

April 27, 1948.

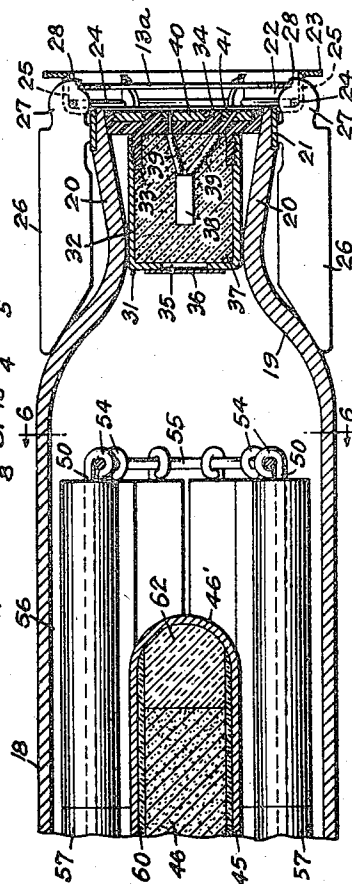
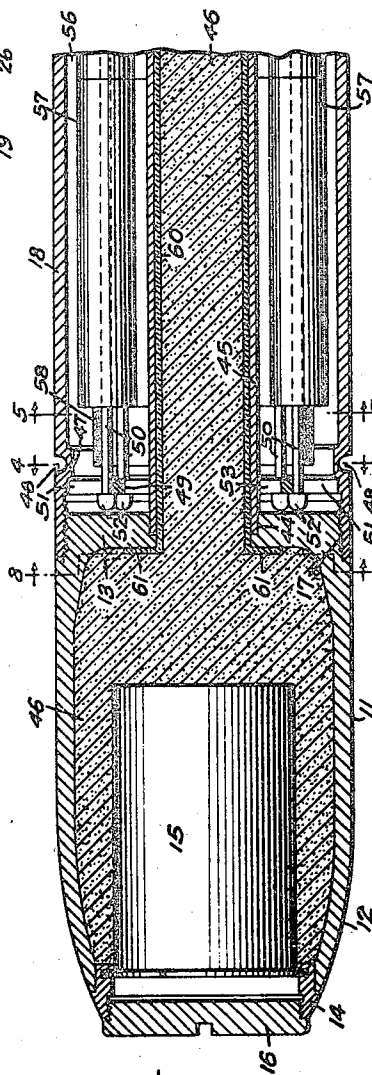
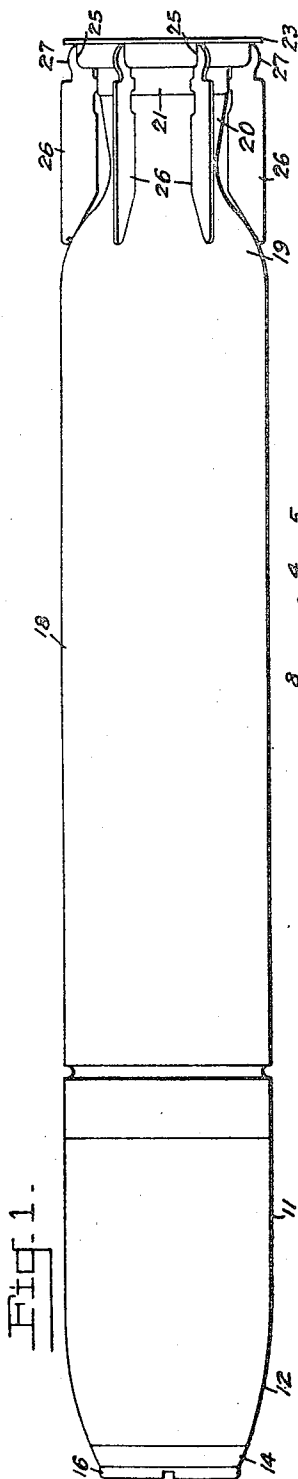
C. N. HICKMAN

2,440,271

ROCKET PROJECTILE

Filed June 26, 1944

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 6-

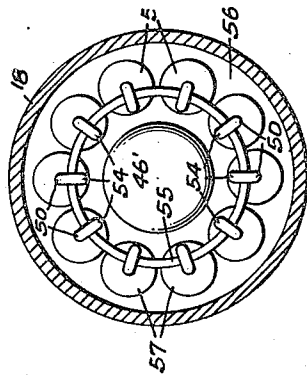


Fig. 5.

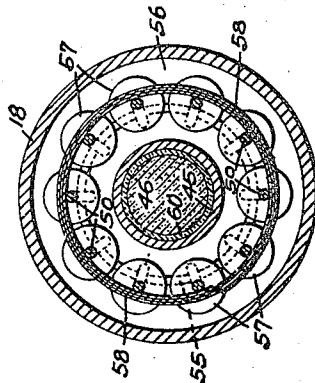


Fig. 4-

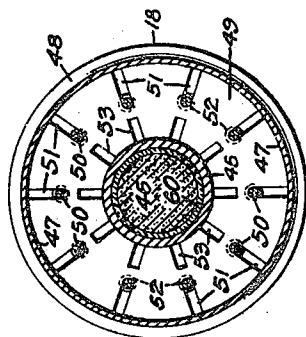


Fig. 3.

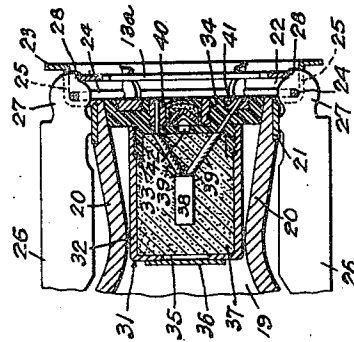


Fig. 2.

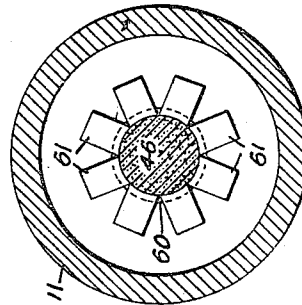
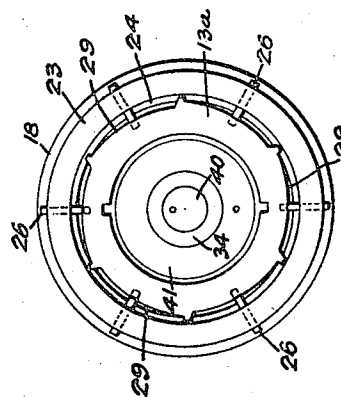


Fig. 1.



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UNITED STATES PATENT OFFICE

2,440,271

ROCKET PROJECTILE

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Application June 26, 1944, Serial No. 542,214

19 Claims. (Cl. 102—49)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

The invention relates to improvements in rocket propulsion of projectiles or other bodies, and has for an object to present a novel structure suited to such uses, and particularly valuable in military applications.

It is a paramount object of the invention to provide a high explosive shell or the like which can be fired without recoil.

It is also an object to provide a large caliber high explosive shell which can be fired from light weight mobile equipment.

It is appreciated that rocket propulsion of high explosive for ordnance purposes has been proposed heretofore even as early as 1863. However, the art has had little to offer to the furtherance of the above objects. This may be due in part to the fact that activity and interest in rocket propulsion had dwindled, because, from the standpoint of efficiency and economy, rocket propulsion could not compare favorably with propulsion of shells or projectiles from a gun.

Development of warfare has made increased and insistent demand for use at the immediate front line of combat encounter of larger caliber and heavier projectiles than can be fired from prior weapons with which the individual foot soldier can be armed, or which may be fired from light structure mobile material.

Satisfaction of this demand by increased use of artillery is prohibited by its initial impedance and unsuitability for advance by portage, and by the mass of carriage, barrel and mechanism being too great for light weight highly mobile equipment.

To a certain extent rifle grenades have effected a small advance in this direction, but stopping far short of requirements, and the Stokes mortar has also been of some benefit, though lacking because of its unsuitability for direct fire, its immobility, and dependance on an earth foundation to absorb recoil.

The field equipment now required by armies must be light, fast, and extremely mobile and in present military tactics speed and mobility is of ever increasing importance such as to subordinate factors of economy previously thought to be dominating, and which were thought to exclude consideration of rocket propulsion for projectiles.

It is therefore an important object of this invention to present a practical construction of a

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high explosive rocket projectile in which full advantage is taken of the effectiveness for propulsion of available explosives in proportion to the weight and bulk, with a minimum sacrifice of energy in moving the effective or destructive elements of the projectile.

One of the objections offered theretofore to the use of rocket propulsion has been that energy used to propel the combustion chamber is so much lost as far as the target action and effectiveness of the weapon is concerned, since heretofore such combustion chamber has served no useful purpose after focussing the discharging gases, and its deceleration effects were not compensated for. It is therefore a very important purpose of the invention to utilize the chamber element as a destructive factor contributing to the work of the explosive head of the projectile by fragmentation.

A further aim is to provide a safety means which will prevent injury to personnel, and the supporting structure generally, in the event of a malfunction of the jet propulsion features of the projectile.

At the present stage of development, the materials available as propellants are explosives, and as the burning characteristics of the propellant as now perfected vary with temperature and may also vary otherwise and from other causes, it is an important object of my invention to enable the rapid and facile alteration of the propellant, either as to quantity or for renewal or removal.

The rocket propelled projectile of my invention has reached an advanced stage in development and several different modifications in design have been tested and found satisfactory in performance.

These modifications principally involve differences in structural details and the objects advantages and features of invention reside as well in the arrangement and for combination of parts involved in the embodiment of the invention, as may be more readily appreciated from the following description and accompanying drawings, wherein,

Figure 1 is an elevation of a complete projectile embodying my invention;

Figure 2 is a fragmentary longitudinal section, enlarged, of the head and adjacent joined part of the motor tube and burster tube;

Figure 3 is a similar view of the rear end portion of the projectile;

Figure 4 is a section on the line 4—4 of Figure 2;

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Figure 5 is a section on the line 5—5 of Figure 2;

Figure 6 is a section on the line 6—6 of Figure 3;

Figure 7 is a rear end elevation of the projectile;

Figure 8 is a cross section on the line 8—8 of Fig. 2;

Figure 9 is a fragmentary vertical longitudinal section of the tail of the projectile.

Referring more particularly to the drawings, there is shown a projectile consisting of a head section 11 of generally cylindrical form in its rear part and having a short ogive 12. The head is chambered so that a lateral wall of substantial thickness is afforded when intended for fragmentation effect, this wall being extended integrally from a base plate 13 at its inner end and thickened somewhat adjacent the latter. At the forward end a large opening is formed, in which there is set fixedly the mounting ring 14 of a fuse 15 extending within the head, the details of which comprise no novel feature of this invention and are not illustrated.

Various forms of fuses for detonating a charge of explosive in the head, adapted to be mounted at the nose of the projectile are available and may be installed as found advisable. The ring has a closing plug 16 screwed thereto. At the rear of the head external threads are formed on a relieved part 17, and screwed thereonto is a cylindrical motor tube 18, with its periphery flush with that of the head 11. The rear end portion of this tube is spun inward to form a Venturi mouth passage or nozzle 19 the outer end wall portions 20 of which are properly divergent.

Fixed at the terminal edge of the tube mouth there is a fin assembly ring 21 of pressed metal extending laterally a distance, then longitudinally, forming a rabbet recess 22 laterally beyond the mouth of the motor and having a peripheral terminal outward flange 23 of important function.

Set or sprung into the rabbet there is a wire ring 24 snugly disposed against the boundary wall of the recess 22. The ring is formed with six equally spaced slots 25 extending from the wall 20 to the base of the flange 23. Flat sheet metal or other fin plates 26 have apertured partly circular base end ears 27 inserted in and partly through these slots, the ring 24 being engaged as a pivot through the apertures of these inserted ends.

These ends are suitably shaped to permit pivotal movement of the fins from radially extended positions to a closed position forwardly beside the peripherally restricted Venturi mouth.

The extremities of the fins are shaped to correspond to the inwardly inclined surfaces at the beginning of the restriction of the tube, so that the fins may extend inwardly close to the sides of the Venturi mouth. The outer edges of the fins are rectilinear and arranged to lie within a rearward geometrical projection of the external surface of the tube 18 when the fins are at their forward positions.

The inner parts of the ears 27 are relieved sufficiently to clear the inner ends of the slots for pivotal movement of the fins and to form respective shoulders 28. The outer parts of the ears continue with greater radius beyond the shoulders and the slots 25 extend correspondingly further, to permit 90 degrees of movement of the fins from closed position.

A fin retainer ring 13a is provided, having respective eccentrically inclined cam edges 29

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adapted to be positioned with their low parts adjacent respective fins, and against the relieved parts of the ears inward of the shoulder 28 while the fins are retracted. By rotating the ring then, the high parts of the cams may be wedged against the shoulders 28, so as to hold the fins retracted. This ring is removed after the projectile is placed in the launcher.

On firing of the rocket the fins are forced outward by the forces of air impinging thereon.

While this specific fin assembly is described with particularity it is in order to present a complete operative showing, and various other fin constructions may be employed without modifying the invention essentially.

There is also shown formally an igniter 31, altho this is not necessarily a fixed part of the projectile, and other conventional or improved igniter means may be used either as a part of the projectile or of launching devices. The igniter comprises a cylinder case 32 the mouth of which is screwed on to a flange cup 33 of a cap and mounting plate 34.

The case is of slightly less diameter than the vortex of the Venturi throat and at its forward part stops therein. Its inner end is formed with a flanged opening 35 covered by a thin foil or plate 36. The mounting plate 34 is of larger diameter than the case and is secured and sealed in the end of the tube mouth. The case carries a charge 37 of black powder, with a squib 38 embedded therein, from which detonator wires 39 are extended to a central insulated contact 40 and an outer contact ring 41 respectively, both on the plate 34, enabling completion of a circuit thereto through conventional brushes, wipers or otherwise. As in Fig. 9, the contact 40 may have a conventional percussion primer set therein over a flash port 42 formed through the plate 32 and opening into the cup 33, so that ignition may be effected by firing of a launcher, or by other concussive device, if desired.

The base plate 13 of the head 11 has an axial opening 44 therethrough, rabbeted at the rear to receive the open end of a snugly fitted cylindrical burster tube 45 secured to the head and extending rearwardly therefrom over the major portion of the length of the motor tube, the rear end thereof being spherically closed as at 46'. Its length is limited only by an arbitrary limit of space required between it and the Venturi throat of the motor tube. There is also a limitation on the diameter of the burster tube in relation to the effectiveness of the propellant (hereinafter referred to) and the range desired in effective use of the projectile, as well as the fragmentation effect desired on the material of the motor tube as will be explained.

The tube 45 is filled with a bursting charge 46 of high explosive of suitable brisance.

The tube 18 is formed with an interior circumferential bead or shoulder 47 immediately to the rear of the head 11 and midway of the longitudinal extent of this shoulder an external circumferential groove 48 is formed in the tube 18, the width of this groove being less than the width of the shoulder as measured longitudinally of the tube, and of such depth as to afford material between its bottom and the inner face of the shoulder of a thickness substantially less than the thickness of the tube 18, in a radial direction.

An annular planiform trap plate 49 is fitted slidably on the forward end of the tube 45, resting between the forward side of the shoulder 47 and the head 11, this plate being also fitted around

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the tube 45, and it may be fixed thereon if desired, or slidably movable thereon, according to the manner of use as hereinafter referred to. A multiplicity of small rectilinear rods or trap wires 50, are supported on the plate 49, either of a diameter small enough throughout to be radially slidable in radial slots 51 formed in the plate 49, the wires having heads 52 thereon to engage the forward side of the plate and to prevent the wires from pulling longitudinally from the trap plate; or otherwise shaped for such purpose. The slots open flush on the periphery of the plate.

The plate 49 may also have slots 53 therein opening radially inward, against the tube 45 to lighten the plate or to facilitate its engagement on the tube, or to facilitate fragmentation of the plate, all or several. The wires have eyes 54 formed at their rear ends through which a wire ring 55 is commonly and snugly engaged on which the wires 50 may pivot for outward swinging movement at times.

The depth of the slots 51 is such as to support the respective wires midway of the radial dimension of the space or combustion chamber between the burster tube and the motor tube, for an important purpose which will be understood hereinafter.

A propellant 57 is provided in the chamber, consisting of axially and cylindrically bored cylindrical rods or sticks of a suitable material which in the present instance has been formed of a double base powder, because of its ready manufacture by extrusion and because its burning characteristics can be developed to a high effectiveness for the purposes in view. Other materials may be used as found expedient. The diameter of this propellant rod material is less than the radial dimension of the chamber between the burster tube 45 and motor tube and the passage therethrough is of a size to engage loosely around the wires 50. For convenience in manufacture and handling in the field in the present instance they are made in uniform length which is somewhat less than an aliquot part of the length of the wires 50 between the eyes 54 and trap plate 49. The external diameter of the rod material is such that when threaded on the wires 50 and the latter mounted in the trap plate as shown, a proper space is afforded between the propellant and the tubes 18 and 45 to avoid excessive local heating of the former adjacent the rods, and also to avoid limitation or impairment of the burning rate of the propellant.

The number of wires 50 is such as to also afford a proper space between the propellant elements on mutually adjacent wires 50.

As will be appreciated, the burning area of a cylindrical stick of the so-called powder having a cylindrical perforation therein may be regarded as constant, especially when the diameter is small in comparison to the length, and when burned as herein indicated.

Figures 2 and 3 are approximately half the actual size of a projectile actually constructed and used, and in this device the interior diameter of the bursting tube has been made one third that of the motor tube, although these proportions may be varied according to the desired fragmentation of the motor tube, and the thickness and nature of the material in the burster and motor tubes, and the required combustion space. In the present instance the latter tubes have been formed of drawn tubing, the semispherical end of the burster tube being spun to shape and place and

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the Venturi nozzle of the motor tube being similarly processed. Both may be submitted to treatments to improve their segmentation under bursting of the charge 46, if desired.

The article illustrated has been produced with an external diameter of 4.5 inches, weighing 38 pounds. Its explosive and destructive effect is similar to that of a 105 mm. howitzer H, E, shell, using approximately 4.3 pounds of TNT in the head 11 and burster tube. The spherical end of the burster tube should be spaced not less than $\frac{3}{4}D$ from the throat of the Venturi mouth 19 of the motor tube where D is the internal diameter of the motor tube body, for efficient flow of gases to and through the nozzle, and in the illustration the spacing is greater.

The propellant extends rearwardly on the wires 50 substantially continuously (although actually three sticks end to end on each wire) from a short distance rearward of the plate 49 to a distance rearwardly of the burster tube at the ring 55.

For the size of device shown and materials indicated, ten of the wires 50 constitute the cage for the propellant and thirty of the sticks are thus involved, three to each wire 50.

The aggregate weight of the propellant under this arrangement is 4.8 pounds or less. On account of varying performance of such explosive at different temperatures, my projectile is constructed to permit variation of the quantity used, this being between twenty-seven short sticks for high temperatures ranging from 50° F. to 130° F., to thirty sticks for low temperatures from 20° F. to 90° F.

With this charge of propellant a muzzle velocity of 850 feet per second has been attained at the muzzle of a launching tube, giving a maximum range of 4600 yards.

Around the end portions of the wires 50 after assembly of the cage and its load of propellant on the trap plate, a binding of adhesive tape 58 is tightly wound thereon so as to hold the wires at the inner ends of the slots 51, to prevent forward sliding movement of the assembled propellant on the wires 50, to limit forward movement of the cage assembly in the motor tube, and to hold the sticks securely in end-to-end abutment on each wire, as well as to cushion the propellant.

The wires 50 may have a good degree of elasticity, and moderate flexibility in relation to the mass of the propellant, so as to minimize liability of fracture of the sticks on the wires under shock incident to handling and shipment.

In manufacture, conventional practice may be followed in the production of the several materials and elements of the projectile and it is an advantage that the motor tube, burster tube, the trap cage, and propellant, largely consist of familiar stock materials, and involve utilization of machines already available, while the head may be made with apparatus already available in large part.

The burster tube and head may be secured together by soldering. The bursting charge may be poured into the head and tube in a liquid state and a recess for the fuse 15 moulded therein so that the fuse in any approved construction may be set in place as and when required. The motor tube may be formed and the igniter 31 assembled thereon before attachment to the head. The cage assembly with trap plate and propellant thereon as a unit may be put in place by slipping the plate longitudinally along the burster tube to the ap-

proximate position thereon shown in Fig. 2, after which the motor tube is engaged slidingly around the caged propellant, moved slidingly to the head, and screwed on to the latter, thus completing the projectile ready for use.

In use, the projectile may be launched from an improvised trough or a tube of suitable size, aligned with the desired line of flight of the projectile, in which it may be laid while the igniter is fired, the launcher being of sufficient length to support the projectile while it becomes accelerated to the proper velocity for sustained and stable flight.

The immediate service or combat use may include an adjustment of the propellant charge to compensate for special temperature conditions, and in that event the motor tube may be unscrewed from the head and the head and cage lifted out, exposing the cage, its charge of propellant and the supporting trap plate. The wrapping of adhesive 58 is removed, and one or more of the wires 51 swung out of the slots 51, while the necessary number of sticks of the propellant are removed, or replaced, by being slipped off or on over the heads 52. The wires are then replaced on the plate 49, the wrapping 58 applied, the head cage and chamber reassembled and the motor tube screwed into place again.

In firing, the projectile is set in place on the launcher and the igniter fired, as by an electric current, or a percussion device, in its described form, but separate means for firing a blast into the open mouth of the tube may be employed or other means. Upon initiation of combustion of the charge of propellant the rate of propagation and the gases evolved will result in the acceleration and sustained flight of the projectile with propulsion continued for a suitable period of time to give a satisfactory trajectory and range at low elevation, enabling direct fire with reasonable accuracy.

Customarily a launching tube of appropriate length will be used, open at both ends and arranged on a vehicle or other support in such manner that there is ample clearance of personnel and matériel before and behind. The ends of a launcher tube in a small vehicle will project forwardly and behind the vehicle, and in larger mobile matériel will be mounted otherwise with due regard for safety, as may be understood. The flight of the projectile will conform to ballistic formulas for the velocity and range indicated and will be stabilized by the fins functioning as above described. On impact the nose fuse 15 will detonate the charge 46, or this fuse may include a delay feature or may consist of one constructed to explode in flight.

On detonation of the burster charge the to-be-expected concussive effect becomes manifest for demolition of the target, and for anti personnel action by fragmentation of the head, the bursting tube, and the motor tube.

Owing to the possibility of modification of the action, or other malfunction of the motor means resulting in building up excessive pressures in the combustion chamber 56, with liability of bursting of the motor tube in or close to the launcher, the weakening groove 48 is provided, and when a critical pressure is reached in the motor tube, and before it can cause lateral bursting of the motor tube, the components of force acting longitudinally of the chamber against the head 11 and against the throat end of the tube, will cause a cleavage of the tube 18 on the line defined by the groove 48. Ordinarily this will result in the motor tube being blown rearwardly through the breech

of the launcher tube, while the head 11 is propelled forwardly.

Any remainder of propellant remaining on the cage will be carried forward also, burning without explosive force as is characteristic of such explosive when free of confinement.

An important function in the form of the burster tube results from its cylindrical form in its forward part and the hemispherical shape of its rear end. This consists in its ability to resist high pressures in the combustion chamber in emergency critical pressure condition notwithstanding that it is thinner than the wall of the motor chamber.

The hemispherical form of the burster tube, its diameter and its relation to the forward part of the Venturi element of the mouth of the motor tube are also correlated so that a stream line flow of the evolved gases from the chamber is produced, the development of turbulence being prevented, which is a material factor in attaining effectiveness in the propulsion of the projectile.

The burster tube has been made with a thickness of approximately one eighth inch, and the motor tube 18 somewhat thicker. Consequently both the burster tube and motor tube are capable of producing dangerous fragments upon bursting.

In case the trap plate 49 is fixed on the burster tube, the cage with the powder sticks or grains threaded thereon is adjusted around the burster tube and the ends of the wires 50 swung into the slots of the trap plate and bound as described.

Adjustment of the propellant is then facilitated because the head and cage may be lifted out of the motor tube as a unit; and after severing the wrapping 58, removal or replacement of the propellant units and reapplication of the wrapping may be returned to the motor tube readily.

Increments may be found desirable in the chamber, other than the particular propellant shown. And certain features of the invention may be extended to function without others, provided the interdependent relation is not essential.

Thus, the safety groove 48 may be used in a device where the burster tube 45 is omitted, and the use of the tubular rod of explosive as a propellant may be found applicable in other forms of rockets; and an equivalent trap device may be useful without the safety groove and the burster tube. Correspondingly the burster tube may be employed in a rocket having none of the other features.

To further limit heat transfer from the propellant gases to that part of the bursting charge which is in the bursting tube, I have fitted snugly to the inner surface of the tube 45 a cylindrical liner 60 made of a fiber pulp material impervious to the explosive 46 when in liquid form or its solvents. In the present instance this liner is longer than the cylindrical portion of the tube 45 and stops at the base of the hemispherical end portion of the tube. The forward end of the liner is multi slitted longitudinally, the intervening ears 61 thus formed being turned outward against the inner face of the base plate 13 of the head 11. The far or rear end of the tube 45 contains a supporting and insulating body 62 of more or less refracting material, which may consist of pulverized fire clay pressed at the end of the tube to a rigid unitary mass tight against the inner spherical surface of the tube wall and against a part of the liner 60, extending forwardly over the latter a suitable distance. This prevents collapse of the hemispherical end of the burster tube in case of severe heating of the latter by the concentration of heat

which will occur therein during flight. This heating will be due in large part to convection by gases moving rearwardly beside the burster tube in the combustion chamber, in some degree to radiation largely due to incandescence, and in part to reflection from the surfaces of the motor tube. The tendency is for the rear end of the burster tube to become most highly heated, since it receives heat from a larger part of the charge in incandescent condition than does the forward portion, and with less insulation by gases in static condition. On this account the use of the compacted fire clay is most important because it not only prevents collapse of the tube end if heated to such degree as to be structurally weakened, but it also serves as an insulation, limiting conduction of heat to the charge.

As hereinbefore indicated, the disclosure herein, while specific and in great detail, is exemplary in large part, and various changes in construction and arrangement, substitution of materials and substitution of equivalents, mechanical or otherwise may be made without departing from the spirit of the invention, particularly set forth in the appended claims, wherein I claim:

1. In a rocket projectile a main projectile body and a motor chamber connected thereto, said body constituting a wall of the chamber, and a propellant charge in the chamber, the connection between the body and motor chamber being yieldable to a predetermined excess pressure due to improper combustion in the motor chamber below the bursting pressure of the remainder of the chamber.

2. In a projectile of the character described, a head, a motor tube connected thereto, a propellant support fixed relatively to the head, a propellant carried thereby, the connection of said tube to the head including a circumferential weakened portion constructed to cleave under predetermined pressure within the tube.

3. The structure of claim 2, in which the tube is formed with a restricted nozzle at its extremity.

4. In a projectile of the character described, a shell head, a motor tube extended therefrom, a multiplicity of longitudinally disposed rods therein, support means for the rods fixed at one end of the tube releasably connected to the adjacent ends of the rod, means to hold each rod in spaced relation to every other rod at the other end, and a multiplicity of tubular bodies of propellant explosive concentrically engaged on said rods substantially continuous from end to end of the rods.

5. The structure of claim 4, in which said support is fixed at the forward end of the tube, and a weakened connection formed between the body portion of the tube and the head rearwardly of the fixed connection with the support.

6. In a rocket projectile, a shell head, a motor tube of material frangible under predetermined explosive pressure and having a terminal Venturi nozzle, a tube extended from said head within the motor tube and having a hemispherical closed end, a bursting charge in the head and second tube, a propellant in the first tube around the second one, said hemispherical end being spaced in a relation to the venturi coordinated with the stream line flow of gases from the propellant beside the second tube to said nozzle.

7. A rocket device comprising in combination a head and a motor tube extended rearwardly therefrom and open rearwardly, a propellant in the tube, means to ignite the propellant, and an extension from said head within the tube, said head and extension having a bursting charge

therein and means to detonate the bursting charge, said tube being formed with a restricted mouth and with a circumferential weakened part rearwardly of the head, constructed and proportioned so that pressure in the excess of a predetermined maximum will cause cleavage and separation of the head and tube.

8. A rocket device comprising in combination a head and a motor tube extended rearwardly therefrom and open rearwardly, a propellant in the tube, means to ignite the propellant, and an extension from said head within the tube, said head and extension having a bursting charge therein and means to detonate the bursting charge; in which said tube is formed with circumferential weak part rearwardly of the head so constructed as to yield to a predetermined excess pressure within the tube, whereby the head and motor element may separate by longitudinal relative movement.

9. A rocket of the character described comprising a projectile head having a bursting charge therein, means to detonate the charge, said head having an axial hollow rearward extension of reduced diameter containing part of said charge therein, a coaxial tube connected to the rear of the head spaced from said extension and propellant material in the tube around the said extension, said tube being formed with a rear restricted discharge nozzle and a circumferential weakened part adjacent the head.

10. A rocket of the character described comprising a projectile head having a bursting charge therein, means to detonate the charge, said head having an axial hollow rearward extension of reduced diameter containing part of said charge therein, a coaxial tube connected to the rear of the head spaced from said extension and propellant material in the tube around the said extension, said extension comprising a tube formed with a convex closed end circular in cross section throughout.

11. A rocket of the character described comprising a projectile head having a bursting charge therein, means to detonate the charge, said head having an axial hollow rearward extension of reduced diameter containing part of said charge therein, a coaxial tube connected to the rear of the head spaced from said extension and propellant material in the tube around the said extension, said propellant material comprising a multiplicity of cylindrical bodies of diameter less than the radial measurement of the space between the tube and said extension, and extending continuously from end to end of the tube, and means to support and space the cylindrical bodies uniformly at both ends, relative to the adjacent cylinders.

12. A rocket of the character described comprising a projectile head having a bursting charge therein, means to detonate the charge, said head having an axial hollow rearward extension of reduced diameter containing part of said charge therein, a coaxial tube connected to the rear of the head spaced from said extension and propellant material in the tube around the said extension, said propellant material comprising a multiplicity of cylindrical bodies of small diameter relative to their length, arranged parallel to each other in an annular series extending longitudinally in the space between the tube and said extension, each extending continuously from end to end of the tube, and means to support and space the cylinders uniformly at both ends, relative to the adjacent cylinders.

13. A rocket of the character described comprising a projectile head having a bursting charge therein, means to detonate the charge, said head having an axial hollow rearward extension of reduced diameter containing part of said charge therein, a coaxial tube connected to the rear of the head spaced from said extension and propellant material in the tube around the said extension, said propellant material comprising a multiplicity of cylindrical bodies having axial openings there-through, a support therefor consisting of a frame of longitudinal rod members engaged through the said openings, means to hold the rod members uniformly spaced at their outer ends and means to support the rods in uniform spaced relation at the forward end of the tube.

14. A rocket of the character described comprising a projectile head having a bursting charge therein, means to detonate the charge, said head having an axial hollow rearward extension of reduced diameter containing part of said charge therein, a coaxial tube connected to the rear of the head spaced from said extension and propellant material in the tube around the said extension, a radially slotted collar mounted at the forward end at the space between the tube and said extension, said propellant comprising a multiplicity of cylindrical axially apertured bodies, a plurality of rods having said bodies engaged coaxially thereon and having forward ends radially slidable in respective slots of the collar and headed forwardly thereof, and spacing means connected between the opposite ends of the rods for uniformly spacing all of said rods.

15. A rocket of the character described comprising a projectile head having a bursting charge therein, means to detonate the charge, said head having an axial hollow rearward extension of reduced diameter containing part of said charge therein, a coaxial tube connected to the rear of the head spaced from said extension and propellant material in the tube around the said extension, said tube being attached to the head and formed with an interior shoulder close to the head, an annular collar set in the tube against the shoulder and having said extension slidable therethrough, said collar having a multiplicity of radial slots opening on an edge thereof extending to a medial line between the sleeve and said extension, longitudinal rods in the space between the tube and said extension having forward ends radially slidable in respective said slots, spacing means connected between the rear ends of the rods, for uniformly spacing said rods, said propellant comprising cylindrical bodies engaged coaxially around the rods and extending continuously from end to end thereon.

16. A rocket of the character described comprising a projectile head having a bursting charge therein, means to detonate the charge, said head having an axial hollow rearward extension of reduced diameter containing part of said charge therein, a coaxial tube connected to the rear of the head spaced from said extension and propellant material in the tube around the said extension, a propellant support fixed between the tube and said extension close to the head, said tube having a circumferential weakened part rearwardly of said support and yieldable for cleavage under predetermined maximum pressure in the tube.

17. In a rocket projectile, a motor element including a combustion chamber and a discharge mouth, a bursting device including a closed tube of substantially less diameter than the chamber extending from the forward part of the motor element and stopping short of said mouth, a bursting charge therein, a propellant in the chamber around the tube, and an insulating wall within and against said tube, said insulating wall including a rigid refractory material at the rear extremity of the tube.

18. In a rocket projectile, a motor element including a combustion chamber and a discharge mouth, a bursting device including a closed tube of substantially less diameter than the chamber extending from the forward part of the motor element and stopping short of said mouth, a bursting charge therein, a propellant in the chamber around the tube, and an insulating wall within and against said tube, and a body of pressure-withstanding refractory material fitting within and against the rear end of the tube.

19. The invention as recited in claim 4 wherein said support means comprises a collar having radial slots extending inwardly from the outer periphery of the collar, for receiving respectively said adjacent ends of said rods, and releasable means for restraining said rods against radial outward movement in said slots.

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The following references are of record in the file of this patent:

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