rocket motor according to claim 2 wherein said inorganic oxidant is selected from the groups consisting of the ammonium, alkali metal, and alkaline earth metal salts of an acid selected from the group consisting of nitric, chloric, and perchloric acids, and said binder is a rubber copolymer of a conjugated diene and vinyl-substituted heterocyclic nitrogen base compound.

6. A method of operating a gas generator having a combustion chamber loaded with a solid propellant charge, said charge having a burning surface substantially coated with a layer of finely divided pyrophoric metal, the steps of releasing a gas in said chamber, said gas being spontaneously and exothermically reactive with said pyrophoric metal, thereby causing the ignition of said burning surface and the consequent combustion of said propellant charge, and releasing the resulting combustion gases from said combustion chamber.

7 The method according to claim 6 wherein said gas is fluorine.

8. The method according to claim 6 wherein said pyrophoric metal has a size in the range of 0.001μ and 1μ.

9. The method according to claim 6, said charge comprising a major amount of a solid inorganic oxidant and a minor amount of a binder, wherein said inorganic oxidant is selected from the group consisting of the ammonium, alkali metal, and alkaline earth metal salts of an acid selected from the group consisting of nitric, chloric, and perchloric acids, and said binder is a rubber copolymer of a conjugated diene and vinyl-substituted heterocyclic nitrogen base compound.

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