

- [54] MULTI-USE MUNITION
- [75] Inventors: William O. Munson; Russell Reed, Jr., both of Brigham City, Utah
- [73] Assignee: Thiokol Chemical Corporation, Bristol, Pa.
- [22] Filed: Jan. 16, 1969
- [21] Appl. No.: 793,922

- [52] U.S. Cl. .... 102/66, 102/56, 149/38
- [51] Int. Cl. ... F42b 13/14, F42b 13/12, C06b 15/00
- [58] Field of Search ..... 102/66, 56, 90, 6, 7.2

[56] **References Cited**

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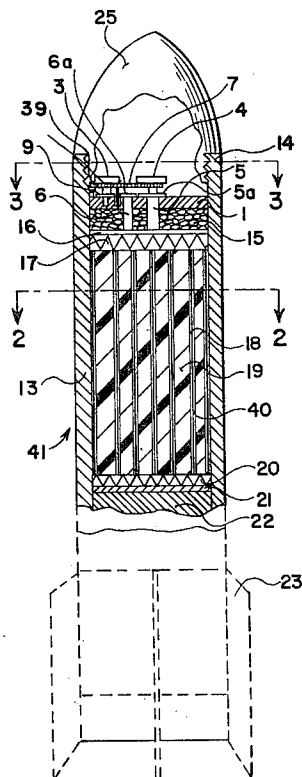
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[57] **ABSTRACT**

A munition in the form of a bomb, rocket or mortar shell casing which is loaded with a munition loading comprising a multiplicity of tubes containing a cured elastomeric high explosive-incendiary composition which will explode when detonated or burn without exploding when ignited and which has detonator and booster means for detonating the composition, thereby causing the munition to explode as a fragmentation weapon, and igniter and pyrogen means for igniting the composition at one end of the tubes, and which further has gas generating means for ejecting the ignited composition and tubes outwardly from the casing, thereby causing the munition to function as an incendiary weapon.

18 Claims, 10 Drawing Figures



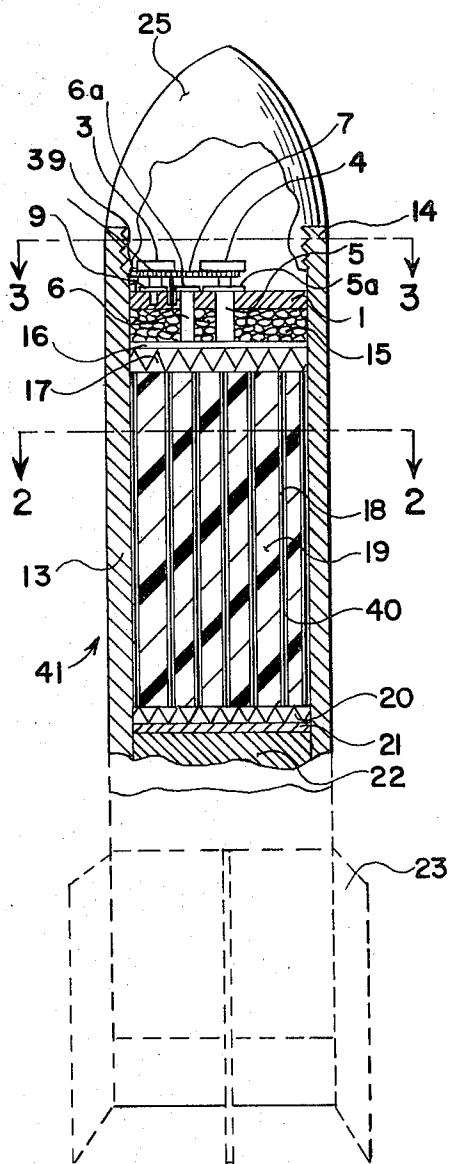


Fig. 1

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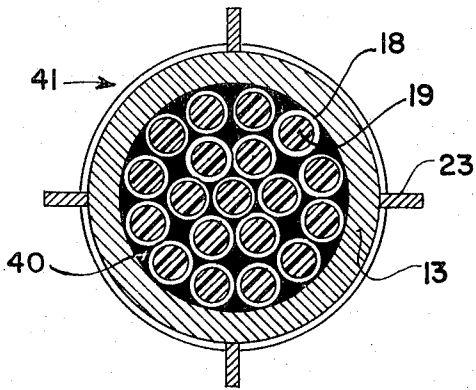


Fig. 2

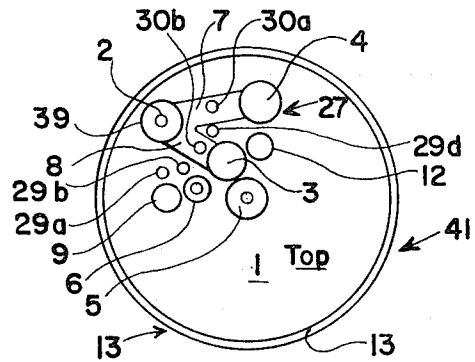


Fig. 3

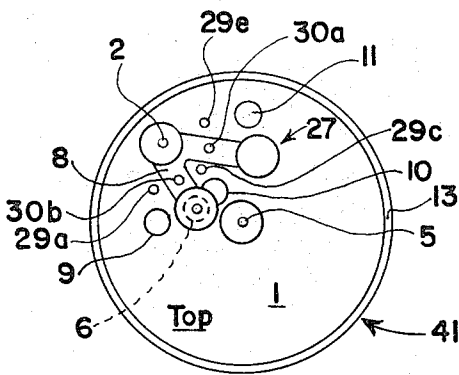


Fig. 4

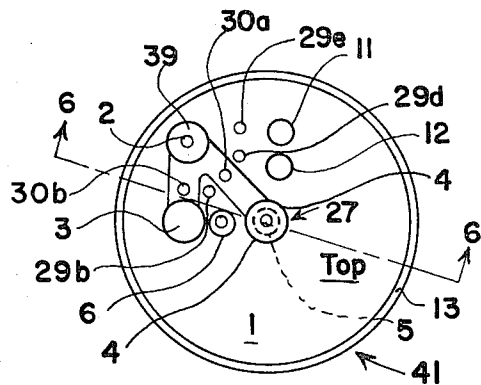


Fig. 5

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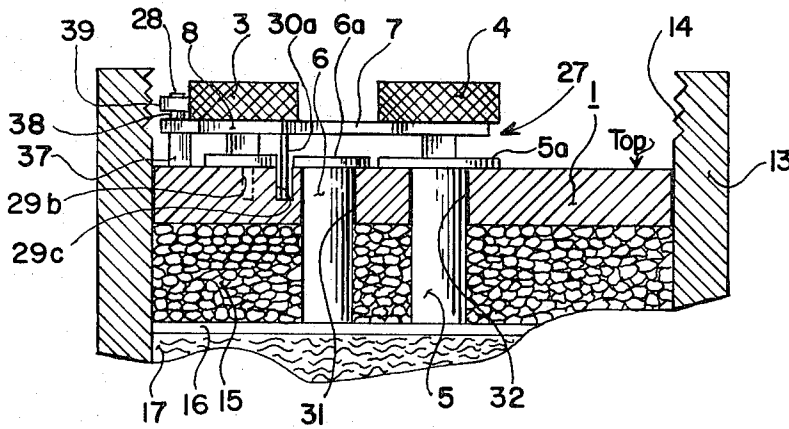


Fig. 6

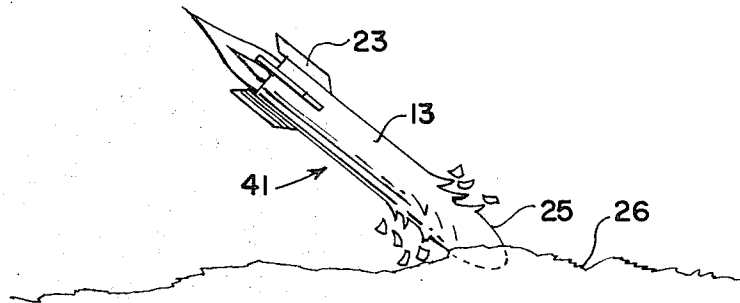


Fig. 7

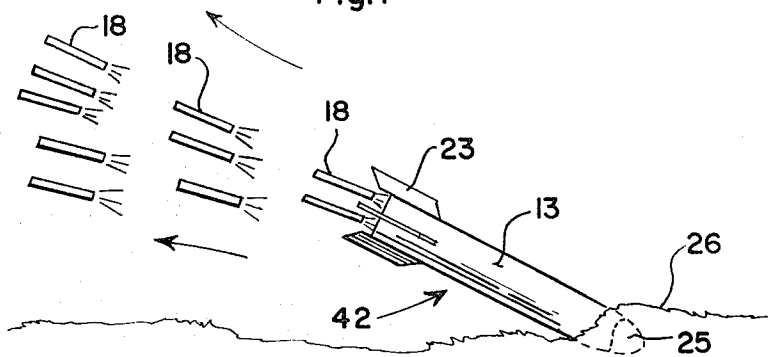


Fig. 8

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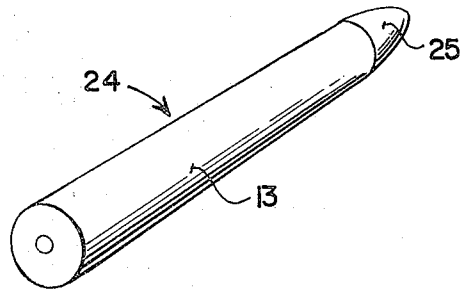


Fig. 9

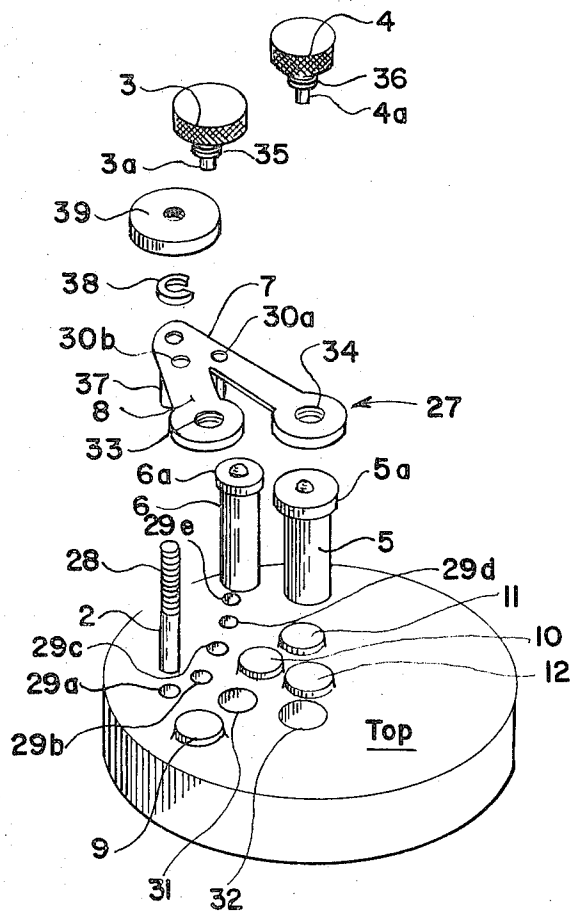


Fig. 10

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## MULTI-USE MUNITION

## BACKGROUND OF THE INVENTION

## 1. Field of the Invention.

The invention relates to munitions for military applications in which either explosive force, fragmentation or incendiary activity is required, and where the munition is to be delivered to its target by various known means, e.g. air drops, rocket propulsion or mortar firing.

## 2. Description of the Prior Art.

Munitions for military applications generally are specific as to their functions, i.e. as explosive devices or as incendiary devices. Also, it is known that the effect of the munition may be a joint effect, although primarily one or the other. Thus, the burst of a high explosive bomb, projectile or shell may be accomplished by flash which may incidentally have some incendiary effect. Likewise, the ignition of an incendiary munition may be accompanied by some blast force as well as dispersal of the incendiary material. However, heretofore, it has not been known to provide a munition with a munition loading which can selectively be fired to provide predominantly and specifically either one or the other effect with the same munition means and munition loading.

## SUMMARY OF THE INVENTION

The present invention comprises a munition which essentially will detonate when initiated by a detonator and also essentially will burn with incendiary heat generation but without exploding when ignited.

The invention further comprises a munition loading comprising an elastomeric high explosive-incendiary composition which contains at least one high explosive material homogeneously mixed with a metal fuel powder and particulate inorganic oxidizer for the fuel in a fluid, curable polymer binder material which is then cured. In practicing the invention, the uncured composition essentially is deposited in a multiplicity of elongated tubes or pipe-like containers having inner diameters of from about one-fourth to five-eighths inches. The composition is then cured in the tubes. The tube containing the cured high explosive-incendiary composition is hereinafter referred to as a strand. The tubes preferably are made of a fuel metal. Each tube has a relatively thin wall thickness, which, however, is sufficient to contain the elastomeric composition without rupturing the container. The strands are disposed within the casing with their long axes parallel to the long axis of the casing, and, when intended for incendiary use, are ejected therefrom through one end of the munition casing.

The invention still further comprises a substantially cylindrical, and elongated munition casing of the fragmentation or high explosive loading type containing a multiplicity of the strands positioned in the casing with their sides parallel to the casing wall between a frangible closure means located at one end, preferably the aft end, of the casing, and a propellant gas generating composition and pyrogen therefor, a booster, and igniter and detonator means located at the other end of the casing, preferably the forward end.

The invention also comprises means for selectively positioning and locking the igniter and detonator means in safe position or in either of two armed firing positions in alignment with either the pyrogen or the booster, respectively.

The strand-containing casing can be extended in length beyond the frangible closure means to provide space for holding a rocket propellant composition of a known type for propelling the munition and for means for projecting the munition as a rocket or as a mortar shell. The munition can also be fitted with bomb fins and be used as an air dropped bomb. In any of the various embodiments, the igniter and detonator means may each be activated individually by separate fuses. The fuses can be proximity fuses, electrically-initiated fuses, impact fuses, or other military type fuses, which are well-known.

The invention provides a munition which can be used either as an explosive munition, e.g. a fragmentation bomb or projectile, or as an incendiary bomb or projectile. The novel munition thus reduces the need for supplying and transporting both categories of munitions to frontline positions, particularly for guerrilla types of military engagements. The munition can be readily armed in the field for use specifically in one category, e.g. as an incendiary, or for use specifically in the other category, e.g. as an explosive weapon; also, a mixture of the two types of armed munitions may be dispersed to obtain combined incendiary and fragmentation effects.

## BRIEF DESCRIPTION OF THE DRAWING

Further objects and advantages of the invention will be apparent to those skilled in the art from the following description and the drawing. In the drawing,

FIG. 1 is a side elevational view of the munition showing in partial section the munition loading and a combination detonation and ignition means of the invention, and illustrates the munition provided with rocket propellant delivery means;

FIG. 2 is an enlarged cross-sectional view of the munition taken along the lines 2—2 of FIG. 1 and shows the disposition of strands in the casing;

FIG. 3 is an enlarged top view of the ignition means of the munition taken along the lines 3—3 of FIG. 1 and shows the arming means in safe position;

FIG. 4 is a view as in FIG. 3 in which the arming means is shown set in a position for igniting the munition as an incendiary device;

FIG. 5 is a view as in FIG. 3 in which the arming means is shown set in a position for detonating the munition as an explosive device;

FIG. 6 is an enlarged fragmentary side elevational view taken along the lines 6—6 of FIG. 5 and illustrates the arrangement of various elements of the ignition means;

FIG. 7 is an illustration of a rocket form of the munition bursting after impact and detonation;

FIG. 8 is an illustration of an aerial bomb form of the munition ejecting ignited incendiary strands after impact and ignition;

FIG. 9 is an illustration of a mortar shell form of the munition; and

FIG. 10 is an exploded view of the elements of the selective detonation and ignition system of the munition.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawing, and in particular to FIG. 1, there is illustrated the multi-use munition of this invention in the form of a rocket motor propelled munition. The munition 41 comprises a cylindrical, frag-

mentable metal casing 13 which includes an aft portion in the form of a rocket motor casing to which is attached a tail fin 23. The casing 13 is separated internally from rocket propellant 22 by heat insulating wadding 21 and a closure means, preferably in the form of a frangible plug, 20. The casing 13 is packed with a multiplicity of thin-walled magnesium metal tubes 18 which extend from the frangible plug 20 to the upper end of the casing 13, where the components of a selective detonation and ignition system are located. The system is detailed in FIGS. 6 and 10. Each tube 18 contains cured elastomeric high explosive-incendiary composition 19 which will be more fully described below. To eliminate voids and to enhance the effectiveness of the munition, the spaces existing between adjacent tubes 18, and between the tubes and inner wall of the casing when the tubes are packed into the casing 13, are filled with a putty-like desensitized RDX (cyclotrimethylenetrinitramine) or other ignitable explosive composition 40. The tubes 18 are preferably all of substantially the same lengths. However, some variations in lengths may exist without adversely affecting the performance of the munition. The upper ends of the tubes 18 are covered with a suitably thick layer of first fire igniter composition 17 which extends from wall to wall of the casing 13. The igniter composition 17 is of a known type suitable for igniting an elastomeric composite rocket propellant composition, e.g. a 1:1.5 mixture of finely powdered metallic titanium and granular KC10<sub>4</sub>, as taught in U.S. Pat. No. 2,929,697. The composition 17 serves to ignite the high explosive-incendiary composition 19 when the munition is used as an incendiary munition. A separator pad 16, made of a combustible material, preferably a resilient material such as a foamed polyesterurethane containing an admixed inorganic oxidizer, e.g. ammonium perchlorate, is located in the casing 13 in contact with the walls thereof and in contact with the igniter composition 17. The pad 16 serves as a separator between the composition 17 and a catalyzed gas generating composition 15, which is retained within the casing 13 between the pad 16 and a casing closure plug 1. The composition 15 preferably is a granular form of a fast-burning composition, e.g. a mixture of ammonium perchlorate, aluminum powder and a polybutadiene binder catalyzed with a burning rate catalyst. Burning rate catalysts are well-known, and any such may be used. A typical advantageous catalyst system is one comprising essentially ammonium dichromate, powdered copper metal and a salt of a trinitrophenolic compound, e.g. sodium styphnate (disodium salt of 2,4,6-trinitroresorcinol), as described, for example, in U.S. Pat. No. 2,969,638. The composition 15 serves to generate gas for ejecting tubes 18 from the casing 13 upon impact of the munition, when it is armed to function as an incendiary, on a target and ignition of a pyrogen 6 by an impact fuse in assembly 3 for an incendiary action. The composition 15 also serves to ignite separator pad 16, which then ignites the first fire igniter composition 17, which in turn ignites the high explosive-incendiary composition 19 at the adjacent open ends of tubes 18 while the tubes 18 are being ejected and dispersed from the casing 13, substantially as illustrated in FIG. 8.

The closure plug 1 is shown in enlarged cross-sectional view in FIG. 6 and in the exploded view in FIG. 10. The plug 1 is disposed within the inner walls of the casing 13 in gas-tight relationship, as by a press-

fit. The plug 1 may be made of any suitable material. Preferably the plug 1 is made of a thermosetting resin, e.g. a phenolformaldehyde resin. The plug 1 may also be made of metal of the same type as that used in casing 13. Plug 1 retains a pyrogen 6, e.g. a polyester bound boron-potassium nitrate composition, for igniting the composition 15. Plug 1 also retains a booster 5, e.g. a blasting cap, for detonating the high explosive-incendiary composition 19 when the munition is used as an high explosive munition, e.g. a fragmentation bomb, substantially as illustrated in FIG. 7. Plug 1 further retains a selective arming switch 27 having a long arm and a short arm which together form a V and which is mounted by a sleeve bearing 37, located at the juncture of said arms to rotate on a pivot pin 2 attached to plug 1, for example, by embedment of the pin 2 in the body of the plug 1. Pivot pin 2 is provided at its free end with threads 28 for holding a lock washer 38 and a lock nut 39 which together serve to retain the switch 27 in a locked position on the pivot pin 2. Closure plug 1 also retains a pyrogen 6, preferably in the form of a squib-initiated heat generating composition, which may be of the same formulation as the igniter composition 17. The pyrogen 6 is obtained in the form of an elongated shell loaded with pyrogen composition and is press-fitted into a pyrogen retainer opening 31 which extends through the plug 1 from the top to the bottom thereof. Pyrogen 6 is obtained in a length sufficient to permit the pyrogen to extend from the bottom of plug 1 through the catalyzed gas generating composition 15, and to contact separator pad 16 when the shoulder 6a of pyrogen 6 seats against the top of plug 1.

Closure plug 1 is provided also with a booster retainer opening 32 which also extends through the plug from the top to the bottom thereof for retaining the booster 5. The booster is obtained to have substantially the same length as pyrogen 6 and also extends through composition 15 and about to separator pad 16 and seats with its shoulder 5a against the top of plug 1. The booster 5 is press-fitted into the opening 32.

Closure plug 1 is further provided with five pin sockets, lettered 29a to 29e for ease of description, which serve to receive a pair of safety lock pins 30a and 30b, which are riveted by their upper ends to long arm 7 and short arm 8 of the arming switch 27. The pins 30a and 30b each have a length and diameter which are sufficient to permit the pins to fit snugly into pin sockets 29a to e, which extend from the top of plug 1 to about half of its thickness.

Closure plug 1 also is provided with a pair of elevated closure pads 9 and 10 positioned one on either side of the pyrogen retainer opening 31 on an arc described by a squib and impact fuse assembly 3 screwed by its threads 35 into matching threads in a retainer opening 33 in short arm 8 of the selective arming switch assembly 27 when the assembly is positioned on pin 2. The closure plug 1 is further also provided with a similar pair of elevated closure pads 11 and 12 both of which are positioned counterclockwise from booster retainer opening 32 on an arc described by a detonator and impact fuse assembly 4 screwed by its threads 36 into matching threads in a retainer opening 34 in long arm 7 of switch assembly 27 when the assembly is positioned on pin 2. The pads 9 and 10 and 11 and 12 preferably are molded integrally with plug 1. The elevations of the pads 9 and 10 are of the same heights relative to the top of plug 1 as the height of shoulder 6a. similarly,

the elevations of pads 11 and 12 are of the same heights relative to the top of plug 1 as the height of shoulder 5 a. Preferably, the heights of the shoulders 5a and 6a and of the pads 9, 10, 11, and 12 are all the same. The length of the discharge tube 3a of the squib and impact fuse assembly 3 is designed so that when the assembly 3 is screwed snugly in opening 33 of short arm 8 it will permit the tip of the tube 3a to seat snugly with substantially a gastight fit against one of the top surfaces of pads 9 and 10 or the exposed end surface of pyrogen 6, as selected, when the selective arming switch assembly 27 is mounted by means of sleeve 37 on pin 2 with pins 30a and 39b positioned in a pair of the holes 29a to 29e, as more fully described below, and with the assembly 27 locked in such position by means of lock washer 38 and lock nut 39. Similarly, the lengths of the discharge tube 4a of the detonator and impact fuse assembly 4 are designed so that when the assembly 4 is screwed snugly in opening 34 of long arm 7 it will permit the tip of the tube 4a to seat snugly with substantially a gas-tight fit against one of the top surfaces of pads 11 and 12 or the exposed end of booster 5, as selected, when the selective arming switch assembly 27 is mounted as described above.

The open end of casing 13 extends axially beyond the assembled switching and detonation-ignition means for a distance sufficient to at least enclose the assembled means. The open end of the casing 13 is provided with internal threads 14 into which a nose cone 25 is screwed after the selective arming switch assembly 27 has been positioned and locked in a selected functional position.

The positioning of the selective arming switch assembly 27 in its various possible positions is illustrated in FIGS. 3, 4 and 5. FIG. 3 shows the munition in a safe position for temporary storage and point-of-use shipment, for example, in, or from, a front-lines supply depot. In this safe position, the selective arming switch assembly 27 is positioned with safety lock pins 30b and 30a inserted into pin sockets 29c and 29e, respectively, and the tips of the squib and impact fuse assembly 3 and of the detonator and impact fuse assembly 4 are pressed against elevated closure pads 10 and 11. The lock washer 38 and lock nut 39 are tightened to hold the assemblies locked in this position. The nose cone 25 is then screwed onto the casing 13 to protect the assemblies against the elements and other sources of possible damage.

FIG. 4 shows the munition 41 in the arming position for incendiary use. In this position, switch assembly 27 is positioned with safety lock pins 30b and 30a inserted into pin sockets 29b and 29d, respectively, and the tip of the squib and impact fuse assembly 3 is pressed against the top of pyrogen 6 while the tip of the detonator and impact fuse assembly 4 is pressed against elevated closure pad 12. Lock washer 38 and lock nut 39 hold the assemblies locked in igniting position. The munition 41 now is armed to function as an incendiary weapon. The nose cone 25 is screwed onto casing 13. The munition 41 is now ready for launching as a rocket propelled incendiary as shown in FIG. 1. Upon impact of the nose cone 25 on a target, the impact fuses of the squib and impact fuse assembly 3 and of the detonator and impact fuse assembly 4 are also impacted and discharge to actuate both the squib and detonator. The detonator is detonated, but because of the position of the tip of discharge tube 4a on elevated pad 12, the en-

ergy is dissipated without initiating bursting of the booster 5. The squib discharges and ignites the pyrogen 6 which in turn ignites the catalyzed gas generating composition 15 and the combustible separator pad 16. The combined heat energies of all the combustible materials ignite the first fire composition 17, and as described above, the latter ignites the high explosive-incendiary composition 19 at the adjacent ends of the tubes 18. The gas pressure from the combustibles, particularly from composition 15, causes the frangible closure plug 20 to rupture and ejects the tubes 18, pad 21 and any residual rocket propellant composition 22 out the aft end of the rocket. The strands of burning incendiary materials, i.e., the tubes 18 and the high explosive-incendiary composition 19 contained therein, along with the ignitable explosive composition 40, are dispersed by the force of the ejection and ignite any combustible material with which the materials come in contact.

FIG. 5 shows the munition 41 in the arming position for fragmentation use. The switch assembly 27 is positioned with safety lock pins 30b and 30a inserted into pin rockets 29a and 29c, respectively. The tip of the squib and impact fuse assembly 3 is pressed against the top of elevated closure pad 9. The tip of the detonator and impact fuse assembly 4 is pressed against the top of booster 5. Lock washer 38 and lock nut 39 hold the assemblies locked in detonating position. The munition 41 now is armed to function as a high explosive fragmentation weapon. The nose cone 25 is screwed onto casing 13. The munition 41 is now ready for launching as a rocket propelled fragmentation projectile. Upon impact of the nose cone 25 on a target, the impact fuses of the squib and detonator assemblies are also impacted, actuating both the squib and detonator. However, in this use the detonator actuates the booster 5 which provides the energy necessary for initiating the explosion of the high explosive-incendiary composition 19 in the tubes 18 and of the ignitable explosive composition 40 which is packed between adjacent tubes. The casing 13 fragments in the usual manner of a fragmentation device.

The munition 41 normally will be stored and shipped with the nose cone 25 screwed on, but without the selective arming switch 27 and its associated assemblies 3 and 4 positioned and locked on the top of the closure plug 1. The switch 27 may be kept separate from the squib and impact fuse assembly 3 and the detonator and impact fuse assembly 4, or the individual assemblies may all be assembled into a complete switching, arming and initiating unit which can be quickly positioned on the pin 2 of the closure plug 1. When the switch 27 and the assemblies 3 and 4 are kept separate until the munition 41 is to be prepared for use, it will be advantageous in some cases to assemble only squib and impact fuse assemblies 3 in a portion of the switches 27 to be used on munitions 41 intended for incendiary use and to assemble only detonator and impact fuse assemblies 4 on another portion of the switches 27 to be used on munitions 41 intended for fragmentation use. Each of such units can be positioned and locked into place in an armed position or a safe position in a way which will be understood from the foregoing descriptions. In the field, the nose cone can readily be unscrewed to obtain access to the switch 27 if it is desirable to change the arming from one position to another. The lock nut 39 can then be un-



screwed, the switch raised so that pins 30a and 30b clear the pin sockets 29a to 29e and the switch then reset in the desired new position. The lock nut 39 can then be retightened on pin 2, and the nose cone replaced.

Also, although the invention has been described for an embodiment using a selective arming switch 27 where selective arming is desired, it is to be understood that the invention can also be practiced by designing closure plug 1 with a single opening having threads into which either a squib-fuse-pyrogen assembly system can be screwed to actuate the munition as an incendiary or a detonator-fuse-booster assembly system can be screwed to actuate the munition as a fragmentation device. The other parts and compositions of the munition would, in such embodiments, be substantially the same as described above for use with the switch 27.

The high explosive-incendiary composition 19 used in practice of the invention is a cured elastomeric composition prepared by homogeneously mixing and curing by heating together, a mixture of ingredients comprising on a weight basis from about 10 to 20 percent of a fluid curable polymer binder, from about 5 to 20 percent of fuel metal powder, from about 10 to 30 percent of particulate solid oxidizer, and from about 40 to 55 percent of particulate high explosive. The above ingredients are mixed in the usual way in a propellant blender to form a flowable, curable high explosive-incendiary composition. The curable composition is extruded or drawn into fuel metal tubes, such as the tubes 18 of the drawing, and cured by heating in the tubes.

The polymer of the curable polymer binder may be any fluid polymer used in the propellant arts. A wide variety of suitable fluid polymers are known to the art and such polymers can be mixed with the other ingredients to form the curable mixture. These include for example, polyalkylhydrocarbons, e.g. polyethylene and polybutadiene, particularly carboxyl-terminated polybutadienes; polysulfide rubbers; polyethers; polyesters, particularly hydroxyl-terminated polyesters; polyfluorocarbons; and polyesters. Other suitable fluid polymeric binders will be found among those described in U.S. Pat. No. 3,235,589, 3,257,801, 3,260,208, 3,158,991, and 3,068,129, all incorporated herein by reference.

The solid oxidizers employed in the composition 19 of this invention can be compounds such as metal perchlorates and metal nitrates. The metal perchlorates employed as oxidizing agents or oxygen carriers in the compositions are anhydrous and have the general formula  $M(ClO_4)_x$ , wherein M is  $NH_4$  or a metal and x is the valence of M, and ordinarily has a value of 1 or 2. Since the propellant composition 19 is required to withstand high temperature storage, it is preferable that the melting point and the decomposition temperatures of the oxidizer be as high as possible. The perchlorates of the Group I-A and Group II-A metals are found to have the required high temperature stability and are employed in the preparation of propellant compositions for use in practice of this invention. Hence, the metal perchlorates used in the preparation of the composition 19 include lithium perchlorate, sodium perchlorate, potassium perchlorate, rubidium perchlorate, and cesium perchlorate which are the perchlorates of the metals of Group I-A of the Periodic Table of Elements; and magnesium perchlorate, calcium perchlorate, strontium perchlorate, and barium perchlorate

which are the perchlorates, of the Group-II-A metals. In addition to the metal perchlorates, the compound ammonium perchlorate may also be used in propellant compositions. Examples of the nitrates of the Group I-A, and I-B and II-B which are employed in preparing compositions 19 of this invention are compounds such as sodium nitrate, potassium nitrate, magnesium nitrate, calcium nitrate, barium nitrate, strontium nitrate, etc. Ammonium nitrate is also used. Also, newer perchlorate compounds, particularly, hydroxylammonium perchlorate, may be used.

The fuel metal ingredient of composition 19 is a particulate form, e.g. finer than about 100 mesh, of fuel metal, especially a powder of aluminum, magnesium, iron, zinc, titanium, or zirconium. The powders may be used individually or admixed with each other. The fuel metal ingredient may also contain in admixture a minor amount of a non-metallic fuel powder, including powders of boron, tellurium and silicon. Aluminum and magnesium powders having a mesh size of less than 100 mesh U.S. Standard are preferred.

The high explosive ingredient of composition 19 is a finely-divided particulate form of a high explosive compound, especially a nitramine, e.g. tetryl (2,4,6-trinitrophenylmethyl nitramine), RDX (cyclotrimethylenetrinitramine), HMX (cyclotetramethylenetetranitramine, ethylenedinitramine; and PETN (pentaerythritol tetranitrate). HMX is especially preferred. RDX may also be identified as 1,3,5-trinitrazacyclohexane, and HMX may be also identified as 1,3,5,7-tetranitrazacyclooctane.

Other substances which are employed in the preparation of the composition 19 of this invention include minor amounts of burning catalysts, well known in propellant compositions. These are composed of one or a mixture of two or more metal oxide powders in amounts sufficient to improve the burning rate of the composition. The amounts usually range from about 0.01 to about 3 weight percent, based on the weight of the oxidizer employed. The particle size of the powders can range from about 10 to about 250 microns in diameter. Non-limiting examples of metals that serve as burning catalysts are copper, vanadium, chromium, silver, molybdenum, zirconium, antimony, manganese, iron, cobalt, and nickel. Examples of metal oxide burning catalysts are ferric oxide, aluminum oxide, copper oxide, chromic oxide, as well as the oxides of the other metals mentioned above. Other burning rate catalysts which may be used will be found among those described in U.S. Pat. 2,969,638, incorporated herein by reference.

Curing catalysts are often added in minor amounts to cure the polymer in the curable composition of this invention. Non-limiting examples of catalysts used for this purpose are aluminum chloride, tris(trimethylsilyl) borate, benzoyl peroxide, and other catalysts well known in the curing of plastics, resins, polymers, and rubbers. Examples of various catalysts may be found in text books such as "Synthetic Rubber," by G. S. Whitley, pp. 892-933, 1954 Ed., published by John Wiley and Sons, Inc., New York. The curing catalysts are added in amounts of from 0.1 to about 10 weight percent based on the weight of the polymer. The particular catalyst and amount employed depend on the state of cure desired, the nature of the polymeric material employed in the composition, and the heating and storage compatibility of the catalyst with the high explosive,

fuel metal and oxidizer ingredients, as well as with the binder.

The blending of the ingredients in preparing the composition 19 is carried out at a temperature sufficiently high to maintain fluidity of the polymer binder ingredient but sufficiently low enough to minimize curing of the polymer binder in the blender. A temperature in the range of about 120° to 135°F. will usually be found suitable. The blending is carried out in accordance with known procedures for a period of time sufficient to homogeneously mix all the ingredients to form a putty like mass which can be flowed upon application of moderate pressure or vacuum.

The curable high explosive-incendiary composition which results from the blending operation is deaerated and then is extruded or otherwise drawn or forced into the tubes 18, where the composition cures on standing for a period of several hours to several days at a temperature of about 135° to 150°F. depending on the type and amount of fluid polymer binder and curing agent therefor which is used. A suitable procedure for filling the tubes by means of vacuum is described in U.S. Pat. No. 3,341,636, incorporated herein by reference.

In practicing the invention, it has been found that the inner diameter of the tube 18 into which the high explosive-incendiary composition 19 is introduced is critical for achieving the advantages and benefits of the invention. If the tube diameter is too small, the composition 19 will be hindered from burning when it is ignited as an incendiary material; on the other extreme, if the tube diameter is too large, the burning rate may become so rapid that detonation may result. The tube diameter, accordingly preferably should have a minimum of about one-fourth inch in order to permit the strand to burn effectively. Also, the tube diameter preferably should not exceed about five-eighths inch in size in order to permit the strand to burn without detoming. While the tube preferably is a metal tube, it may also be made of a synthetic material, e.g. polyethylene or other plastic material. When the tube is a metal tube, the metal preferably is selected from magnesium, aluminum or iron.

The following examples further illustrate the invention:

#### EXAMPLE I

A curable, flowable high explosive-incendiary composition is prepared by blending together in a propellant mixer at 135°-145°F. the following ingredients until a homogeneous flowable mixture is obtained:

<u>Ingredient</u>	<u>Percent by Weight</u>
Liquid carboxyl-terminated polybutadiene polymer	10.65
Epoxide curing agent (C <sub>19</sub> H <sub>23</sub> O <sub>4</sub> )	2.35
Aluminum powder	10.00
Ammonium perchlorate powder	24.00
HMX (cyclotetramethylene-tetranitramine) powder	53.00

#### EXAMPLE II

The curable composition made according to the method described in Example I is used to prepare strands of cured high explosive incendiary composition in the following way. The flowable mixture is drawn under vacuum into a series of magnesium metal tubes having an internal diameter of about one-fourth inch, a wall thickness of about 0.01 inch and a length of about 3 inches. The filled tubes are placed in a curing oven and cured by heating at 135° F. for 24 hours. The mixture cures to form a solid tough mass. The resulting strands are then used to load the munition casing.

#### EXAMPLE III

Strands made according to the method of Example II were divided into groups and each group was packed into a separate casing. A first group of 14 strands was packed into a steel casing having 1 inch diameter and a wall thickness of about one-fourth inch. The lower end of the casing was closed with a plastic plug. The munition so formed was detonated with a detonator-booster system, causing the casing to fragment.

A second group of 14 strands was packed into a similar steel casing of 1 inch inner diameter. The munition so formed was ignited with a squib-pyrogen system and burned at a rate of 0.033 in./sec. at an ambient pressure of 12.6 psi. without exploding.

#### EXAMPLE IV

Strands made according to the method of Example II were packed into a one-half inch pipe and detonated. The detonation velocity was measured and determined to be about 6,800 meters/sec.

#### EXAMPLE V

Strands having a length of 3 inches and made according to the method of Example II were packed into a pair of steel casings having an inner diameter of about 2 inches, a wall thickness of about three-eighths inch and a length of 6 inches. Each casing held 55 strands. One end of each casing was closed with a frangible phenol-formaldehyde plug. The space between the tubes was filled with uncured composition made according to Example I. The casings were placed in an oven and cured as described in Example II. In each casing, the space above the ends of the strands then was packed, in the order described, with a first fire composition consisting of aluminum powder and KClO<sub>4</sub>, a polyurethane-ammonium perchlorate separator pad, a layer of granular gas generating composition consisting of aluminum powder and ammonium perchlorate catalyzed with

copper oxide and bound with a polybutadiene binder, and a closure plug with a threaded hole for receiving either a detonator-booster initiator or a squib-pyrogen initiator. A detonator-booster initiator was screwed into the plug of the first casing and the initiator was fired by means of an electrical impulse. The high explosive-incendiary composition detonated, fragmenting the casing into small fragments.

A squib-pyrogen initiator was screwed into the plug of the second casing. The casing was locked in a firing vise at an angle of about 45° with the end holding the frangible plug placed at the higher elevation. The initiator was fired by an electrical impulse. The ignition and gas propellant compositions ignited the strands and ejected them from the casing for a distance of from 20 to 50 yards where they continued to burn intensely without exploding.

#### EXAMPLE VI

13.2 parts of Morester 905 binder, a hydroxy terminated polyester, are mixed with 1.8 parts of PAPI (polymethylene polyphenylisocyanate). To this mixture are added 15 parts of magnesium powder having a mesh size of about 100 mesh, 25 parts of  $KClO_4$  and 45 parts of HMX. This formulation is then thoroughly mixed at 135°-145° F. until a flowable mixture is obtained. The mixture is then deaerated and cast into the tubes for use in a munition according to the invention. The mixture is then cured to a solid tough mass by heating to 135° F. for 24 hours. The mass has a specific gravity of 1.50 or greater. The strands so made are then packed into a munition casing according to the invention.

#### EXAMPLE VII

16 parts of a liquid fluorocarbon binder (Viton A, 8-10%, a copolymer of vinylidene fluoride and perfluoropropylene dissolved in 1,1,7-trihydroperfluoroheptyl acrylate to which a catalytic amount, about 0.2%, of benzoyl peroxide has been added as a curing catalyst), 16 parts of aluminum powder of about 100 mesh size, 22 parts of  $KClO_4$  and 45 parts of HMX are mixed together at 125° F. for 20 to 30 minutes. The mixture is deaerated and flowed under pressure into strand tubes. The formulation is cured at 135° F. for 24 hours. A tough, solid elastomeric mass is formed, having a specific gravity of 1.80 to 1.85. The strands so made are ready for use in preparing a munition of the invention.

Following the procedures described above, one skilled in the art will be able to prepare many suitable combinations of the disclosed ingredients to obtain the cured high explosive-incendiary composition essential for the practice of the invention. Thus, one may readily substitute another high explosive, e.g. RDX, for HMX, or other binders, e.g. epoxy curable polybutadieneacrylic acid copolymer or polybutadiene-acrylonitrile copolymer for the binders in the above examples to obtain the advantages and benefits thereof. Also, one may readily substitute other metal oxidizers and metal fuels, as described above.

The means for propelling the munition 41 to its target will be obvious to those skilled in the munitions art whether as a rocket propelled projectile, a bomb 42, or a mortar shell 24, or other device and therefore are not further described herein.

Although specific embodiments have been shown and described, it is to be understood that they are illus-

trative and are not to be construed as limiting on the scope and spirit of the invention.

We claim:

1. A munition which will explode when detonated and which when ignited will eject burning incendiary strands which will burn without exploding, comprising in combination:

a substantially cylindrical elongated munition casing having accessible opposite ends and having its inner wall extending between said ends;

frangible closure means for said casing disposed in one of said ends;

a munition loading disposed in said casing with one end thereof adjacent to said closure means, said munition loading comprising a multiplicity of ejectable elongated strands of high explosive-incendiary composition disposed within said casing with the long axes of said strands arranged parallel to said casing wall, and substantially filling said casing between said ends, each of said strands comprising an open-ended tube, said tube containing a cured high explosive-incendiary composition which will burn when ignited and explode when detonated;

gas generating means disposed adjacent to the other said end of said munition loading for ejecting said loading from said casing after ignition of the strands;

closure means for the casing disposed in said casing adjacent to said gas generating means; and

initiator means for igniting and exploding said loading, said initiator means being supported by said latter closure means.

2. The munition of claim 1 wherein the high explosive-incendiary composition comprises a cured elastomeric composition prepared by homogenously mixing and curing together a mixture of ingredients comprising on a weight basis from about 10 to 20% of a fluid curable polymer binder, from about 5 to 20% of fuel metal powder, from about 10 to 30% of particulate solid oxidizer, and from about 40 to 55% of particulate high explosive.

3. The munition of claim 2 wherein the high explosive is a nitramine.

4. The munition of claim 2 wherein the high explosive is selected from HMX and RDX.

5. The munition of claim 2 wherein the solid oxidizer is selected from metal perchlorates and ammonium perchlorate.

6. The munition of claim 2 wherein the curable polymer binder is selected from carboxy terminated polybutadienes, hydroxyl terminated polyesters, and polyfluorocarbons.

7. The munition of claim 2 wherein fuel metal powder is selected from magnesium and aluminum.

8. The munition of claim 1 wherein said tube is a magnesium tube.

9. The munition of claim 1 wherein said tube has an inner diameter of from about one-fourth to about five-eighths inches.

10. The munition of claim 1 wherein high explosive-incendiary composition is disposed between adjacent tubes and said inner casing wall.

11. The munition of claim 1 wherein the means for exploding and igniting the munition loading and ejecting the ignited strands comprises in combination:

a layer of granular igniter composition disposed in said other end of the casing in contact with the

ends of the strands disposed in said other end and extending to said inner wall of the casing,  
 at least one combustible separator means disposed in contact with said igniter composition and extending to said inner wall of the casing,  
 a layer of granular catalyzed gas generating composition disposed in contact with said separator means and extending to said inner wall of the casing,  
 a substantially flat cylindrical closure means disposed with one flat surface contacting said gas generating composition and disposed in sealing contact with the inner wall of the casing,  
 booster means supported by said cylindrical closure means and extending through said cylindrical closure means and having a lower portion extending into said gas generating composition,  
 pyrogen means supported by said cylindrical closure means and extending through said cylindrical closure means and having a lower portion extending into said gas generating composition,  
 rotatable selective switch means pivotally supported by said cylindrical closure means on the outer surface thereof and including means for locking said switch in a fixed position,  
 booster initiator means supported by said switch means and arranged to be disposed thereby in initiating position opposite to said booster means for initiation thereof, and  
 pyrogen initiator means supported by said switch means and arranged to be disposed thereby in initiating position opposite to said pyrogen means for initiation thereof.

12. The munition of claim 11 wherein said cylindrical closure means comprises a closure plug having an off-center pivot pin extending perpendicularly outwardly from its outer surface and rigidly supported thereby, said pin supporting said switch means and being provided with locking means therefor.

13. The munition of claim 12 wherein said closure plug comprises in combination:  
 a first pair of elevated closure pads integral therewith and arcuately positioned on either side of said pyrogen means, and level with the outer surface therewith and further positioned between said pivot pin and the outermost side of the inner wall of the casing,  
 a second pair of elevated closure pads integral there-

with and arcuately positioned adjacent one side of said booster means and level with the outer surface therewith and further positioned between said first pair of pads and said side of said casing wall,  
 a series of pin sockets disposed in said closure plug between said pivot pin and said first pair of pads, said pin sockets extending part way through said plug from the outer surface thereof, and wherein said switch means comprises  
 a pair of arms disposed in the form of a V and having at their juncture bearing means for fitting around said pivot pin, one of said arms being essentially a short arm relative to the other arm which is a long arm,  
 each of said arms having attached thereto and depending from the same surface thereof a locking pin designed to fit into any of said pin sockets of said closure plug and arranged to fit into an adjacent pin socket when said bearing of said switch is positioned on said pin and the switch is rotated to an adjacent pin socket position,  
 said short arm being provided with means for supporting said pyrogen initiator means with its discharge end on the opposite side of said closure plug from said pyrogen means and said first pair of pads, said long arm being provided with means for supporting said booster initiator means with its discharge end on the opposite side of said closure plug from said booster means and said second pair of pads, said closure plug and said switch means cooperating to position and lock said switch means in one of three positions which are a safe position, a booster initiating position, and a pyrogen initiating position.

14. The munition of claim 13 wherein said booster initiator means comprises a detonator and a fuse for said detonator.

15. The munition of claim 13 wherein said pyrogen initiator comprises a squib and a fuse for said squib.

16. The munition of claim 1 which further comprises rocket propulsion means for delivery of the munition to a target.

17. The munition of claim 1 which further comprises aerial bomb means for delivery of the munition to a target.

18. The munition of claim 1 which further comprises mortar shell means for delivery of the munition to a target.

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