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TM 9-1950

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

ROCKETS

DEPARTMENT OF THE ARMY • JULY 1950

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DEPARTMENT OF THE ARMY TECHNICAL MANUAL
TM 9-1950

This manual supersedes TM 9-1950, 9 July 1945; TB 9-1950-S, 6 July 1949, including C 1, 29 July 1949; and those portions of TB ORD 273, 26 March 1945, pertaining to matériel covered herein.

ROCKETS



DEPARTMENT OF THE ARMY

JULY 1950

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BY ORDER OF THE SECRETARY OF THE ARMY;

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Chief of Staff, United States Army

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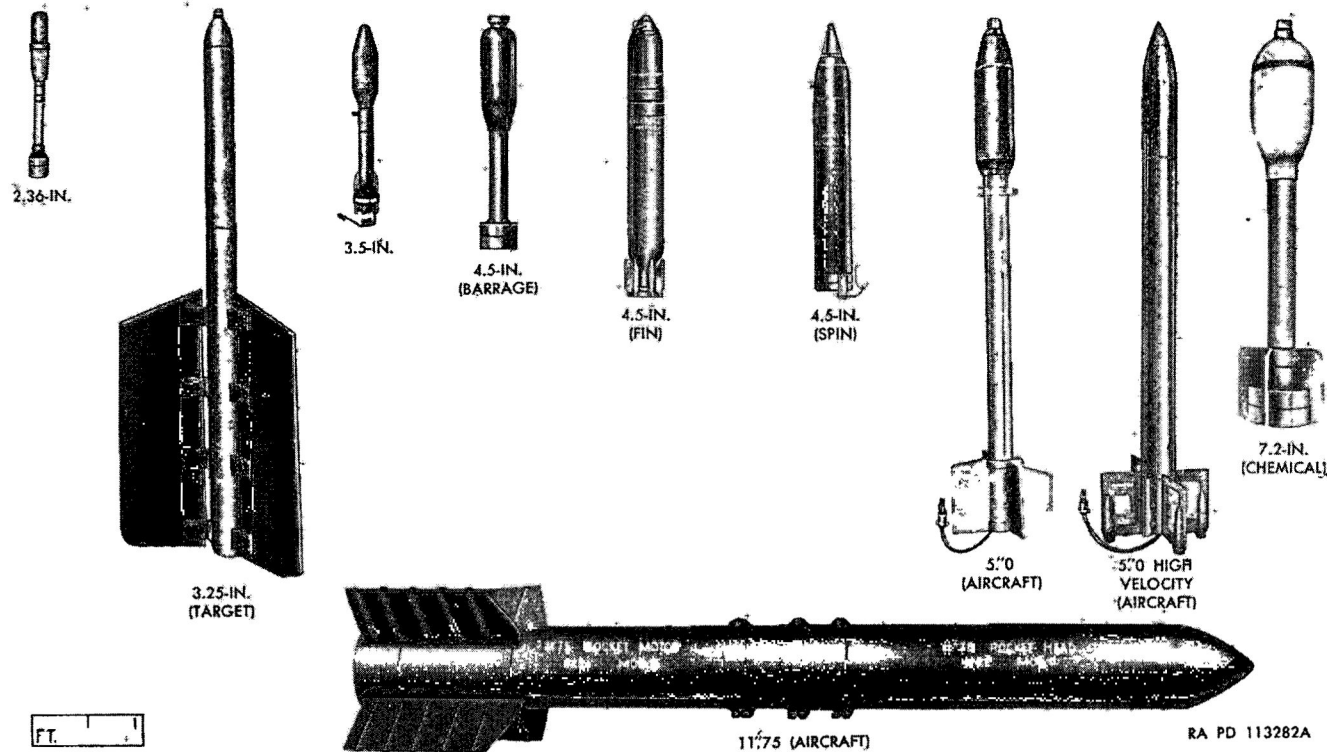


Figure 1. Representative types of rockets.

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CHAPTER 1

GENERAL

Section I. INTRODUCTION

I. Scope

a. This manual describes solid-propellant rockets used for military purposes and contains technical information necessary for their identification, care, and use.

b. The appendix contains a list of current references, including supply catalogs, technical manuals, and other available publications applicable to the matériel.

c. This manual differs from TM 9-1950, 9 July 1945, as follows:

(1) Adds information on—

Rocket, HE, AT, 2.36-inch, M6A6.

Rocket, practice, 2.36-inch, M7A7.

Rocket, smoke, WP, 2.36-inch, M10A4.

Rocket, HE, AT, 3.5-inch, M28.

Rocket, practice, 3.5-inch, M29.

Rocket, smoke, WP, 3.5-inch, T127E2.

Rocket, HE, 4.5-inch, M16A2.

Rocket, HE, 4.5-inch, M16A1.

Rocket, practice, 4.5-inch, M17A2.

Rocket, practice, 4.5-inch, M17A1.

11.75-inch Navy type rockets.

Rocket-kit, M34, for modification of 5.0-inch high-velocity aircraft rocket (Navy).

Tool Kit, T39.

Modification of Navy fuzes Mk 145, Mk 155, Mk 157, Mk 159, Mk 163, Mk 164, and Mk 165.

Fuze, VT, M402.

Fuze, VT, M403.

Fuze, rocket, BD, M404.

Fuze, rocket, BD, M405.

Fuze, rocket, BD, T2015E2.

Circuit continuity tester 680A.

Solid propellants:

Destruction of rockets to prevent enemy use.

- (2) Revises information on—

Rocket principle.

Rocket, 4.5-inch (Navy) (high capacity, smoke FS, and smoke WP).

Rocket, chemical, 7.2-inch, M25 (T21).

Rocket, chemical, 7.2-inch, M27 (T52).

2.25-inch, 3.5-inch, and 5.0-inch Navy type rockets.

- (3) Deletes information on—

Early type launchers including 7.2-inch M17 and 8-inch.

Rocket, HE, AT, 2.36-inch, M6, M6A1, and M6A2.

Rocket, practice, 2.36-inch, M7, M7A1, and M7A2.

Rocket, smoke, WP, 2.36-inch, M10, M10A3.

Rocket, target, AA, 3.25-inch, M2A1.

Rocket, HE, 4.5-inch, M8, M8A1, M8A2, and M8A3.

Rocket, practice, 4.5-inch, M9, M9A1, M9A2, and M9A3.

Rocket, HE, 4.5-inch, T83.

Rocket, practice, 4.5-inch, T87.

Rocket, SAP, 4.5-inch, T78.

Rocket, practice, 4.5-inch, T86.

Rocket, HE, 7.2-inch, T37.

Rocket, HE, 8.0-inch, T25.

Rocket-kit, aircraft, 4.5-inch, T23.

Fuze, rocket, Mk 146 (Navy).

Fuze, rocket, Mk 148 (Navy).

2. Field Report of Accidents

If an accident or malfunction involving the use of ammunition occurs during training or combat, the range officer for a unit in training or the officer or noncommissioned officer in charge of the firing unit in combat immediately will discontinue firing ammunition of the lot which malfunctions. He then will report the occurrence and all pertinent facts of the accidents or malfunction to the technical service officer under whose supervision the ammunition for the unit involved is maintained or issued, in order that the action prescribed in SR 385-310-1 may be taken. If conditions of combat preclude immediate compliance, the action prescribed above will be taken as soon as practicable.

Section II. GENERAL DISCUSSION

3. Rocket Terminology

A *rocket* (fig. 1) is a missile which is propelled by the reaction caused by a discharging jet of gas from the burning of a charge of propellant powder within the rocket. A military rocket con-

sists essentially of a head, a motor, and means of stabilization during flight. The head comprises the element necessary to produce the desired effect at the target, usually an explosive filler and fuze. The motor comprises the elements necessary to propel the rocket, including the propellant charge, nozzle or nozzles, and means of igniting the propellant. Stabilization is accomplished either by fins attached to the motor (fin type) or, in the case of multiple nozzle rockets, by so locating the nozzle that the rocket is rotated in flight (spin type). In order that a rocket may be launched on a definite trajectory, a device called a *launcher* is required. Aside from providing means for initiating ignition of the rocket propellant, the launcher is required only to aim the rocket. Consequently, rocket launchers may be so light and portable that rockets can be fired from airplanes and from ground areas inaccessible to conventional artillery. The employment of rocketry is more economical than that of artillery against light and, in some instances, heavy targets at relatively short ranges. A further advantage of the use of rockets lies in the fact that the forces of setback are relatively small but spread over a comparatively long period of acceleration, thus permitting the use of light-case projectiles of higher capacity and less expensive construction than artillery shell of similar caliber, and the use of fuzes of less rugged construction. A rocket is relatively inexpensive, easily launched, and economical of personnel. The disadvantage of rockets, as compared with conventional artillery rounds, lies in the fact that operating personnel and inflammable material must be protected from the rearward blast of hot gas, that dispersion of rockets is considerably greater than that of comparable artillery shell, and that operation is limited to relatively short distances from the target, and to a narrower temperature range.

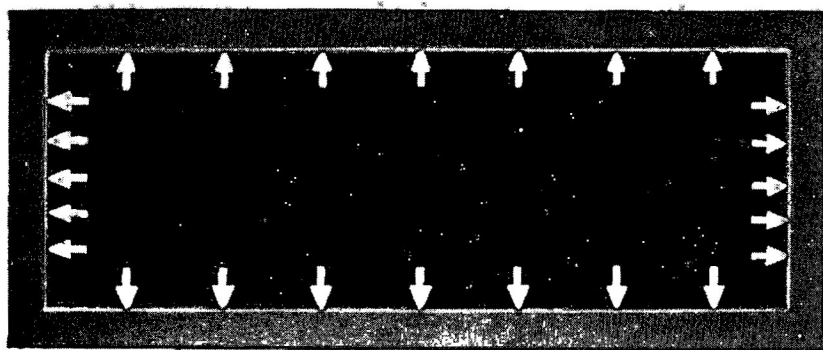
4. The Rocket Principle

The basic principle of rocket propulsion may be described and illustrated as follows:

a. When a gas is compressed in a closed vessel of any shape, pressure (as stated in Pascal's law) is equal and opposite in all directions; hence, the force in one direction is counterbalanced by an equal force in the opposite direction with no resulting motion of the closed vessel. This is illustrated diagrammatically by arrows and shading in figure 2 representing a closed tube. Note that although the equal and opposite forces on the side walls of the tube are represented in figure 2, they are omitted in figures 3 and 4 because they cancel each other and therefore are not necessary in the further discussion of the rocket principle.

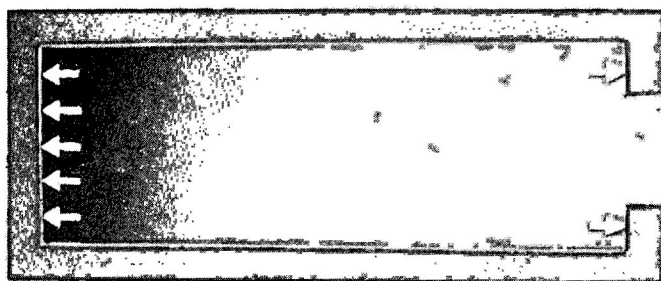
b. When an opening to the atmosphere is made in one end of the tube (fig. 3), the pressure at the opening drops to near atmospheric while the pressure on the closed end remains momentarily greater than atmospheric; as a consequence, the tube tends to move in the direction of the closed end as a stream or jet of gas is ejected from the open end. If pressure is continually built up within the tube, as by the burning of a propellant powder, high pressure is maintained at the closed end until the powder burns out, while near-atmospheric pressure prevails at the opening. Thus the high pressure at the closed end, acting on an area equal to the area of the opening, results in a force or thrust in the direction of the closed end. Note that for comparatively small openings, the pressure at the open end may be considered substantially the same as that at the closed end, except at the actual opening which is atmospheric. Thus it is that the forces at the closed and open ends are equal and opposite, except on an area equal to that of the opening; at the opening, this force is zero, whereas at the closed end the force which tends to produce motion is equal to the pressure times the area of the opening. The forces causing motion in the direction of the closed end while the propellant is burning are represented diagrammatically by the shading. The burning of a propellant in a tube, closed at one end and with an opening in the other end, results in pressure and heat energy which, by reaction, as the gas escapes through the opening or nozzle, tends to move the tube.

c. As the gas passes by the square corners near and at the opening (fig. 3), there are substantial frictional losses due to turbulence which are represented by the curlicues in the shading near the opening. These losses are largely overcome by using the shape shown in figure 4, forming a nozzle. This type of opening comprises a smooth contour which provides for a nonturbulent, hence relatively frictionless, flow of gas represented by the smoothness of the shading. The constricted opening, called the throat, limits the flow of gas and thereby maintains pressure within the tube while the propellant is burning. The gas, while flowing through the nozzle, is still under a pressure which decreases from the throat to the open end of the nozzle. Such pressures represented by (d) and (d') normal to the wall of the nozzle result in force components (f) and (f') in the direction of flight. Hence, energy which otherwise would be lost, if the gas were discharged through an opening such as that in figure 3, is converted to additional thrust by use of the nozzle. Forces, such as (c) and (c'), resulting from pressure on the approach side of the nozzle are of substantially the same magnitude as (may be slightly less due to somewhat lower pressure at the



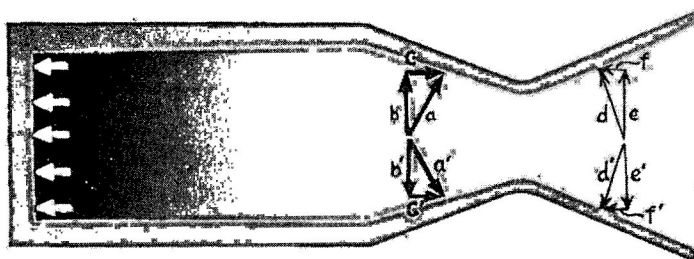
RA PD 113283

Figure 2. The rocket principle (pressure in closed tube).



RA PD 113284

Figure 3. The rocket principle (movement of tube—opening in one end).



RA PD 113285

Figure 4. The rocket principle (movement of tube—nozzle in one end).

nozzle end) but in the opposite direction to those on an equivalent area at the closed end; hence, they balance each other. Since force components represented by (b) and (e) are equal and opposite to (b') and (e') they have no effect on motion. Thus, the principal forces producing motion of the tube consist of those resulting from the internal pressure acting at the closed end on an area equivalent to that of the throat plus the axial forces (f) and (f') resulting from the pressure within the nozzle.

5. Classification

a. USE. Rockets are classified according to use as aircraft and ground.

b. PURPOSE. Rockets are classified according to purpose as service, practice, target, drill, and subcaliber. Service rockets are used for effect in combat; practice rockets are used for training and target practice; target rockets are used to provide a fast moving aerial target for practice firing of automatic anti-aircraft weapons; drill rockets are used for training and handling; subcaliber rockets are smaller rockets designed for practice purposes and for reasons of economy to be fired from standard launchers by means of an adapter.

c. FILLER. Rockets are classified according to the filler in the head as high-explosive, chemical, and inert.

- (1) High-explosive rockets contain a filler of high explosive for blast, fragmentation, mining, or demolition effect. The high-explosive antitank (HE, AT) rocket, which contains a filler consisting of a shaped charge of pentolite or other high explosive, is used for penetration of armored targets. (The designation HE, AT identifies ammunition utilizing the shaped charge principle.)
- (2) Chemical rockets contain a chemical agent and a burster or an igniter to disperse or ignite the agent at the target. The chemical agent may be a gas for producing a toxic or harassing effect, a smoke producer for screening or signaling, an incendiary, or a combination of these.
- (3) The head of inert rockets which are intended for target practice contains an inert filler; the motor contains a standard propellant charge. Drill rockets, intended for practice and training in service of the piece, are completely inert—both head and motor.

6. Identification

a. GENERAL. Rockets, in common with other types of ammunition, are identified by the standard nomenclature and a lot num-

ber of the item. Such identification is marked on all containers and, unless the item is too small, on the ammunition itself.

b. LOT NUMBER. When ammunition is manufactured, a lot number is assigned in accordance with pertinent specifications. A "lot" consists of a number of items, manufactured from similar materials under similar conditions, which may be expected to function alike. The lot number for rockets consists, in general, of the loader's initials or symbol, and the number of the lot. The number of the lot may be either a basic number or a basic number with subnumber. The use of the lot number is required in all references to specific items of ammunition in reports and records.

c. LOT NUMBER (NAVY). The ammunition lot system for rockets provides a means by which an adequate record may be maintained of the components assembled into this type ammunition. The ammunition lot serves as a unit by which defective components may be withdrawn from the fleet or restricted from issue. In addition, the ammunition lot is used for control purposes in recording, stowage, and shipping ammunition. The ammunition lot system authorizes the assembly of more than one lot of a nonexplosive component with one lot of a major explosive component into a single ammunition lot.

d. MODEL. When a particular design is adopted as standard, it is assigned a model designation consisting of the letter M (Mk for Navy) and an arabic numeral. If this design is modified, the fact is indicated by the addition of the letter A (Mod for Navy) and the appropriate arabic numeral; for example, M6A5 indicates the fifth modification of a model whose original designation was M6. Modifications which are functionally identical with the original model but which have manufacturing differences may be designated by the letter "B" and an arabic numeral. When a particular design has been accepted only for a limited procurement and service test, the model designation is indicated by the letter "T" and an arabic numeral, and modifications by the addition of "E" and an arabic numeral. In such cases, if the design subsequently should be standardized, the "M" designation is assigned; hence there may be encountered some lots still carrying the original "T" designation (not yet remarked to show the later standardized "M" designation). There is no direct relationship between the numerical designation of a "T" item and that of the item when standardized and assigned an "M" designation.

e. PAINTING. Service ammunition is painted with lusterless paint to prevent rust and in various colors to provide means of identification. In general, rocket motors are painted olive drab. The colors used for painting rocket heads are as follows:

	<i>Army</i>	<i>Navy</i>
High-explosive -----	Olive drab; marking in yellow.	Olive drab; marking in white.
Chemical (casualty gas) ----	Gray; band and marking in green.	Gray; green band, lettering in white.
Chemical (smoke) -----	Gray; band and marking in yellow.	Gray; yellow band, lettering in white.
Practice -----	Blue; marking in white.	Blue; marking in white.
Inert -----	Black; marking in white.	Black; marking in white.

f. MARKING. Ammunition items are marked, by stamping in the metal or by stenciling, with the type, size, model, and lot number. The safe temperature limits for storage and use is shown on the rocket motor.

g. DATA CARD. A 5- by 8-inch card for each lot is supplied with each shipment of ammunition. This card gives the ammunition lot number of the item, the lot number of each component of the item, and other pertinent data such as expected muzzle velocity, AIC symbol, and assembling and firing instructions when required.

h. AMMUNITION IDENTIFICATION CODE. An ammunition identification code (AIC) symbol is assigned to facilitate requisitioning and record keeping in the field. The code symbol consists of five characters. Once a code symbol is assigned to an item, that code symbol is never used for any other item. Code symbols as marked on the packing container are published in the Department of the Army Supply catalog and explained in SB 9-AMM 5 and Ordnance pamphlets (Navy) 1219J, 1219M, and 1219N.

7. Complete Round

a. DEFINITION. The complete round consists of all the components of the rocket necessary for it to function. The complete round may be issued as a single assembled unit or as separate components to be assembled in the field. The separate components are described below.

- (1) The motor which propels the rocket contains the propelling charge and the igniter and is assembled to the rear of the head. It consists of a tube closed at the forward end and having one or more nozzles (venturi) at the rear end. The propelling charge, usually in stick form, is held in place by a trap, grid, or cage. Provision is made in the form of contact rings, fixed connections to fin shrouds, or cable and plug, dependent upon the design of the launcher, for electrically connecting the igniter to the external firing circuit. Details are described in the sections pertaining to specific rockets.

- (2) The rocket head is that component which contains the high-explosive charge or other filler, the booster, and the fuze. Its purpose is to produce the desired effect at the target.

b. **EXPLOSIVE TRAIN.** The explosives of rocket heads must be comparatively insensitive to permit safe handling in storage and transit. Sensitive explosives that can be detonated by the impact of a firing pin generally are safe to handle when they are in small quantities, highly compressed, and inclosed in a metal capsule. They are used in that form in fuzes and primers. The small spit of flame from a primer will not properly detonate a large charge of comparatively insensitive explosive, and it is therefore necessary to interpose a medium quantity of explosive of medium sensitivity. Such an arrangement of explosive charges is called an explosive train. The propelling charge train, which is in the motor, consists of the igniter and the propelling charge. The bursting charge explosive train, which is in the head, consists essentially of a primer, a detonator, a booster, and the bursting charge. A delay element sometimes is incorporated in the fuze to meet requirements for delay action.

8. Head

a. **HIGH-EXPLOSIVE.** Some high-explosive rocket heads are of thin-walled construction for maximum capacity of explosive and blast effect; some have heavy walls to permit penetration of light armor before exploding; and others have walls of medium thickness to provide a maximum number of effective fragments. High-explosive rocket heads are adapted for point fuzes, base fuzes, or both.

b. **HIGH-EXPLOSIVE ANTITANK (HE, AT).** Heads of these rockets are of special shape and contain a shaped charge for penetration of armored or other resistant targets.

c. **CHEMICAL.** Chemical rocket heads usually are of thin-walled construction. They may be adapted for point fuzes or base fuzes and have a burster well extending along the axis of the head from the fuze seat. Chemical rocket heads may be loaded with casualty or harassing gas, or smoke.

d. **PRACTICE.** Practice rocket heads usually consist of the metal parts of high-explosive heads loaded with inert material.

9. Fuze

a. A fuze is a device which initiates an explosion at the time and under the circumstances desired.

b. Rocket fuzes are classified according to location in the head as "point detonating" (PD) (the Navy term is "nose") or "base

detonating" (BD); and, according to functioning, as "time," "VT" (variable time or proximity), or "impact." Time fuzes function a preselected number of seconds after the round is fired. Impact fuzes function upon impact with superquick, non-delay, or delay action. In the case of superquick action, the shell functions practically instantaneously on impact, initiated by a firing pin driven into a detonator. Non-delay action occurs in impact fuzes initiated by inertia-driven firing pins or detonators, being only slightly slower than superquick action. In delay action fuzes, the shell functions a fixed time after impact (the amount of delay, usually between 0.025 and 0.15 second, is dependent upon the delay element incorporated in the fuze) to permit penetration of the target before the shell explodes. Arming may be accomplished by mechanical means utilizing gear trains, air stream (air arming), spring action, centrifugal force or inertia, gas pressure (pressure arming), or a combination thereof.

c. The VT fuze detonates the rocket head at a distance from the target to produce optimum blast and fragmentation effects. It is essentially a radio transmitting and receiving unit and requires no prior setting or adjustment. Upon firing, after elapse of the minimum arming time (pars. 61 and 82), the fuze arms and continually emits radio waves which, as the rocket approaches the target, are reflected back to the fuze. The reflected waves produce a "beat" which, when received by the fuze with a predetermined intensity, as on approaching close to the target, operates an electronic switch in the fuze. This permits electric current to flow through an electric squib, initiating the explosive train and detonating the shell. VT fuzes are of two types—one for ground type rockets, the other for aircraft type rockets. VT fuzes are interchangeable with other standard fuzes in ground type rockets having deep fuze cavities.

Caution: Rockets fuzed with VT fuzes may function prematurely if fired too close to trees or other intervening objects. There should be at least 250 feet clearance from objects short of the target.

d. Boresafe rocket fuzes are those in which the explosive elements are separated in such a manner that explosion of the rocket head before the rocket leaves its launcher is prevented, even if the more sensitive elements (primer or detonator) should function.

10. Motor

a. A rocket motor is that component which propels the rocket and is assembled to the rear of the head. It consists of a steel tube which is closed at the forward end by its attachment to

the head. In some types, the tube is constricted at the rear end to form the throat of a single nozzle. In other types, there are several nozzles located in the base. The motor contains the propelling charge, the propelling charge support, and the igniter. The flight of the rocket is stabilized by fins attached to the rear of the motor, or by the rotation of the rocket about its axis, called spin. This spin is produced by the reaction of the gas passing at high velocity through the several nozzles (fig. 28), the axis of which are at an angle to the base of the motor. The openings in the motor are sealed against the entrance of dirt and moisture by closures (fiber, metal, plastic, or other type disks) which are blown out when the rocket is fired.

b. The igniter consists of a charge of black powder and an electric squib. In general, the lead wires from the squib are connected to contact points or rings on the rocket that engage launcher contacts which, in turn, are connected to a source of electricity. In some types of rockets, the lead wires are connected to fin shrouds or to a standard electrical plug.

c. The propelling charge in rockets generally consists of a double-base powder. The charge may be formed into a single large grain or a number of smaller grains and held in place by a trap assembly (fig. 29). The weight of the propelling charge is adjusted for each lot of powder to give uniform flight characteristics.

d. The burning rate of propellant powder varies with temperature and pressure so that the higher the temperature or pressure (or both), the faster the powder will burn. When rockets are fired at temperatures higher than those for which they are specified, higher pressures are built up in the motor causing longer and erratic ranges. In extreme cases, the motor, and even the head, may explode. When rockets are fired at temperatures below those specified, the propellant charge burns slower causing shorter and erratic ranges.

11. Launchers

a. GENERAL. The rocket launcher serves to hold and aim the rocket, to provide a source of electric power for firing, and, in some cases, to protect the firer against the blast of the rocket. The launcher proper, as distinct from the mount, consists of a tube or a set of tubes or rails with a means of holding the rocket in place and a system of electrical contacts. There is no recoil since the propulsion of the rocket is accomplished by the jet action of the propellant powder in the stabilizer tube of the rocket and does not depend upon gas pressure built up inside the launcher tube. Therefore, the launcher tube need be only heavy enough to prevent denting or bending during handling and to prevent

excessive heating at normal rates of fire. Some launchers are expendable; that is, they are used for only one firing of a rocket. In such cases, the launcher consists of the tube in which the rocket is shipped. Other launchers may be of semipermanent or permanent construction, designed for firing a limited or a substantial number of rounds respectively.

b. 2.36-INCH LAUNCHER. The rocket launchers M9, M9A1, and M18, used to fire 2.36-inch rockets, are of the two-piece open-tube type equipped with a sight, grip, and stock. The source of electricity for firing is a magneto assembled in the grip. The rocket is held in place by a single spring clamp which also serves as the ground contact for the electric leads. The live contact is in the form of a spring terminal mounted on an insulated band (fig. 5). The launcher tube is long enough for the propelling charge generally to burn completely before the rocket leaves the muzzle. Personnel who fire are protected against the occasional long-burning rocket by a flash deflector attached to the muzzle. However, the deflector will not guard against the blast of rockets fired below the prescribed temperature; hence, face masks or eye shields always should be worn when firing such launchers. For complete description of launcher, see TM 9-294.

c. 3.25-INCH TARGET ROCKET PROJECTORS M1 AND M1A1. These projectors are made of two parallel steel rails mounted, with

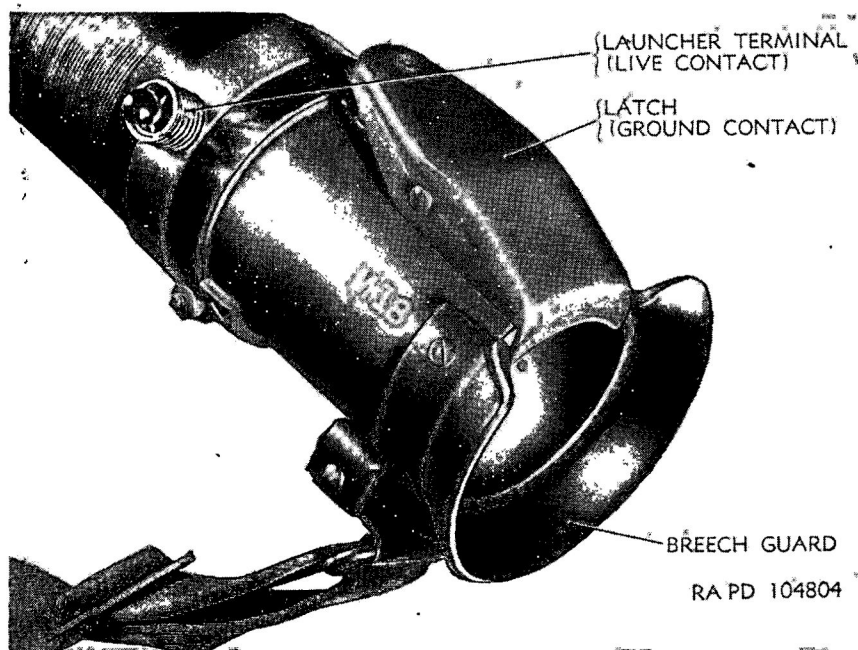
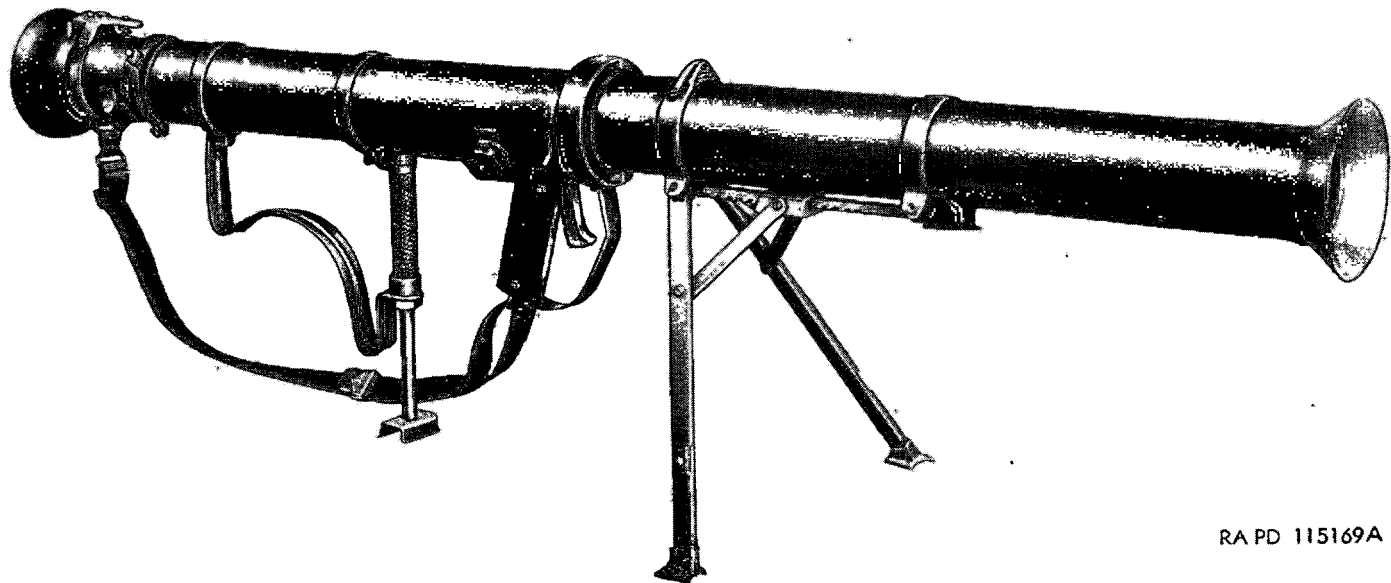


Figure 5. Clamp and contacts—2.36-inch launcher M18.



RA PD 115169A

Figure 6. 3.5-inch rocket launcher M20—bipod extended.

means for elevating, on a two-wheel carriage. Traverse is accomplished by shifting the trail. The rocket rests on the rails against a back stop. The M1 projector is suitable for firing the M2 rocket only. Ground contact is through contact of the rocket and the body of the launcher. Live contact is made through a darting firing contact with the head of the rocket. Batteries are mounted on the carriage and a long firing cable provides for firing from cover or a safe distance. To provide a projector for firing the M2A2 rocket, the M1 projector was modified by substituting a different firing mechanism, including a 10-cap blasting machine and a new receptacle, and designated M1A1. The M1A1 projector has a socket for plugging in the leads of the igniter circuit of the M2A2 rocket; batteries and firing switch are not on the projector. For complete description, see TM 9-856.

d. 3.5-INCH LAUNCHER. The 3.5-inch rocket launcher M20 (figs. 6 and 7) is a two-piece smooth-bore weapon of the open-tube type and is fired electrically. The weapon can be fired from the shoulder in standing, kneeling, and sitting positions. A bipod and rear monopod permit firing in the prone position. To save weight and improve portability, the front and rear barrel and other metal parts are made of aluminum. This launcher is used to launch high-explosive rockets and smoke rockets against ground targets. The high-explosive antitank rockets are capable of penetrating heavy armor at angles of impact up to 30°. The weapon is sighted on the target by means of a reflecting sight mounted on the launcher. In firing position, the front and rear barrel assemblies comprising the launcher are joined in tandem to form a launching tube. In carrying position, the barrels are fastened together in a double-tube arrangement, thereby eliminating the unwieldy length of the assembled weapon. Front barrels are interchangeable with each other and rear barrels are interchangeable with each other. However, the reflecting sight of the launchers must be recalibrated if barrels are interchanged. A gun sling is used as an accessory for carrying the launcher. A magneto-type firing device in the trigger grip provides the current for igniting the rockets. For complete description, see TM 9-297.

e. 4.5-INCH EXPENDABLE LAUNCHERS. See paragraph 12.

f. 4.5-INCH LAUNCHERS FOR FOLDING-FIN ROCKETS. These are permanent or semipermanent types consisting of an assembly of a number of metal or plastic tubes, each equipped with a release assembly for holding the fin flange of the rocket and a pair of spring-type contacts. These launchers are mounted on various types of carriages and aircraft mounts. For further information, see TM 9-394 and TM 9-395.

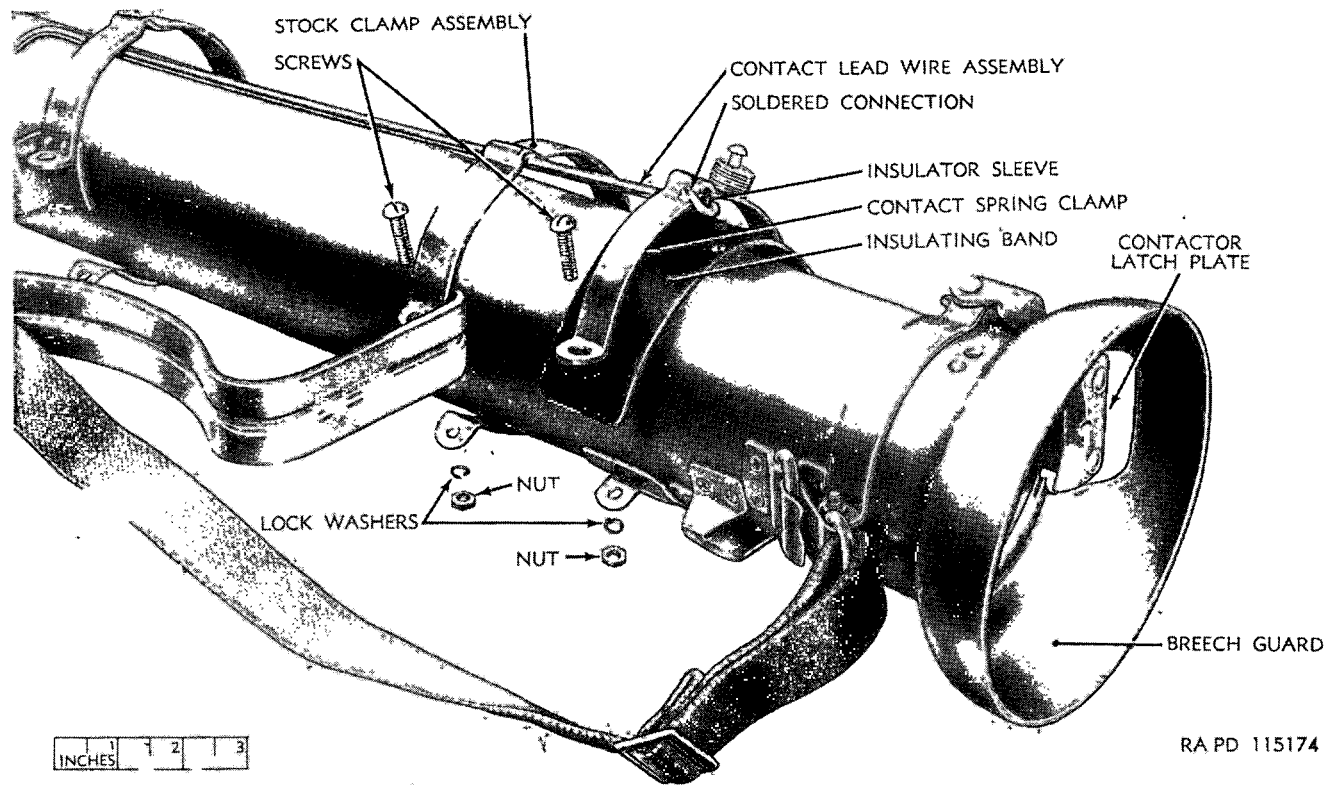


Figure 7. 3.5-inch rocket launcher M20—insulating band and insulator sleeve exposed for inspection.

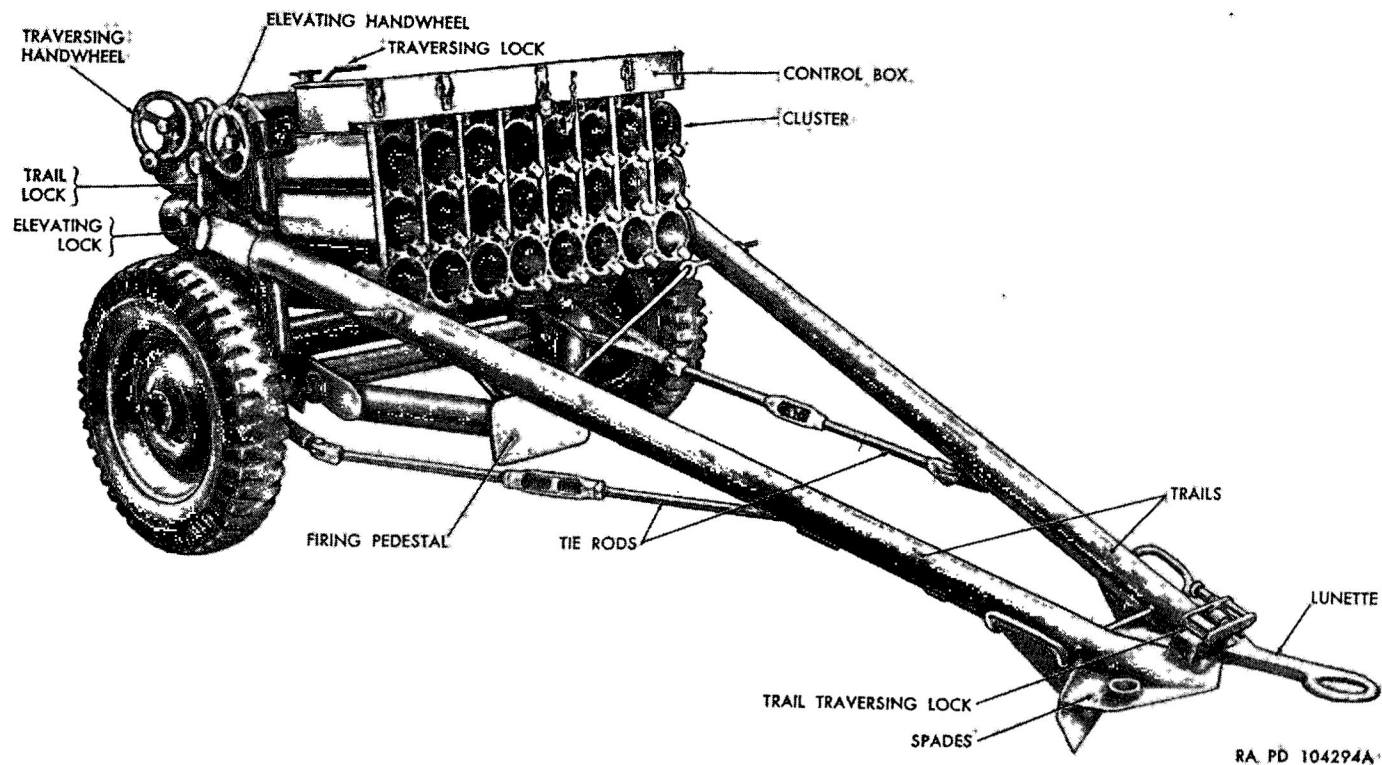


Figure 8. 4.5-inch multiple rocket launcher T66.

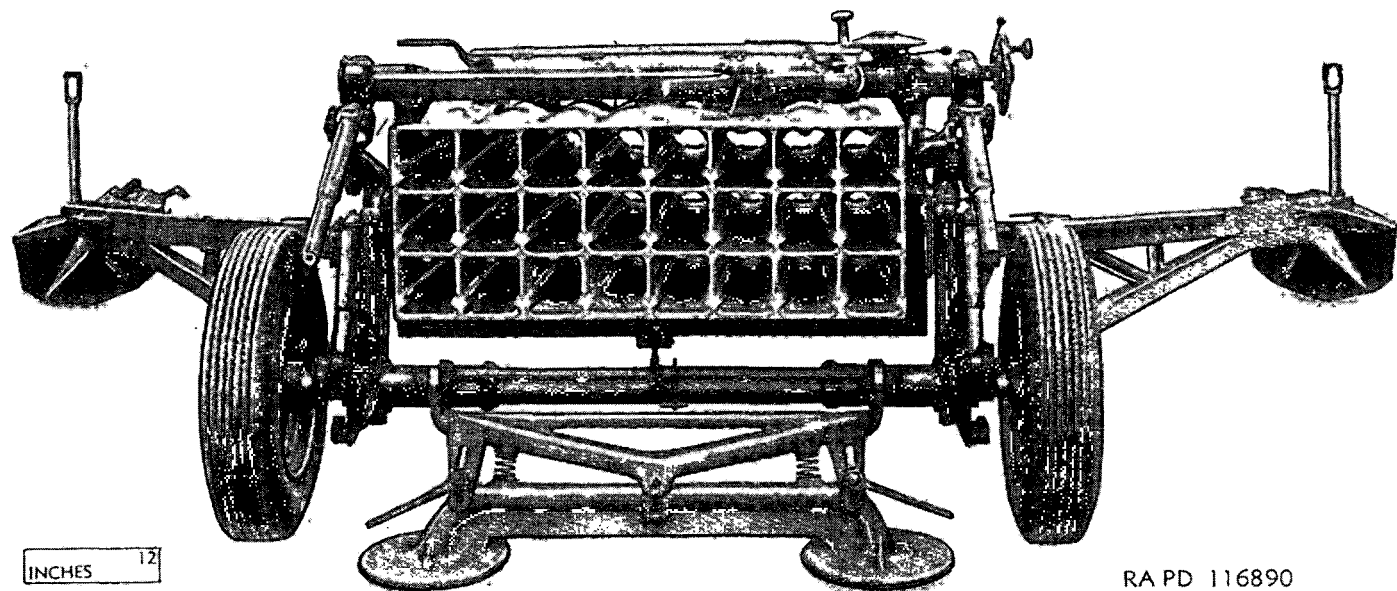


Figure 9. 4.5-inch multiple rocket launcher M21 (T106E1).

g. 4.5-INCH LAUNCHERS FOR SHROUDED-FIN ROCKETS. (NAVY TYPE). Launchers for the barrage type of rocket may consist of assemblies of box-type rails or metal tubes, or may be double-rail type with an automatic gravity feed magazine. A knife-edge contact for the forward fin shroud provide a live contact; the ground contact to the rear fin shroud also serves as a back stop. For further information, see TM 9-394.

h. 4.5-INCH LAUNCHERS FOR SPIN-TYPE ROCKETS (ARMY TYPE). Launchers for 4.5-inch spin-type rockets (fig. 8) consist of an assembly of metal or plastic tubes each of which has three internal ribs or rails, and a back stop to hold the rocket in firing position. Plastic tubes have two spring-type electrical contacts, and metal tubes have single contact, the tube itself serving as the ground contact. For further information, see TM 9-392. Launcher, rocket, multiple, 4.5-inch, M21 (T106E2) (fig. 9), which is similar to the T66 series launchers, is standard.

i. POST LAUNCHERS. This type (ARL Mk 5-Navy) consists of front and rear pairs of posts attached to base plates, which are, in turn, attached to the underside of airplane wings (figs. 56, 57, and 58). The number of pairs used is suited to the type of plane. This type of launcher is designated the "zero-length" because the rocket is free of the launcher after one-half to 3 inches of travel from its initial position. The rocket (Navy fixed-fin type) can be attached to the front post with a button-type stud and to the rear post by means of a loop-type lug. The fuze-arming control is built into the front post, and a latch and pigtail (the electric cable and plug) receptacle is built into the rear post. Late modifications of this type of launcher contain a spring-operated latch which is actuated by a lanyard attached to the rocket motor electric igniter cable. The spring-operated latch eliminates the necessity for shear wires used with earlier types.

j. T-SLOT LAUNCHER. This type of launcher (ARL Mk 4-Navy) (fig. 55) consists of an assembly of single rails, each of which has a T-slot running its entire length for engaging button-type suspension lugs. A spring catch at the rear serves as a back stop and allows the entry and removal of the suspension lugs. An electrical receptacle for the rocket igniter plug and a hook for attaching the igniter cable are mounted at the rear of each rail. A snap for the attachment of the arming wire is mounted on the side of each rail near the mid-point.

k. RETRACTABLE JETTISONING LAUNCHER. This type, shown in figure 64, consists of front and rear post mechanisms installed in an airplane. The front mechanism consists of a retracting post which may be caused to protrude from the lower surface of the wing. In the bottom of the forward post is a $\frac{3}{8}$ -inch hole into

which a rearward pointing finger attached by a band to the 5.0-inch high velocity aircraft rocket, as modified (par. 69) for these launchers by rocket-kit M34, may be inserted and held by a shear wire. The rear mechanism consists of the rear posts, carrying lead wires from the source of electricity in the airplane, which protrudes from the lower surface of the wing and which extend into tubular electrical sockets provided on the edges of the rocket fins at the rear. A second rocket may be hung under the first rocket; the finger on the forward band is hooked into a hole on the bottom of the forward band of the first rocket, and two fins of the second rocket engage slots in the leading edges of fins of the first rocket. Near the leading edge of the airplane wing, there is a bomb-arming control from which fuze arming wires extend to the nose fuzes of the rockets. Provision is made in the forward post for jettisoning the rockets.

l. 7.2-INCH MULTIPLE LAUNCHER. Launcher M24 for the 7.2-inch rockets consists of a 24-rail cluster arranged for mounting on a 2½-ton 6 x 6 cargo truck furnished by the using services. Traverse is accomplished by changing direction of the truck.

12. Expendable Launchers

One general type of expendable launcher, consisting of a shipping tube with tripod mount and represented by the M12 series for 4.5-inch rockets (figs. 10 to 13), is in current use. Long wires are connected with the igniter leads to provide for firing from a safe distance. The M12 type launcher consists of a plastic or metal alloy tube in which the rocket and fuze are shipped, and a light adjustable tripod for mounting. Sights and mounting clamps are assembled to the launcher as shipped, and accessories, such as spades, batteries, and reels of wire, are packed in the spacers within. In using this type of launcher the covers are removed and the rocket is fuzed. The tripod then is set up and adjusted

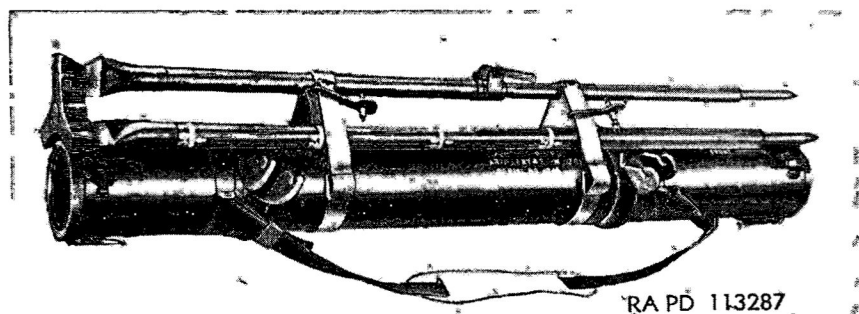


Figure 10. 4.5-inch launcher M12A1—as issued.

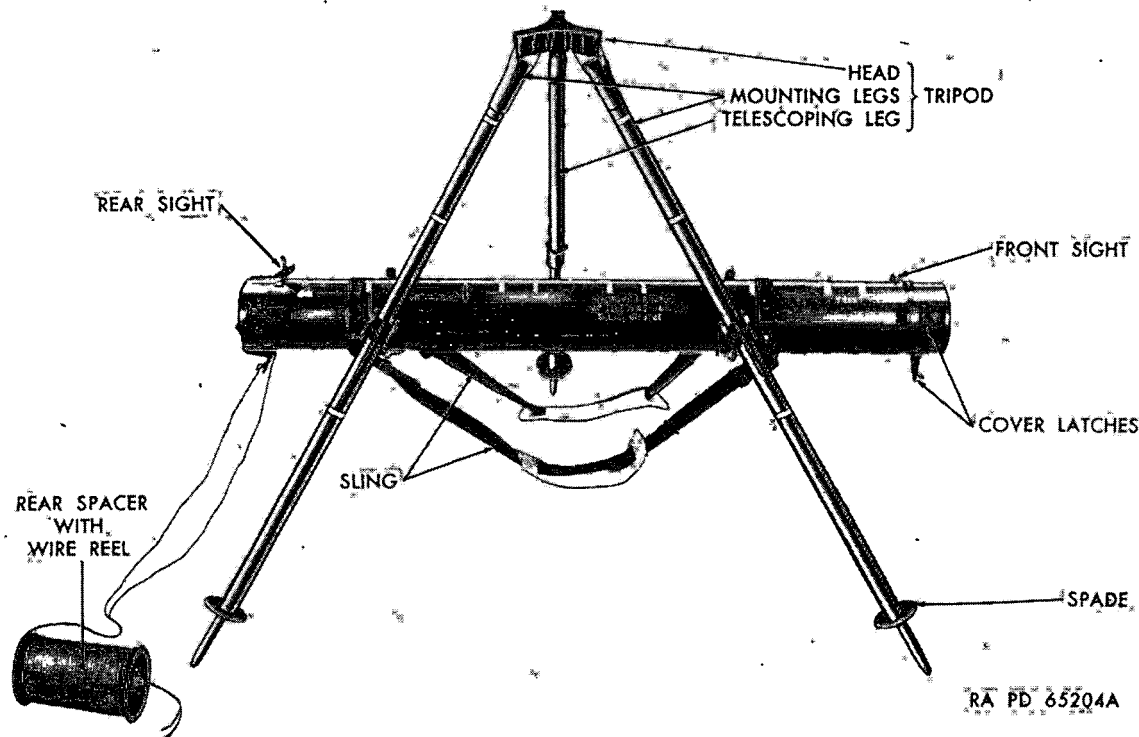


Figure 11. 4.5-inch launcher M12A1—emplaced.

and the launcher attached and aimed. The lead wires are unreeled to reach a safe firing position and the rockets are fired alone or in salvo by means of the batteries or magneto-type firing device. For further information, see TM 9-394.

13. Inspection Prior to Use

When rockets are unpacked in preparation for use, the following conditions should prevail:

a. All safety devices, such as safety wires, safety pins, short-circuiting devices (shorting strips or clips, and the like) should be in place.

b. Motors should be free of serious dents, and fins should be straight.

c. Motor sealing disks and caps should be securely in place. Loose disks may be replaced and the rocket used if it can be ascertained that no moisture or other foreign material has entered the motor.

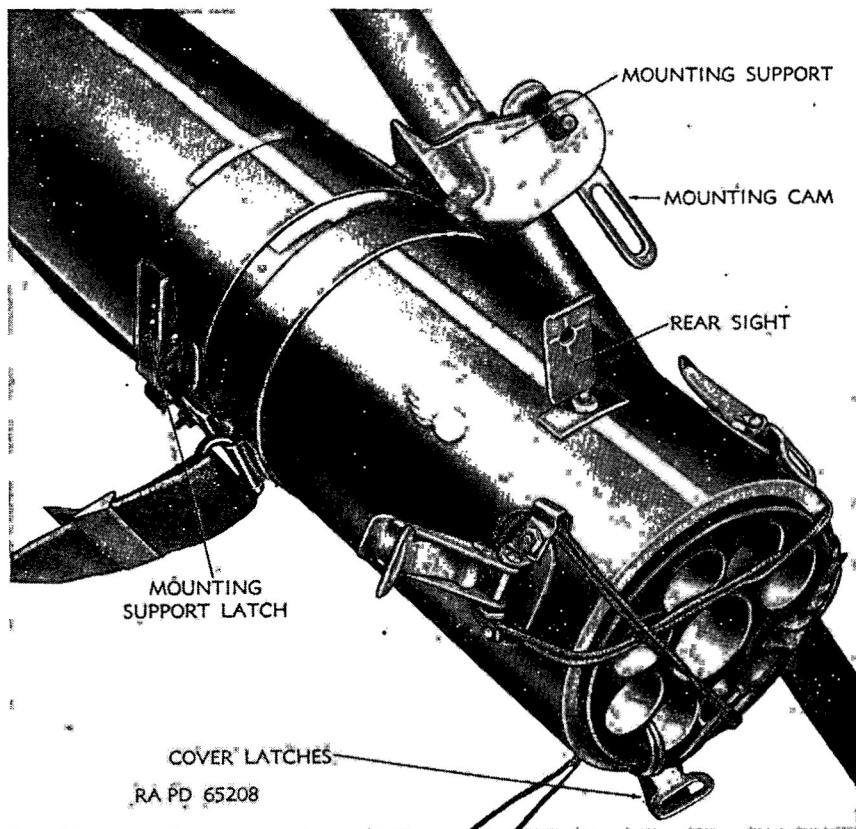


Figure 12. 4.5-inch launcher M12A1—breech detail.

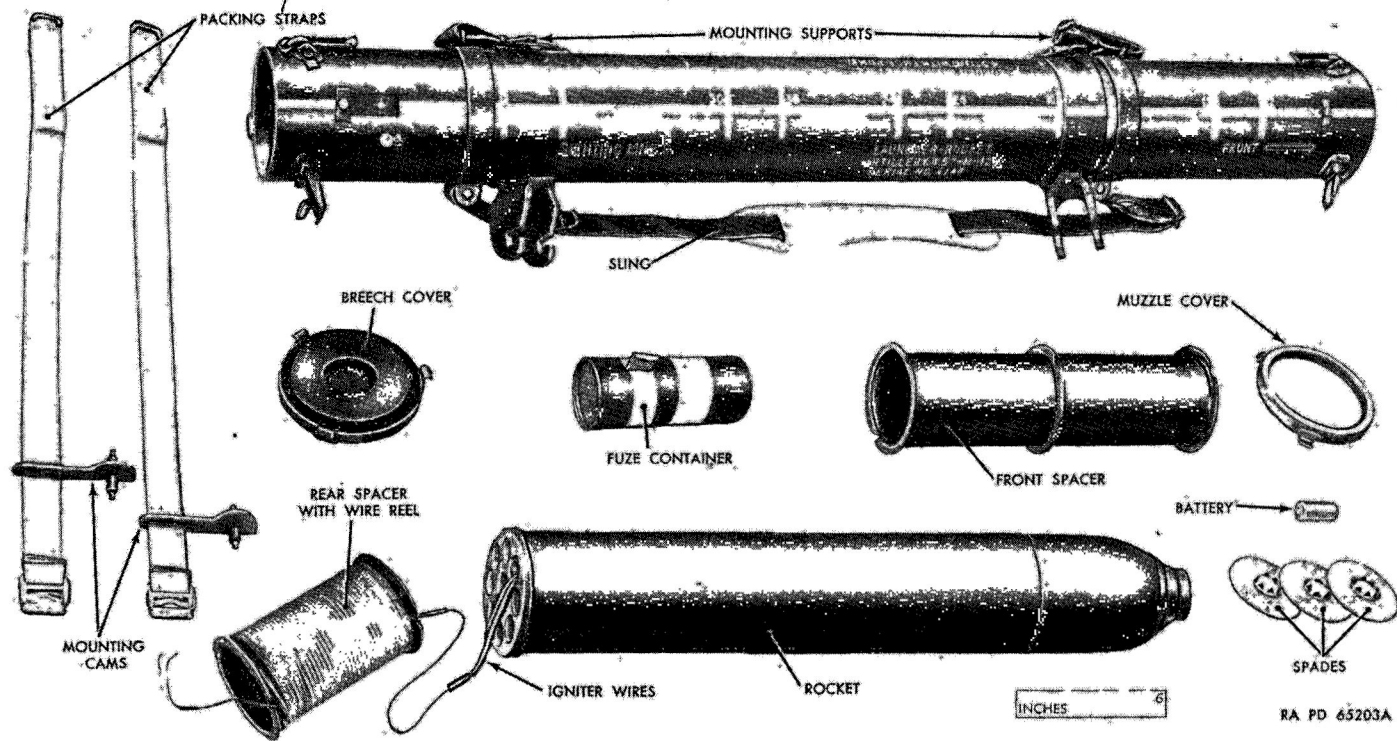
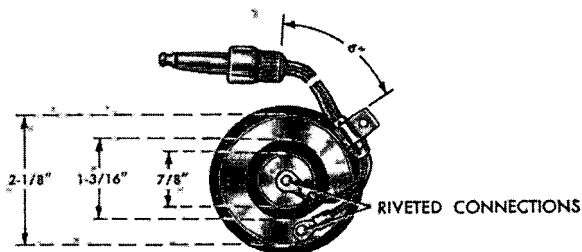
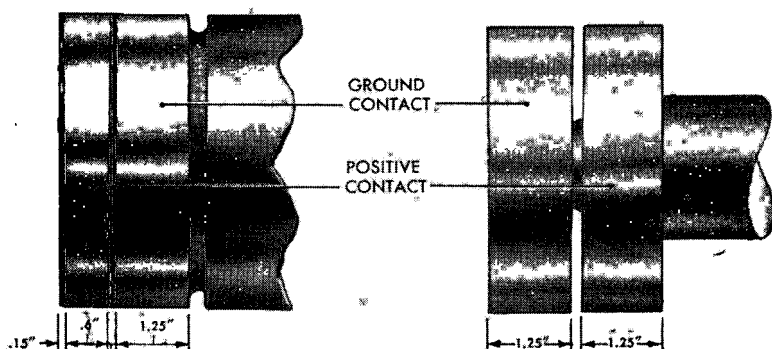


Figure 13. 4.5-inch launcher M12A1—components and ammunition.

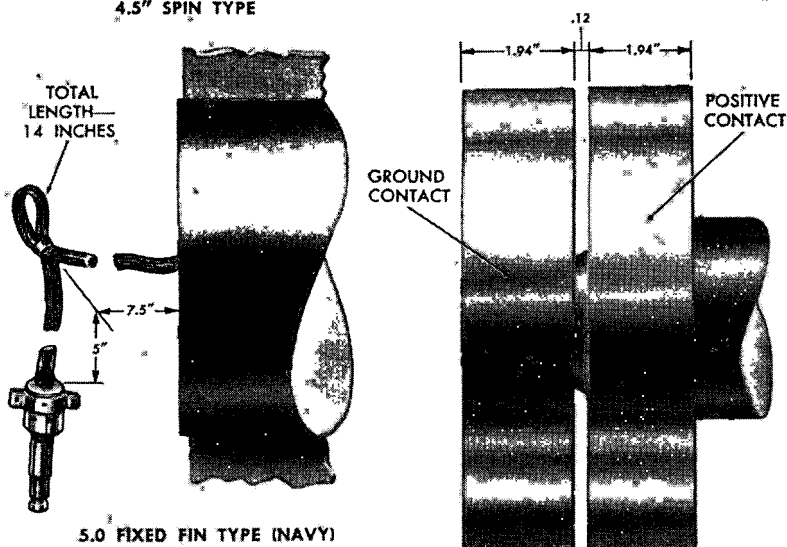


T22
4.5-IN. FOLDING FIN TYPE



4.5" SPIN TYPE

4.5 SHROUDED FIN TYPE (NAVY)



5.0 FIXED FIN TYPE (NAVY)

RA PD 113286A

7.2-IN. SHROUDED FIN TYPE (ARMY)

Figure 14. Electrical contacts of rockets.

d. All components should be free of corrosion, dirt, grease, or other foreign material. This applies particularly to electrical contacts (fig. 14), mating threads, and fuze seats.

e. Temperature range, marked on the rocket, should not be exceeded at the time of use or for several hours prior to use.

f. Exuding high-explosive heads may be cleaned and used; leaking chemical heads and exuding motors should be carefully segregated and destroyed.

g. Rocket heads designed for base fuzes should be inspected for presence of the fuze.

Caution: Rockets of this type will not be fired under any circumstances unless the base fuze is in place; if the fuze is not in place, a premature will occur should the rocket be fired.

14. Testing Circuit Continuity of Rockets

a. GENERAL. The following requirements will apply wherever electrical energy is applied to the ignition system of a rocket for testing circuit continuity:

- (1) The device selected for testing purposes will not be used unless prior approval has been obtained from the chief of the technical service concerned.
- (2) Testing operations will be conducted in an area where it has been determined that there is no possibility of induced currents from other sources of electricity initiating the unit under test.
- (3) To provide maximum protection to personnel and property in the event of an incident during testing operations, the unit tested will be placed behind substantial structures (capable of withstanding the full thrust of the rocket motor), held rigidly, preferably in a vertical position, nose down, in such a manner that flight will be prevented in the event of an accidental motor function. In addition, a proper vent must be provided to dissipate hot gases from the test bay to open atmosphere should the propellant explosives contained in the motor become ignited.
- (4) Test connection arrangements will be conducted in such manner that no individual is exposed to the unit at the time of the test. Mirrors or other remote control features should be utilized to perform testing operations.

b. TESTER, CIRCUIT CONTINUITY, W/CARRYING CASE.

- (1) The circuit continuity tester-17-T-5505-57 (fig. 15) is issued for testing the electric components in rockets. These testers provide a means for determining definitely whether or not the electric circuit in the rocket motor

is defective. When the resistance of a circuit is "high" or "low" as shown on the tester scale, the rocket will not be used.

- (2) The circuit continuity tester is an electric instrument based on the Wheatstone bridge principle. The instrument consists of a meter, a switch, two external sockets, a battery, and two test leads.
- (3) The meter (fig. 15) on the instrument indicates the resistance in ohms of the electric circuit in the rocket motor. A double scale is provided. The lower scale, marked "HVAR," is to be used only for the 5.0-inch HVAR rocket and the 11.75-inch AR rocket with the switch in the "ROCK CONT HVAR ONLY" position. These two rockets contain two electric igniters wired in parallel and, therefore, require a separate scale on the meter. The upper scale indicates the resistance of the electric circuit for all other rockets. An adjusting screw is located below the dial for use in zeroing the pointer before using the instrument. The pointer is zeroed by turning the screw slowly and carefully so that the pointer rests directly over the index mark centered over "OK" on the dial, the switch being in the "OFF" position.
- (4) An army socket and a navy socket (fig. 15) are located on the side of the instrument for insertion of rocket igniter plugs.
- (5) The two test leads (fig. 17) issued with the instrument terminate in an army plug on one end, each of the other ends having a prod. These leads are used for testing rockets the lead wires of which are not connected to a standard plug. The army plug on the test leads must be connected to the army socket and the prods used to contact the electric terminals (contact rings, shrouds, or disks) of the rockets.

c. To CHECK THE BATTERY.

- (1) With plug removed from socket, turn the switch to "BATT CHECK" and note the reading on the dial. Turn the switch to "OFF."
- (2) A good battery is indicated by a pointer deflection to the right of the line marked "BATTERY OK."
- (3) A low battery is indicated by a pointer deflection to the left of the line marked "BATTERY OK."
- (4) If necessary to replace a battery, do so as follows:
 - (a) Unscrew the four screws in the corners of the instrument.

- (b) Lift the face of the instrument away from its base and turn the face over (fig. 16).
- (c) Remove the battery from its clips.
- (d) Replace the battery with a Signal Corps battery BA-42. When putting in the new battery, make sure that the center terminal of the battery is toward the long battery holder, marked with a red dot.
- (e) Replace the cover on the instrument.

d. TO TEST ELECTRIC CIRCUITS OF ROCKETS.

Caution: NEVER connect the tester to equipment that contains batteries or other sources of electricity.

(1) *Rockets with electric plugs.*

- (a) Check the battery in accordance with c above.
- (b) Turn the switch to the type of rocket being tested. For 5.0-inch HVAR rockets and 11.75-inch AR rockets, turn the switch to "ROCK CONT HVAR ONLY." For other rockets, turn the switch to "ROCK CONT."
- (c) Plug the rocket into the appropriate socket on the instrument. Note the movement of the pointer on the meter.
- (d) If the pointer comes to rest within the space marked "OK" the rocket is satisfactory for use. Do not use the rocket if the pointer comes to rest within the "LOW" or "HIGH" sections of the scale.
- (e) Remove the rocket plug from the socket and turn the switch to the "OFF" position.

(2) *Rockets with contact rings, shrouds, or contact disks.*

- (a) Test the battery in accordance with c above.
- (b) Connect the army type plug of the test leads firmly into the army socket on the instrument.
- (c) Turn the switch to "ROCK CONT."
- (d) Remove shorting strip or clip from rocket. Touch one prod of the test lead to one shroud, one contact ring, or one contact disk of the rocket. At the same time touch the other prod to the other shroud, contact ring, contact disk, or body of the rocket and note the movement of the pointer.
- (e) If the pointer comes to rest within the space marked "OK," the rocket is satisfactory for use. Do not use the rocket if the pointer comes to rest within the "LOW" or "HIGH" sections of the scale.
- (f) Remove the prods from the rocket and remove the test leads from the instrument. Turn the switch to "OFF." Replace shorting clip or strip on rocket.

(3) 2.36-inch, 3.25-inch, 3.5-inch, 4.5-inch, and 7.2-inch rockets.

(a) Test the battery in accordance with *c* above.

(b) Connect the army type plug of the test leads firmly into the army socket on the instrument.

(c) Turn the switch to "ROCK CONT."

(d) Withdraw the igniter wire from the tail fin of the rocket and wrap the uninsulated portion of this wire several times around one of the prods of the test lead. Make sure that the igniter wire does not touch the tail fin of the rocket. Touch the other prod to the tail fin of the rocket at a point where the bare metal is exposed. If completely painted over, scratch the metal with the prod. Note the movement of the pointer.

(e) If the pointer comes to rest within the space marked "OK," the rocket is satisfactory for use. Do not use the rocket if the pointer comes to rest within the "LOW" or "HIGH" sections of the scale.

(f) Disconnect the prods from the rocket and remove the leads from the instrument. Turn the switch to "OFF."

e. CAUTIONS.

(1) Keep switch in "OFF" position at all times when the instrument is not in use. Failure to do so will cause the battery to run down.

(2) Handle the instrument carefully at all times to prevent damage to the internal and external parts.

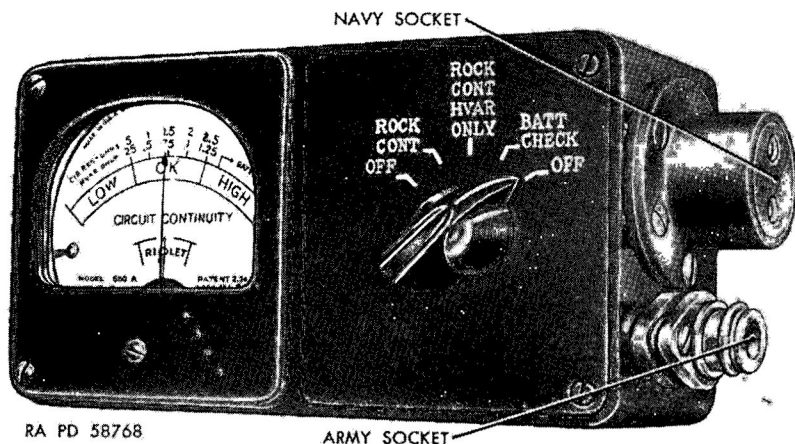


Figure 15. Circuit continuity tester 680A.

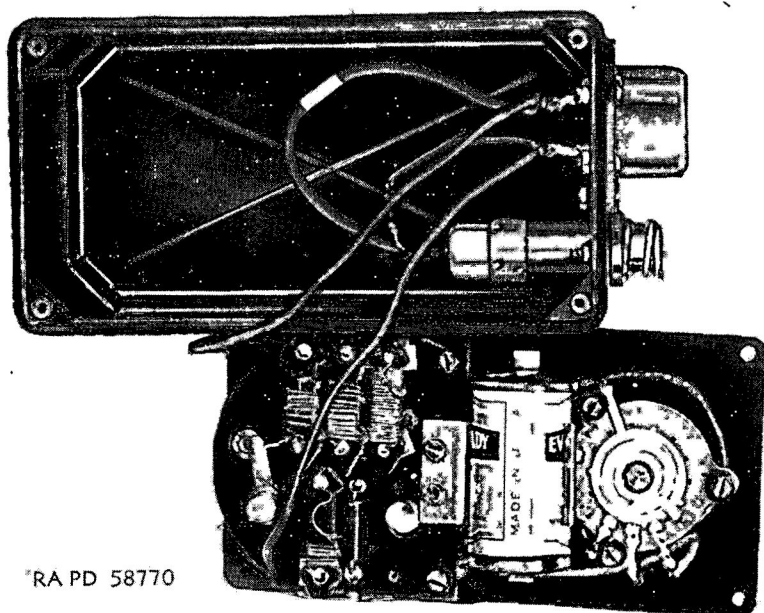


Figure 16. Circuit continuity tester 680A—interior.

- (3) Prevent the instrument and carrying case from getting wet.
- (4) When placing the instrument in the carrying case, make sure the meter end is towards the bottom.

15. General Precautions

a. Rockets, in common with other types of ammunition, are designed to be as safe in handling as is consistent with their function, and are packed to withstand all conditions ordinarily encountered in storage and transit. In order to insure that the ammunition will be in serviceable condition when required for use and to provide the highest possible protection to personnel and matériel, the precautions outlined in this paragraph and in paragraphs 16 and 17, which apply to all rockets, and the precautions specified in the description of each item will be observed.

b. Boxes of ammunition should not be handled roughly, dropped, slid, tumbled, "walked" on the corners, or struck, as in lining up a stack.

c. Rockets should be protected from sources of high temperatures such as steam lines and direct sunlight. Rockets will not

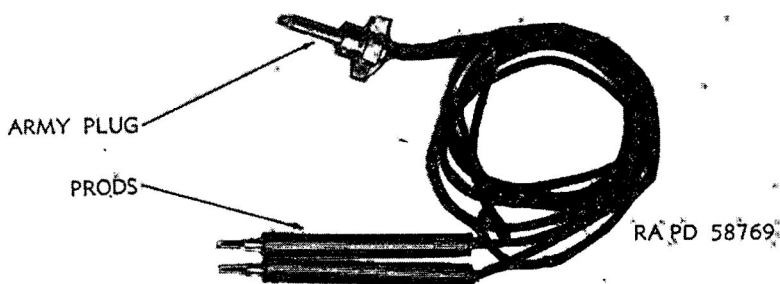


Figure 17. Test leads for tester 680A.

be stored where the temperature may exceed 120° F. Rockets which are known to have been exposed to a temperature higher than that indicated as their upper limit (firing temperature limits are marked on the item) for more than 2 hours will not be fired until they have been cooled down. They will be placed in cool storage until they have returned to a safe temperature, when they then may be fired. Rockets should not be exposed to extreme, rapid, and recurrent variations in temperature which exceed the temperature limits prescribed for them. Rockets that show signs of serious deterioration, as a result of exposure to extremes of temperature, will not be fired.

d. Since explosives are adversely affected by moisture, do not break the moisture resistant seal on the container until ready to use the rocket. Rockets removed from airtight containers, particularly in warm damp climates, are subject to accelerated corrosion and deterioration, thereby causing them to become unserviceable.

e. Rockets, components of which are issued separately, should not be assembled in advance of anticipated requirements, and those assembled for use but not used will be returned to their original condition and packings.

f. Safety devices will be removed, as specified, in preparation for firing, but at no other time.

g. Packings will not be opened until the items are required for use or for inspection. Partly used containers and repacked items will be resealed and marked. They will be used first for subsequent requirements, in order that stocks of opened packages may be kept to a minimum.

h. Damaged packings will be repaired or replaced, and special care will be given in transferring all markings to new parts of the container.

i. Packings will not be opened, repaired, or replaced within 100 feet of a magazine or other store of explosives.

j. No rocket or component will be disassembled except as specifically authorized by the chief of the technical service concerned.

16. Precautions in Storage, Handling, and Use

a. STORAGE.

- (1) The composition of rocket propellants is such that they are somewhat more susceptible to deterioration than other types of propellant powders, if stored under adverse storage conditions. They should be stored in a dry cool place, if possible, never in the direct rays of the sun. They should not be stored where temperatures are beyond the limits marked on the rocket. The prolonged exposure of rocket motors to either high or low temperatures will increase the normal rate of deterioration, or render the propellant more susceptible to malfunction if subsequently handled improperly.
- (2) Separate rocket heads will be stored in accordance with regulations in TM 9-1900 for items of comparable loading, that is, HE-loaded heads as class 10, WP-loaded heads as class 2, and FS-loaded heads as class 11.
- (3) Rocket motors that are closed at the forward end with a closure having substantially the same strength as the motor body will be treated as rockets. Double-base rocket propellants are sensitive and on strong initiation may detonate rather than burn; as a consequence, separate rocket motors will be stored the same as fixed rounds (class 4), with the propellant computed as high explosive.
- (4) Separately issued rocket fuzes are stored as class 6 fuzes.
- (5) When rockets are assembled, they are similar to rounds of fixed artillery ammunition with two important exceptions. The first, as noted above, is that the propellant will detonate if the head detonates; as a consequence, the weight of the propellant must be added to the weight of the high-explosive filler in computing quantity-distance requirements. The second exception is that, if involved in a fire, the range of the rocket is not limited as in the case with other fixed rounds; on ignition, whether in its launcher or wherever located, the rocket is accelerated as when normally fired but in whatever direction it may be pointed at the instant of ignition. As a consequence, the range of the rocket must be added

to the effective radius of the shell burst in computing fragmentation or missile distances. High-explosive rockets are stored as class 10 except the T22 which is in class 4. Rockets other than high explosive are in class 4.

- (6) Assembled rockets should be stored with the rockets all pointing in one direction, preferably nose down or toward a barricade, that is, in the direction likely to cause the least damage in the event of accidental ignition of the propelling charge.
- (7) Rocket components ordinarily will be stored as shipped. Those components shipped in one packing may be stored together, and those shipped separately should be stored separately. However, rocket heads and motors may be stored together.

b. HANDLING AND USE.

- (1) Care should be taken to protect rockets from excessive heat, including direct rays of the sun. If heated to extremely high temperatures, they will ignite. However, spontaneous ignition is not at all likely if they are stored, even for several hours, at temperatures up to 200° F. Prolonged storage at these high temperatures and also at lower temperatures (between 120° and 150° F.) causes increased rate of deterioration of the propellant and, therefore, should be avoided.
- (2) The upper safe temperature limit marked on rockets is the maximum temperature at which the rockets should be fired. If fired at higher temperatures, pressures will be produced which exceed the design strength of the metal parts. The lower temperature limit is the minimum temperature at which the rockets should be fired. If fired at lower temperatures, the flight of the rocket may not be regular and dependable. Therefore, all rockets should be used only within the designated temperature range. If, in an emergency, rockets must be used beyond the temperature limits marked on the rockets, appropriate allowance should be made for malfunction as some may be expected.
- (3) If any change is made to an item or its packing, which may be done only by authority of the Chief of Ordnance, the item and the packing (if it is repacked) will be marked in accordance with such change. The original or previous markings will not be altered.
- (4) Care should be exercised to avoid denting the motor or bending the fins. Serious dents may cause dangerous pressures; bent fins will cause erratic flight.

- (5) Assembled rockets should not be stood on the tail or base as this may damage fins, electrical connections, or motor seals.
- (6) Care should be exercised in firing through a screen of brush or trees. Impact with a twig or branch may deflect the rocket or cause it to detonate.
- (7) In making electrical connections, care should be exercised to see that connections are good and that uninsulated sections are protected against short circuit. Before making such connection, tests must be made to insure that the circuit to which the connection is to be made is not energized.
- (8) The danger area from the blast of ground-launched rockets is illustrated in figure 18. The burn-out distance is given in the data table for each type. In some cases, the propellant burns out before the rocket leaves the launcher; in others, the propellant may continue to burn as much as 140 yards in front of the muzzle of the launcher. Personnel should not be permitted in the danger area after the launcher is loaded and prepared for firing, unless protected by adequate shelter. Ammunition and inflammable material should be given the

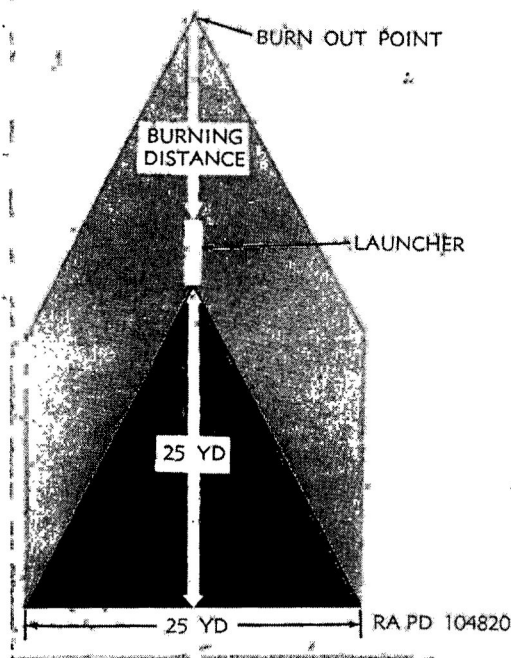
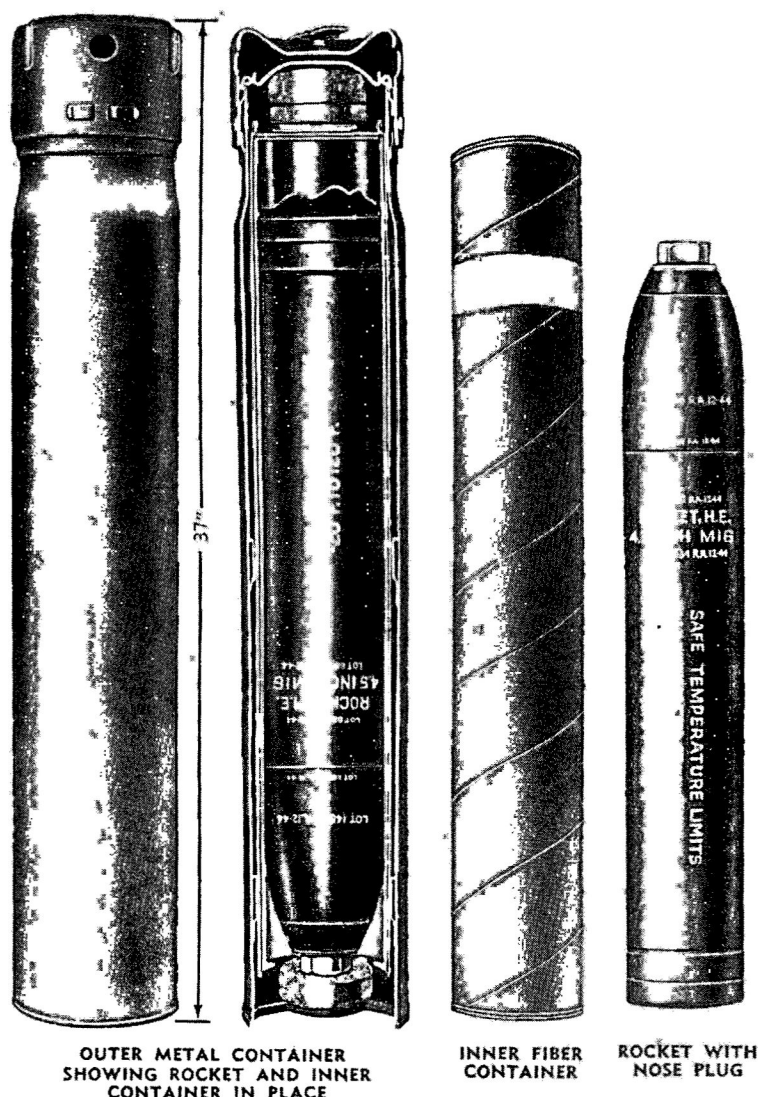


Figure 18. Blast danger area.

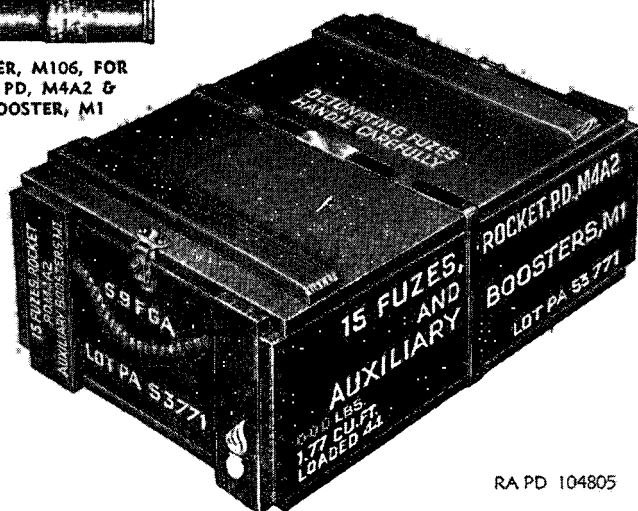
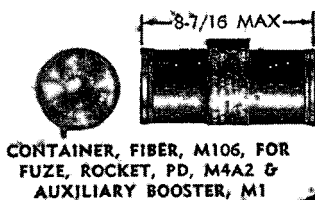


RA PD 113268

Figure 19. Packing—outer metal and inner fiber container.

same protection as personnel. If practicable, the danger area should be cleared of dry vegetation and other inflammable material before firing.

- (9) To avoid possible injury by accidental ignition of the rocket during loading, care should be exercised to see that the loader does not stand directly behind the launcher and rocket.



RA PD 104805

Figure 20. Fuze packing.

17. Misfires, Hangfires, and Duds

a. MISFIRES AND HANGFIRES.

- (1) A misfire is a failure of the propelling charge or igniter to function when the firing mechanism is operated in the normal manner. A hangfire is a temporary failure to function—that is, there is an unexpected delay between operation of the firing mechanism and ignition of the propelling charge.
- (2) Since misfire and hangfire cannot be distinguished immediately, any failure to fire will be regarded as a hangfire until sufficient time has elapsed to render the existence of a hangfire distinctly improbable. Such time ranges from 5 seconds for 2.36-inch rockets to 2 minutes for 4.5-inch rockets and larger.
- (3) A failure to fire may be caused by failure of electric power from weak batteries or generator, by poor connections in the firing circuit, by short circuit in the firing circuit, by broken lead wires, by faulty squib in the igniter, or by moisture in the igniter powder or propellant.
- (4) After a failure to fire, several more attempts should be made to fire. If the malfunction persists, the safety interval should be observed and then the launcher may

be approached from the side. The firing circuit should be examined for good contact and for short circuits. If, after checking, the rocket still fails to fire, the launcher should be unloaded (after observing the hang-fire interval), safety devices should be replaced, and the rocket turned in for disposition with a report of the malfunction.

- (5) During hangfire intervals and examination of firing circuit, the launcher should point towards the target, and personnel should keep clear of blast area.

b. DUDS. A dud is an item of ammunition which has been projected but has failed to function. A dud must be regarded as liable to function at any time. Unless the cause of the malfunction is evident without moving the dud (for example, failure to remove safety pin or fuze dropping off in flight), the dud will not be moved but will be destroyed in place by authorized personnel in accordance with the provisions of TM 9-1900.

18. Packing

Small rockets are packed as assembled complete rockets in sealed fiber or metal containers which, in turn, are packed in wooden boxes. Medium caliber rockets are packed, some unfuzed, others fuzed, in fiber containers which then are packed in metal containers (fig. 19) or wooden boxes. Large caliber rockets are shipped with head and motor unassembled. Complete rockets may be shipped unassembled in one box or components may be shipped separately. Rocket nose fuzes are packed in individual sealed containers which, in turn, are packed in boxes (fig. 20). Base fuzes are shipped assembled to the rocket head. Dimensions, weights, and other packing and shipping data are published in the Department of the Army Supply catalog, ORD 11 SNL S-9.

CHAPTER 2

GROUND TYPE ROCKETS

Section 1. 2.36-INCH ROCKETS

19. General

a. GENERAL DESCRIPTION. The 2.36-inch rocket (figs. 21 and 23) consists of a head and motor and fin assembly. This assembly consists of the motor with integral (silver-soldered) base fuze and the fin assembly. The head and the fin assembly are full caliber in diameter; the motor tube is approximately one-half caliber in diameter. The M6 (HE, AT) series, the M7 (practice) series, and the MIO (WP) series are used in the M9A1 and M18 launchers.

b. HEAD. The rocket head, which carries the high-explosive or chemical charge or inert filler, is rounded (or in some instances flattened) at the nose. Detailed descriptions are given in this section in the paragraph on the specific model.

c. MOTOR AND FIN ASSEMBLY. The motor body, which carries the propelling charge and igniter, is closed at the forward end by a brazed-on or soldered-on base fuze. The forward end of this fuze is threaded externally to receive the rocket head. The fin assembly is welded to the outside of the nozzle which is screwed to the rear of the motor body.

d. FUZE. The fuze consists of a simple inertia plunger carrying a firing pin, a creep spring, a primer-detonator, and in high-explosive rockets a tetryl booster. For safety in handling, the firing pin is held in the "safe" position by a safety wire, which passes through the body of the fuze and the firing pin plunger, and clips around the motor body (fig. 39). The safety wire is a simple wire clip in earlier models and a waterproof band type in later models (fig. 40). The sensitivity of fuzes is shown by the fact that if the safety wire were removed, a blow equivalent to dropping the rocket on normal ground on its nose from a height of 2 to 4 feet, dependent upon the particular modification, will cause the firing pin plunger to strike the primer with sufficient force to operate the fuze. This type fuze is described in paragraph 50.

e. PROPELLING CHARGE AND IGNITER. The propelling charge consists of a group of longitudinally placed sticks of double-base

powder 4.42 inches long. The charge is ignited by an electric squib igniter which rests inside the group of powder sticks. Insulated copper wires from the terminals of the squib pass out through a plastic closing plug in the nozzle, which seals the motor against dirt and moisture. The wires are of unequal length; the short wire is soldered to a fin and the long wire, called the contact wire, is stripped of insulation near its outer end for attachment to the launcher terminal. To protect the contact wire during shipment and storage, it is coiled to take up the slack, and attached to a fin with tape.

Note. When considered necessary to test the continuity of the igniter circuit, test with circuit continuity tester (par. 14).

f. DATA.

Model	M6A3	M10A1, M6A3D	M10A2, M6A3F, M6A4, M6A5	M10A4, M6A6
Range (max) -----	700 yd -----	700 yd -----	700 yd -----	
Dispersion -----	6 mils -----	6 mils -----	6 mils -----	
Velocity (max) -----	270 fps -----	270 fps -----	275 fps -----	330 fps
Temperature limits ---	0° to 120° F. ---	20° to 120° F. ---	40° to 120° F. ---	
Burning time -----	0.08 to 0.03 sec			
Burn-out point (feet from muzzle) -----		Normally within the launcher from 70° F. and upward		

20. Rocket, HE, AT, 2.36-Inch, M6A6

This rocket is similar in many respects to the M6A5 described in paragraph 21. It differs principally in that it has the new type fin (fig. 22), an improved head, and a longer propelling charge weighing 61 grams which gives substantially greater power. The result is that this rocket has a velocity of 330 fps as compared with 275 fps for the M6A5, and its range is extended considerably.

21. Rocket, HE, AT, 2.36-Inch, M6A5

a. DESCRIPTION. This rocket (fig. 21) is 19.4 inches long and weighs 3.4 pounds. The head, which is 8.8 inches long and weighs 1.64 pounds, contains approximately one-half pound of 50-50 pentolite. The propellant is of the M7 type consisting of 5 cylindrical grains each three-eighths inch in diameter by 4.42 inches long and weighs 59 grams. The rocket has a rounded nose and a shrouded fin assembly. The fuze which is located at the forward end of the motor is the M401 (par. 50) and has a bore-riding pin which keeps the fuze unarmed until the rocket leaves the launcher. After ejection of the safety pin, the fuze may be ex-

pected to function by a blow on the nose equivalent to a drop of 48 inches on normal soil. Temperature limits are -40° to 120° F.

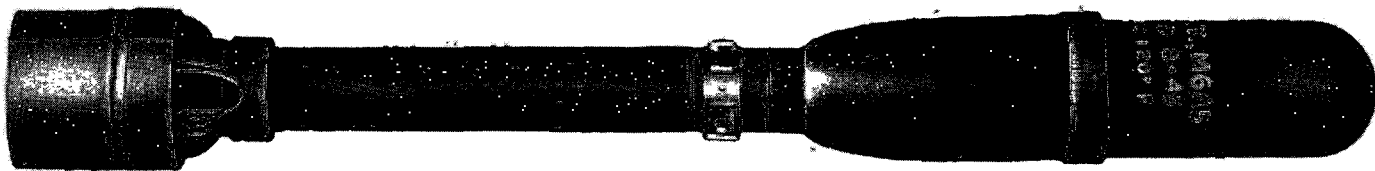
b. **EFFECT.** This rocket has effect against various targets as follows:

- (1) *Armorplate.* The thickness of armor that can be defeated by the rocket depends upon the quality of the plate and several other variables including the slope of the plate and the angle of fall of the rocket. The approximate thickness of homogeneous armor of average quality, which the rocket will defeat at various angles of positive slope and at selected ranges, are as follows:

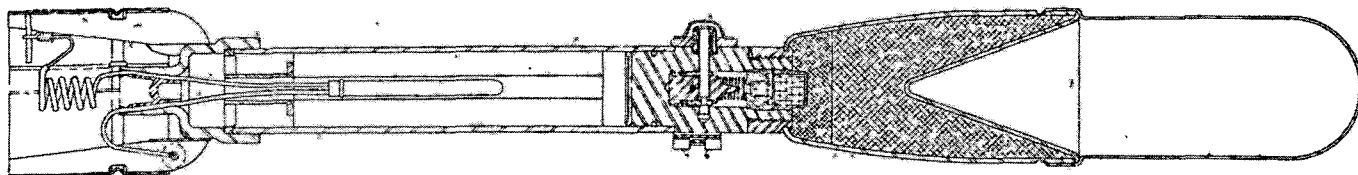
Slope of plate (degrees from vertical)	Approximate thickness (in) of homogeneous armor of average quality which will be defeated at ranges of				
	25 yd	100 yd	200 yd	300 yd	400 yd
60	$\frac{1}{2}$	$\frac{1}{2}$	1	3	4
45	1	$2\frac{1}{4}$	$4\frac{1}{4}$	$4\frac{1}{2}$	$4\frac{3}{4}$
30	$4\frac{1}{4}$	$4\frac{1}{2}$	$4\frac{3}{4}$	5	5
0	5	5	$4\frac{3}{4}$	$4\frac{1}{2}$	$3\frac{3}{4}$

A hole is blown through the armor and heated particles of metal are sprayed through in a cone-shaped pattern. Any ammunition within this pattern usually is exploded.

- (2) *Masonry.* Penetration of brick and masonry from several inches to a foot or more may be expected, depending on quality of structure.
- (3) *Structural steel.* Produces shattering effect against cast steel and such materials as girders and railroad rails. Produces extensive damage, probably irreparable, to motor blocks.
- (4) *Wood.* Penetration of timber from several inches to a foot or more may be expected, depending on the timber.
- (5) *Soil.* Impact with the ground at ranges below 300 yards ordinarily will result in a ricochet rather than a detonation. At ranges in excess of 300 yards, the angle of impact is steep enough to cause a detonation which resembles that of a 57-mm high-explosive shell. However, impact on the very soft material such as mud, soft sand, or water will not cause detonation of the rocket.
- (6) *Fragmentation.* Fragmentation and antipersonnel effects are somewhat greater than 60-mm mortar shell.



OLIVE DRAB (MARKING IN YELLOW)



RA PD 113289

Figure 21. Rocket HE, AT, 2.36-inch, M6A5

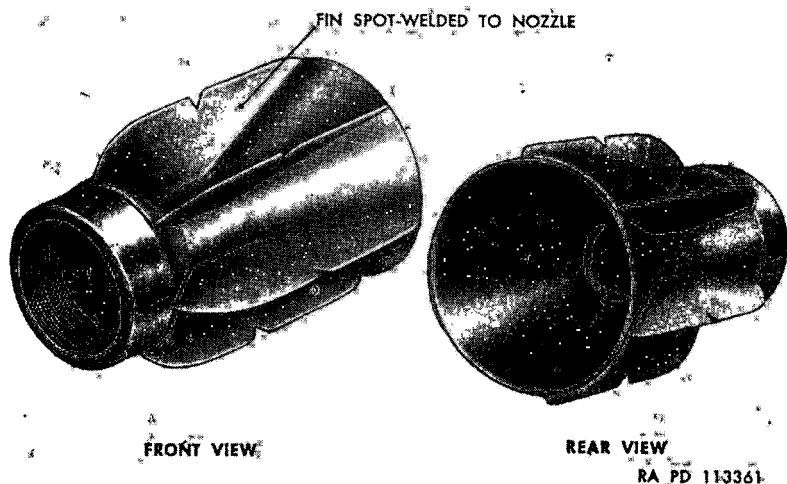


Figure 22. Nozzle and fin assembly—new type.

22. Rocket, HE, AT, 2.36-Inch, M6A4

This rocket differs from the M6A5 only in the fuze, which for the M6A4 rocket is the M400 base detonating fuze (par. 50). This fuze is identified by the safety pin, which is a wire, one end of which holds the firing pin in place; the other end is shaped to slip over the motor body, thus holding the safety pin in place (fig. 39). Temperature limits are the same as for the M6A5.

23. Rocket, HE, AT, 2.36-Inch, M6A3

This rocket and its modifications are similar to the M6A5 except that it is fitted with the old type simple inertia type fuze without bore-riding pin but with a wire type safety pin. Certain other differences of the modifications are described in paragraphs 22, 23, 24, and 25. The M6A3 uses a propellant which is composed of powder of an earlier type than that used in the M6A4 and M6A5. Temperature limits are 0° to 120° F.

24. Rocket, HE, AT, 2.36-Inch, M6A3C

In this model the detonator holder cover, a safety device for keeping the rocket relatively insensitive to short drops and shock after removal of the safety pin, is omitted from all 2.36-inch HE, AT rockets M6A3 produced after 26 March 1945. Rockets without this cover are designated M6A3C, and can be identified by a 1/2-inch white stripe painted all the way around the ogive just

above the bourrelët. Omission of this cover greatly increases the sensitivity of the rocket. It will function upon impact with hedges or heavy brush and, in most cases, on impact with soft ground. With safety pin removed, the M6A3C will function 100 percent of the time when dropped from a height of 11 inches, as compared with a drop of 78 inches from the M6A3 with detonator holder cover. Because of this added sensitivity, it is imperative that the rocket be handled with care after removal of the safety pin. The safety pin will not be removed until the rocket is partially inserted into the launcher, in accordance with the sequence of loading instructions given in FM 23-32. Temperature limits are 0° to 120° F.

25. Rocket, HE, AT, 2.36-Inch, M6A3D

The M6A3D is the same as the M6A3C except that the propellant is T1E1 (salted) powder, which has better burning characteristics at lower temperatures. The temperature limits for motors loaded with the powder are -20° to 120° F.

26. Rocket, HE, AT, 2.36-Inch, M6A3F

This model is similar to the M6A30 except that the propellant powder used is the M7, and the plastic nozzle closure is added. Temperature limits are -40° to 120° F.

27. Rocket, Smoke, WP, 2.36-Inch, M10A4

This rocket (fig. 23) is somewhat similar to the M10A2 (par. 28) except that it has a new type tail and longer propelling charge with resulting increase in velocity and range. It is a further modification of the M10A3 of which none were produced.

28. Rocket, Smoke, WP, 2.36-Inch, M10A2

a. DESCRIPTION. This rocket is 17.1 inches long and weighs 3.4 pounds. The head is 5.9 inches long and weighs 1.64 pounds. It contains 0.9 pound of white phosphorus. The propellant consists of 5 cylindrical grains of M7 powder, each three-eighths inch in diameter by approximately $4\frac{1}{8}$ inches long and weighs 59 grams. This model may be identified by markings and by its head. The fuze is the M401 base detonating type with clamp, the booster being replaced by a long detonator burster extending into the head (par. 50). The detonator charge weighs approximately 20 grams. Temperature limits are -40° to 120° F.

b. EFFECT. The WP smoke rocket bursts on impact to produce a spray of white phosphorus particles over a radius of 25 yards.

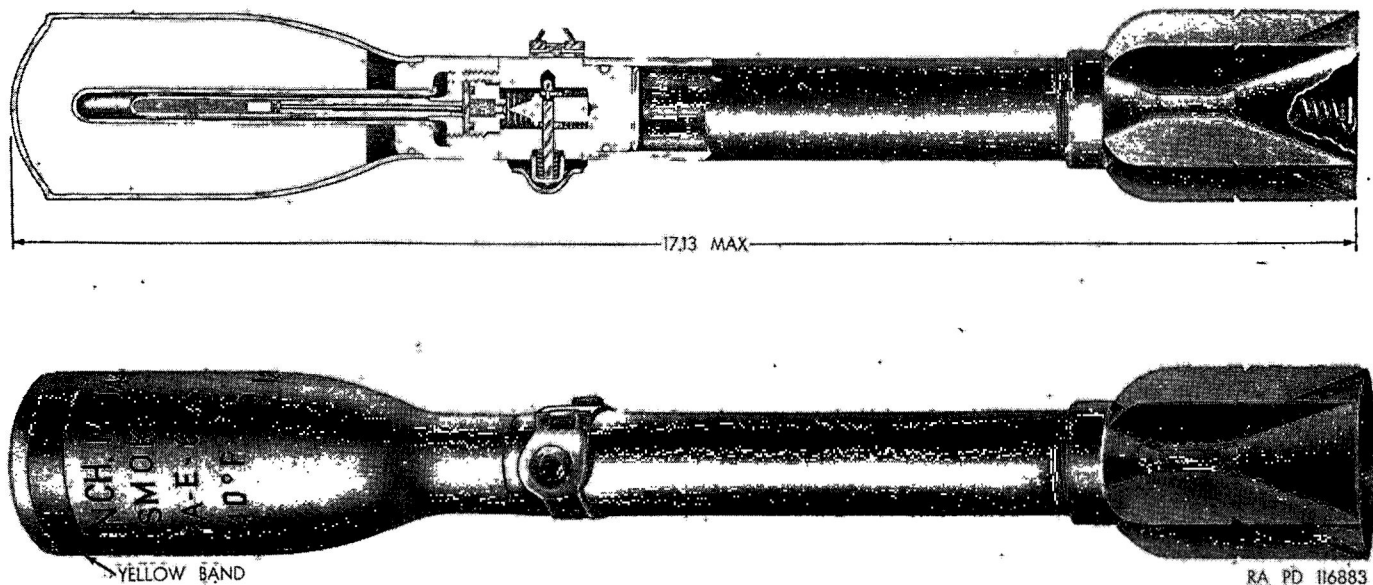


Figure 23. Rocket, smoke, WP, 2.36-inch, M10A4.

The phosphorus ignites spontaneously on contact with air and produces a dense white smoke. The smoke itself is harmless but the burning particles produce painful burns.

29. Rocket, Smoke, WP, 2.36-Inch, M10A1

This rocket is the same as the M10A2 except that it has the older type safety pin, the T1E1 (salted) powder is used in the propellant charge, and temperature limits are -20° to 120° F. The T1E1 powder gives better results at lower temperatures than early types of powder.

30. Rocket, Practice, 2.36-Inch, M7A7

Practice rockets of the M7 series are used to simulate the various modifications of the M6 series service HE, AT rockets for target practice. They have dummy fuzes. They are made up of the corresponding service type motors and an inert-loaded head of the same shape, weight, and center of gravity as the service round. The M7A7 simulates the M6A6 and has the same kind of motor.

31. Rocket, Practice, 2.36-Inch, M7A6

The M7A6 simulates the M6A3F, M6A4, and M6A5 service rockets. It has the same kind of motor which carries the M7 propellant, and has the same temperature limits, that is, -40° to 120° F.

39.

32. Rocket, Practice, 2.36-Inch, M7A5

This rocket simulates the service rocket M6A3D. The motor is loaded with the T1E1 salted powder and has temperature limits of -20° to 120° F.

33. Rocket, Practice, 2.36-Inch, M7A4

This rocket simulates the service rockets M6A3 and M6A3C. Temperature limits are 0° to 120° F.

34. Rocket, Practice, 2.36-Inch, M7A3

This rocket simulates the M6A3C. It differs from the other types of practice rockets in that the head is weighted with an internal iron cylinder. Temperature limits are 0° to 120° F.

Section II. 3.25-INCH ROCKETS

35. General

a. GENERAL DESCRIPTION. The 3.25-inch target rocket is designed to provide a fast-flying target for training of antiaircraft gun crews operating automatic weapons. It consists of a motor assembled in a long tubular body to which three large plywood fins are attached. The motor is assembled in the forward part of the body and contains a 3.2-pound propelling charge in the form of 18 single-perforated grains strung on the wires of a cage-like support. The individual grains are $\frac{7}{8}$ -inch outside diameter and 5 inches long. The igniter squib leads are brought out to the rear of the motor. The fins are shipped unassembled and are attached to the body by lugs. In order to provide a large target area, the fins are larger than necessary to stabilize flight. In firing in a cross wind, personnel should stand as far to the windward as practicable because the wind acting on the large fins causes the tail from which the blast emerges to point somewhat to leeward.

Note. When considered necessary to test continuity of igniter circuit, test with circuit continuity tester (par. 14).

b. DATA.

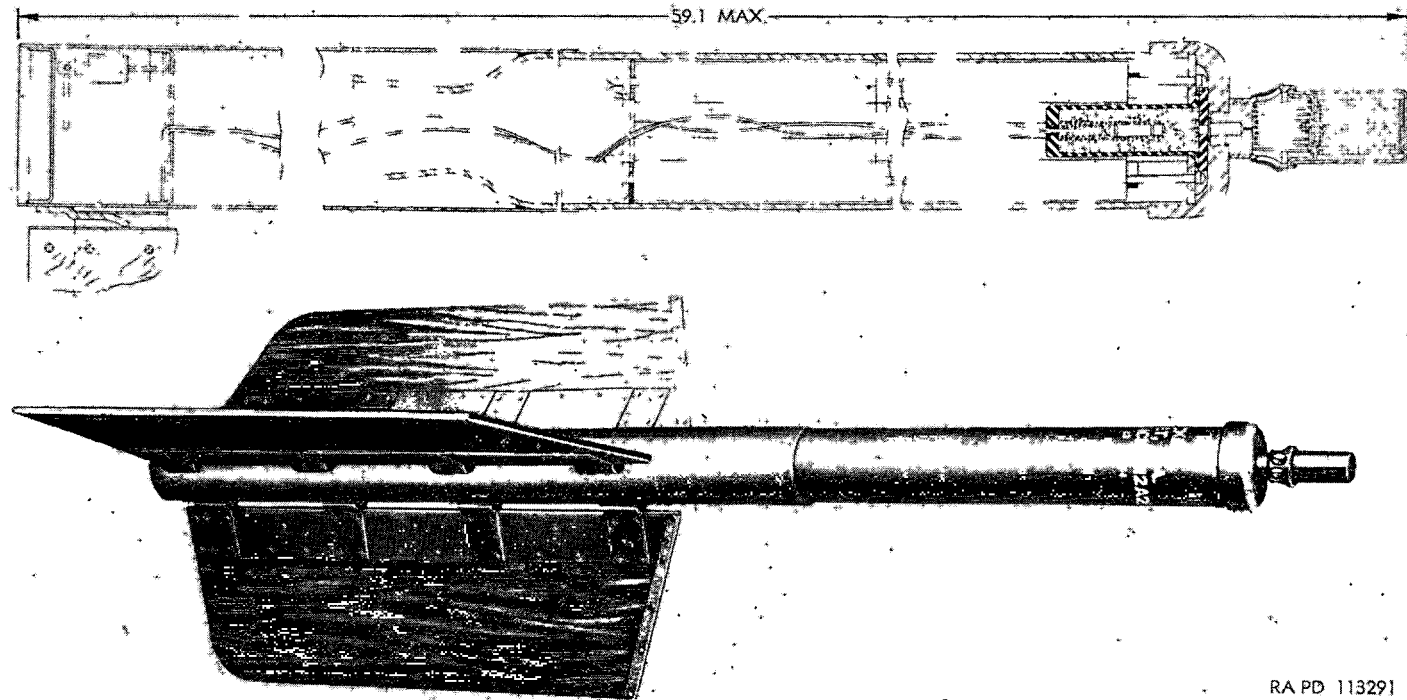
	<i>Model</i>	<i>M2</i>	<i>M2A2</i>
Range (max)	-----	1,700 yd	2,350 yd
Velocity (max)	-----	530 fps	645 fps
Temperature limits	-----	30° to 110° F.	30° to 110° F.
Burning time	-----	0.25 sec at 30° F. to 0.10 sec at 110° F.	0.25 sec at 30° F. to 0.10 sec at 110° F.
Burn-out point (feet from muzzle)	-----	75 ft	75 ft
Length	-----	59.1 in.	59.1 in.
Weight	-----	35.1 lb.	32 lb
Flare, burning time	-----		20 to 30 sec

36. Rocket, Target, AA, 3.25-Inch, M2A2

This rocket (fig. 24), which is for night practice, is characterized by a flat nose with the yellow light flare assembled thereto for increased visibility and easier spotting. The igniter consists of a charge of black powder in a plastic case in the nose. This model has the lead wires passing in turn through the nozzle and an inner fiber closing cup and is connected to a standard service plug, which is held by an outer fiberboard closing cup. Eighteen inches of igniter cable coiled between the closing cups, provides for withdrawing the plug for connection to the launcher.

37. Rocket, Target, AA, 3.25-Inch, M2

This rocket is characterized by the ogival nose, closed by a standard pipe cap, and an igniter located in the nose, plus



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Figure 24. Rocket, target, AA, 3.25-inch, M2A2

auxiliary powder bags attached to the propellant. One igniter lead is grounded to the rocket; the other is connected to the nose which is insulated from the body in a fiber disk.

Section III: 3.5-INCH ROCKETS

38. General

a. DESCRIPTION. Like the 2.36-inch rocket (par. 21), the 3.5-inch rocket also consists of a head and motor fin assembly. They are packed in boxes shown in the figure 27. Specific descriptions are given in paragraphs 39, 40, and 41.

b. COMPLETE ROUND DATA.

Complete round nomenclature	Complete round		Head		Motor		Fuze — Model and action
	Length (in)	Weight (lb.)	Filler type	Filler kind	Igniter model No.	Propellant model No.	
Rocket, HE, AT, 3.5-inch, M28 (T80E2).	23.5	8.61	HE----	Comp B	M20	M7	BD, M404 (T160E6), non-delay.
Rocket, smoke, WP, 3.5-inch, T127E2.	23.5	9.05	Smoke..	White Phosphorus.	M20	M7	BD, T2015E2, non-delay.
Rocket, practice, 3.5-inch, M29 (T885E2).	23.5	8.61	Inert---	Plaster of Paris.	M20	M7	Dummy, M405 (T2008E2), inert.

39. Rocket, HE, AT, 3.5-Inch, M28

This is a high-explosive antitank rocket generally similar in construction and use to the 2.36-inch rocket of the M6 series for its greater size, range, and power. The complete round (fig. 25) is an assembly consisting of a head, fuze, motor, and nozzle and fin assembly.

a. HEAD. The head, which contains the explosive charge (composition B, 1.82 lb.), is of light steel construction. It is cylindrical in shape, 3.5 inches in diameter, with a conically shaped ogive, and tapers to 2 inches in diameter at the rear. It contains an internal cone which provides for shaping the explosive charge. The rear of the head is threaded internally for attachment of base detonating fuze M404 (par. 51). The fuze is cylindrically shaped—2 inches in diameter. The front end is threaded externally to screw into the head; the rear end is threaded internally to receive the motor.

b. FUZE M404. See paragraph 51.

c. MOTOR. The motor consists of a body, closure, trap and spacer assembly, propellant, igniter with electric squib (cap) and leads, nozzle closure (blow-out plug), and nozzle and fin assembly as follows:

- (1) *Body.* The body of the motor consists of a steel tube, 2-inch outside diameter, threaded at the forward end and tapered at the rear to form a venturi-shaped nozzle. The outside surface of the tapered portion forms part of the seat for the tail assembly.
- (2) *Closure.* This is a flanged steel plug threaded at both ends for joining the body to the fuze. A steel disk pressed into the motor side of the plug prevents leakage of gases from the burning propellant from escaping to the front.
- (3) *Trap and spacer assembly.* A grid trap is seated inside the motor body forward of the nozzle. Spacer plates attached to this trap provide four compartments inside the motor for the grains of propellant powder.
- (4) *Propellant.* The propelling charge consists of 12 grains of the M7 propellant powder. Each grain is 5 inches long and approximately $\frac{3}{8}$ inch in diameter. Three grains are placed in each of the four compartments formed by the spacer plates. Each lot of propellant is adjusted at the time of manufacture to give standard velocity. Since the rate of burning increases with the initial temperature, it is important not to fire rockets at temperatures beyond the limits marked thereon. Firing at temperatures below the lower limit will give erratic ranges and excessive black blast of powder particles; firing at temperatures above the upper limit will cause dangerous pressures to build up within the motor. The propellant is ignited by the igniter M20.
- (5) *Igniter and leads.* The igniter M20, which consists of a short, cylindrical, plastic case containing a small black powder charge and an electric squib (cap), is assembled in the forward end of the motor on top of the propellant spacer plates. The leads of the electric squib (cap), running parallel to the grains of propellant, pass from the igniter through the nozzle closure into the expansion cone ((7) below). The green lead (ground wire) is connected to the support ring of the contact ring assembly ((7) below). The red lead (live wire) is connected to a pin which is insulated from the support ring but is in contact with the contact ring. These connec-

tions are positioned 180 degrees apart. The blue lead ("pigtail") actually is an extension of the live wire (fig. 26) and, as such, has one end connected to the same terminal as the red lead—the free end being connected, at the time of loading, to one of the contact springs on the launcher contact clamp. The free end of the pigtail is stripped of insulation for a short distance and then covered with a piece of plastic tubing which insulates the stripped end during handling and shipping; this insulating tubing is removed just prior to connecting the blue lead to the contact spring. The blue lead is coiled and placed in the expansion cone during shipment; it is held in this position by a piece of adhesive tape.

- (6) *Nozzle and fin assembly.* This assembly consists of an expansion cone which is fitted to the motor tube at the nozzle, three double-bladed fins which are welded to the outside of the cone, and a contact ring assembly. The contact ring assembly which encircles the fins consists of three rings, the innermost of which is an aluminum support ring which is separated from a cadmium-plated copper contact ring by a laminated insulating ring. A nozzle closure (plastic plug) is cemented into the throat of the nozzle. The red and green igniter leads pass through, and are cemented in, holes in this plug. The plug is blown out when the rocket is fired.

d. DATA.

Velocity (burnt)	300-330 fps
Range, maximum at 70° F.	855 yd
Deflection at max range	6.4 yd
Lateral probable error	2 mils at 500 yd.
Penetration, max (homogeneous steel plate at 0 degrees obliquity)	10½ in
Stabilization	Fixed fin
Propellant, weight	160 ± 1.5 grams
Temperature limits	-20° to 120° F.
Burning time	3.5 to 15 milliseconds
Launcher—fired in	M20

40. Rocket, Smoke, WP, 3.5-Inch, T127E2

This rocket uses the same metal motor parts while its head is of the same general shape, weight, and ballistics as the M28 (par. 39). The rocket has a white phosphorus filler and a non-delay BD fuze T2015E2 (par. 52).

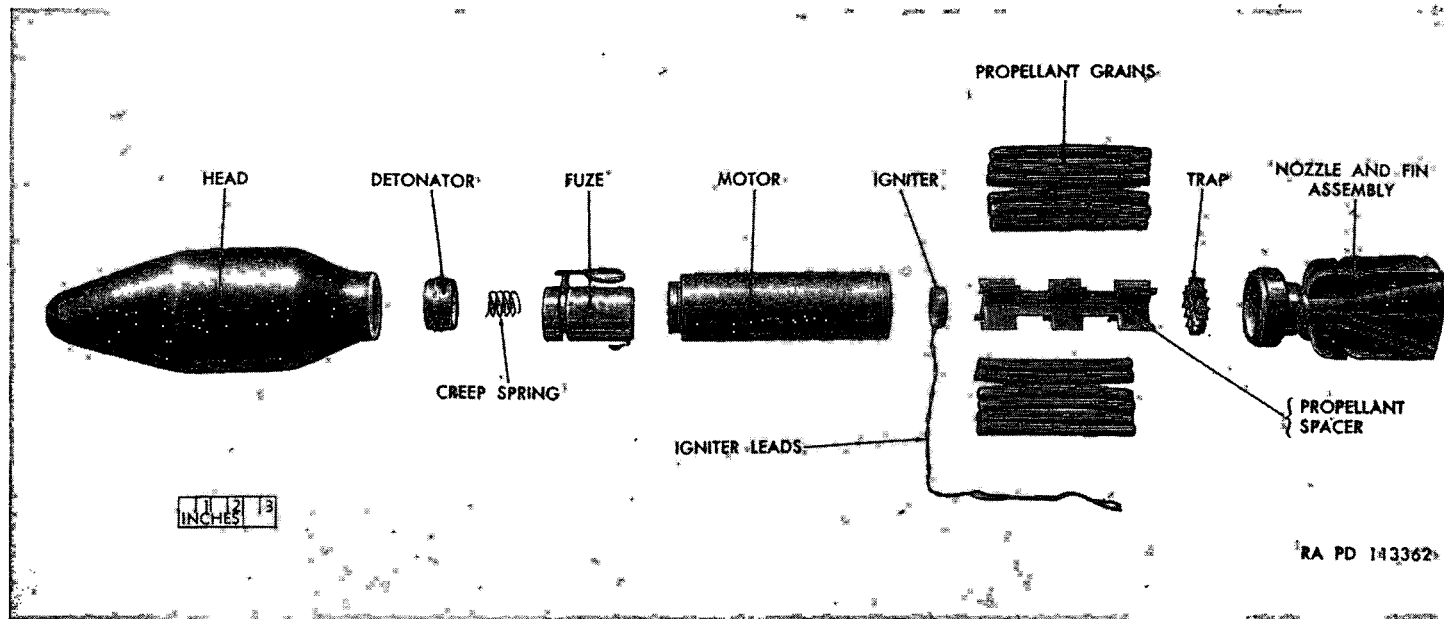
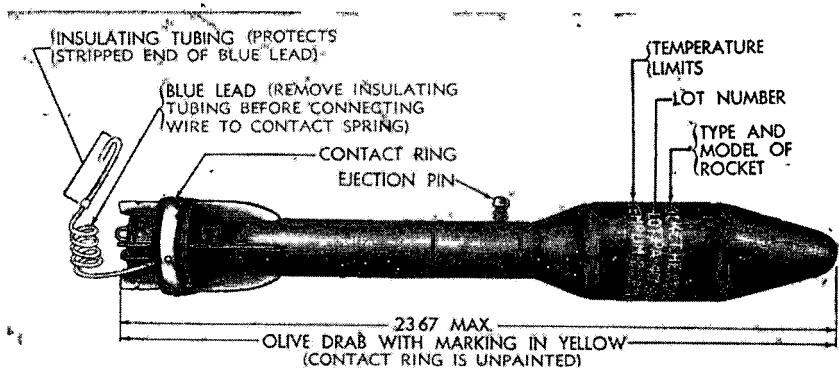
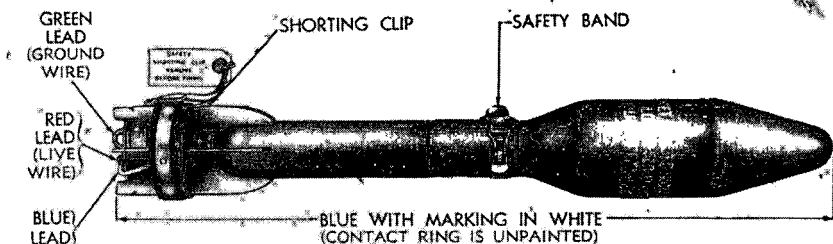


Figure 25. Rocket, HE, AT, 3.5-inch, M28—components.



A—ROCKET, HE, AT, 3.5-INCH, M28
 (SHOWN READY FOR LOADING—
 SHORTING CLIP AND SAFETY BAND REMOVED AND BLUE LEAD
 WITHDRAWN FROM EXPANSION CONE)



B—ROCKET, PRACTICE, 3.5-INCH, M29
 (SHOWN AS REMOVED FROM
 PACKING—BLUE LEAD, SHORTING CLIP, AND SAFETY BAND IN PLACE)

RAPD 113352

Figure 26. 3.5-inch rockets.

41. Rocket, Practice, 3.5-Inch, M29

This rocket generally is similar to the M28 rocket except that it is provided with an inert bursting charge and the inert dummy fuze M405 (par 59c). The inert charge (plaster of paris and stearic acid) weighs 1.82 pounds. Other characteristics are the same as for the M28 (par. 39c).

Section IV. 4.5-INCH ROCKETS

42. General

a. **TYPES.** There are three general types of 4.5-inch rockets. They may be distinguished by the type of stabilization, namely, folding-fin, circular-fin (shroud), and spin.

b. **FOLDING-FIN.** In this type (fig. 28) the several fin blades are hinged near the base of the motor. Prior to firing, the fin

NOTE: IN ADDITION TO THE MARKING SHOWN, THE CLEATS OF BOXES CONTAINING PRACTICE AMMUNITION ARE PAINTED BLUE AND A BLUE STRIPE, 3 INCHES WIDE, IS PAINTED AROUND THE CENTER OF THE BOX IN THE POSITION INDICATED BY BROKEN LINES

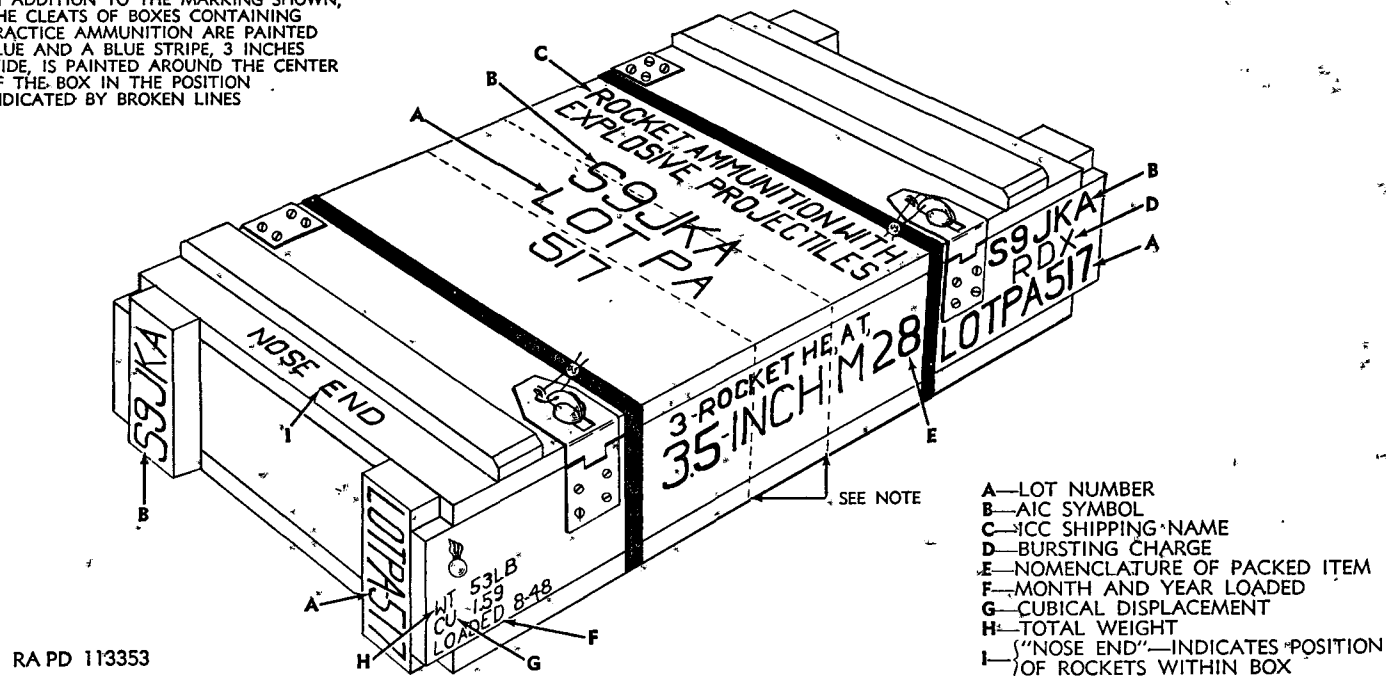


Figure 27. Packing box for 3.5-inch rockets.

blades are in a folded position in the constriction of the motor forming the nozzle. Setback due to firing causes the fins to open, thus providing means of stabilization.

c. CIRCULAR-FIN (SHROUD). This type (fig. 33) has a fixed shrouded stabilizing fin of the same diameter as the head.

d. SPIN-STABILIZED. This type (fig. 28) does not use fins. Flight stabilization is accomplished by rotation of the rocket, which is effected by the angular set of the motor nozzles.

43. 4.5-Inch Folding-Fin Type Rockets T22 (HE) and T46 (Practice)

a. GENERAL. These rockets (fig. 28) are cylindrical except for the ogival nose and nozzle constriction at the tail. They are for limited procurement only and may be issued as unfuzed complete rounds. The service round (T22) differs from the practice round (T46) in that the head of the practice round is loaded with inert filler and uses a dummy fuze.

b. HEAD. The rocket head (warhead) and burster tube with their fillers (fig. 35) constitute the high-explosive elements of the rocket. The head is approximately $7\frac{1}{4}$ inches in length and has an ogive of 9-inch radius. The burster tube (to be distinguished from burster used in chemical ammunition) extends about 15 inches from the base of the head into the motor. In addition to increasing the explosive capacity of the head, the burster tube has the advantage of using the motor body as an additional source of fragments. The head contains a fuze well which is the receptacle for the auxiliary booster (par. 53d). The fuze well is closed in storage and transit by a plug screwed into the nose of the shell and held by a set screw.

c. FUZE. The fuze used with the fin-stabilized service rocket is the point detonating rocket impact fuze M4A2 with auxiliary booster M1A1 (par. 53). The fuze for the fin-stabilized practice rocket is the dummy rocket fuze M6 (par. 59a).

d. MOTOR. The basic components of the motor are the motor body, the nozzle, the propellant, the propellant support, and the igniter. The motor body is of steel and is constricted near the tail end to form a nozzle. The forward end is threaded for assembly to the rocket head, and the rear end is adapted for attachment of the fin assembly. The fin assembly consists of a fin ring mounting six fin blades which, prior to firing, are held into the constriction of the motor body by a fin retainer. When the rocket leaves the launcher, the fins are opened by setback to a 12-inch spread.

e. PROPELLANT. The propelling charge consists of 30 sticks of double-base powder mounted on the wires of a cage-like support

(fig. 29).. This consists of 10 wires attached to a base ring and an annular plate which is slotted to receive the top ends of the wires. The plate rests on a seat formed by a shoulder in the forward end of the motor body.

f. **IGNITER.** The igniter consists essentially of a charge of black powder and an electric squib. In earlier models (fig. 35), the squib and black powder are contained in a plastic cup which is cemented in the nozzle opening. The leads of the squib are connected to a contact disk and a contact ring on the base of the cup. In combination igniters, a percussion primer is assembled in the base. In later models, the igniter is assembled in a long plastic igniter bag (fig. 35) attached to the support plate with the igniter wires leading to a contact plate in the nozzle. The plate has, in addition to the contact rings, a cable and plug for electrical connection. When this igniter is used in the launchers equipped with spring contact arms, the plug wires should be cut close to the contact rings. See figure 32 for ignition contact with new type plug.

g. **PREPARATION FOR USE.** After removing the packings, the rocket is ready for use except assembling the fuze (par 53e).

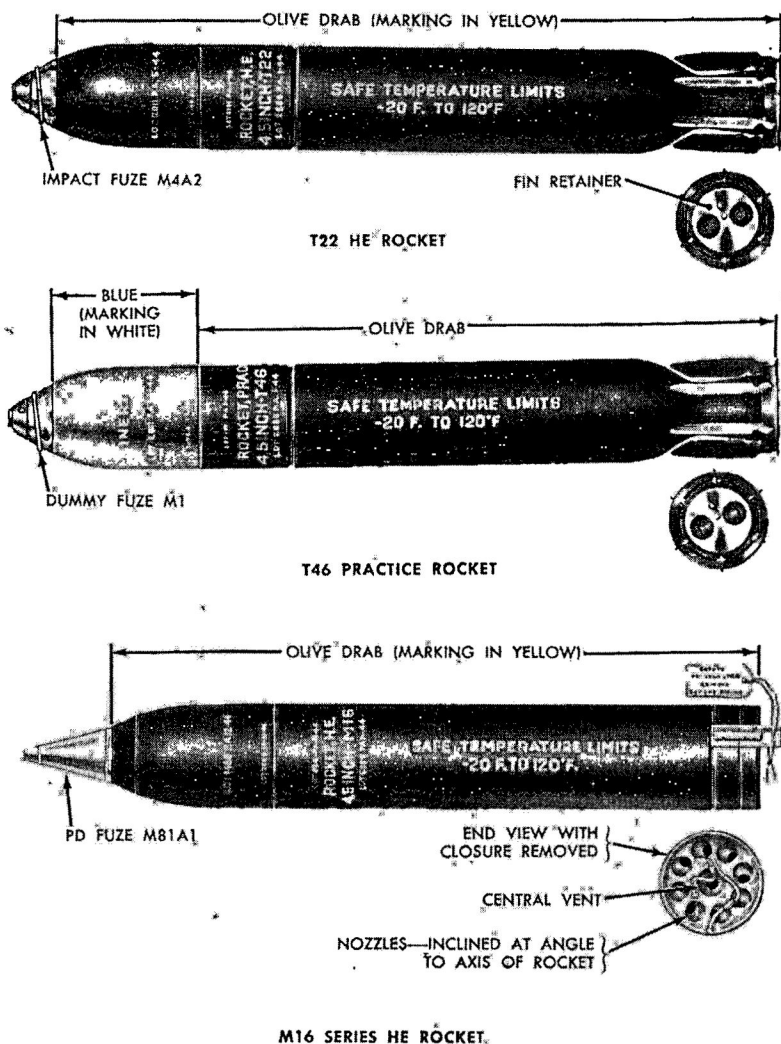
h. DATA.

	High-explosive T22 and Practice T46
Length, unfuzed, w/plug	31.15 in.
Weight, fuzed	40 lb
Range (max)	4,000 yd
Dispersion	12 mils
Velocity (max)	865 fps
Temperature limits	-20° to 120° F.
Burning time	0.36 to 0.10 sec
Burn-out point (feet from launcher)	70 to 80 ft
Head, length	7 in.
Head, weight of filler	3.4 lb
Propellant, weight	4.75 lb

i. **PRECAUTIONS.** In this type of rocket, since the fins open to a spread of 12 inches as soon as the rocket leaves the launcher, care should be exercised to see that there is sufficient clearance for the rocket's flight.

44. 4.5-Inch Rockets (Navy) (High Capacity, Smoke FS, and Smoke WP)

a. **GENERAL.** These rockets, commonly called beach-barrage rockets, are of the circular-fin (shroud) type (fig. 33). The rocket consists of a head, motor and fin assembly, and nose fuze, all issued separately. Head and fin are full caliber but the motor is of smaller diameter.



RA PD 113292A

Figure 28. 4.5-inch rockets.

b. HEAD. The head is cylindrical with a hemispherical nose and tapered base. There is a fuze well opening in the nose, and an adapter for attachment of the motor at the tapered end. Both are protected by shipping plugs in storage and transit. Auxiliary booster Mk 3 is shipped in the fuze well of the high-capacity round.

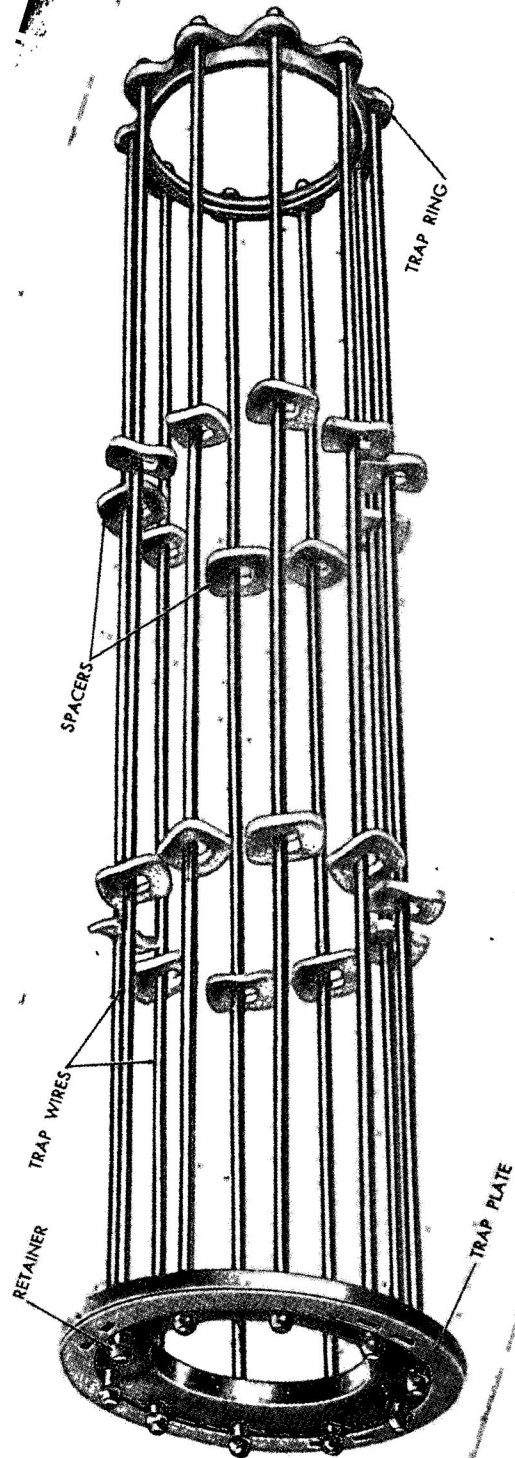


Figure 20. Trap assembly.

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INCHES

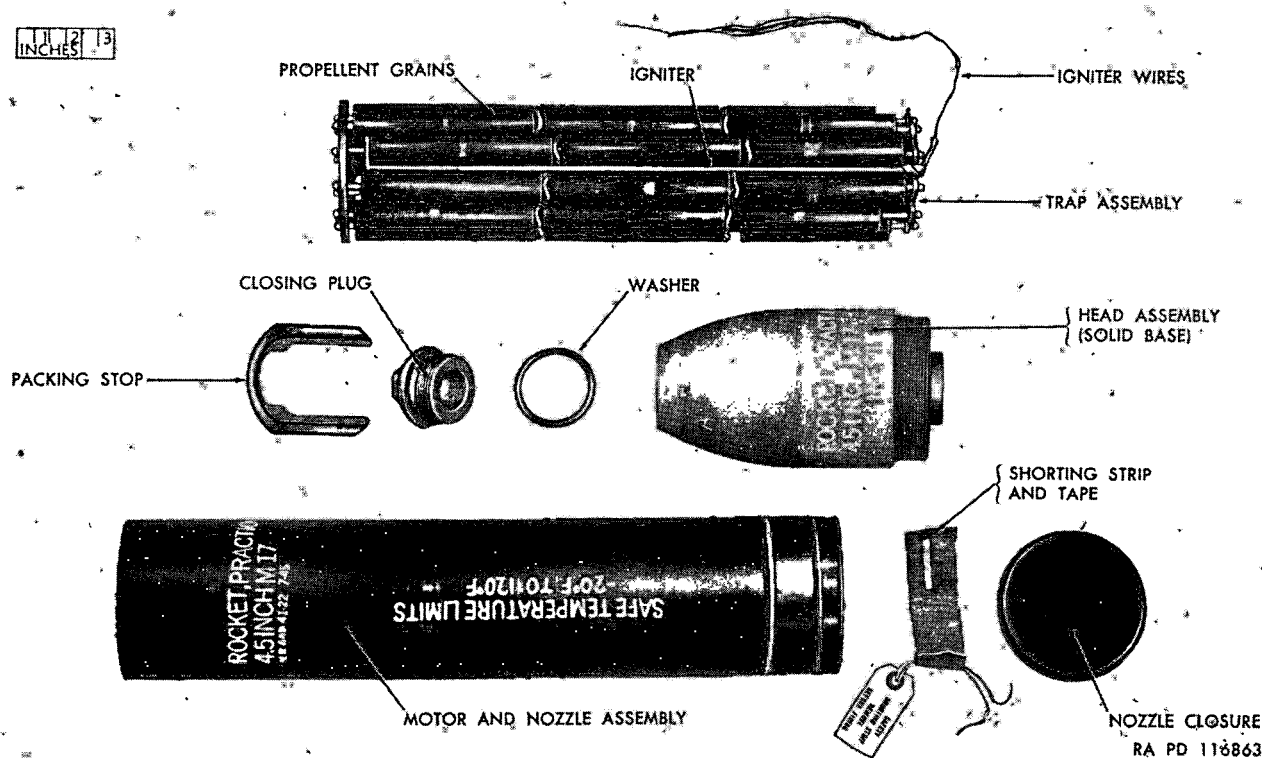


Figure 30. Rocket, practice, M17A2—components.

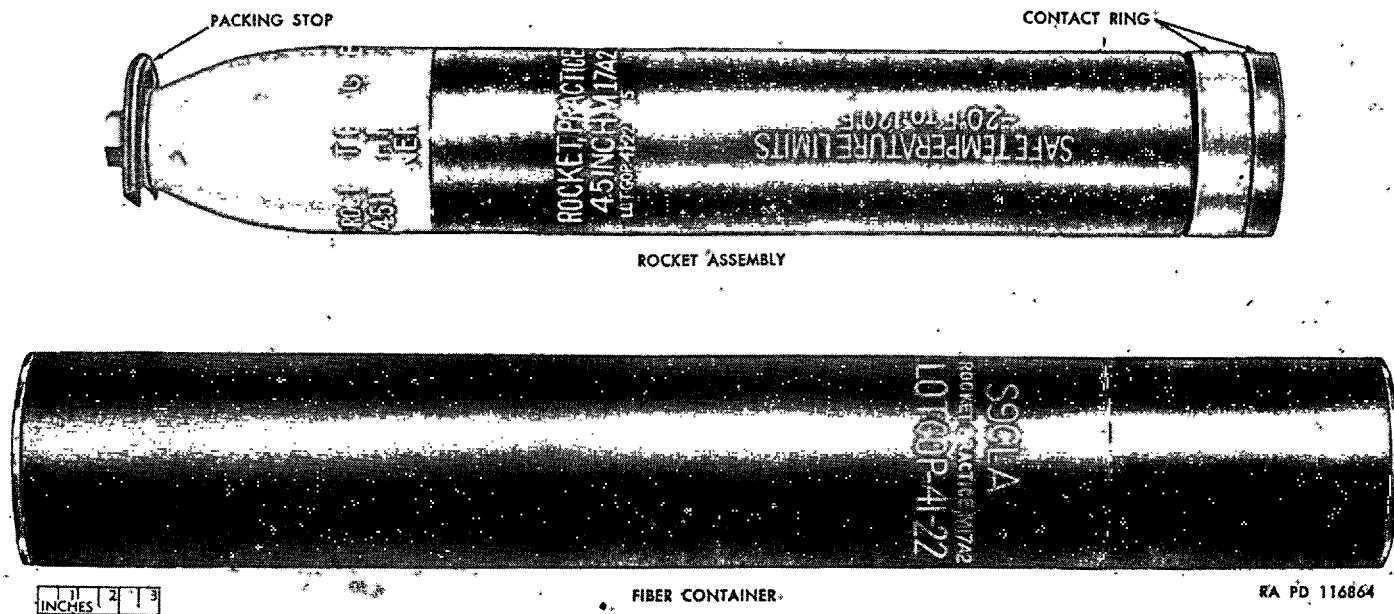
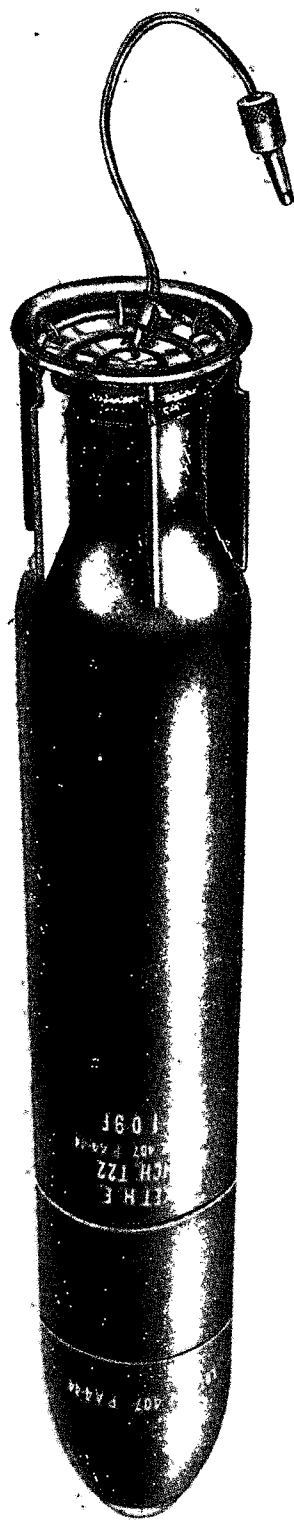
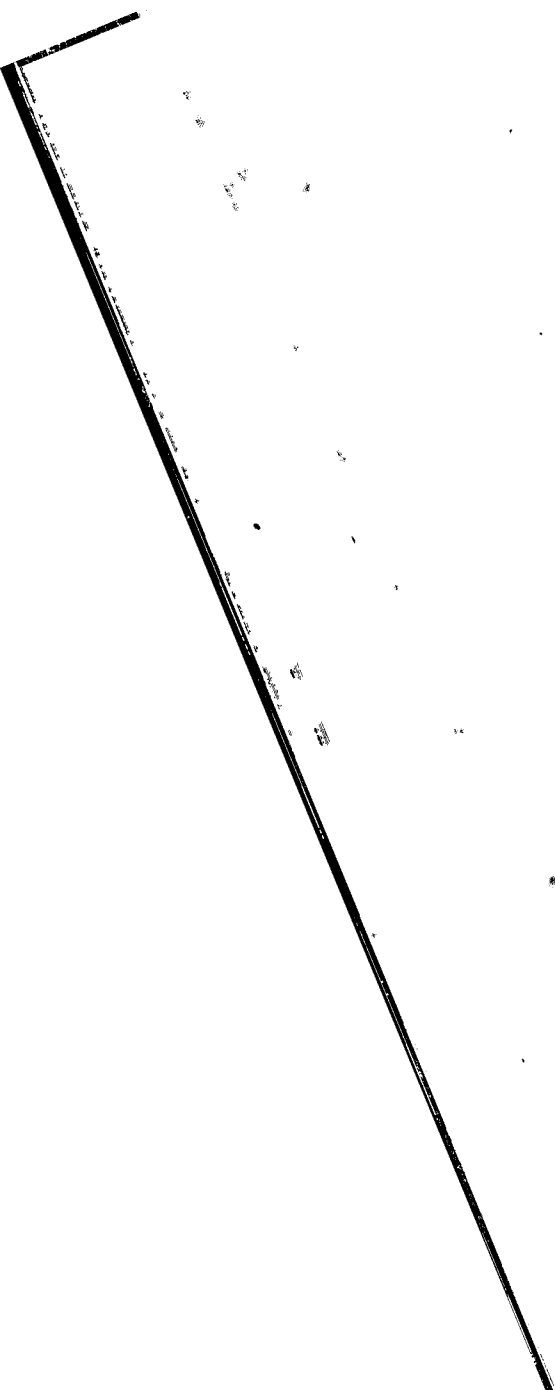


Figure 31. Rocket, practice, M17A2—assembly and fiber container.



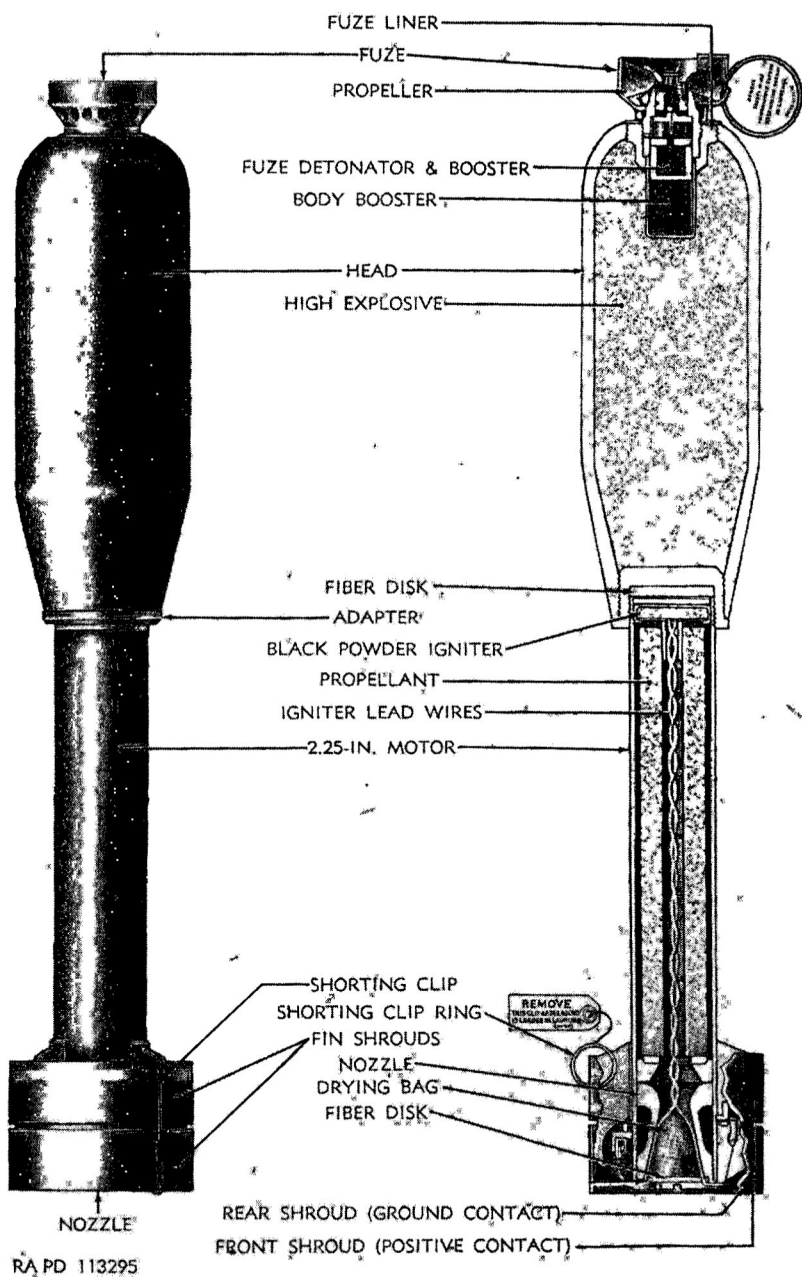


Figure 33. 4.5-inch high capacity rocket (Navy) Mk 1 Mod O.

c. **MOTOR AND FIN ASSEMBLY.** The motor is a steel tube 2.25 inches outside diameter and 15 inches long. It contains an electric igniter, a propelling charge consisting of a single large grain, a grid-like support, and a bag of drying agent. Both ends of the motor are sealed by waterproof fiber disks. The forward end of the motor is threaded for assembly to the adapter in the head; the rear end carries two fin shrouds which serve as flight stabilizers and as electrical contacts for the igniter. A shorting clip connects the two shrouds to prevent accidental ignition. This clip must be removed when the rocket is loaded into the launcher.

d. **FUZE.** The standard fuze for the high-explosive round is the rocket nose fuze Mk 137 Mod 2 (par. 55). Fuze Mk 145 Mod 1 (0.02-sec delay) also may be used. The standard fuze for the smoke rocket is the rocket nose fuze Mk 154 Mod 3 which is similar to the fuze Mk 137 Mod 2 except that it has a long burster replacing the booster in the base of the fuze.

e. **PREPARATION FOR USE.** Prior to use, it is necessary to assemble the round as follows:

- (1) Unpack components and inspect for serviceability (par. 55d).
- (2) Remove shipping plug from adapter and protection cap from motor body.
Leave the closing disk in place.
- (3) Screw motor into adapter and tighten with strap wrench. Be sure at least 1 inch of threads is engaged.
- (4) Remove shipping plug from fuze well. Make sure that booster is in place for high-explosive rocket or that burster well is clear for smoke rocket.
- (5) Inspect fuze and screw into place. Tighten with fuze wrench.
- (6) Remove fuze safety wire and shroud shorting clip when the rocket is about to be placed in the launcher.
- (7) In case the rocket is not fired, disassemble for storage as follows:
 - (a) Inspect the fuze to make sure that it is not armed. Fuzes in unfired rockets may have been damaged, or armed, by the rearward blast of rockets fired from adjacent tubes.

Warning: If a fuze is found to have a propeller which extends beyond the guard, handle with great care because it may be armed. Do not touch such a propeller except to prevent it from turning. Remove the fuze carefully and return it to ordnance personnel for disposition.

- (b) Having inspected the fuze and having found it to be undamaged and unarmed, replace the fuze safety wire and remove the fuze from the rocket. Replace the nose shipping plug.
- (c) Replace the shorting clip to its original position.
- (d) Unscrew rocket motor from the back end of the rocket head and replace the shipping plug.
- (e) Replace the parts in their original packing.

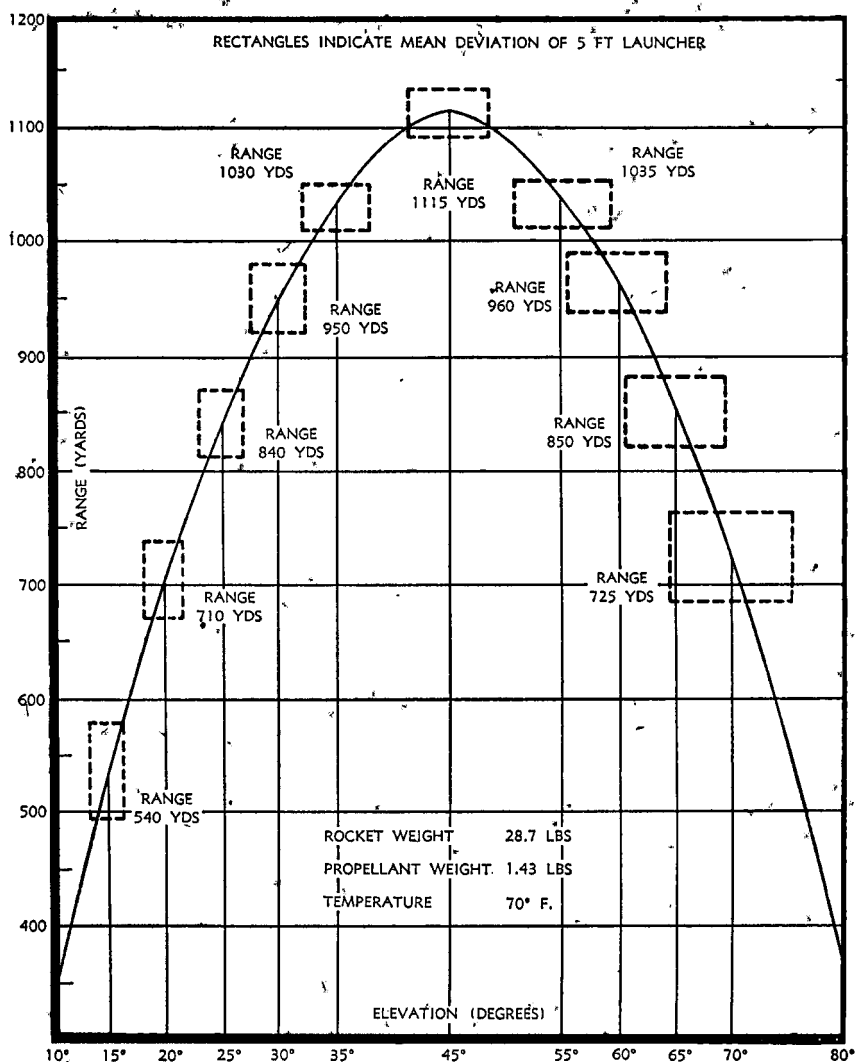
f. DATA.

	<i>High capacity</i>	<i>Smoke (FS)</i>	<i>Smoke (WP)</i>
Head model (Navy) ----	4.5-inch, Mk 3	4.5-inch, Mk 7	4.5-inch, Mk 10
	Mod 0	Mod 0	Mod 0
Motor model (Navy) ----	2.25-inch, Mk 9	2.25-inch, Mk 9	2.25-inch, Mk 9
	Mod 0	Mod 0	Mod 0
Fuze Model (Navy) ----	Mk 137 Mod 2 or Mk 145 Mod 1	Mk 154 Mod 3	Mk 154 Mod 3
Complete round with fuze, length -----	30 in.	37.2 in.	36.7 in.
Complete round, weight -----	28.7 lb	28.8 lb.	28.8 lb
Range (max) -----	1,130 yd	1,130 yd	1,130 yd
Dispersion -----	37 mils	37 mils	37 mils
Velocity (max) -----	355 fps	355 fps	355 fps
Temperature limits ----	-10° to 120° F.	-10° to 120° F.	-10° to 120° F.
Burning time -----	0.30 sec	0.30 sec	0.30 sec
Head, length -----	16 in.	23 in.	23 in.
Head, weight -----	20 lb	20 lb	20 lb
Head, filler type -----	TNT	FS	WP
Head, weight of filler --	6.4 lb	12.1 lb.	12.1 lb
Propellant grain model (Navy) -----	Mk 1	Mk 1	Mk 1
Propellant grain weight -----	1.4 lb	1.4 lb	1.4 lb

g. RANGE—ELEVATION DATA. Reference should be made to figure 34 for provisional range—elevation data for this rocket.

h. PACKING. Motors, bodies, and fuzes are packed in separate containers as follows:

- (1) *Motors* are packed 8 per wooden box, 21 in. x 17 $\frac{3}{8}$ in. x 10 $\frac{1}{8}$ in. Total weight—83 pounds.
- (2) *Bodies* are packed 4 per wooden box, 17 $\frac{3}{4}$ in. x 11 $\frac{1}{4}$ in. x 11 $\frac{1}{8}$ in. Total weight—95 pounds.
- (3) *Fuzes* are packed 28 in a sealed metal container, 9 $\frac{3}{8}$ inches in diameter and 13 $\frac{5}{8}$ inches high. Four sealed cans are packed in a wooden box 25 $\frac{5}{32}$ in. x 19 $\frac{17}{32}$ in. x 14 in. Total weight—120 pounds. A later packing for fuzes is 1 fuze per individual metal can, 48 per wooden box, 23 $\frac{1}{4}$ in. x 15 in. x 18 $\frac{3}{8}$ in. Total weight—55 pounds.



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Figure 34. Range—elevation chart for 4.5-inch high capacity rocket (Navy).

45. 4.5-Inch Spin-type Rockets M16, M17, M20, M21, and Modifications

a. GENERAL. The spin-type rocket (figs. 28 and 35) is cylindrical throughout except for the ogival nose and a groove near the base. A contact ring assembly is crimped to the nozzle plate on the base of the rocket. The rocket is issued as an unfuzed round.

b. HEAD. The heads of the several models of 4.5-inch spin-type rockets have the same contour. Earlier models have a burster

tube designed to extend into the center of the motor where it is surrounded by the grains of the propellant charge (fig. 35). Late models do not have the burster tube; the bottom of the head is plugged or made solid (fig. 36). The fuze wells on spin-type rockets are designed for point detonating artillery-type fuzes as well as a VT fuze and, with the exception of early models, have a supplementary charge.

c. MODELS. The following shows the relationship among various modifications of types as used in different types of launchers:

Models used in multiple-type launchers M21 (T106E1) and T66 series		Models used in expendable-type launchers M12 series	
Present designation	Former designation	Present designation	Former designation
High-explosive			
M16 -----	T38E3 -----	M20 -----	T38E7 -----
M16E1 -----	{ T38E2 -----	} M20E1 -----	-----
M16A1 -----	{ T38E8 -----		
M16A2 -----	M16E5 -----	M20E2 -----	-----
	M16E4 -----		
Practice			
M17 -----	T39E3 -----	M21 -----	T39E7 -----
M17E1 -----	{ T39E2 -----	} M21E1 -----	-----
M17A1 -----	{ T39E8 -----		
M17A2 -----	T17E5 -----	M21E2 -----	-----
	T17E4 -----		

Notes. The letter H (fig. 36) stamped on the head approximately $2\frac{1}{2}$ inches from the fuze seat of the M16A2, M16A1, M17A2, and M17A1 indicates that the head has met the static load test and hydrostatic pressure requirements. This stamping normally is covered by paint.

d. DIFFERENCE IN TYPES. The principal external difference between rockets used in multiple-type launchers and those used in expendable-type launchers is in the method of firing. In those for the multiple-type launchers, the igniter wires are connected to contact rings (fig. 35); those for expendable launchers have the igniter wires brought out through a nozzle and connected to exterior wires which are wound around the rear spacer (figs. 11 and 13).

e. FUZES. The impact fuze authorized for use with the spin-type rocket is the point detonating fuze M81A1 (par. 54). This fuze consists of the fuze M48A3 (SQ-0.05-sec delay) assembled with the booster M24. The alternate fuze is the fuze M48A2

(SQ-0.05-sec delay) assembled with the booster M21A1 (par 54); no subsequent modification of this booster can be used. The fuze and booster for this round are staked together and shipped as a unit. However, if such units are not available, components of fuze and booster, as stated above, may be assembled in the field. FUZE, rocket, VT, M402 (par. 61) is authorized for use with cavitized 4.5-inch spin-type rockets.

f. MOTOR. The motor body (fig. 35) is a cylindrical steel tube threaded at one end for assembly to the head and at the other for assembly of the nozzle plate. It contains the propelling charge and the igniter. The nozzle plate is a thick steel plug containing eight nozzles located near the outer edge and a central vent which normally is closed by a safety blow-out plug. The nozzles (fig. 28) are inclined at an angle with the axis of the rocket to impart rotation as well as driving thrust. The safety blow-out plug in the central vent is designed to blow out should the motor pressure exceed the safe limit. A contact ring assembly with its shorting strip is secured to the rear of the nozzle plate. A plastic closing disk (closure) cemented to the contact ring assembly seals the motor against moisture.

g. PROPELLANT. The propelling charge is similar to that for the folding-fin type rocket described in paragraph 43e.

h. IGNITER. The igniter consists of a charge of black powder and an electric squib assembled in a long flat plastic tube which is hung from the support plate besides the propellant sticks. The lead wires are tied to the trap ring and pass through one of the nozzles. One wire is grounded to the nozzle plate; the other is connected to the contact ring on the closing cap.

i. ROCKET, HE, 4.5-INCH, M16A2 (M16E4). This rocket, the head of which is shown in paragraph 36, and the body of which is shown in figure 35 (M16 (spin type)) is the standard type of the M16 series. It has a solid head without burster tube and has a deep cavity and supplementary charge. This charge is to be removed when a VT fuze is used.

j. ROCKET, HE, 4.5-INCH, M16A1 (M16E5). This rocket is the same as the M16A2 except that it has a steel plug in the bottom of the head where the burster tube was removed in the modification from an earlier M16 model. The M16A1 is a limited standard type.

k. ROCKET, HE, 4.5-INCH, M16E1 (T38E2) (W/DEEP CAVITY AND W/O SUPPLEMENTARY CHARGE). This rocket is an earlier modification which has the burster tube. The head of this type is provided with a deep booster cavity to permit the use of a VT fuze.

l. ROCKET, HE, 4.5-INCH, M16E1 (T38E8) (W/DEEP CAVITY AND W/SUPPLEMENTARY CHARGE). This rocket is the same as the

M16E1 (T38E2) except that it has a supplementary charge to permit the use of either point detonating artillery fuzes or a VT fuze.

m. ROCKET, HE, 4.5-INCH, M16 (T38E3). This rocket, formerly the experimental T38E3, is the first of the spin-stabilized M16 type. It utilizes contact rings instead of the plug-type ignition (fig. 32) of the fin-type rockets.

n. ROCKET, HE, 4.5-INCH, M20 (T38E7). This rocket, shown in figures 10, 11, 12, and 13 with the expendable-type (M12 series) launcher in which it is fired, is the same as the M16 type except that it differs in the igniter wires not being connected to contact rings but brought through a nozzle and the closing disk and connected to a reel of wire on the rear spacer. The M20E1 and the M20E2 are the same as the M20 except for minor variations and increased weight of propellant.

o. PRACTICE ROCKETS—4.5-INCH SPIN TYPE. These rockets, designated as M17 series and M21, are listed in the tabulation in c above. They are the same as the corresponding models of the M16 series models and the M20 respectively except that they have inert-filled heads. For example, the M17A2 is the same as the M16A2 except that it has an inert-filled head, the M17A1 is the same as the M16A1, and so on. The M21E1 and M21E2 are the same as the M21 except for minor variations and increased weight of propellant. These rockets use the dummy fuze M73 (par. 59b).

p. PREPARATION FOR FIRING. The spin-type rocket is prepared for firing as follows:

- (1) Remove from packing and inspect for serviceability. Should the plastic closing disk be loose or damaged, and evidence found of moisture corrosion which would adversely affect the igniter or propellant, the rocket should be disposed of as unserviceable.

Note. Should it be considered necessary to test the continuity of the igniter circuit, test with circuit continuity tester (par. 14).

- (2) Remove nose plug and assembly fuze. Tighten with fuze wrench. Some models may have a set screw in the fuze adapter. In this case the set screw should be loosened to remove the nose plug and tightened after assembly of the fuze.
- (3) Set fuze for desired action (par. 54).
- (4) Remove the safety shorting strip when loading the rocket into the launcher.
- (5) If the rocket is prepared for firing and not fired, both rocket and fuze should be restored to their original condition and packings and marked for priority of use in order that opened packages will be kept to a minimum.

q. DATA.

	HE, M16, M16E1, M20, and Practice M17, M17E1, M21	HE, M16A2, M16A1, M20E1, M20E2 and Practice M17A2, M17A1 M21E1, M21E2
Length, unfuzed	28.7 in.	28.98 in.
Weight, fuzed	42.5 lb	42.5 lb
Range (max)	5,210 yd	6,300 yd
Dispersion, lateral, probable error	9 mils	
Velocity (max)	840 fps	937 fps
Temperature limits	-20° to 120° F.	-20° to 120° F.
Burning time	0.34 to 0.10 sec	0.34 to 0.10 sec
Burn-out point, feet from launcher	80 ft	80 ft
Head, length	9.4 in.	9.4 in.
Head, weight	17 lb	17 lb
Head, weight of filler (HE or inert)	5.2 lb	5.2 lb
Propellant (solvent double base powder)	4.75 lb	4.81 lb
weight.		
Fuze (VT)	M402	M402
or		
Fuze (HE)	M81 or M48A2 SQ-0.05-sec delay	M81 or M48A2 SQ-0.05-sec delay
Fuze (practice)	M73, dummy	M73, dummy

46. Rocket, Drill, 4.5-Inch, M24

This rocket is provided for training in handling and operation. It is for use with launchers which fire the M16 and M20 rockets and is made up of the metal parts of the M16 rocket modified for training purposes. The modifications consist of loading the motor with wooden sticks to simulate propellant powder sticks, filling the head with inert material and fitting it with dummy fuze M73 which simulates the service fuze M81. The total weight is approximately the same as the M16 complete round. The igniter is omitted and, in order to simulate firing operations visibly, an indicator light is installed in the nozzle plate at the rear of the rocket. The light glows when the firing switch on the launcher is closed thus simulating the firing of the rocket, and may be seen through a plastic window which is attached to the nozzle plate.

Section V. 7.2-INCH ROCKETS

47. General

a. TYPE. There is only one type of 7.2-inch rocket (fig. 37), a chemically filled rocket, used for medium range ground firing. The head and fin assembly are of caliber diameter; motors of different diameters are used to obtain the desired ballistic properties. Point or base fuzing is used as required.

b. HEAD. The rocket head is pear-shaped and has a hemispherical nose, adapted for a point detonating fuze.

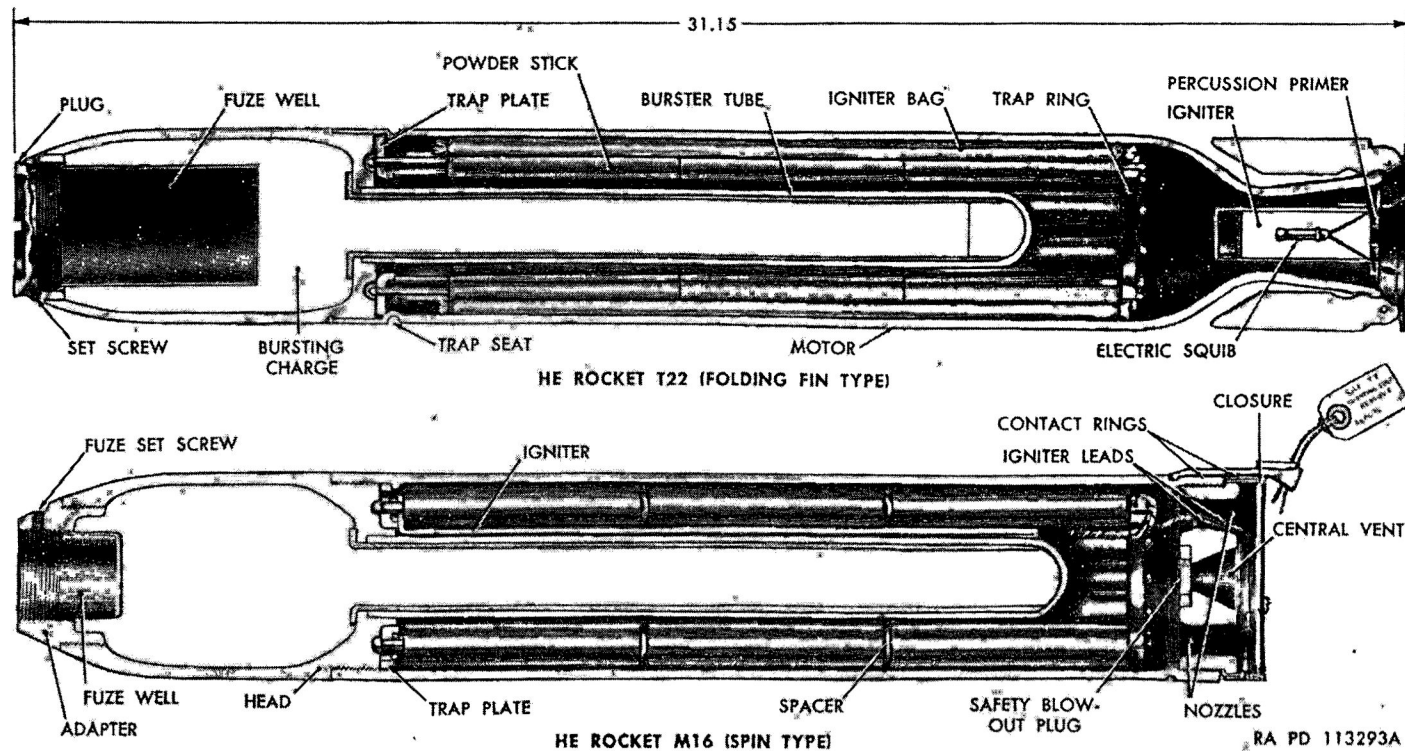
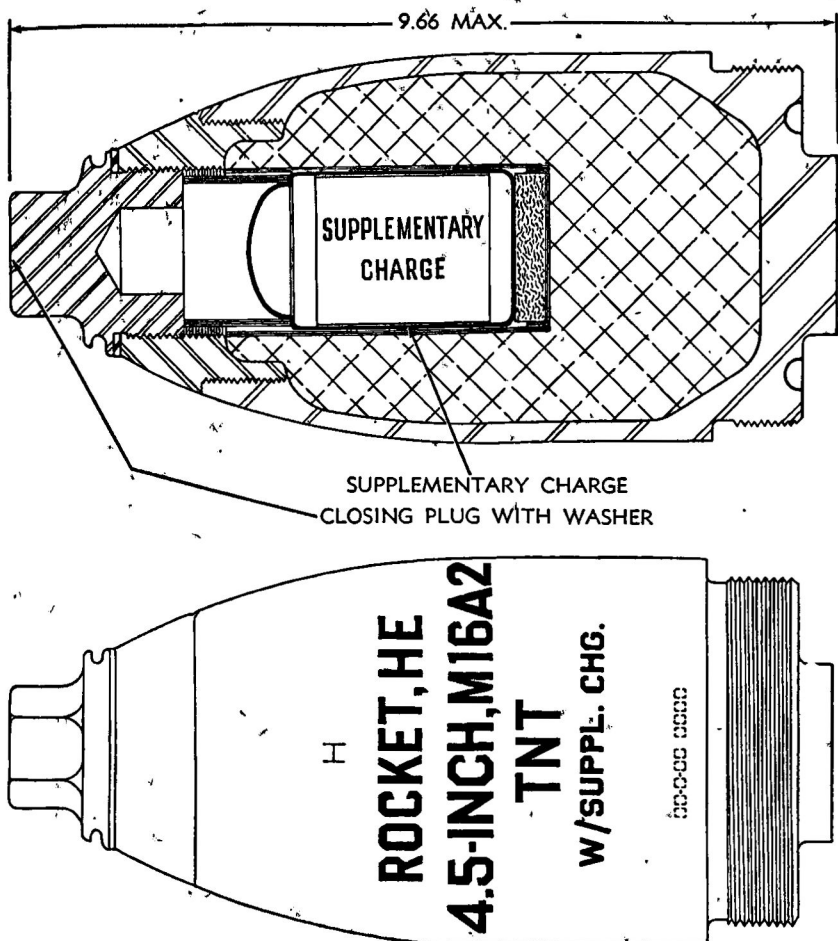


Figure 35. 4.5-inch unfuzed rockets.



RA PD 113294A

Figure 36. 4.5-inch rocket head showing supplementary charge.

c. **MOTOR.** The motor is similar to those for 5.0-inch AR and 4.5-inch (Navy type) BR rockets except that shrouded fins, 7.2 inches in diameter, are assembled to the motor and the igniter leads are connected to the forward (live contact) and rear (ground contact) fin shrouds.

48. Models

a. **ROCKET, GAS, CG, 7.2-INCH, M25 (T21) AND ROCKET, GAS, CK, 7.2-INCH, M27 (T52).** These are issued as unassembled complete rounds—head, fuze and burster, and motor. The head fillers are phosgene (CG) and cyanogen chloride (CK) respectively. The components are packed in the same box, with fuze and burster

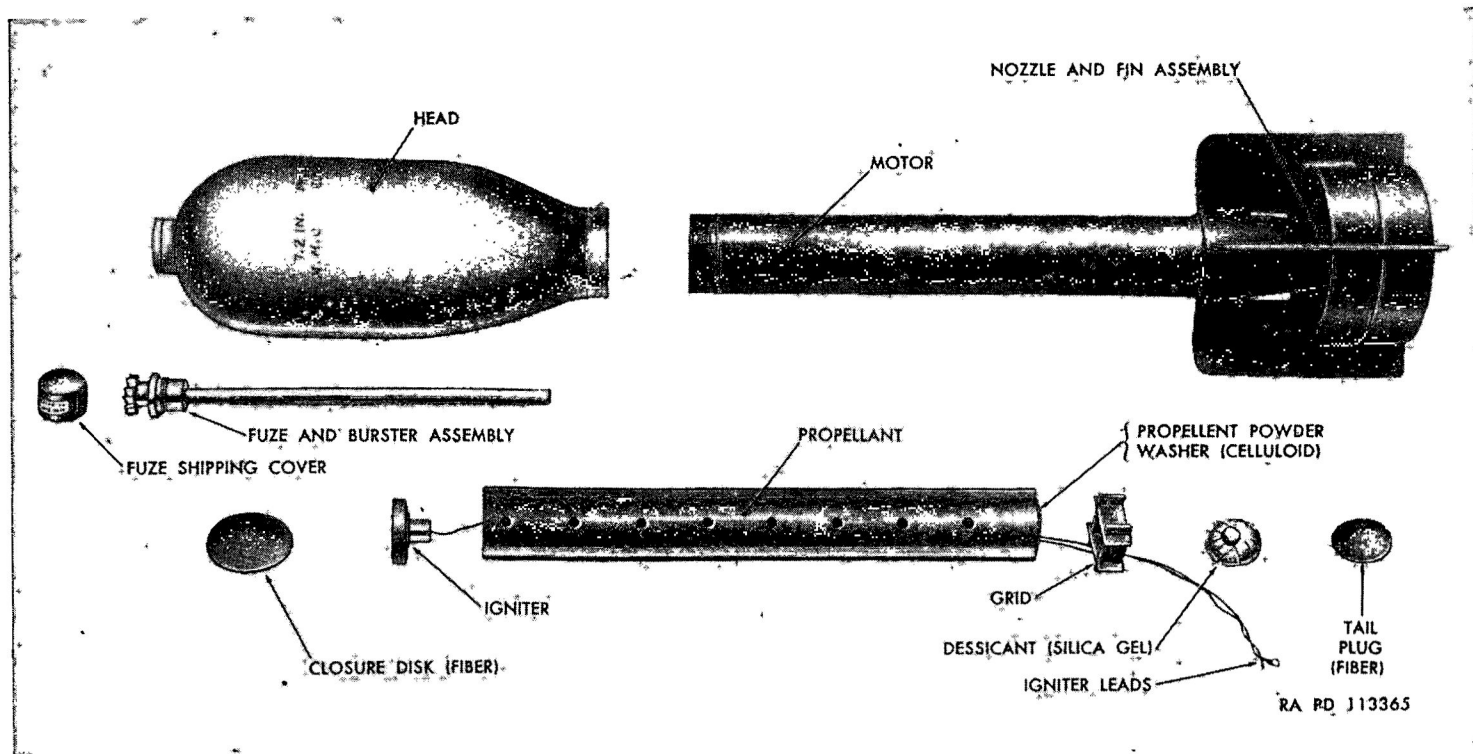


Figure 37. Rocket, gas, CG, 7.2-inch, M25 (T21)—components.

packed separately, or with all three packed separately. The complete round is assembled as follows:

- (1) Remove components from packing and inspect for serviceability.
- (2) Assemble motor to shell. Tighten with strap wrench.
- (3) Insert fuze and burster assembly in fuze seat, screw in hand tight, and tighten with fuze wrench.
- (4) Remove fuze safety wire and shroud shorting clip when rocket is loaded into the launcher.
- (5) If rocket is not used, restore to original condition and packing, and mark for prior issue.

b. DATA.

CG M25 (T21)
and
CK M27 (T52)

Length (without fuze)	47 in.
Weight	51.8 lb.
Range (max)	3,430 yd
Dispersion	35 mils
Velocity (max)	680 fps
Temperature limits	10° to 120° F.
Burning time	1 sec (@ 10° F.) to 0.33 sec (@ 120° F.)
Head, length	16.2 in.
Head, weight	31 lb
Head, type of filler	Gas (CG or CK, as indicated)
Head, weight of filler	20 lb
Motor, diameter	3.25 in.
Motor, weight of propellant	5.25 lb
Fuze, model (Navy)	MK 147 Mod 1 w/burster (propeller arming)
Fuze, type (Navy)	PD

SECTION VI. TIME AND IMPACT FUZES FOR GROUND TYPE ROCKETS

49. General

a. CHARACTERISTICS. See paragraph 9.

b. ARMING. A fuze is armed when the various parts are in a position such that detonation or ignition may be initiated. For safety in shipping and handling, fuzes are kept unarmed. This may be accomplished by safety pins or wires preventing the motion of the firing mechanism, or by arrangement of the components so that they cannot function until moved into position by forces incident to firing. A fuze in which the detonator is held out of line so that it cannot explode the shell until armed is detonator safe; when this condition persists until after the round leaves the weapon, the fuze is boresafe. Various forces are employed for arming rocket fuzes. Fuzes used on fin-stabilized rockets may be armed by setback, the air resistance operating a propeller, motor

pressure, cessation of acceleration, or a combination of these. Fuzes for spin-stabilized rockets usually are armed by centrifugal force.

c. PRECAUTIONS. *Fuzes contain the most sensitive explosives used for military purposes. They are particularly susceptible to heat, moisture, and shock, and should be handled with due care at all times. Safety devices should be removed only in preparation for firing and should be replaced in unused rounds before further handling. Fuzes will not be disassembled except when specifically authorized by the chief of the technical service concerned. A fuze which is suspected of being armed should be handled as though it were certainly armed. No attempt will be made to disarm a fuze; any attempt to reverse the steps in arming may cause the fuze to detonate.*

50. Integral Base Fuzes

a. GENERAL. The base detonating fuze which is integral with 2.36-inch rockets is a simple inertia type consisting of a weighted firing pin which is held away from the detonator by a light creep spring (fig. 38). The firing pin is prevented from moving, in shipping and handling, by a safety wire which passes through the fuze body and the firing pin. The sensitivity of this fuze is controlled by varying the thickness of a thin metal disk covering the detonator. In some models this disk is omitted, making the fuze more sensitive in order to prevent malfunction.

b. BD FUZES M400 AND M401. These fuzes (figs. 39 and 40) incorporate an arming pin (bore-riding pin) which prevents the

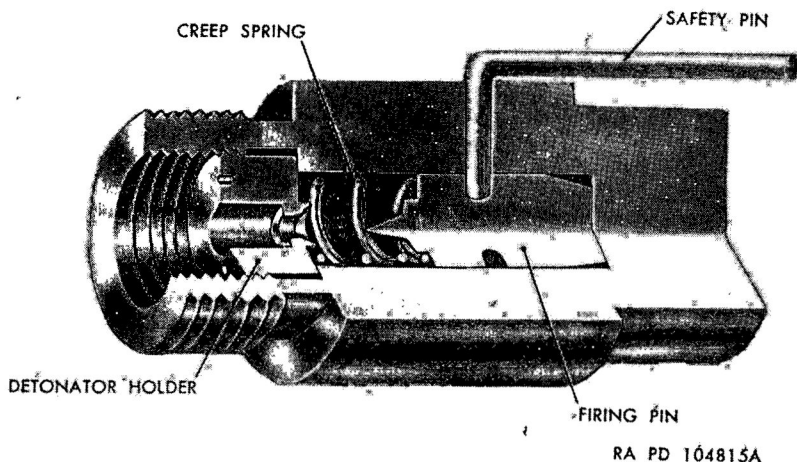
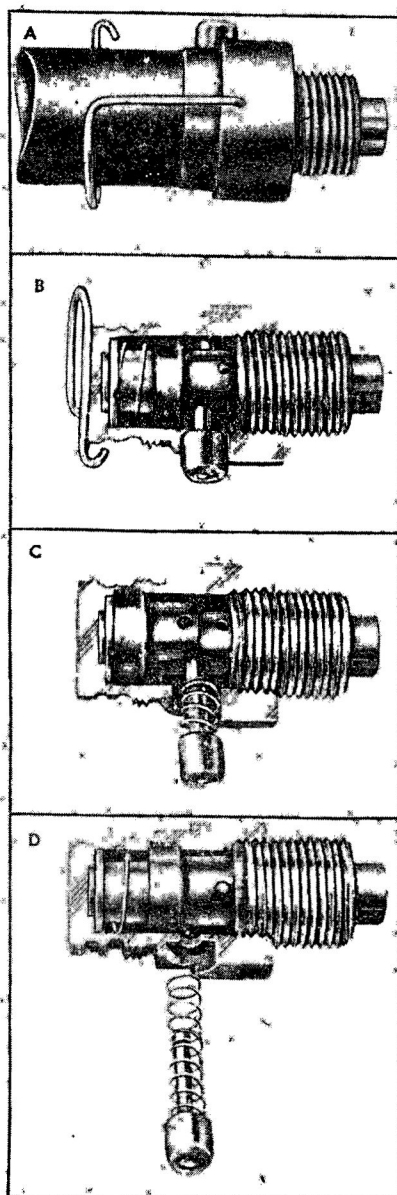
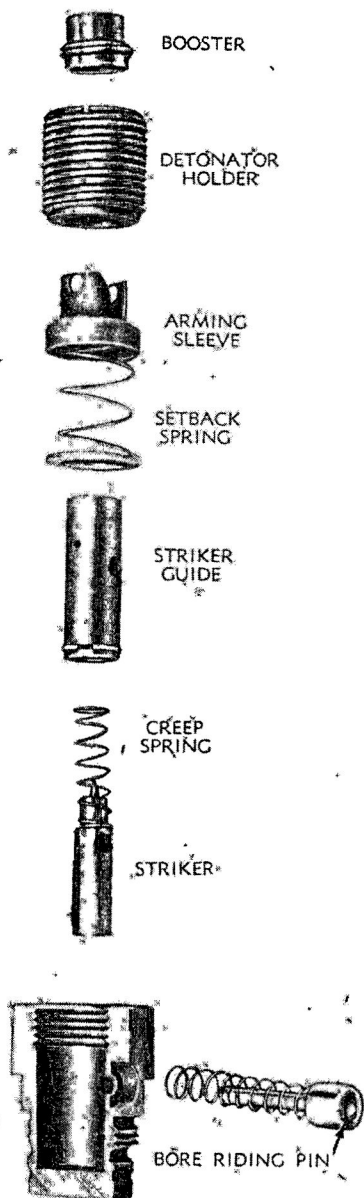
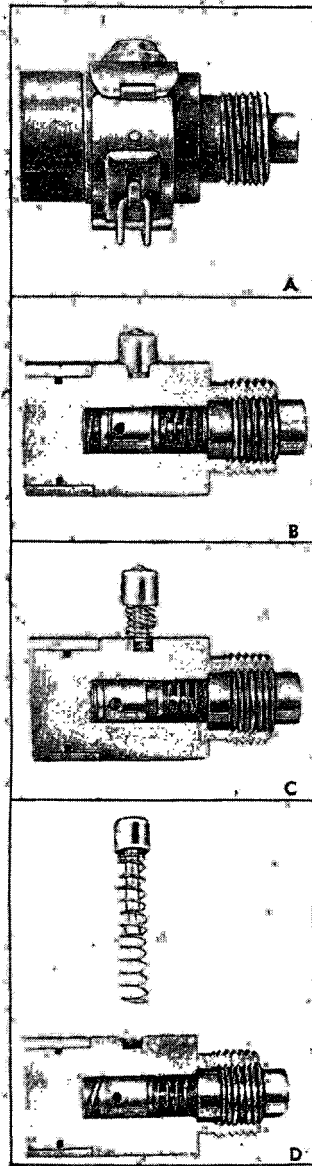
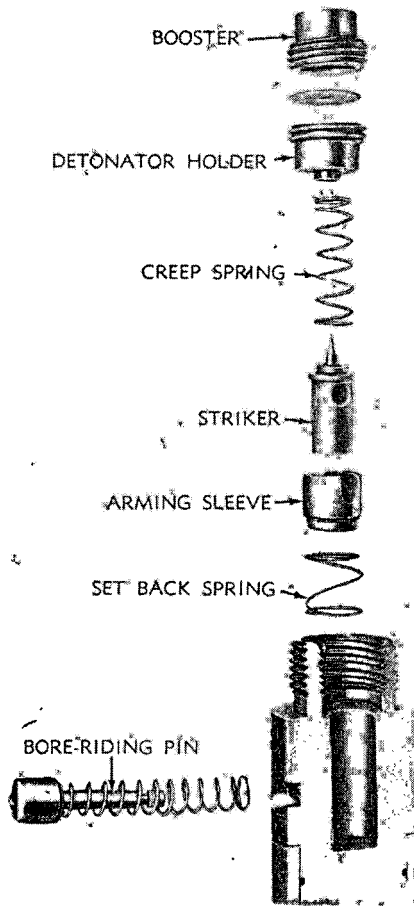
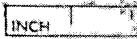


Figure 38. Integral BD fuze for 2.36-inch rocket.



RA PD 95666

Figure 39. BD fuze M400—disassembled and functioning.



RA PD 104816

Figure 40. BD fuze M401—disassembled and functioning.

firing pin and slider from moving until after the rocket leaves the launcher. When unarmed, the firing pin and slider are held by the safety pin and arming pin (bore-riding pin) (B, fig. 39 and B, fig. 40). On firing the rocket, the slider sets back, compressing the slider spring and releasing the arming pin (bore-riding pin) which is held by the wall of the launcher (C, fig. 39 and C, fig. 40). On leaving the launcher, the pin is completely ejected, the fuze is armed, and the firing pin and slider are restrained only by the firing pin spring (creep spring) (D, fig. 39 and D, fig. 40). On impact equivalent to a 24-inch drop, the firing pin and slider overcome the resistance of the firing pin spring (creep spring) and fire the fuze. The principal difference between those fuzes is that the M400 has the old type safety pin and the M401 has the waterproofing clamp over the arming pin. This difference has necessitated some differences in design of the internal parts.

51. Fuze, Rocket, BD, M404

This fuze (fig. 41) consists of a body which contains the functioning parts, a detonator holder, and a booster. The fuze joins the head and motor assemblies.

a. DESCRIPTION. The base-detonating fuze is of the simple inertia type which functions with non-delay action upon impact. The fuze mechanism consists of a plunger, an actuating sleeve, a firing pin, a setback sleeve, a creep spring, a stop pin, and a lock pin. The explosive train includes a detonator and a booster. An ejection pin, which passes through the fuze body and prevents movement of the internal parts, is provided to preclude accidental functioning during shipping, handling, and firing. The safety band (fig. 26) covers the head of the ejection pin and prevents it from moving during shipping and handling. The fuze body and safety band are olive drab; the fuze nomenclature, the loader's lot number, and the month and year of loading are stamped into the metal.

b. FUNCTIONING. The ejection pin is held in a "safe" position by the safety band assembly (B, fig. 26). When this is removed, the ejection pin is moved three-eighth inch outward (A, fig. 26) by its spring, in which position it is held by an internal setback sleeve. This is the "locked" position. The fuze cannot arm with the ejection pin in either the "safe" or "locked" position. Upon loading the rocket into the launcher, the rounded head of the ejection pin, coming in contact with the bore of the launcher, pushes the pin back to a position midway between "safe" and "locked." This intermediate position is the position of the ejection pin in which arming of the fuze can be accomplished but only when the rocket is fired. Thus, should the rocket be accidentally

dropped out of the launcher the ejection pin would move to its "locked" position in which the fuze cannot arm. Upon firing the rocket, however, the setback sleeve moves rearward with relation to other fuze parts and is locked in place. Then, upon emergence of the rocket from the launcher, the ejection pin is completely ejected and the fuze becomes "armed." The sleeve and plunger are held back by the creep spring during flight. Upon impact, normal or graze, the plunger and sleeve drive the firing pin into the detonator, exploding the rocket. Due to the shape of the plunger and the lever action of the firing pin, the fuze is rapid in action and sensitive even to low angle graze impacts.

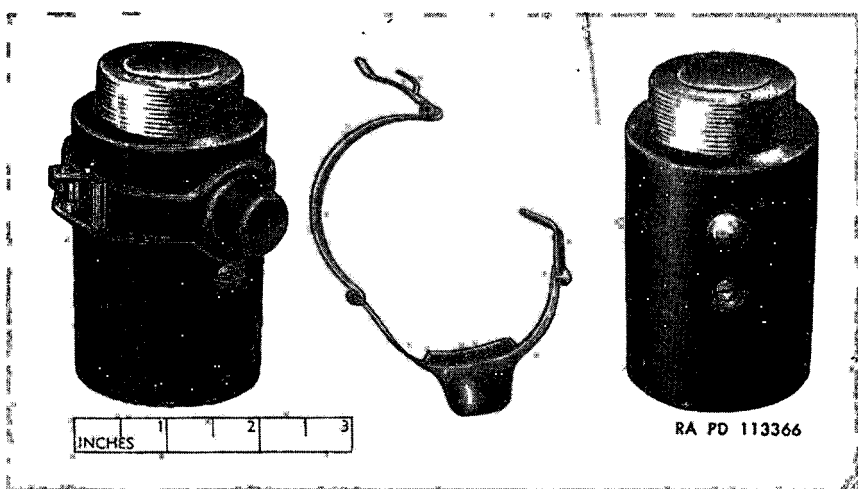


Figure 41. Fuze, rocket, BD, M404.

52. Fuze, Rocket, BD, T2015E2

This fuze which has an appearance similar to the M404 (par. 51), is used in connection with the burster in head of the WP smoke rocket T127E2 (par. 40).

53. Fuze, Rocket, PD, M4A2, and Modifications

a. GENERAL. This is a selective superquick-delay impact fuze for fin-stabilized rockets. It is used in 4.5-inch rocket T22 (par. 43). The delay time is indicated in the nomenclature and marked on the fuze. At present, the SQ-0.10-second delay fuze is furnished for ground-fired rockets; the SQ-0.015-second delay fuze is furnished for aircraft-fired rockets. The rockets for which this fuze is designed have deep fuze cavities; therefore, an auxiliary booster (fig. 44) is issued with the fuze. The fuze has an integral booster assembled to the base (figs. 42 and 43). A safety wire,

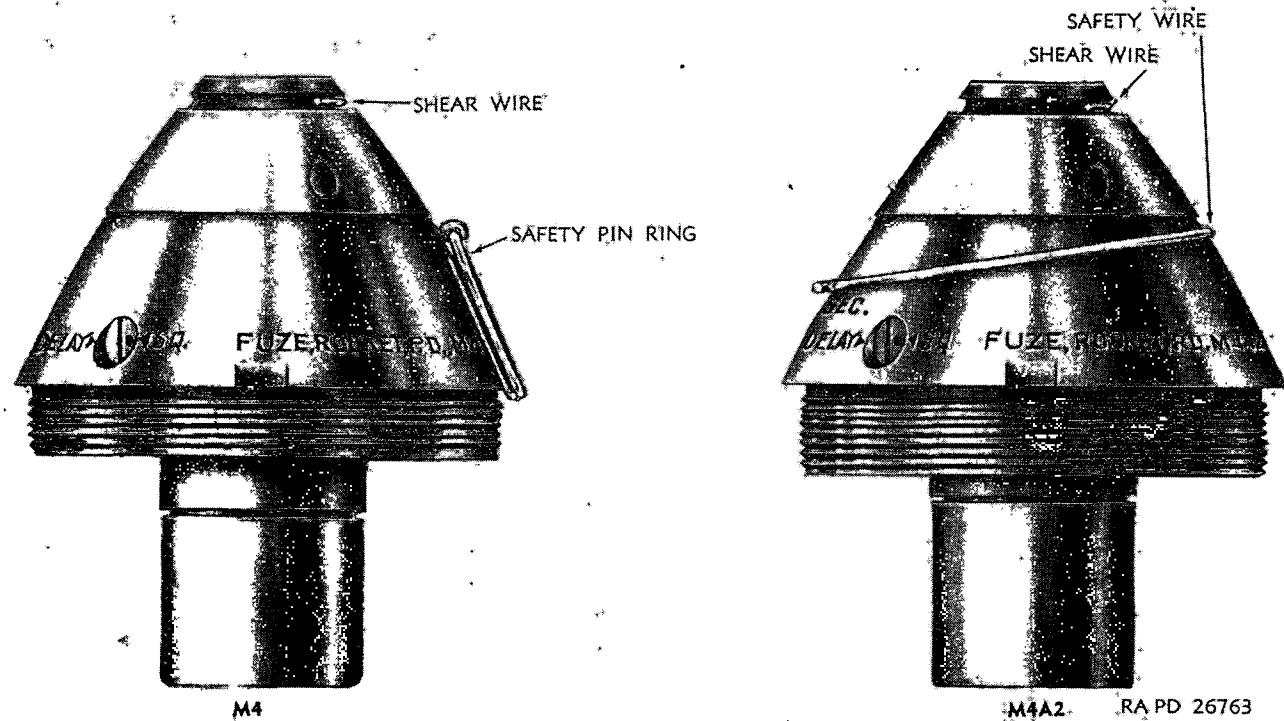


Figure 42. Fuze, rocket, PD, M4, and M4A2.

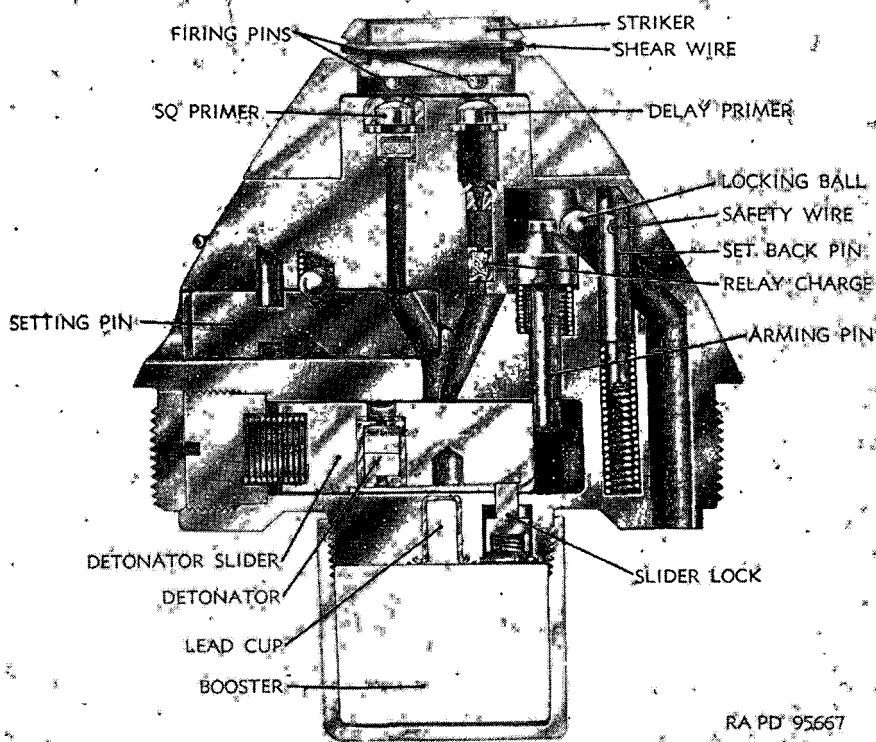


Figure 43. Fuze rocket, PD M4A2—section.

or a safety pin with pull ring, prevents arming of the fuze while the pin is in place. The slotted head of the setting pin appears in the side of the fuze, with the body of the fuze marked to indicate "SQ" or "DELAY." The action of the fuze is selected by turning the setting pin until the dot on the pin registers with the arrow indicating the desired action.

b. FUNCTIONING. On firing, the setback pin (fig. 43) compresses its spring and moves toward the base of the fuze, releasing the locking ball. The arming pin is held in place by setback until acceleration is over. When the motor is burned out and the rocket is in free flight, a spring pushes the arming pin forward, thus releasing the detonator slider which moves into position, aligning the detonator with the booster lead and the common flash tube. On impact, the striker is forced back, cutting the shear wire and firing both superquick and delay primers. The delay primer ignites the delay charge which ignites the relay charge which, in turn, fires the detonator. The superquick primer, if the fuze is set "superquick," fires the detonator directly; if the fuze is set for

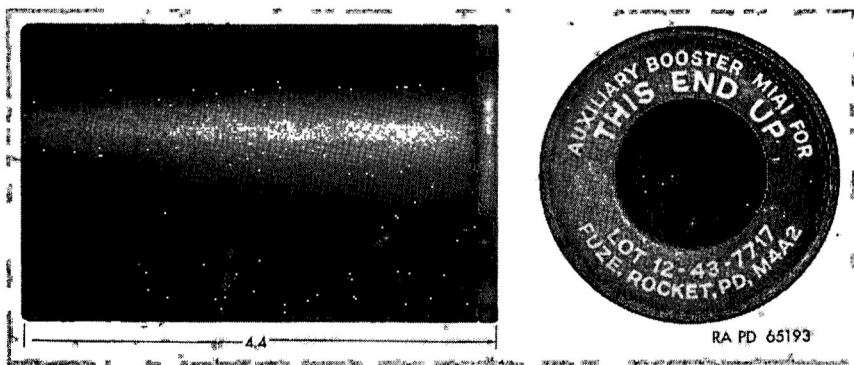


Figure 44. Auxiliary boosters M1 and M1A1.

delay, the channel in the setting pin is turned out of line, closing the flash tube, and the superquick primer has no effect.

Note. The safety wire must be removed just before inserting the rocket into the launcher, otherwise the setback pin cannot move and the fuze will not arm.

c. MODIFICATIONS. In the fuze M4, the setting pin also controls the delay flash tube; as a consequence, if the setting pin slot is not parallel to the fuze axis, both flash tubes are blocked and the fuze will be a dud.

d. AUXILIARY BOOSTER. The auxiliary booster (fig. 44) which is an essential adjunct to the M4A2 fuze when used in a deep cavity rocket head, *and which must not be omitted*, is provided to fill the space in the deep cavity, thus increasing the explosive charge and insuring that the fuze will detonate the shell. The auxiliary booster M1 is a cylindrical chipboard and metal container with flat ends. It contains 0.8 pound of flake TNT. The auxiliary booster M1A1, although longer, contains a recess in which the fuze booster nests, hence may be used interchangeably with the booster M1. It contains 0.8 pound of TNT and a 0.2-pound tetryl ring.

e. FUZING. The following procedure will be followed in assembling this type of fuze to the rocket:

- (1) Remove fuze from packings and inspect to insure that threads are clean, safety wire and shear wire are in place, and that there is no indication of serious corrosion or other evidence of unserviceability.
- (2) Loosen set screw in adapter and remove rocket shipping plug. Inspect fuze seat for clean threads and absence of foreign material.
- (3) Insert auxiliary booster with marked end outward.
- (4) Screw fuze in place and tighten. Tighten adapter set screw.
- (5) If necessary, set fuze for desired action with screwdriver

or similar tool. Be sure slot is parallel with fuze axis.

- (6) Remove fuze safety wire when loading rocket into launcher.

f. UNFUZING. If the rocket is not used, return components to original packings by reversing above steps. Reseal packings and mark so that these components may be used first in subsequent operations.

g. PRECAUTIONS.

- (1) If the shear wire is broken or missing, the fuze should be handled, nose down, with care until it can be destroyed.
- (2) If the slot in the setting pin is not parallel to the fuze axis, fuze M4A2 will function only with delay action, but fuzes M4 and M4A1 will not function at all.
- (3) A small amount of external corrosion is not harmful in itself but it does indicate the possibility of sufficient internal corrosion to bind or freeze moving parts and cause malfunction.
- (4) The striker must be protected from blows. If the shear wire is broken, the primers are liable to fire. Light blows which do not break the shear wire may weaken it to such an extent that it will shear from setback on firing.
- (5) The auxiliary booster is an essential part of the fuze when used in deep cavity rocket heads; *it must not be omitted.*

54. Fuze, PD, M81A1

a. GENERAL. This fuze is of the artillery type with booster assembled, and is used with spin-stabilized rockets of the M16, M17, M20, and M21 series (par. 45). It is a selective superquick-delay type and arms by centrifugal force. The fuze consists of an assembly of the standard fuze M48A3, SQ-0.05-second delay, and the booster M24. Booster M21A1 may be substituted. Dependent upon the source of the components, the earlier model may be marked M81 or M48A2.

b. DESCRIPTION. The fuze is a standard contour artillery fuze (fig. 45) with booster assembled. The slot of the setting sleeve is parallel to the axis of the fuze when set "superquick" and perpendicular to the axis when set for delay action. Booster M21A1 differs from the booster M24 illustrated, in that it has a safety cotter pin and pull ring which must be removed before assembling the fuze to the rocket, and replaced if the rocket is unfuzed. The components of this fuze are described and illustrated in TM 9-1901.

c. **FUZING.** After removing fuze from packing and inspecting fuze and fuze seat, set the fuze for the desired action and screw into adapter; tighten fuze and adapter set screw.

55. Fuze, Rocket, Nose, MK 137 Mod O, Mod 1, or Mod 2 (Navy)

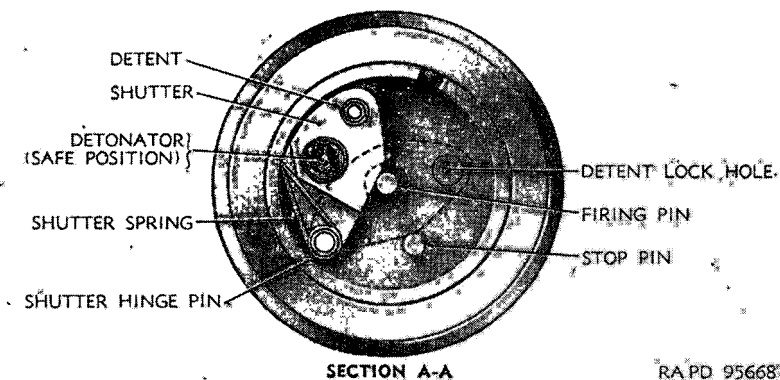
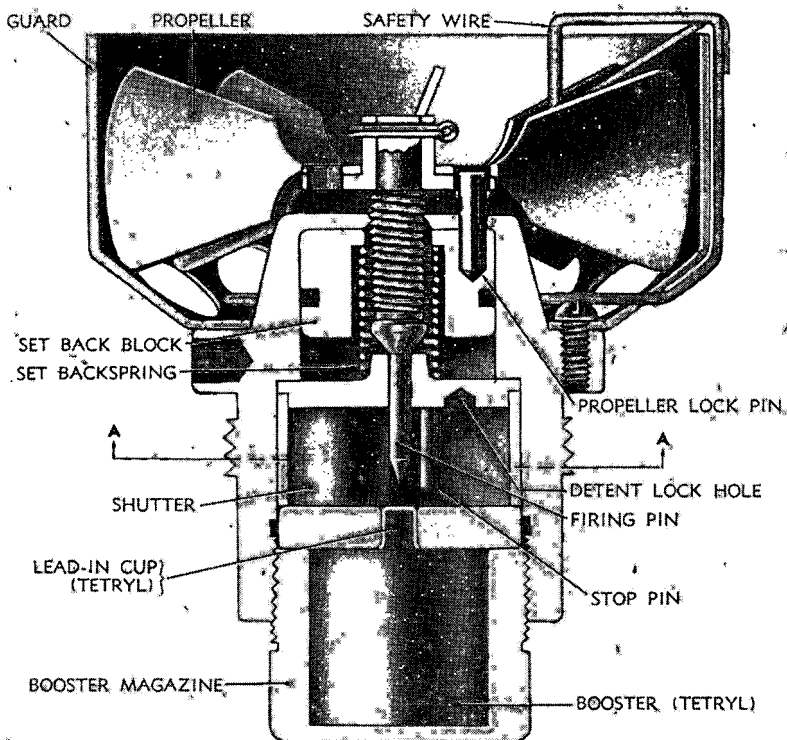
a. **GENERAL.** This is a setback, air-arming, impact-firing nose fuze. It is detonator safe and functions with superquick action on impact with ground or water. It is used in rounds to be launched from small craft in beach-barrage action and for other applica-



Figure 45. Fuze, PD, M81A1.

tions. The Mod O propeller has 8 vanes and the Mod 1 has 10 vanes. The Mod 2 has the modifications of the Mod 1 plus a rivet head stop on the propeller hub in place of an embossed stop.

b. **DESCRIPTION.** The fuze (fig. 46) generally is cylindrical with the booster, propeller, and vane guard assembled to it. The detonator is assembled in a spring-loaded shutter which is held out of the armed position by the firing pin. The firing pin passes through the firing pin guide and is threaded through a shear plate in the top of the fuze. The propeller is attached to the outer end of the firing pin. The propeller is kept from turning by a lock pin mounted in a setback block within the fuze. The setback block is held in place by a safety wire passing through the fuze body.



SECTION A-A

RA PD 95668

Figure 46. Fuze, rocket, nose, MK 137 Mod 0, Mod 1, and Mod 2 (Navy).

c. FUNCTIONING. The safety wire will be withdrawn when the rocket is loaded into the launcher. On firing the rocket, the set-back block is forced back against its spring, withdrawing the lock pin from the propeller. The air stream rotates the propeller and screws the firing pin forward through the shear plate. When

acceleration is over, the propeller has moved forward far enough that the lock pin will not reengage it. The firing pin, thus, having been withdrawn from the position where it prevented the detonator shutter from moving, allows the shutter spring to swing the shutter so that the detonator is in line with the firing pin and booster lead. At this point, the detent engages the detent lock hole in the firing pin guide, thereby locking the shutter. On impact, the firing pin is driven inward, shearing the threads in the shear plate and the pin striking the detonator, firing the fuze.

d. INSPECTION. In addition to inspection for clean threads, bent vanes, and corrosion, the following points will be observed:

- (1) If the forward edges of the propeller vanes extend beyond the guard, the fuze will be considered armed and will be handled with extreme caution until it can be destroyed.
- (2) Remove the safety wire and, by exerting pressure with the fingers, test the propeller for resistance to turning to insure that the propeller lock pin is in place. If the lock pin is not in its proper place and the propeller starts to turn, by pressure of the fingers, do not allow the propeller to turn more than one-half turn. In such a case the fuze will be considered armed and must be destroyed.
- (3) With safety wire, push on the head of the lock pin to see that it is free to move. Do not allow the propeller to turn during this test.

Caution: Be sure the lock pin springs back into place in the propeller hub. Replace safety wire.

e. FUZING.

- (1) Remove fuzes from containers and inspect as specified above.
- (2) Remove shipping plug, gasket, and paper tube from rocket. Inspect fuze to insure that threads are clean, the auxiliary booster is in place, and that there is no foreign matter present or other evidence of unserviceability.
- (3) With fuze gasket in place, screw the fuze into the adapter, and tighten with fuze wrench.
- (4) When the rocket is placed in the launcher, remove fuze safety wire.
- (5) If the rocket is not used, replace the safety wire. Then remove fuze from the rocket and restore components to original condition and packing.

Warning: If the fuze is accidentally armed, no attempt will be made to disarm it, because turning the arming vane will cause the firing pin to pierce the detonator and

fire the fuze. If the fuze is assembled to the rocket when its armed condition is discovered or suspected, the rocket will not be unfuzed, but the entire round will be handled with utmost care until it can be disposed of safely.

56. Fuze, Rocket, Nose, MK 145 Mod 1, 0.02-Sec Delay

This fuze is similar to the fuze Mk 137 described in paragraph 55 except that the detonator incorporates a 0.02-second delay element. The same descriptions are pertinent and the same procedures and precautions will be observed.

57. Fuze, Rocket, Nose, MK 147 Mod O and Mod 1

This type (fig. 47) is the setback, air-arming, impact-firing nose fuze similar to the Mk 137 type described in paragraph 55 except that it has a burster and an adapter in place of a booster. With this exception, the same descriptions, procedures, and precautions apply. The Mod O is fitted with a cylindrical guard which protects the propeller from damage. The propeller vanes are bent to an angle of 70° . The Mod 1 has a detachable shipping cap which protects the propeller from damage during shipping and the fuze from the weather. The vanes on the Mod 1 are bent to an angle of 78° to keep the arming distance the same as for the Mod O. The shipping cap and safety wire on the Mod 1 are removed as the rocket is loaded into the launcher. If the round is not fired, the safety wire and the shipping cap must be replaced in the fuze and the components restored to their original condition and packings.

58. Fuze, Rocket, Nose, MK 154 Mod O, Mod 2, or Mod 3

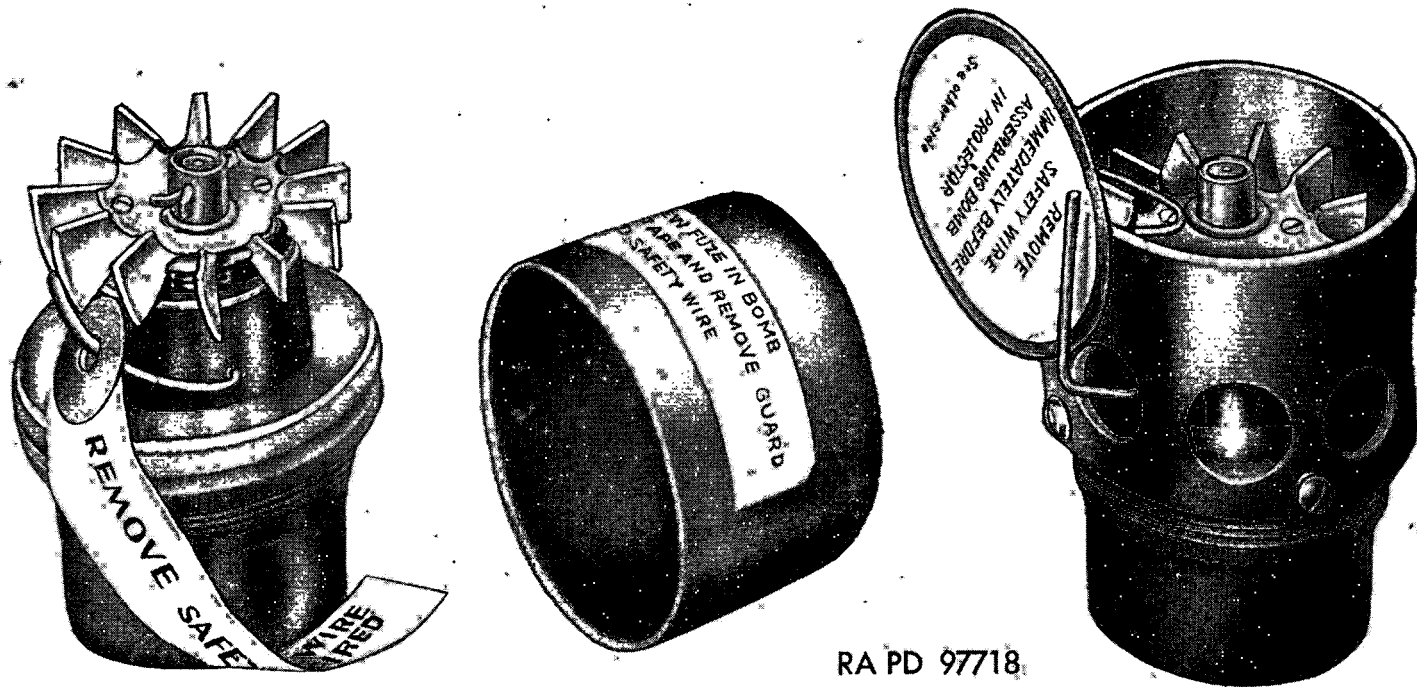
This fuze is identical with fuze Mk 137 except that a teteryl-filled burster replaces the booster. It is used in 4.5-inch rocket heads Mk 7 (FS smoke) and Mk 10 (WP smoke).

59. Fuze, Rocket, Dummy, M6, M73, and M405

a. M6. This is an inert fuze of the same shape and weight as the fuze M4. It is intended for use in practice rocket T46 (par. 43).

b. M73. This is an inert fuze of the same shape and weight as the fuze M81 or M81A1 and is provided for use in practice rockets M17 and M21 (par. 45o) and drill rocket M24 (par. 46).

c. M405. This is an inert fuze of the same shape and weight as the fuze M404. It incorporates an ejection pin and safety clamp



RA PD 97718

Figure 47. Fuze, MK 147 Mod 0 (right) and MK 147 Mod 1 (left) without burster.

simulating that used with the M404. It is provided for use with the 3.5-inch practice rocket M29 (par. 41). The body of the safety clamp is painted blue. The fuze nomenclature, the loader's lot number, and the month and year of loading are stamped into the metal.

Section VII. VT FUZES FOR GROUND TYPE ROCKETS

60. General

For general description of VT fuzes, see paragraph 9.

61. Fuze, Rocket, VT, M402

a. GENERAL. The VT fuze M402 (T31E1) (fig. 48) is a proximity fuze for ground-to-ground use in the Army (rotated) 4.5-inch HE rockets M16A2 (M16E4) and M16A1 (M16E5) (par. 45). This fuze is, in effect, an automatically set time fuze. Without field adjustment, it produces an air burst at a height to cause greatest lethal fragmentation effect against personnel without top cover, such as men in foxholes or slit trenches. The VT fuze M402 requires a special deep cavitized rocket head, which cavity is provided in the M16A2 (M16E4) and M16A1 (M16E5) rockets. The supplementary charge, provided with the M16A2 (M16E4) and M16A1 (M16E5) rocket heads, is for use when employing the point detonating fuze M81 or M81A1. When using the VT fuze, the supplementary charge must be removed. The rockets M16A2 (M16E4) and M16A1 (M16E5), when VT fuzed, are ballistically

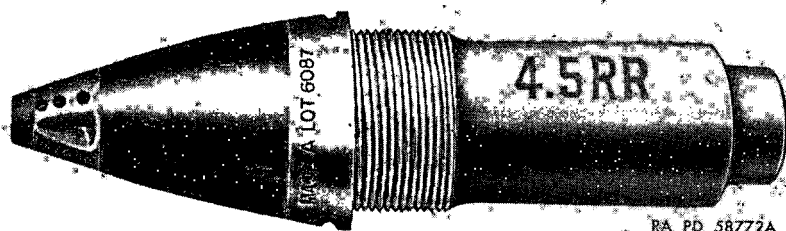


Figure 48. Fuze, rocket, VT, M402.

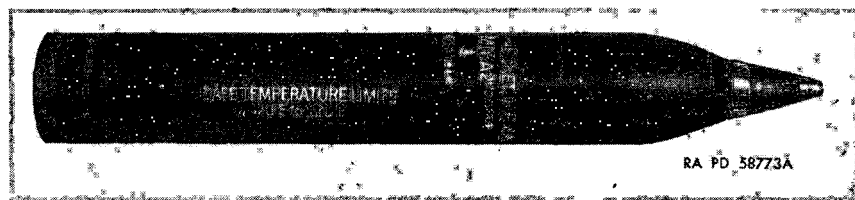


Figure 49. 4.5-inch rocket M16 series with VT fuze M402.

the same and have the same contour as the rockets M16, M16A2 (M16E4), and M16A1 (M16E5) with standard point detonating fuzes (fig. 49).

b. CHARACTERISTICS OF FUZE.

- (1) *Arming.* Arming of these fuzes is delayed for at least 4.0 seconds after being fired. The exact time of arming will vary between fuzes within the range of approximately 4.0 to 8.0 seconds. Arming is delayed by a series of safety devices which depend on rocket rotation.
- (2) *Burst height.*
 - (a) The height of burst varies with the angle of fire, thus maintaining nearly optimum burst height at all ranges over average level ground (fig. 50). The height of burst over a body of water will be approximately twice that over land, and will be greater over wet soil or soil containing metal fragments than over dry soil.
 - (b) Burst height dispersion normally will not vary from the average (fig. 50) by more than 50 percent. The dispersion in height of burst decreases as the time of flight increases.
 - (c) Light tree foliage and vegetation do not materially affect the height of burst, but dense tree foliage and thick vegetation will increase the height of burst over ground. This effect is less at steeper angles of fires,

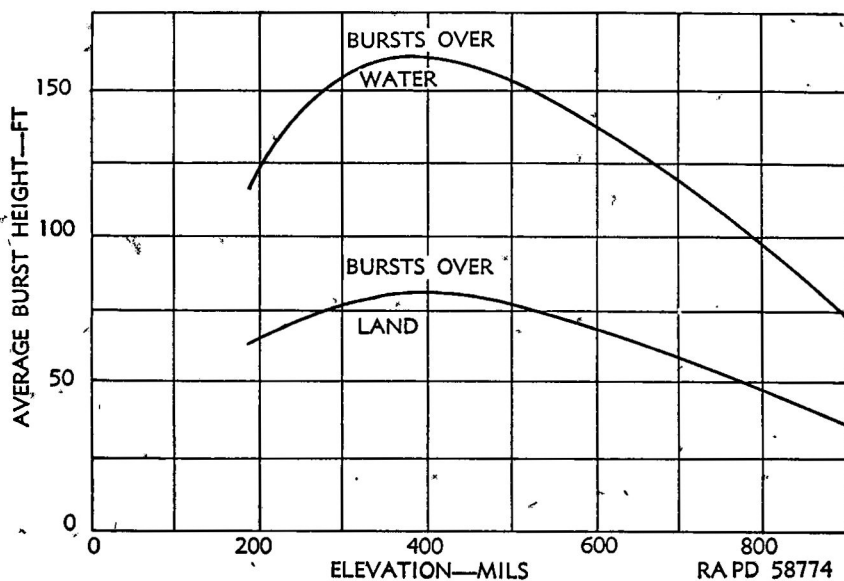
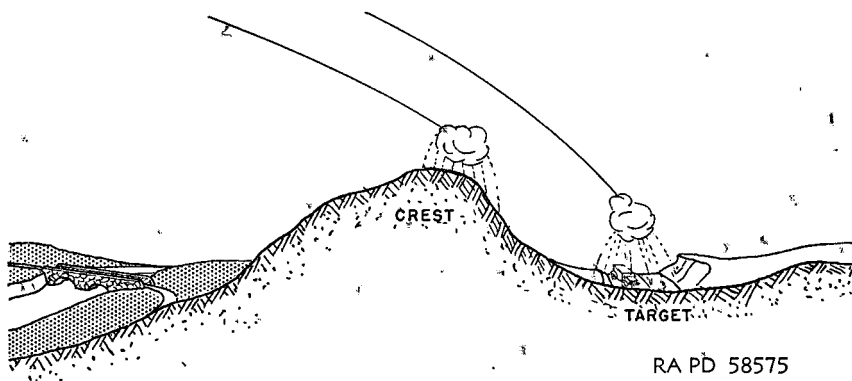


Figure 50. Burst height as compared with launcher elevation.

in which case, most bursts will occur slightly below tree top level.

- (d) Close passage or approach to crests, trees, streams, towers, parked aircraft, mechanized equipment, etc. will cause functions at heights greater than indicated in figure 50. This characteristic may be used to advantage, in that fire power will tend to be concentrated on such irregularities. When targets are beyond such irregularities, clearance of at least 250 feet should be allowed to insure maximum effect over the target area (fig. 51).



RA PD 58575
ADEQUATE CLEARANCE IS REQUIRED TO
AVOID WASTING ROUNDS ON CREST.

Figure 51. Adequate clearance required to avoid wasting rounds on crest.

- (3) *Danger to aircraft.* Aircraft will cause armed fuzes to function if the rocket passes within 30 feet of the craft.
- (4) *Minimum range.* The minimum range for use of these fuzes is limited by the arming and burst height characteristics to 2,400 yards (212 mils QE).
- (5) *Safety.* These fuzes can withstand rough handling and dropping with safety; they are also boresafe. This boresafety is derived from an electric delay, a mercury unshorter which when closed shorts out the electric firing squib, and a spin switch which at low values of spin makes the firing circuit inoperative.
- (6) *Malfunctions.* In the present state of development, approximately 80 percent of the fuzes will function properly on approach to a target; the remainder will be divided about evenly between those which function upon impact and those which function in mid-flight between the point of arming and the end of the trajectory ((9) below).

- (7) *Ripple firing.* Rockets with M402 fuze's may be fired satisfactorily from multiple-tube launchers at normal (0.4-sec) intervals. A slight increase in mid-flight functions may be observed when several multiple-tube launchers are firing simultaneously. Launchers fired simultaneously should be at least 100 feet apart.
- (8) *Impact functions.* Fuze M402 is equipped with a non-delay impact-detonating device (fig. 54) which will function if an air burst is not produced. This reduces duds to less than 5 percent.
- (9) *Climatic effects.*
 - (a) Fuze M402 may be used in day or night operations with equal effect. In light precipitation, the fuze will operate normally; however, in heavy snow or rain there may be an increase in the number of mid-flight functions.
 - (b) Full advantage should be taken of the sealed fuze containers in tropical and damp climates. In all but tropical climates, fuze's should be used within 2 months after removal from their original packing containers. In tropical climates, the storage time of unpacked fuze's should be kept to a minimum. Exposure of unpacked fuze's to rain or immersion in water will hasten deterioration but will not decrease fuze safety.
- (10) *Temperature.* Optimum fuze performance will be obtained when fired at temperatures between 0° and 120° F. Therefore, the fuze's should not be used outside these temperature limits. As long as the fuze's themselves are between these limits at the time of firing, they will operate even though the atmospheric temperature is outside these limits. Temporary exposure of the fuze's to temperatures outside of these limits will not permanently injure them. Prolonged exposure to temperatures outside these limits will result in increased mid-flight and impact functions, but will not decrease fuze safety.

62. Use and Care of Fuze M402

a. ASSEMBLY OF VT FUZE M402 TO ROCKETS M16A2 (M16E4) AND M16A1 (M16E5).

- (1) Loosen the set screw and remove the nose plug from the rocket with the wrench provided.
- (2) Remove the supplementary charge.
- (3) Inspect the fuze cavity of the rocket for chips or dust of high-explosive filler. Remove all loose material with a non-ferrous (brass, copper, wood, etc.) tool to provide

a clean cavity. Reject any rocket having badly damaged threads or cavity side walls.

- (4) Open the metal fuze container and remove the VT fuze. Make certain that the booster is screwed in hand tight. *Note.* Boosters are screwed to the fuze with a *left-hand thread*. **DO NOT STAKE THE BOOSTER.**

- (5) Screw the fuze into the rocket by hand to be certain that the fuze fits properly. If binding occurs, inspect the fuze cavity and threads and reject either the rocket or the fuze; whichever is at fault.

- (6) Tighten the fuze with the special fuze wrench issued in each box of fuzes. Use only such force as can be applied by hand to the fuze wrench handle. **DO NOT HAMMER ON THE WRENCH OR USE AN EXTENSION HANDLE.** If the fuze cannot be tightened so as to obtain a good seat between the fuze and rocket, reject the item which is at fault. **DO NOT STAKE FUZE TO ROCKET.** Tighten the set screw in the nose of the rocket.

Note. Standard impact fuzes cannot be used with the M16A2 (M16E4) and M16A1 (M16E5) rockets unless the supplementary charge is in place in the deep cavity.

b. DISASSEMBLY PROCEDURE.

- (1) *VT fuzes will not be disassembled under any circumstances by using troops or ordnance troops.*
- (2) VT fuzes may be removed from the rocket, as occasion requires, by loosening the set screw and unscrewing the fuze with the wrench provided with the fuzes.

c. PACKING AND MARKING.

- (1) Each fuze is packed in a hermetically sealed metal container (fig. 52) equipped with a tear strip and key for opening. Twelve of these containers are packed in a corrugated carton with a special wrench for assembling the fuze to the rocket shell. The carton is enclosed in a steel fuze box (fig. 53). Weights and dimensions of the fuze and packing box are tabulated below:

Fuze weight	2.7 lb.
Fuze length, over-all	8.43 in.
Fuze length, in cavity	4.91 in.
Box dimensions	15 1/4 x 12 x 14 1/2 in.
Box weight w/fuzes and wrench	67 lb
Box volume	1.54 cu-ft

- (2) Each fuze has the model of the fuze, and the manufacturer's lot number die-rolled into its nose section. The identifying symbol of its application, 4.5RR, is stamped (fig. 48) in the cylindrical section of the fuze.



RA PD 58775A

Figure 52. Hermetically sealed container.



RA PD 58776B

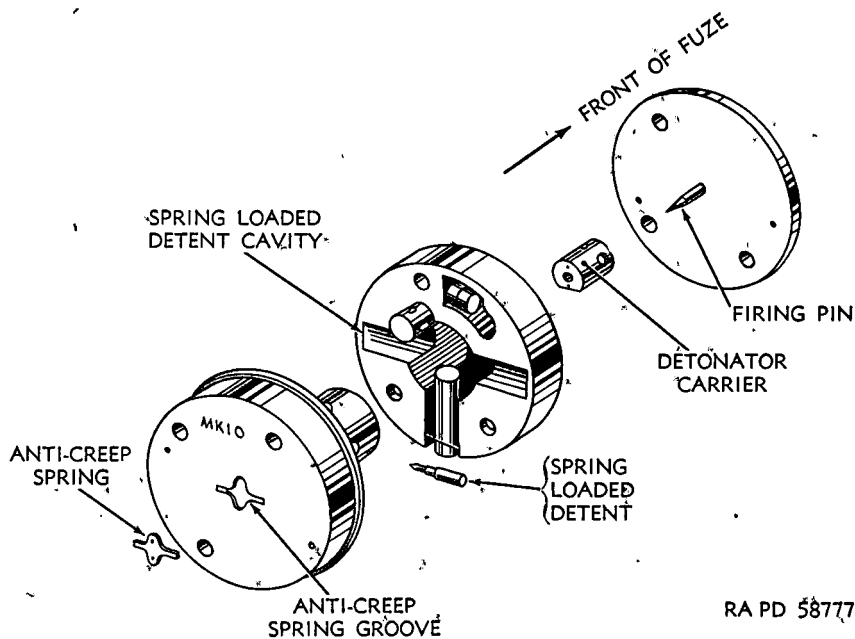
Figure 53. Packing box for VT fuzes.

d. STORAGE.

- (1) *Fuzes.* The normal facilities available for storage of ammunition, both at the battery position and in the ammunition dumps are, in general, suitable for VT fuzes. These fuzes may be stored in their original unopened

metal containers provided they receive proper security and the same care given all packed ammunition, in addition to keeping the storage temperature limits between -20° and 130° F. Storage outside these limits for any extended interval will result in permanent damage. Fuzes, whether packed or unpacked, should be kept out of the direct rays of the sun, which serves as a source of heat sufficient to raise their temperature.

- (2) *Unfuzed rockets.* Storage conditions will follow standard practice.
- (3) *Fuzed rockets.* Storage conditions will be the same as for other fuzed ammunition except that, insofar as practicable, the fuzed rockets should be protected against excessive shock and exposure to high humidity and high temperatures.



RA PD 58777

Figure 54. Impact detonating element.

e. **HANDLING.** The same care should be given fuzes and fuzed rockets as normally is given in handling mechanical time and impact fuzes. Excessive rough handling may increase fuze malfunctions but will not decrease fuze safety.

f. **TRANSPORTATION.**

- (1) If occasion requires the movement of VT fuzed rockets over considerable distances, it is recommended that the fuzes be removed from the rockets. The fuzes should

be inserted into their correctly marked individual metal containers and sealed with tape. These fuze containers then should be packed in their original cartons and steel boxes prior to loading on an ammunition carrier.

- (2) Reinsert the supplementary charge (if any) and nose plug in the rockets and replace in properly identified containers.
- (3) If the above is not practicable for short movements of VT fuze rockets, proceed as with mechanical fuze rockets.
 - (a) Place several extra cardboard spacers under the fuze rocket when inserting it in the fiber container. This will take up the play between the shell and the container, thus preventing possible damage to the fuze. This play ordinarily is taken up by the horseshoe support which engages the wrench slots of the mechanical fuzes. However, the horseshoe support will not enter the wrench slots of the VT fuzes.
 - (b) Make sure that the designation on the container indicates the actual fuze which is in the rocket.

g. DISPOSAL OF DUD AMMUNITION.

- (1) *General:* Should it become necessary to recover or dispose of dud ammunition, the fuze may be considered safe for handling, as far as the VT element is concerned, 1 hour after the projectile is fired. The impact detonating element in this fuze presents approximately the same problem as a base detonating fuze in that it operates by travel of a detonator carrier, against an anticreep spring, into the fixed firing pin.
- (2) *Condition of impact element in a dud.*
 - (a) The impact detonating element (fig. 54) consists of a detonator carrier positioned by two spring-loaded detents and an anticreep spring. On rotation of the rocket, the spring-loaded detents move out of recesses in the detonator carrier, freeing it so that on impact, inertia causes it to strike the fixed firing pin.
 - (b) In a dud, the detonator carrier may have moved forward and the anticreep spring, which normally is positioned in a slot in the impact unit body, can no longer restrain the detonator carrier from striking the firing pin. Therefore, in handling a dud, a jolt may cause the impact element to function and fire the explosive train.

Caution: In the event duds are recovered, they should not be moved and must not be approached closer

than 50 feet for 1 hour. When circumstances do not permit destruction of the dud in place, it may be moved with extreme caution by authorized bomb disposal personnel. It must be constantly borne in mind that a dud contains a fully armed impact element and may be functioned by a slight jar or jolt.

h. DESTRUCTION OF VT FUZES. See paragraph 93.

CHAPTER 3

AIRCRAFT TYPE ROCKETS

Section I. 2.25-INCH, 3.5-INCH, 5.0-INCH, AND 11.75-INCH ROCKETS

63. General

Several Navy type rockets are used by the United States Air Force for forward-firing from aircraft rocket launchers of the post type (zero length), the rail type, the drop type, or the retractable jettisoning type. Ignition is by electric squib or cap through wires and standard plug. The following rockets of similar construction are included in this category. Should it be desirable to check the continuity of their electrical circuits, use continuity circuit tester (par. 14).

2.25-inch rocket (fig. 55)

3.5-inch rocket (fig. 56)

5.0-inch rocket (fig. 57)

5.0-inch high-velocity rocket (figs. 58, 65, 66, and 67)

11.75-inch rocket (figs. 68 and 69)

Note. The components comprising the complete rounds shown in table I are described below. Table II gives physical and ballistic data.

64. 2.25-Inch Rockets

The 2.25-inch forward-firing subcaliber aircraft rockets (SCAR) (fig. 55) are used as practice ammunition in place of the 3.5-inch and 5.0-inch forward-firing aircraft rockets. Their trajectories are intended to be identical with those of the service ammunition for aircraft firing at 70° F., at 20° dive angle, 265 mph, and 1,000-yard range. The rocket consists of a motor approximately 29 inches long with four 3- by 5-inch fins welded in place on the motor body. Two lug buttons are attached to the motor body to engage Mk 6 adapters on the Mk 5 launchers. The 2.25-inch rocket Mk 1 Mod O, using a 1.6-pound head, is used as practice ammunition for the 3.5-inch aircraft rocket or the 5.0-inch high-velocity aircraft rocket. The 2.25-inch rocket Mk 2 Mod O (now obsolescent) used an 8.6-pound head and was used as practice ammunition for the 5.0-inch aircraft rocket. The 2.25-inch rocket Mk 2 Mod 1, using a 1.6-pound head and a motor

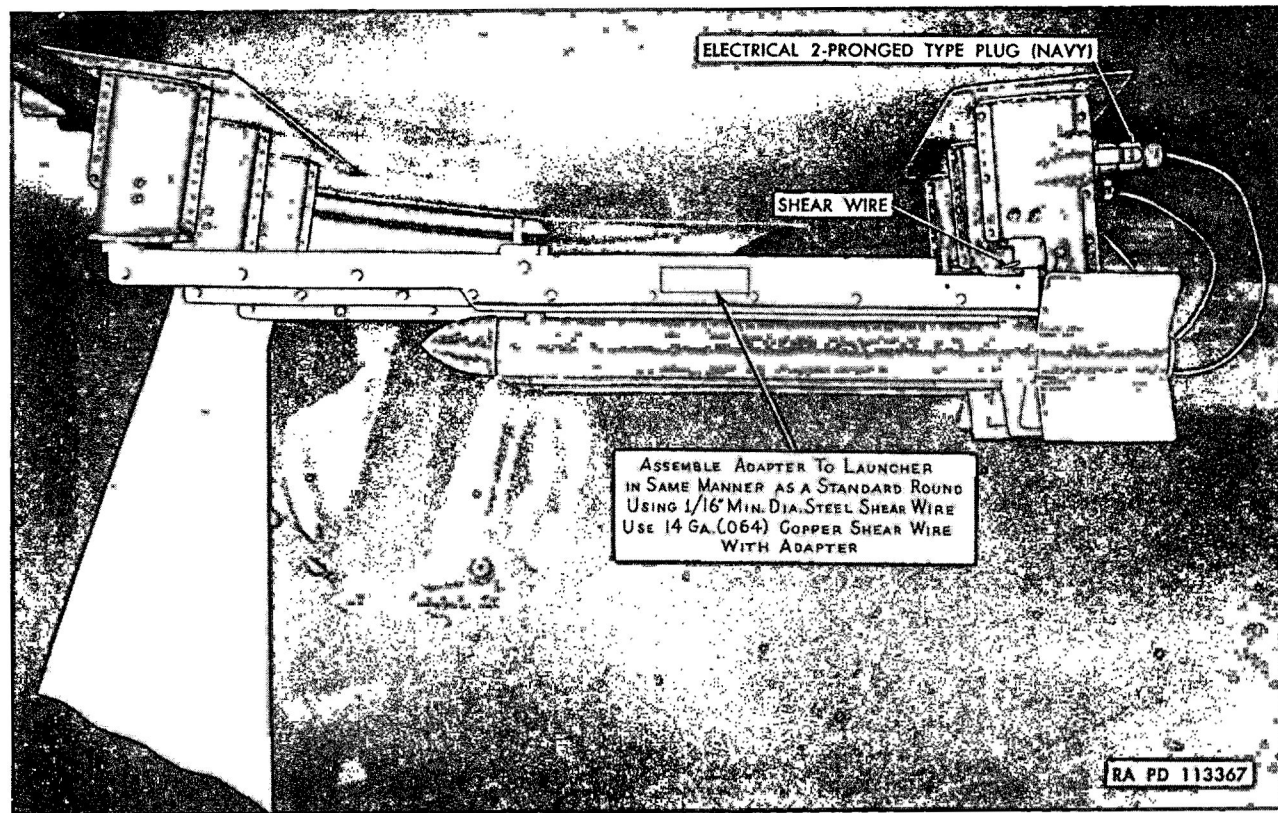


Figure 55. 2.25-inch subcaliber aircraft rocket with M6 adapter rail on post launcher.

with less thrust than that employed with the 2.25-inch rocket Mk 2 Mod 0, is used as practice ammunition for the 5.0-inch aircraft rocket.

65. 3.5-INCH ROCKETS

a. GENERAL. The 3.5-inch aircraft rockets (AR) (tables I and II) are fin-stabilized using the 3.25-inch motor Mk 7 modifications as the propulsive unit (fig. 56). Rockets equipped with a 3.5-inch solid steel head are used against light armored vehicles and for penetrating submarines and other lightly armored vessels.

b. HEAD. The Mk 8 Mod 1 head, which is used in the service round, is a 20-pound solid steel shot, 11.75 inches long, having a double ogive giving it the effect of an ogive of several calibers radius. The head Mk 8 Mod 1, when fired at angles of 20° or less, has a lethal underwater range of 120 feet. Since the Mk 1 (Mods) or Mk 2 (Mods) heads, used on some rounds, have a shorter ogive radius, thus giving them a more blunt appearance, the lethal underwater range of such rounds is only 60 feet; these heads are capable of penetrating 1.5 inches of mild steel at normal incidence. The smoke shell with FS (sulfurtrioxide-chlorosulfonic acid) filler uses the head Mk 6 Mod 0 and the drill (dummy) round uses the head Mk 2 Mod 0. The fuze used in the smoke rocket is the nose fuze Mk 155 Mod 0 (par. 75). The armor-piercing and drill (dummy) round has no fuze.

c. MOTOR. The 3.5-inch rocket uses the motor Mk 7 Mod 0, which consists of a steel tube, 3.25 inch outside diameter, containing a single cruciform inhibited propellant grain supported internally on a grid. The inhibitors, sometimes called deterrents, are of plastic material. They consist of longitudinal strips cemented to the edges of the grain and shaped washers cemented to the front and rear ends of the grain. They control the burning area of the grain, and consequently, the pressure developed in the motor. At the front end of the grain is a black powder igniter and electric squib contained in a plastic case. An electrical connector from the squib terminates in a plug similar to that shown in figure 59. At the rear is the nozzle, which is sealed with a moistureproof closure. The fin assembly, which is reversible, is a metal sleeve with four equally spaced rectangular fins. The sleeve slides over the rear end of the motor and is secured by screwing it onto the tail ring. Front and rear shipping caps are provided to protect the motor during shipment and storage.

d. PREPARATION FOR FIRING AND SAFETY PRECAUTIONS. See paragraphs 71 and 72.

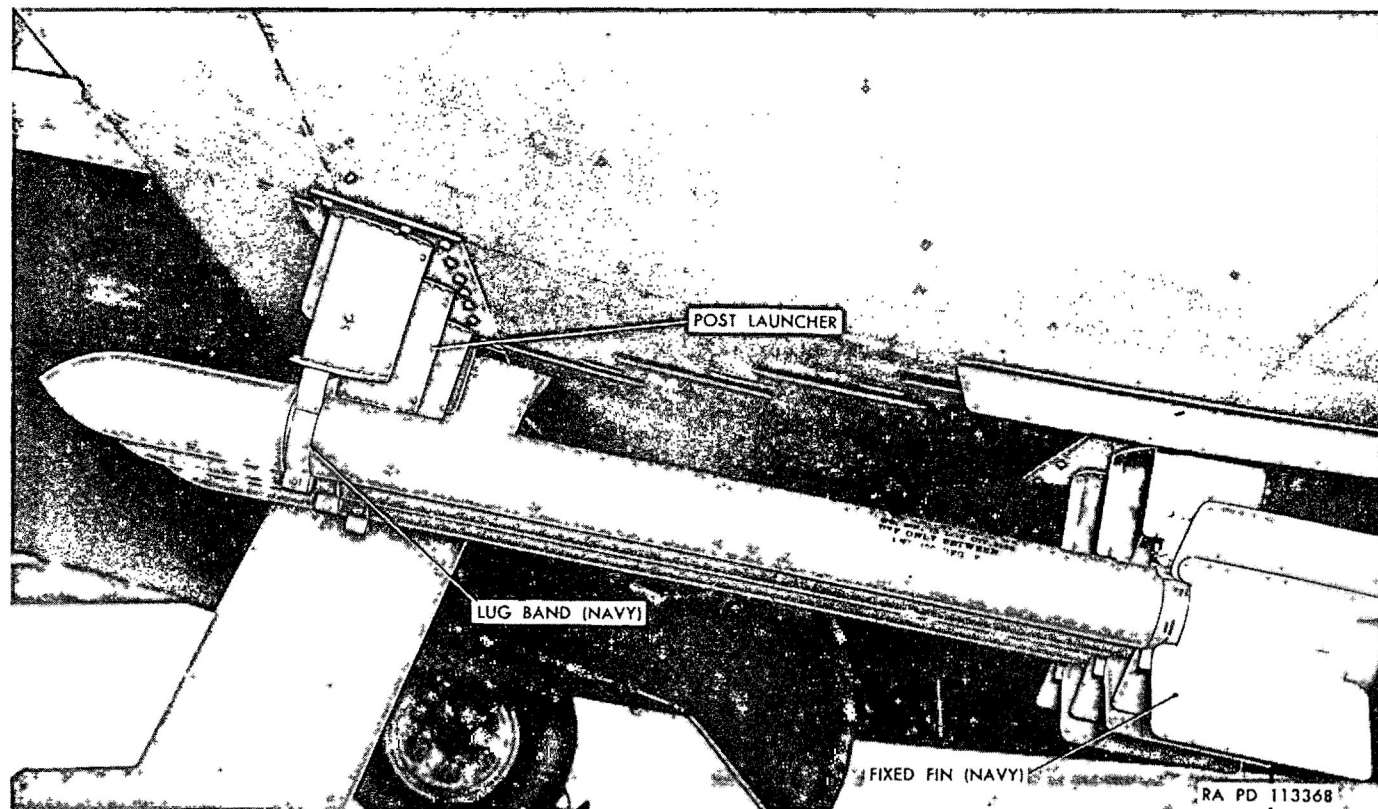
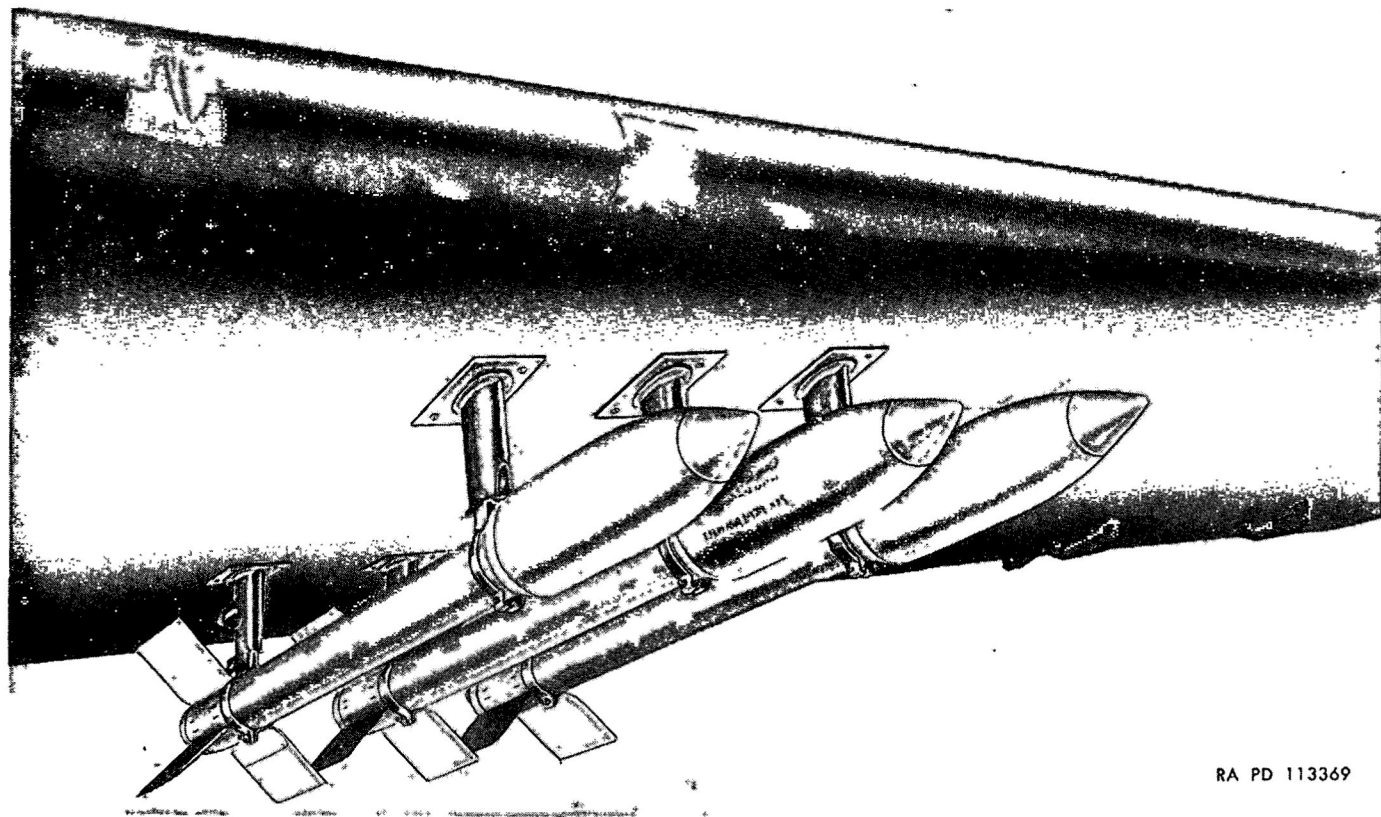


Figure 56. 3.5-inch aircraft rocket (3.5-inch head MK 8 Mod 1 and 3.25-inch motor MK 7 Mods).



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Figure 57. 5.0-inch aircraft rocket (5.0-inch head MK 1 Mod 0 and 3.25-inch motor MK 7 Mods).

66. 5.0-Inch Aircraft Rockets

a. GENERAL. The 5.0-inch aircraft rockets (AR) (tables I and II) are fin-stabilized, using the 3.25-inch motor Mk 7 and modifications as the propulsive unit (fig. 57). Rockets equipped with the 5.0-inch high-explosive head Mk 1 Mod 0 or 1 are for use against shipping, personnel, bivouac areas, and light armor.

b. HEAD. The head Mk 1 Mod 0 with one of the modifications of the motor Mk 7 is shown on the Mk 5 Mod 1 post launcher in figure 57. This head, which has a TNT filler, is equipped with nose fuze Mk 149 Mod 0 (par. 74) or conical nose plug, and a base fuze Mk 165 Mod 0 (par. 80) or MK 157 Mod 2 (par. 76). When used with a conical nose plug, it will have the same fragmentation and penetration characteristics, at comparable velocities, as the 5.0-inch common antiaircraft projectile (Navy) of which it is a modified design. The Mk 1 Mod 0 head, when plaster-filled and equipped with a conical nose plug but no base fuze, is used as a component of the target practice rocket. The same head, plaster-filled and with neither nose nor base fuze, is used as a component of the drill (dummy) rocket. When the TNT-filled Mk 1 Mod 0 head is shipped with a flat nose plug, the plug must be replaced by nose fuze Mk 149 Mod 0 (par. 74); the base fuze, which is installed in the rear of the head and staked in place *must not be removed under any circumstances*. The 5.0-inch head Mk 1 Mod 1, is specially deep cavitized to receive the VT fuze M403 (par. 82) (figs. 75 and 76) for plane-to-ground firing. It also is fitted with base fuze Mk 165 Mod 0 (par. 80).

c. MOTOR. The 5.0-inch aircraft rockets (AR) have the motor Mk 7 and modifications. This is the same motor as is used as a component of the 3.5-inch aircraft rocket (AR) (par. 65).

d. PREPARATION FOR FIRING AND SAFETY PRECAUTIONS. See paragraphs 71 and 72.

67. 5.0-Inch High-Velocity Aircraft Rockets

a. GENERAL. The 5.0-inch high-velocity aircraft rockets (HVAR) (tables I and II) are used for forward firing from aircraft against heavy tanks and gun emplacements (figs. 65, 66, and 67). Due to the large charge of propellant in the motor, the rocket has a velocity of 1,360 fps which is nearly double that of the 5.0-inch aircraft rocket (AR) with the 3.25-inch motor.

b. HEADS. The heads used in the service rounds are—the TNT-filled head Mk 6 Mod 1 (used with motor Mk 2 Mod 3 or 4) equipped with the nose fuze Mk 149 Mod 0 (par. 74) and the base fuze Mk 164 Mod 0 (par. 79) or the MK 159 Mod 1 (par. 77); the same head and fuzes used with the Mk 10 Mod 4 motor; and the TNT-filled head Mk 6 Mod 4 which is specially deep-cavitized to

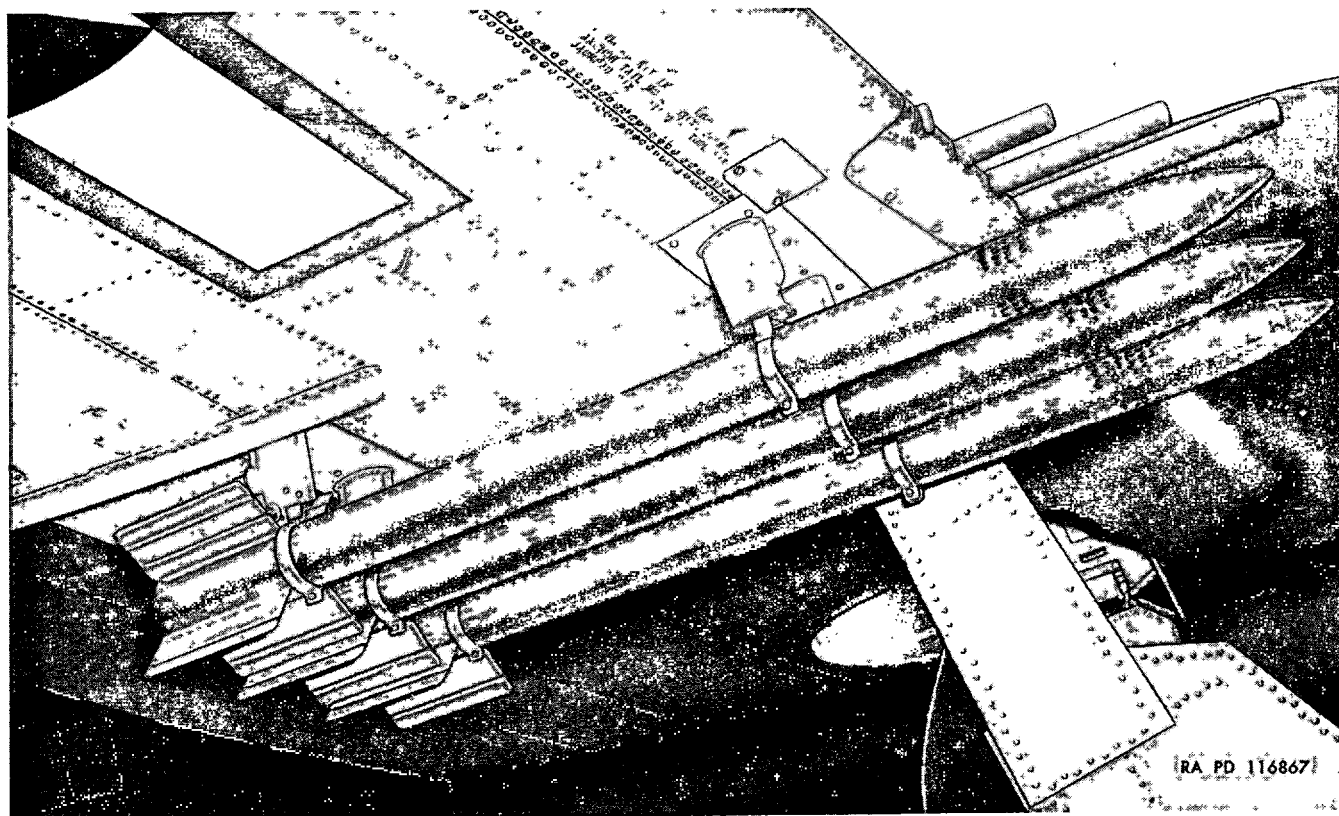


Figure 58. High-velocity aircraft practice rocket with Navy fin.

receive the fuze VT M403 (par. 82) for plane-to-ground firing. The head Mk 6 Mod 4 is equipped with the base fuze Mk 164 Mod 0. Earlier heads Mk 6 Mod 1 are equipped with the nose fuze Mk 149 Mod 0 and base fuze Mk 159 Mod 1. The head used in the target practice round is the Mk 6 Mod 1 plaster-filled and equipped with nose fuze Mk 149 Mod 0 or a conical nose plug, and without a base fuze. *No attempt will be made to remove a base fuze.*

c. MOTOR. The motors used with the service rockets are the Mk 2 Mod 3 or 4 and the Mk 10 Mod 4. The target practice rocket uses the Mk 2 Mod 3 or 4 motor. The 5.0-inch rocket motor consists of a seamless steel tube with internal threads on both ends.

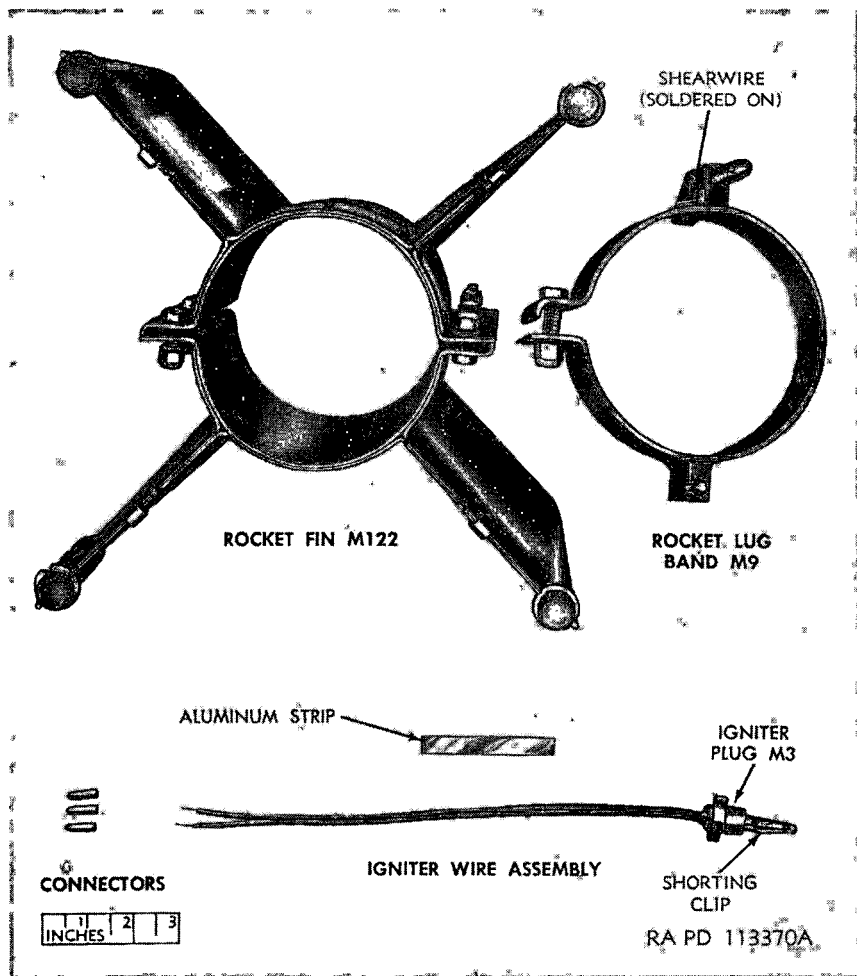


Figure 59. Rocket-kit M34, for modification of 5.0-inch high-velocity aircraft rocket (Navy).

At the rear is a nozzle plate having eight nozzles arranged in a circle and a central blowout nozzle closed by a copper disk. The central nozzle acts as a safety valve blowing out at a pressure of approximately 2,400 psi which is the normal motor pressure when the propellant is ignited at an initial temperature of 100° F. The propellant consists of a cruciform grain of powder inhibited on the outer surfaces and supported by a spacer and steel grid at the nozzle end. The propellant is ignited by a squib and black powder igniter which is contained in a small metal case in contact with the propellant grain. Igniter leads from the squib are brought through the central blowout nozzle and terminate in a plug. For Air Force use, two-prong plugs are to be replaced by standard plugs. See paragraphs 68 and 69.

d. FIN. The fin assembly (fig. 58) consists of a fin retaining plate and four detachable fins. This fin assembly is to be removed and replaced by the Army-type fin when converting the rocket with rocket-kit M34 for use with the retractable jettisoning launchers in Air Force aircraft. See paragraphs 68 and 69.

e. PREPARATION FOR FIRING AND SAFETY PRECAUTIONS. See paragraphs 71 and 72.

68. Rocket-Kit M34, for Modification of 5.0-Inch High-Velocity Aircraft Rocket (Navy)

a. GENERAL. This kit (fig. 59) is used to modify the 5.0-inch high-velocity aircraft rockets (Navy) (fig. 58) so that they can be used with the Air Force type retractable jettisoning launcher. Modified rockets are shown with the launcher schematically in figure 64, and installed in an airplane in figures 65, 66, and 67.

b. DESCRIPTION. The parts used for this modification consist of fin M122, lug band M9, igniter wire assembly with igniter plug M3, shorting clip, connectors, and aluminum strip.

- (1) The fin, fabricated from sheet steel, has four blades. It is made in two halves with flanges and bolts which provide for clamping the fin securely to the rocket. At the rear outer corner of each blade is an electrical socket with protector cap. When the fin flanges are horizontal, the two upper sockets, after removal of the protector caps, are for engagement with the rear launcher posts which support the rear end of the rocket (figs. 64 and 65). With reference to the "view looking forward" of figure 64, the lower left socket of the upper rocket is for insertion of the plug of the igniter wire leading from the upper rocket; the lower right socket of the upper rocket is for insertion of the plug of the igniter wire from the lower rocket. The sockets at the rear of the outer edge

of the blades of the fin of the lower rocket play no part in the firing; hence, the protector caps are left on. At approximately the middle of the leading and rear edges of each blade is a slot. The slots in the rear edges of the uppermost blades of the fin of the lower rocket engage the slots in the leading edges of the lower blades of the fin of the upper rocket. Diametrically opposite sockets are connected by a single insulated wire which passes within the blades and through a bead in the body of the fin. Each wire has a solderless connector splice at the flange. Small metal clips are attached to the rear edges of all blades for taking up the slack in rocket igniter wires (fig. 59). When rockets are installed on the launcher and the igniter plugs are plugged into the appropriate sockets in the manner explained above in this paragraph, insert the igniter wires as indicated in figure 63 under the clips on the rear edge of fins and close the clips with pliers or fingers. Gather surplus igniter wire close to the nozzle of the rocket and bind the folds, as shown, with the aluminum strip furnished with the rocket-kit.

- (2) The lug band, which is designed to be clamped to the rocket forward of the fin, has a lug and, diametrically opposite, a socket. The lug fits into a mating hole in the front launcher post for suspension of the front of the rocket. The socket of the lug band receives the lug on the lug band of a second rocket which may be suspended from the rocket installed directly on the launcher. Thus, two rockets may be installed on one launcher—the upper one directly on the launcher, the lower one suspended from the upper. To secure the rocket on the launcher, a shear wire is inserted through a hole in the protruding end of the lug. This shear wire is furnished with the lug band, the bent end being lightly soldered to the lug to prevent loss. It should be noted that the rear face of the front launcher post, adjacent to the hole in the post, is flat; whereas, that of the socket on the lug band is relieved on one side. Hence, the shear wire in the lug of rocket which is installed directly in the launcher (upper rocket) will be in “double shear,” while the shear wire in the lug of the lower rocket will be in “single shear.” Thus, the lower rocket may be fired without carrying the upper rocket with it, since the force required to shear a wire in single shear is one-half of that required to shear the same wire in double shear.

- (3) The igniter wire assembly consists of an Army-type plug which consists of a head, a tapered shank with insulated tip, and lead wires. The tapered shank is for ground contact and the insulated tip is for live contact.

c. ELECTRICAL CIRCUIT. As indicated in figure 64, the electrical firing circuit for the 5.0-inch high-velocity aircraft rockets (Navy), as modified by the rocket-kit M34, consists of the wiring within the airplane, the fin wiring, and the igniter wiring terminating in the plug M3. One side of the electrical firing circuit is grounded. The other side, including the controls and switches within the airplane, terminates in the plugs of the rear launcher posts. The wiring is connected so that the plug on the left rear post of a launcher is energized when the firing switch designated for firing the lower rocket installed in that launcher is closed (LEFT plug—LOWER rocket). The plug on the right rear post is energized when the firing switch designated for firing the upper rocket is closed (RIGHT plug—UPPER rocket). The socket on each fin blade is connected electrically to the socket on the diametrically opposite blade as described in *b* above. Thus, when a rocket (flange on the fin must be horizontal) is installed on the launcher and a lower rocket suspended from it, the connection from the plug on the left rear launcher post is extended to the socket on the lower right blade of the upper rocket. Hence, the igniter plug of the lower rocket *must* be plugged into the lower right socket of the upper rocket. Similarly, the igniter plug of the upper rocket *must* be plugged into the lower left socket on its own fin. Therefore, it is of paramount importance that the igniter plug be plugged into the proper fin socket which depends upon whether it is that of the lower or upper rocket—otherwise, the upper rocket would be fired first and carry the lower rocket with it. Other pairs of upper and lower rockets on other launchers of the airplane are connected in the same manner.

Caution: Test all sockets to insure that they are completely de-energized before plugging in the igniter plugs. If the igniter plug is plugged into an energized socket, the rocket will be fired, resulting in injury to personnel and damage to property.

69. Modification of 5.0-Inch High-Velocity Aircraft Rocket (Navy)

a. GENERAL. The modification of a 5.0-inch high-velocity aircraft rocket (Navy type) with rocket-kit M34 involves the use of tool kit T39, which includes a positioning jig, hand crimping and skinning tools, socket wrenches, end wrenches, nonsparking screwdrivers and hammers, and instruction sheets—all in a tool box. The positioning jig is a device used to facilitate assembly of the

lug band to the rocket so that the rocket will fit properly into the front post of the retractable launcher. It also is used similarly for assembly of the lug band on the lower rocket so that the lower rocket will hang properly suspended from the upper rocket.

b. MODIFICATION PROCEDURE.

- (1) Remove Navy-type fin and lug band from the 5.0-inch high-velocity aircraft rocket (Navy) to be modified.
- (2) Loosen or, if necessary, remove the bolts of fin M122 (fig. 59).
- (3) Slip the fin over the nozzle ring at the rear of the rocket and assemble so that the rear edge of the fin is flush with the front of the nozzle ring ((b), fig. 61). Tighten the nuts so that the fin will be attached securely to the rocket.
- (4) Assemble the lug band loosely on the rocket at approximately its correct position.
- (5) Set positioning jig (figs. 60 and 61) to the launcher post spacing as follows:
 - (a) To set the jig for the outboard launcher, loosen thumb screw "C" and place the jig in the outboard launcher posts as if installing a rocket. Make sure that the bushings of the jig bear on the shoulders of the rear launcher posts and front face of the front launcher post; also, that collars "A" and "B" do not bear on the spider holder during this setting operation.
 - (b) Tighten thumb screw "C."
 - (c) Slide collar "A" to touch the end of the spider holder; then tighten thumb screw "A."
 - (d) Check this setting of the jig by observing proper contact at the front and rear launcher posts.
 - (e) To set the jig for the inboard position, loosen thumb screw "C" and place jig in the inboard launcher. This operation is similar to that described above for the outboard launcher except that, in this case, collar "B" should be slid to touch the end of the spider holder and thumb screw "B" then should be tightened.
 - (f) Thus the jig is set for the outboard launcher when the spider holder is moved to the left to contact the collar "A" and the thumb screw "C" tightened, or for the inboard launcher when the spider holder is moved to the right to contact collar "B" and thumb screw "C" tightened.
 - (g) It should be noted, in comparing figures 60 and 61, that for the parts of the jig which mate with the launchers there are corresponding but opposite parts

which correspond to launcher connections each displaced a fixed distance to the left; also, that after setting the jig for the particular launcher, the spider holder is rotated 180° before placing the jig on the rocket to locate the lug band properly. It should be noted further that the counterpart of the lug that fits into the front launcher post is displaced to the right a distance equal to the length of the fin. Thus the lug band of the lower rocket may be located from the original setting of the jig.

Note. If necessary the above settings may be changed to the average spacings of all launchers in a squadron.

- (6) Assemble yoke to positioning jig (fig. 61) as shown in view for upper rocket or lower rocket as applicable. Secure with thumb screw that fits into threaded hole indicated by "1/4 TAP" in figure 61.
- (7) Remove rocket caps from rocket fin, and assemble the positioning jig to the rocket as shown in views for upper or lower rocket as applicable. Move fin clamp to the right to bear against one of the blades of fin as

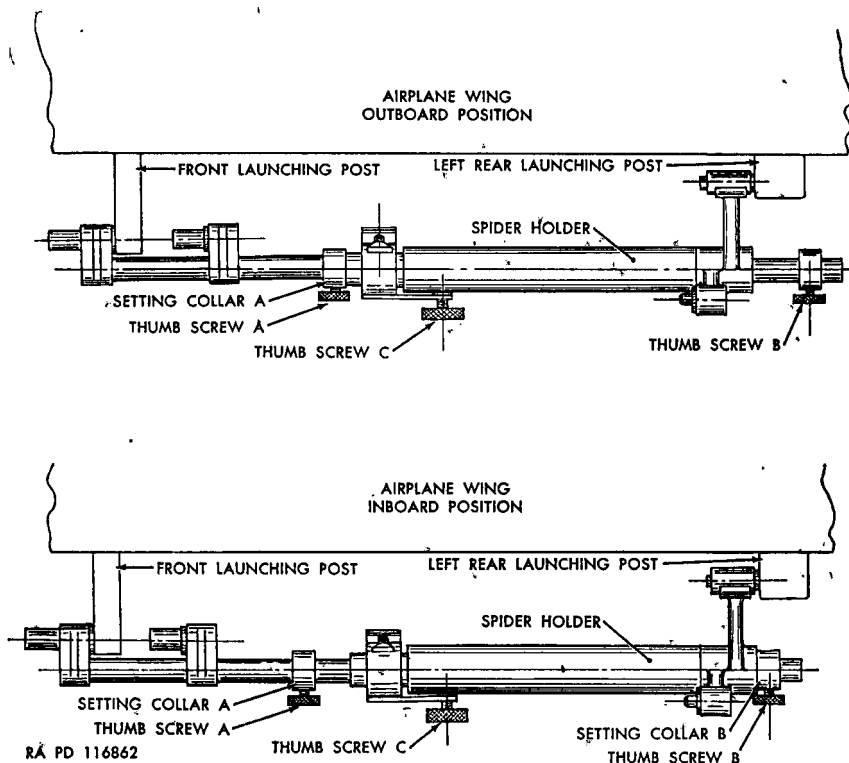
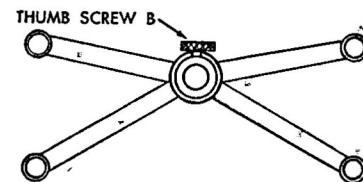
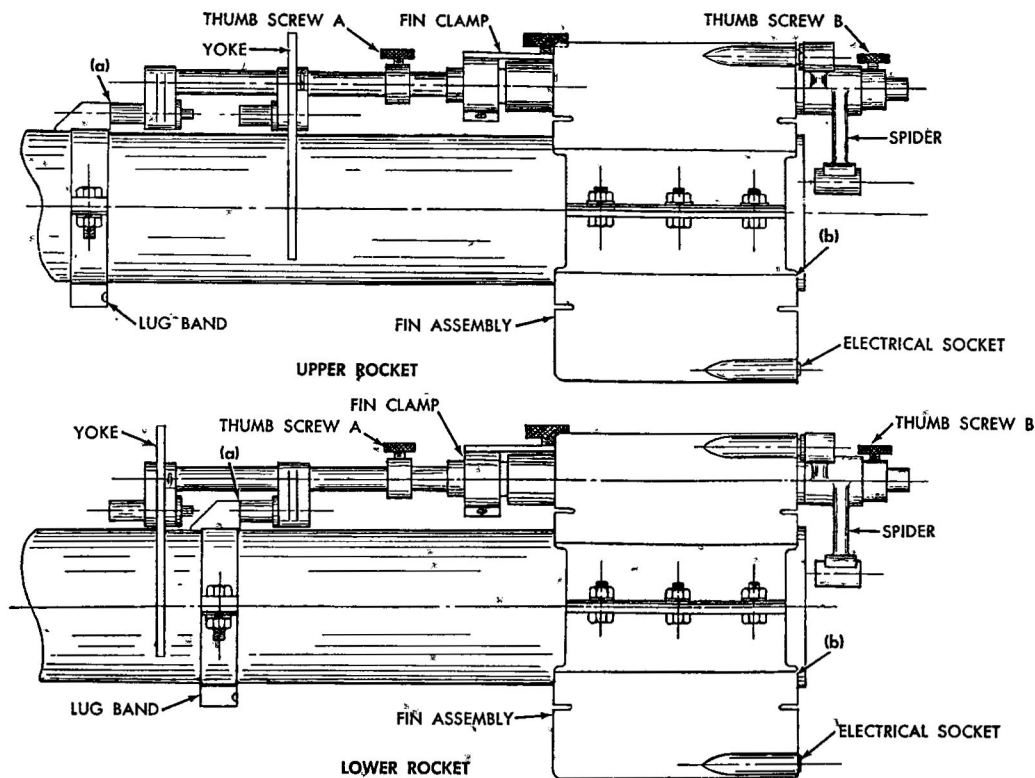
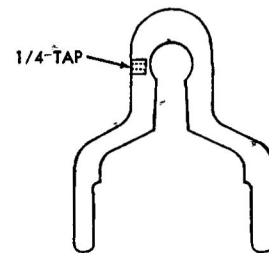


Figure 60. Tool kit T39, for use with rocket-kit M34—positioning jig in outboard and inboard positions.



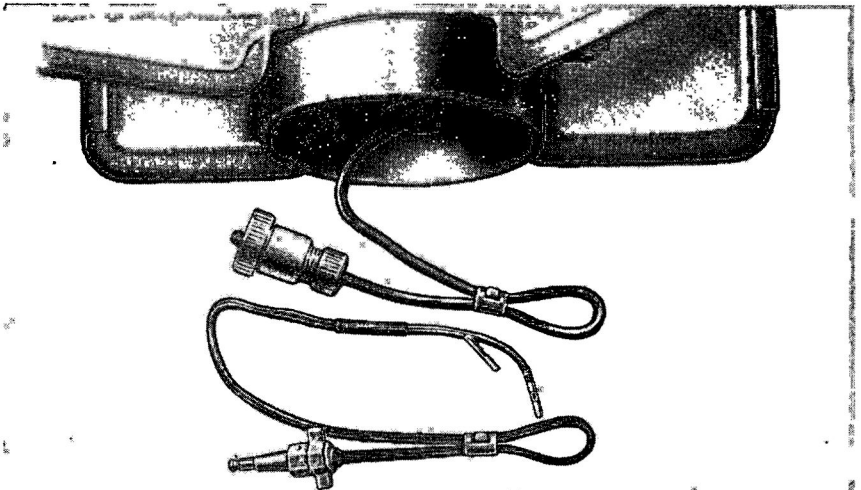
SPIDER-END VIEW



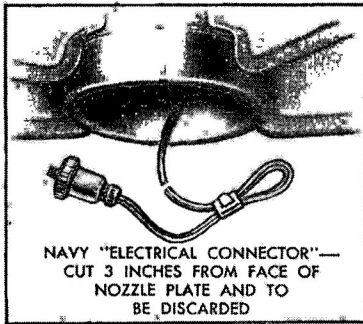
YOKE-END VIEW

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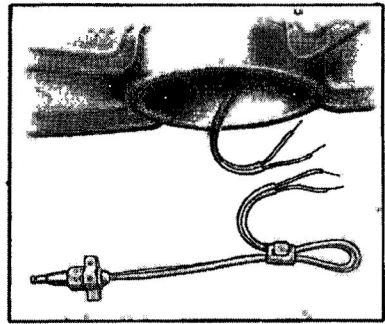
Figure 61. Tool kit T39—positioning jig—locating lug band on rockets for inboard position.



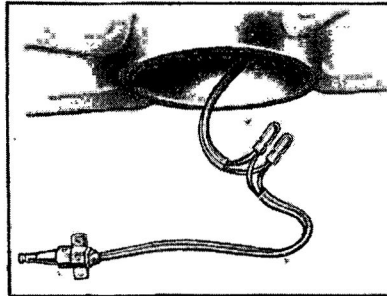
A—NAVY "ELECTRICAL CONNECTOR" WITH NAVY TWO-PRONGED PLUG ATTACHED TO 5.0-INCH HIGH VELOCITY AIRCRAFT ROCKET, AND ARMY "IGNITER PLUG ASSEMBLY"



NAVY "ELECTRICAL CONNECTOR"—
CUT 3 INCHES FROM FACE OF
NOZZLE PLATE AND TO
BE DISCARDED



B—END OF NAVY "ELECTRICAL CONNECTOR" AND ENDS OF ITS LEADS, AND ENDS OF ARMY "IGNITER WIRE" LEADS—PREPARED FOR INSERTION INTO SOLDERLESS CONNECTORS



C—ENDS OF LEADS CONNECTED BY SOLDERLESS CONNECTORS AND FOLDED TOGETHER

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Figure 62. Replacement of Navy electrical connector and two-prong plug by army igniter wire and plug.

shown and secure by tightening the fin clamp thumb screw, which is on the fin clamp.

- (8) Be sure that the face of the lug ((a), fig. 61) bears on the face of the positioning jig bushing as shown in views of both upper and lower rocket positions. Tighten the lug band bolt to hold the lug band securely to the rocket.

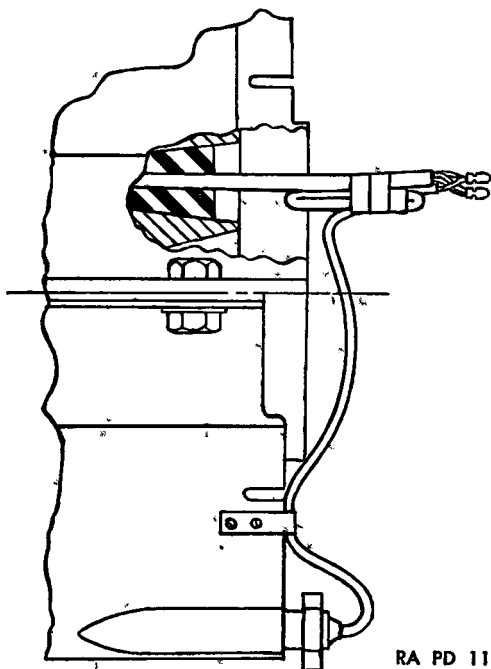


Figure 63. Igniter wire assembly with plug inserted in fin rocket and slack taken up.

- (9) Loosen the fin clamp and remove the positioning jig. The alignment of the lug band must be such that the positioning jig can be freely removed from the rocket with the yoke in place as shown. Replace the socket caps.
- (10) Remove the shipping cover from the nozzle of the 5.0-inch Navy rocket (HVAR) being modified. Cut the rocket igniter wire 3 inches from the nozzle plate (A, fig. 62) with the hand tool furnished with tool kit T39. Using the #10 skinner position on the hand tool, remove approximately 1 inch of the outer rubber covering of the rocket igniter wire. Do not cut the insulation of the leads. Using the #20/#22 skinner position of the hand tool, remove insulation from one-quarter inch of the end of each igniter lead (B, fig. 62). Be careful not to cut the wires in this operation.

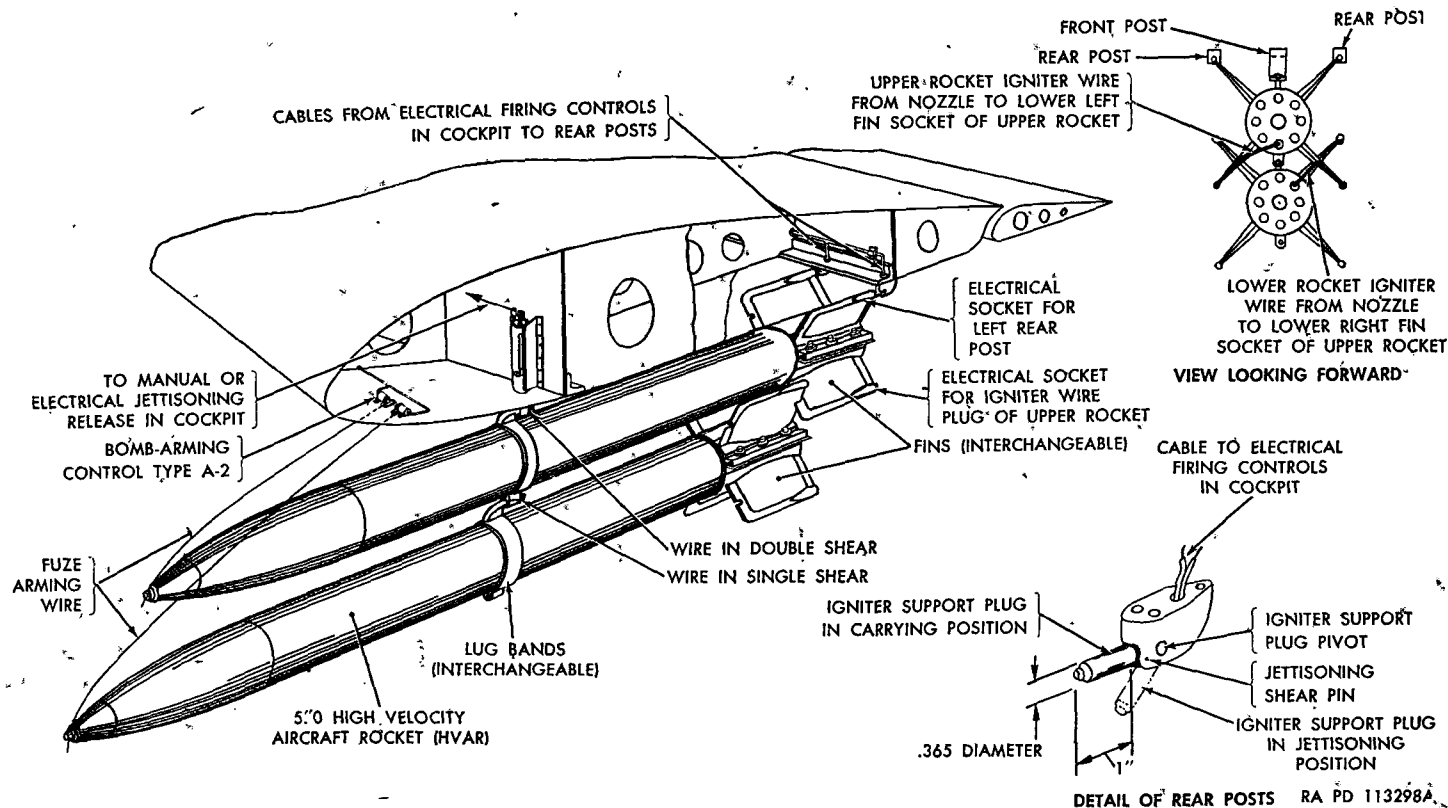
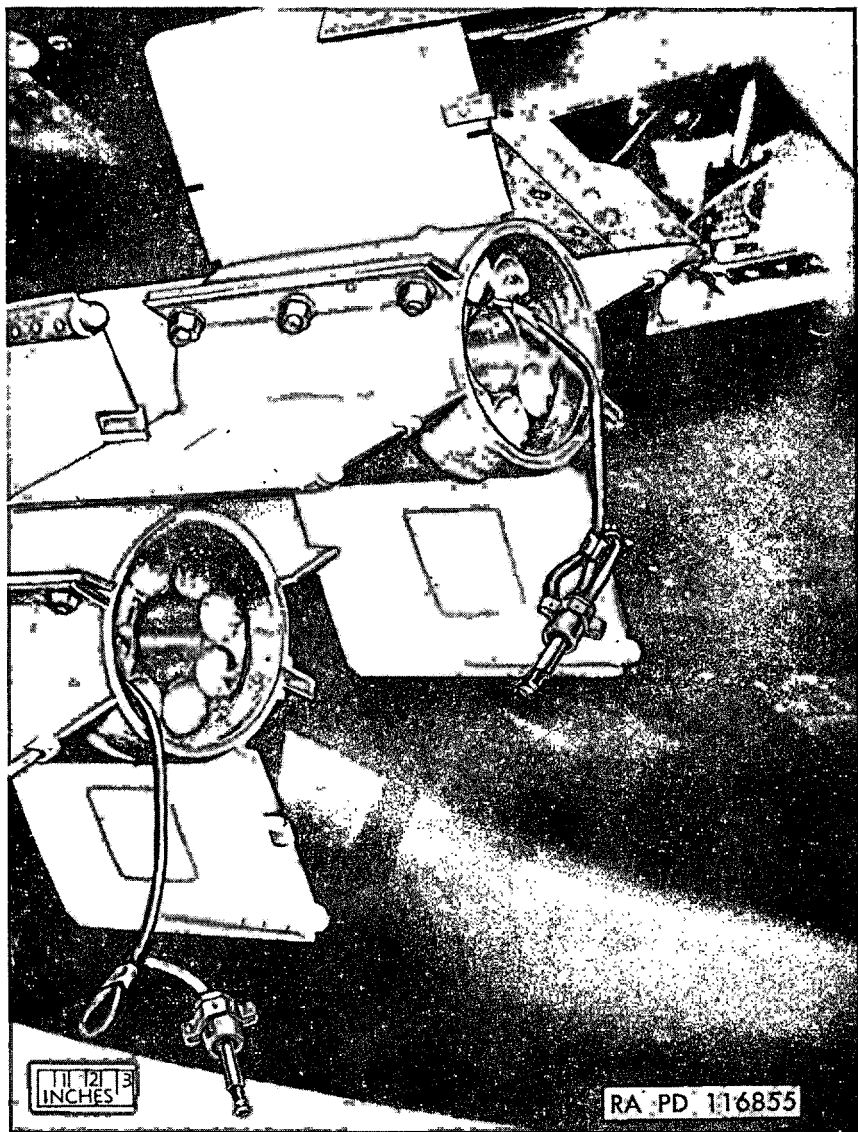


Figure 64. Schematic arrangement of 5.0-inch high-velocity aircraft rocket, as modified by rocket-kit M34, installed in retractable jettisoning aircraft launcher.



as assembled to rear launcher posts.

Figure 65. 5.0-inch high-velocity aircraft rockets modified by rocket-kit M34,

- (11) Connect one of these igniter leads (C, fig. 62) to one lead of an igniter plug assembly (furnished with the rocket-kit M34) as follows: Open the crimping tool (furnished with tool kit T39) and insert closed-end connector (furnished with rocket-kit M34) until it bottoms on the stop. Close the crimping tool slightly so that it just holds the connector. Insert the two wires to be con-

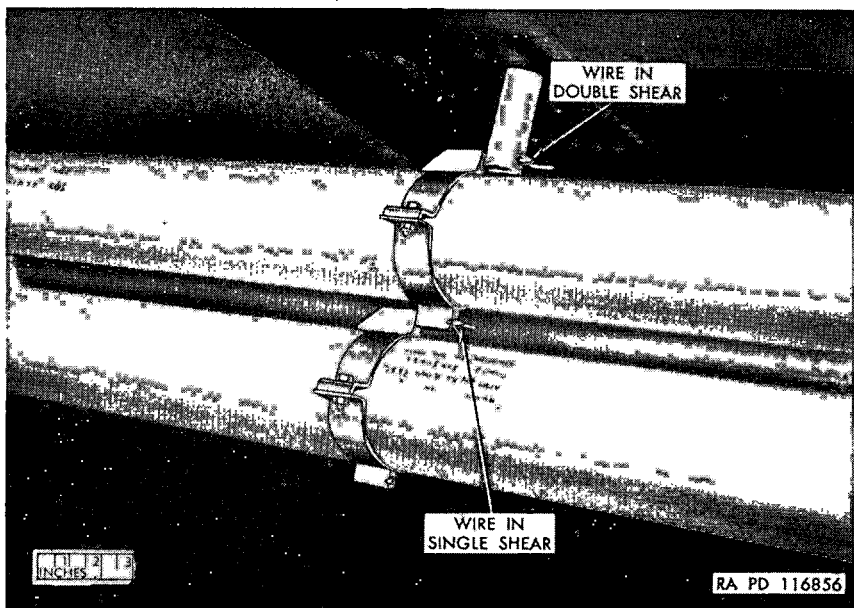


Figure 66. 5.0-inch high-velocity aircraft rockets modified by rocket-kit M34, with front lug band assembled to front launcher post.

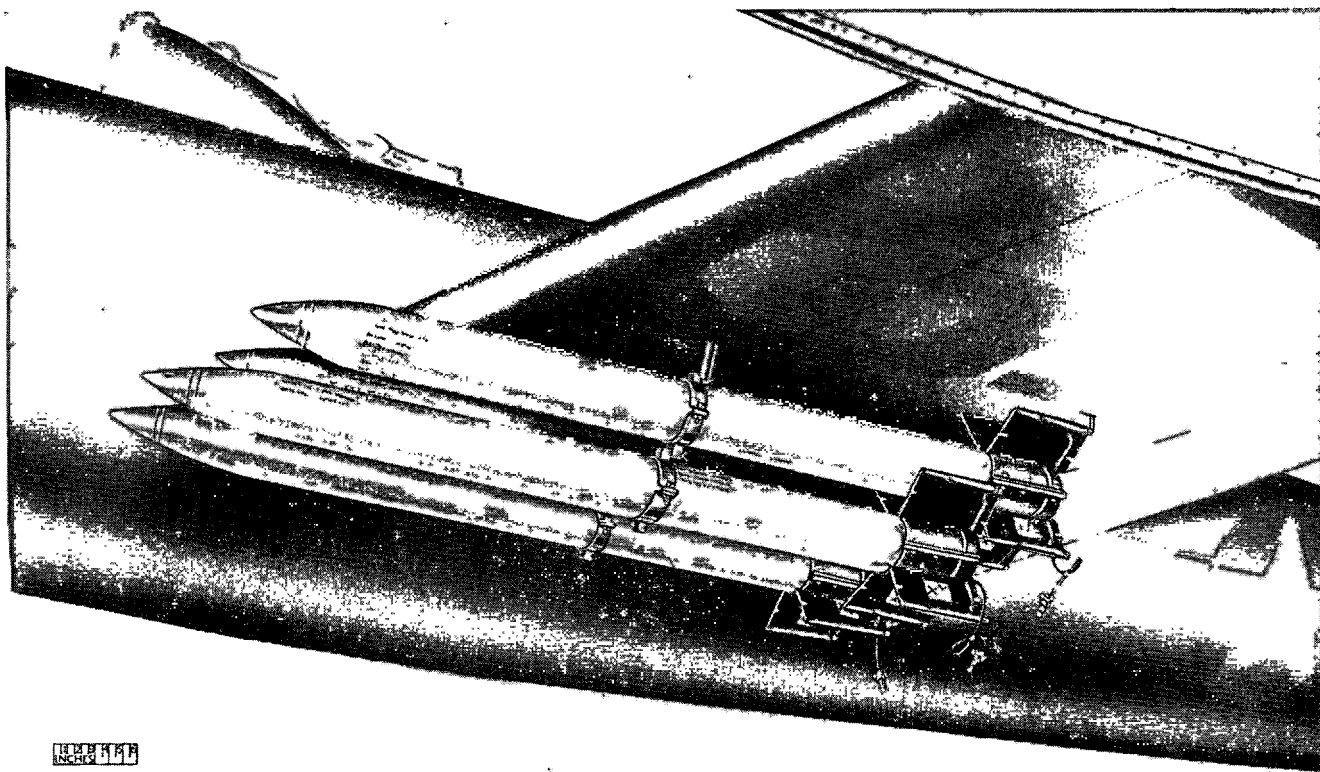
nected, making sure that each wire bottoms in the connector. Close the crimping tool the remainder of the way, completing the crimping operation.

Note. The crimping tool is equipped with an automatic ratchet so that the tool must be closed completely before it can be reopened.

- (12) Connect the other two wires in the same manner.
- (13) Test each connection by applying a pull of approximately 10 pounds.

Note. One spare connector is furnished with each rocket-kit M34. Additional spare connectors and igniter plug assemblies are furnished with tool kit T39.

- (14) Remove the shorting clip from the plug and check the rocket's electrical circuit using continuity circuit tester 680A (par. 14).
- (15) After testing the circuit, be sure that the shorting clip is replaced on the igniter plug. Coil the igniter plug assembly and place it inside the nozzle ring of the rocket. Replace the shipping cover.
- (16) Ordinarily, rockets will be modified in quantities just sufficient to meet immediate requirements. In any event, rockets modified in accordance with the above instructions should be clearly marked to show the nature of the modification. Such marking should include type of airplane for which modified; particular launcher for which



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Figure 67. 5.0-inch high-velocity aircraft rockets modified by rocket-kit M34, installed on airplane.

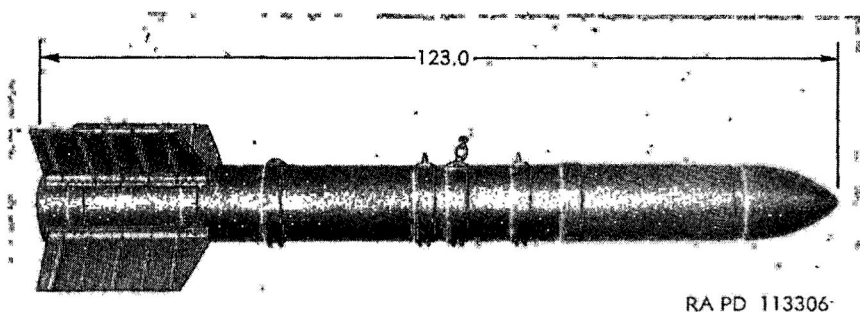


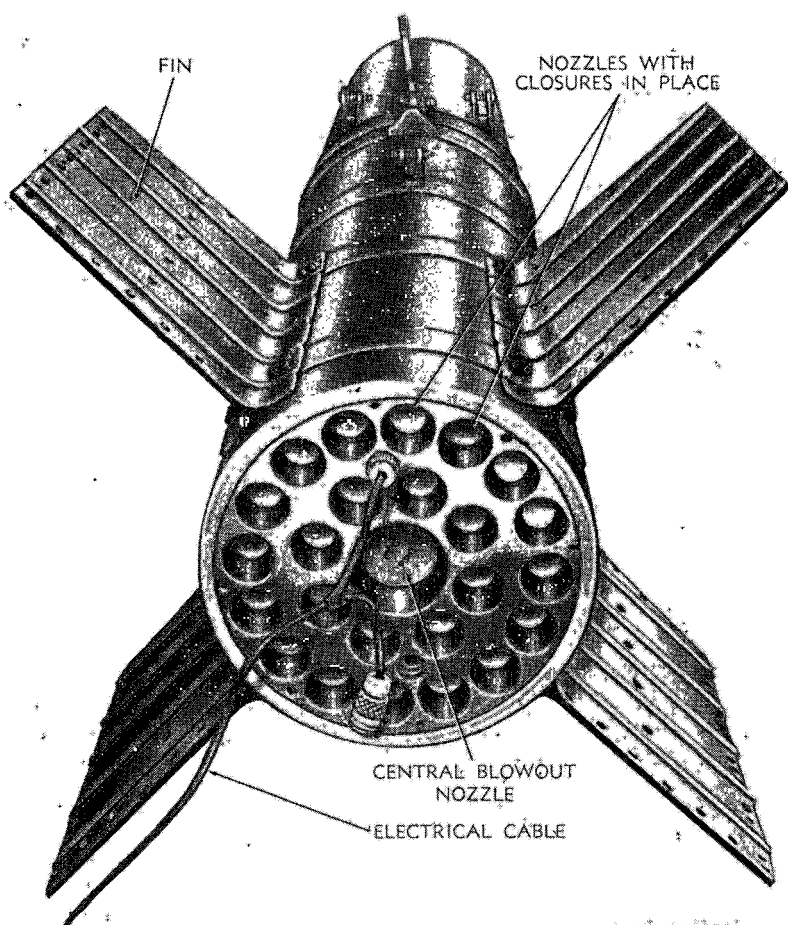
Figure 68. 11.75-inch rocket (head MK 2 Mod 0, motor MK 1 Mod 0, three base fuzes MK 157 Mod 2)

modified, such as inboard or outboard as applicable; location of rocket on launcher, such as "UPPER" if for installation directly on launcher, "LOWER" if for suspension from the underside of upper rocket in launcher; date and designation of unit or agency accomplishing the modification. Rockets modified and not used immediately should be repacked and the package marked to show clearly the contents, including all essential information as to the modification.

70. 11.75-Inch Rockets

a. GENERAL. These rockets (figs. 68 and 69) (tables I and II) are used in forward firing from aircraft against shipping and large ground targets. The assembled rocket consists of 11.75-inch head, 11.75-inch motor, and tail fin. Total weight is 1,255 to 1,283 pounds depending upon the particular model and modification. Maximum velocity is attained with an initial motor temperature of 70° F.

b. HEADS. The head Mk 2 Mod 0 or 1, which is used as a component of the service round is a Navy "common" type fitted with three base fuzes Mk 157 Mod 2 (par. 76) or Mk 163 Mod 0 or 1 (par. 78). For assembling to the head, these fuzes have provision for lead and copper projectile-type gas check gaskets (fig. 71 shows similar gaskets with fuze Mk 159 Mod 1). These gaskets are calked at the time the base fuze is assembled to the head. Each of the three fuzes used in the Mk 2 Mod 0 head has one auxiliary booster Mk 1 Mod 0. *Base fuzes must not be removed from the head under any circumstances.* The head weighs 590 pounds and contains approximately 150 pounds of TNT. An earlier 11.75-inch rocket assembly uses the head Mk 1 Mod 0 or 1; this head is equipped with two base fuzes Mk 157 Mod 1 or 2, or two base fuzes Mk 163 Mod 0 or 1, with two auxiliary



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Figure 69. 11.75-inch rocket—rear view.

boosters Mk 2 Mod O. The Mk 1 Mod O or 1 head is a 500-pound modified semi-armor-piercing (SAP) bomb AN-M58A1. The boosters are contained in a metal fuze seat liner which is attached to the forward face of the special base plug which is used with the modified bomb body. Head Mk 3 Mod O or 1 and head Mk 3 Mod 2 are used in target practice rocket assemblies and have no fuzes.

c. **MOTOR.** The motor Mk 1 and Mods is a steel tube, 11.75-inch outside diameter and 0.40-inch wall thickness. A nozzle plate having 25 nozzles is at the rear end. The motor contains 4 cruciform inhibited grains of Mk 19 Mod O propellant with a total weight of 150 pounds, and a 0.5-pound black powder igniter in a metal case with two electric squibs in parallel which are wires to receptacles in the nozzle plate. Pressure developed in the motor is 1,000 to 2,500 psi dependent on initial temperature. Should pressure exceed 2,000 psi, the closing disk in the central nozzle is blown out and that nozzle brought into operation. The safe temperature range is stenciled on the motor. Burning time of the motor is about 0.9 second at 70° F.

d. **FINS.** The fins are aluminum, 10 inches by 24 inches, and are attached to two bands as shown in figures 68 and 69. Fins are shipped secured to the bands and this assembly is clamped around the motor when the rocket is assembled in the field.

e. **PREPARATION FOR FIRING AND SAFETY PRECAUTIONS.** See paragraphs 71 and 72.

71. Preparation for Firing Aircraft Type Rockets

a. Remove components from packings and inspect for serviceability. Rocket heads which are shipped separately or unfuzed should be inspected prior to assembly for use to see that the fuze and adapter threads are clean, that the nose fuze well contains an auxiliary booster where appropriate, and that heads adapted for base fuze have the appropriate base fuze assembled. Motors should be inspected to see that they are free from dents, that threads are clean, that closing disks and shorting clips are effectively in place, that fins are not bent, and that lugs appropriate to the launcher or adapter are securely in place. Fuzes should be inspected as indicated in the paragraph covering the particular fuze (Secs. II and III, ch. 3).

b. Remove shipping plugs and caps and, in the case of heads and motors shipped separately, assemble motor tightly to head. Where required, assemble fin to motor.

c. Assemble fuze to head as prescribed in paragraph covering the particular fuze or in paragraph covering fuze to which the particular fuze is similar.

d. Remove shorting clip from igniter plug and safety wire from fuze after rocket is loaded into the launcher.

72. Safety Precautions for Aircraft Type Rockets

a. *Be sure that rockets adapted for a base fuze or base fuzes have the proper number of fuzes assembled. If such a rocket is fired with the base fuze or fuzes missing, the head will detonate on the launcher when the rocket is fired.*

b. The propellant in rocket motors is highly inflammable, hence constitutes a serious fire hazard. No smoking should be allowed near motors.

c. *Do not remove a base fuze from the head at any time.* Before screwing a head into a motor, make certain that the fuze is securely in place.

d. The shorting plugs in electrical receptacles in nozzle plate are not to be removed until the electrical connector (igniter wire plug) is ready to be attached.

e. The usual safety precautions in handling explosive ammunition should be observed.

f. A rocket motor is potentially propulsive and as soon as the head is screwed into the motor the whole rocket becomes potentially propulsive. Hence, assembly should take place only just before installation. The assembled round should not be pointed at fuel tanks, ammunition installations, or other vulnerable installations. Personnel should avoid standing in front of or behind the round.

g. All firing circuit switches should be open at the time of installation. Before plugging in the electrical connector (igniter wire plug), the electric socket on the launcher should be tested to be certain that the circuit is open. Electrical connectors (igniter wire plugs) are not to be plugged in until the airplane has taxied away from all personnel and is about to take off.

Table I: Components Comprising Complete Rounds of Aircraft Type Rockets and Related Data

Head			Motor			Fuze		Velocity (fps)	Use
Diameter (in.)	Mark and mod	Filler	Diameter (in)	Mark and mod	Propellant	Nose	Base		
2.25-----	Mk 3 Mod 2	Zinc-----	2.25	Mk 11 Mods	Mk 16 Mod 1	None-----	None-----	1130	Target practice (subcaliber for 3.5-inch rocket and 5.0-inch high-velocity rocket).
2.25-----	Mk 3 Mod 2	Zinc-----	2.25	Mk 13 Mods	Mk 17 Mod 0	None-----	None-----	775	Target practice (subcaliber for 5.0-inch rocket).
3.5-----	Mk 2 Mod 0	Solid steel	3.25	Mk 7 Mod 0 (inert)	None-----	None-----	None-----		Drill.
3.5-----	Mk 6 Mod 0	FS Smoke	3.25	Mk 7 Mods	Mk 20 Mod 0	Mk 155 Mod 0	None-----	1140	Service.
3.5-----	Mk 8 Mod 1	Solid steel	3.25	Mk 7 Mods	Mk 20 Mod 0	None-----	None-----	1140	Service.
5.0 (AR)---	Mk 1 Mod 0	TNT-----	3.25	Mk 7 Mods	Mk 20 Mod 0	Mk 149 Mod 0 or Conical Plug	Mk 165 Mod 0 or Mk 157 Mod 2	715	Service.
5.0 (AR)---	Mk 1 Mod 1	TNT-----	3.25	Mk 7 Mods	Mk 20 Mod 0	M403, VT	Mk 165 Mod 0	750	Target practice
5.0 (AR)---	Mk 1 Mod 0	Plaster---	3.25	Mk 7 Mods	None-----	None-----	None-----		Drill.
5.0 (HVAR)---	Mk 6 Mod 1	TNT-----	5.0	Mk 2 Mod 3 or 4	Mk 18 Mod 0	Mk 149 Mod 0	Mk 164 Mod 0 or Mk 159 Mod 1	1360	Service.
5.0 (HVAR)---	Mk 6 Mod 1	TNT-----	5.0	Mk 10 Mod 4	Mk 18 Mod 0	Mk 149 Mod 0	Mk 164 Mod 0	1360	Service.
5.0 (HVAR)---	Mk 6 Mod 4	TNT-----	5.0	Mk 2 Mod 4	Mk 18 Mod 0	M403, VT	M164, Mod 0	1360	Service.
5.0 (HVAR)---	Mk 6 Mod 1	Plaster---	5.0	Mk 2 Mod 3 or 4	Mk 18 Mod 0	Conical Plug or Mk 149 Mod 0	None-----	1360	Target practice.
11.75-----	Mk 2 Mod 0 or 1	TNT-----	11.75	Mk 1 Mods	Mk 19 Mod 0	None-----	Three: Mk 157 Mod 2 or Mk 163 Mod 0 or 1	810	Service.
11.75-----	Mk 3 Mod 0 or 1	Plaster---	11.75	Mk 1 Mods	Mk 19 Mod 0	None-----	None-----	830	Target practice.
11.75-----	Mk 3 Mod 2	None-----	11.75	Mk 1 Mods	Mk 19 Mod 0	None-----	None-----	830	Target practice.

Table II. Physical and Ballistic Data for Aircraft Type Rockets

Size of rocket	2.25-inch		3 5-inch		
HEAD—Mark and mod	Mk 3 Mod 2	Mk 3 Mod 2	Mk 2 Mod 0	Mk 6 Mod 0	Mk 8 Mod 1
Length (in.)	3.75	3.75	10.35	19.13	11.75
Diameter (in.)	2.25	2.25	3.5	3.5	3.5
Weight (lb)	1.6	1.6	20.0	16.71	20.0
Weight of filler (lb)	Solid steel	Solid steel	Solid steel	7.85 (FS smoke)	Solid steel
MOTOR—Mark and mod	Mk 11 Mods	Mk 13 Mods	Mk 7 Mod 0 (inert)	Mk 7 Mods	Mk 7 Mods
Length (in.)	26.0	26.0	45.0	45.0	45.0
Diameter (in.)	2.25	2.25	3.25	3.25	3.25
Weight (lb)	10.30	9.60	26.0	36.4	36.4
Model of propellant	Mk 16 Mod 1	Mk 17 Mod 0	None (drill)	Mk 20 Mod 0	Mk 20 Mod 0
Weight of propellant (lb)	1.75	1.12		8.50	8.50
FUZE—type, mark and mod	NOSE	NOSE	NOSE	NOSE	NOSE
	None	None	None	Mk 155 Mod 0	None
	BASE	BASE	BASE	BASE	BASE
	None	None	None	None	None
ROCKET (assembled):					
Length (in.)	29.20	29.20	56.4	69.5	56.5
Weight (lb)	11.9	11.3	45.0	55.2	55.0
Velocity (max) (fps)	1130	775	(drill)	1140	1140
Temperature limits (° F.)	20 to 110	20 to 110	(drill)	0 to 120	0 to 120
Burning time (static) (sec)	0.79 to 0.37		1.47 to 0.59	1.47 to 0.59	1.47 to 0:59
Burning time (effective) (sec)	0.64 to 0.10	0.47			
Burn out point (ft from launcher)	480 to 230				800 to 350

Table II. Physical and Ballistic Data for Aircraft-Type Rockets—Continued

Size of rocket	5.0-inch (AR)				5.0-inch (HVAR)			
HEAD—Mark and mod.	Mk 1 Mod 0	Mk 1 Mod 1	Mk 1 Mod 0	Mk 1 Mod 0	Mk 6 Mod 1	Mk 6 Mod 1	Mk 6 Mod 4	Mk 6 Mod 1
Length (in.)	17.0	17.0	17.0	17.0	16.45	16.73	16.73	16.73
Diameter (in.)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Weight (lb)	46.0	46.0	46.0	46.0	48.8	45.5	45.5	45.5
Weight of filler (lb)	8.6 TNT	8.6 TNT	8.6 Plaster	8.6 Plaster	7.9 TNT	7.5 TNT	7.5 TNT	7.9 Plaster
MOTOR—Mark and mod.	Mk 7 Mods.	Mk 7 Mod 0	Mk 7 Mods.	Mk 7 Mods.	Mk 2 Mod 3 or 4	Mk 10 Mod 4	Mk 2 Mod 4	Mk 2 Mod 3 or 4
Length (in.)	45.0	45.0	45.0	45.0	51.62	52.0		51.62
Diameter (in.)	3.25	3.25	3.25	3.25	5.0	5.0		5.0
Weight (lb)	36.4	36.4	36.4	26.0	89.3	89.3		89.3
Model of propellant	Mk 20 Mod 0	Mk 20 Mod 0	Mk 20 Mod 0	None (drill)	Mk 18 Mod 0	Mk 18 Mod 0	Mk 18 Mod 0	Mk 18 Mod 0
Weight of propellant (lb)	8.50	8.50	8.50		24.0	23.9		24.0
FUZE—type, mark and mod.	NOSE	NOSE	NOSE	NOSE	NOSE	NOSE	NOSE	NOSE
	Mk 149 Mod 0	VT M403	Conical Plug	None	Mk 149 Mod 0	Mk 149 Mod 0	VT M403	Conical Plug
	or							or
	Conical Plug							Mk 149 Mod 0
	BASE	BASE	BASE	BASE	BASE	BASE	BASE	BASE
	Mk 165 Mod 0				Mk 164 Mod 0			
	or	Mk 165 Mod 0	None	None	or	Mk 164 Mod 0	Mk 164 Mod 0	None
	Mk 157 Mod 2				Mk 159 Mod 1			
ROCKET (assembled)								
Length (in.)	66.0	65.2	66.0	66.0	69.0	68.6		69.0
Weight (lb)	83.0	80.7	83.0	72.0	137.1	134.0		137.1
Velocity (max) (fps)	715	715	750	(drill)	1360	1360	1360	1360
Temperature limits (°F.)	0 to 120	0 to 120	0 to 120	(drill)	-20 to 120	-20 to 120		-20 to 120
Burning time (static) (sec)	1.47 to 0.59	1.47 to 0.59	1.47 to 0.59	(drill)	1.4 to 0.9			1.4 to 0.9
Burning time (effective) (sec)				(drill)				
Burn out point (ft from launcher)				(drill)	950 to 575			950 to 575

Table H. Physical and Ballistic Data for Aircraft Type Rockets—Continued

Size of rocket	11.75-inch		
HEAD—Mark and mod.	Mk 2 Mod 0 and 1	Mk 3 Mod 0 and 1	Mk 3 Mod 2.
Length (in.)	46.66		44.0.
Diameter (in.)	11.75	11.75	11.75.
Weight (lb)	590.0	590.0	590.0
Weight of filler (lb)	150 TNT	150 Plaster	None.
MOTOR—Mark and mod.	Mk 1 Mods	Mk 1 Mods.	Mk 1 Mods.
Length (in.)	82.0	82.0	82.0.
Diameter (in.)	11.75	11.75	11.75.
Weight (lb)	665.0	695.0	695.0
Model of propellant	Mk 19 Mod 0	Mk 19 Mod 0	Mk 19 Mod 0.
Weight of propellant (lb)	145.8	145.8	145.8.
FUZE—type, mark and mod.	NOSE	NOSE	NOSE.
	None	None	None.
	BASE	BASE	BASE.
	Three:		
	Mk 157 Mod 2	None	None.
	or		
	Mk 163 Mod 0		
ROCKET (assembled):			
Length (in.)	119.0	126.0	126.0.
Weight (lb)	1255.0	1283.0	1283.0.
Velocity (max) (fps)	810	830	830.
Temperature limits (° F.)	-20 to 120	-20 to 120	-20 to 120.
Burning time (static) (sec)	1.43 to 0.73	1.43 to 0.73	1.43 to 0.73.
Burning time (effective) (sec)	1.24 to 0.8	1.24 to 0.8	1.24 to 0.8.
Burn out point (ft from launcher)			

Section II. TIME AND IMPACT FUZES FOR AIRCRAFT TYPE ROCKETS

73. General

- a. CHARACTERISTICS. See paragraph 9.
- b. ARMING. See paragraph 49b.
- c. PRECAUTIONS. See paragraph 49c.

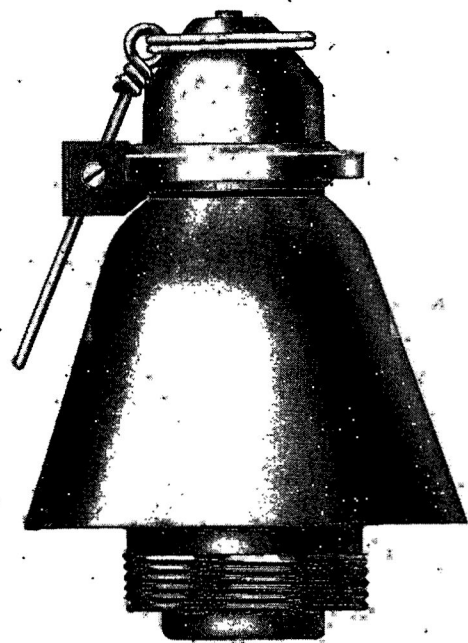
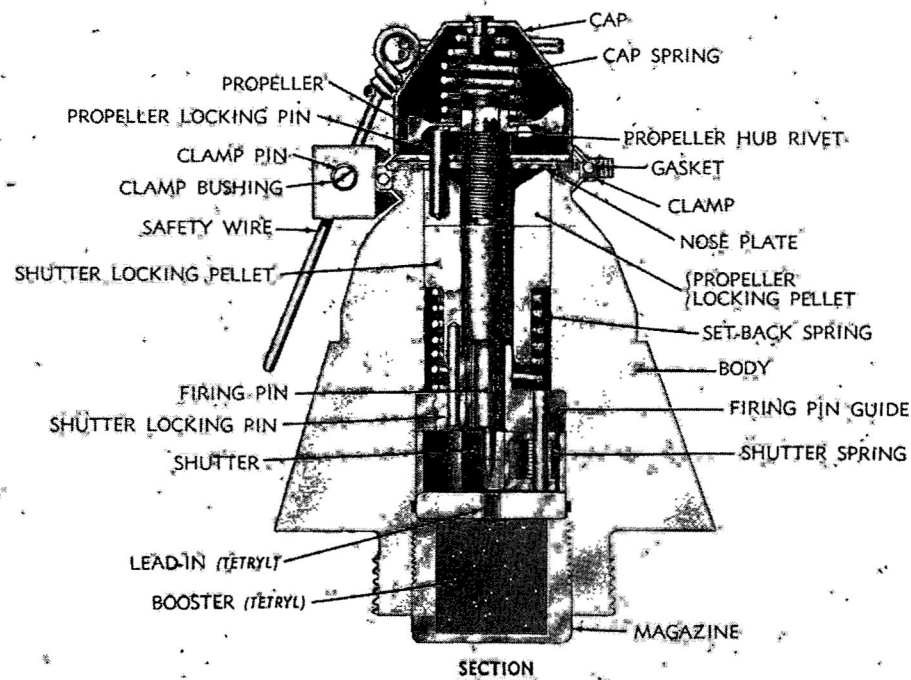
74. Fuze, Rocket, Nose, MK 149 Mod 0

a. GENERAL. This is an air-arming, impact-operated fuze for forward-firing aircraft rockets. It is detonator safe and functions with superquick action on impact with ground, water, or plate. It requires the use of an arming wire.

b. DESCRIPTION. This fuze (fig. 70) is streamlined and has a spring-loaded protective cap which protects the propeller and seals the fuze against the weather. The cap is held in position by a split clamp which, in turn, is held together by a collar and pin through which the safety wire and arming wire are assembled. The mechanism of the fuze is similar to that of other AIR fuzes described above except that the detonator shutter is held in the safe position by a locking pin controlled by a setback pellet. Thus the detonator cannot move to the armed position until acceleration stops, even if the firing pin has been retracted by propeller action. Arming distance in the 5.0-inch rocket AR varies from 275 to 600 feet; in the 5.0-inch high-velocity rocket, it varies from 650 to 1,100 feet.

c. FUZING.

- (1) Remove fuze from packing and inspect to insure that it is free from serious corrosion or dents and that the threads are clean. If slight corrosion is present, work clamp back and forth so that it slides freely on fuze body and cap. If the fuze is more than slightly corroded, discard it.
- (2) Remove shipping plug from rocket and inspect fuze seat to insure that threads are clean, the auxiliary booster (Mk 3 Mod 1) is in place, and that there is no foreign matter present or other evidence of unserviceability.
- (3) Screw fuze into fuze seat and tighten securely.
- (4) After rocket is placed in launcher, turn clamp so that the safety wire is aligned with launcher arming mechanism.
- (5) Thread arming wire through second hole in clamp pin and collar.
- (6) Attach arming wire to launcher arming mechanism. Pull wire through clamp pin so as to take up all slack but not to place any strain on the wire.



EXTERNAL

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Figure 70. Fuze, rocket, nose, MK 149 Mod 0.

- (7) Place one Fahnestock clip on the wire against the collar.
- (8) Cut off excess wire and remove all kinks and burs.
- (9) Remove safety wire from clamp pin.

d. UNFUZING. If the rocket is not used, first replace the safety wire in the clamp pin; then the arming wire may be removed. The rocket may be removed from the launcher and unfuzed. All components should be returned to their original conditions and packings.

75. Fuze, Rocket, Nose, MK 155 Mod 0

This fuze differs from the Mk 149 (par. 74) only in that it is provided with a tetryl-filled burster tube assembly instead of a booster.

76. Fuze, Rocket, Base, MK 157 Mod 2

a. The base fuze Mk 157 Mod 2, of which the Mk 159 series fuzes (fig. 71) are modifications, is a detonator-safe 0.02 second-delay base detonating fuze. It is essentially the base fuze Mk 157 Mod 0 in which material for the fuze body has been changed for increased strength, and the number of threads between the fuze and the fuze adapter has been doubled.

Note. The Mk 157 Mod 0 is no longer considered safe.

Provision is made so that a projectile-type gas check ring or gasket (fig. 71 which pertains to the fuze Mk 159) is used to seal the motor gases from the explosive filler. The joint between the fuze and base of the head is calked at the time the fuze is assembled to the rocket. The fuze weighs approximately 3 pounds.

b. The explosive components are—

- (1) Delay detonator—housed in shutter.
- (2) Lead-in—housed in lead-in disk.
- (3) Booster—approximately 12 grams (0.42 oz.) tetryl—housed in magazine.

c. The fuze head screws into the base of the rocket head. The projectile-type gas check and a rubber gasket make a gastight seal in the body between the rocket motor and the interior of the rocket head. The rear end of the fuze (the exterior surface of the plug) is exposed to the front end of the rocket motor. The fuze body extends into a cavity in the fuze seat liner in the interior of the rocket head.

d. This fuze is armed by gas pressure from the motor at the time of firing. The head of the fuze contains a gas pressure chamber located between the diaphragm and the closing plug. The fuze arms in two stages as follows:

- (1) Through a small orifice in the inlet screw, gases from the rocket motor slowly enter the pressure chamber in

the head of the fuze. Debris from the rocket motor is filtered out by the inlet screen. When the pressure in the chamber has reached a value of approximately 300 psi, which is delayed by the small orifice in the inlet screw until approximately half the burning time is consumed, the diaphragm collapses, forcing the arming plunger down and shearing the shear wire which holds the plunger in place. Movement of the plunger releases the locking ball, which, in the unarmed condition, locks the firing pin body in place, and allows the latter to move toward the rear under the force of the firing pin spring and the inertia of the firing pin body due to acceleration. The firing pin, attached to the firing pin body by a lock wire, thus is withdrawn from the delay-detonator shutter which it normally locks in the safe position.

- (2) When the rocket accelerates, the inertia of the shutter forces it back against the firing pin guide, compressing the shutter spring and engaging the shutter locking pin in a hole in the firing pin guide. About midway during acceleration, the firing pin is withdrawn from the shutter, but the shutter, held by the shutter locking pin, remains locked in the safe position. When acceleration is over, the shutter spring forces the shutter forward against the lead-in disk, disengaging the shutter locking pin from the hole in the firing pin guide. The shutter spring then swings the shutter into the armed position (delay detonator in line with the firing pin and the lead-in), where it is locked by the detent.

e. The fuze fires by inertia of the firing pin body driving the firing pin forward against the delay detonator on impact. After striking the primer in the delay detonator, the firing pin telescopes back into the firing pin body, shearing the lock wire. The fuze has a fixed delay of 0.02 second, in addition to which there is a slight delay in firing, inherent in the forward motion of the firing pin body and firing pin on impact. The delay detonator initiates the tetryl lead-in and tetryl booster. This action directly detonates the auxiliary booster beneath the fuze and the main filler of the rocket.

f. The safety features of the fuze are—

- (1) This fuze is detonator safe. In the unarmed position, the detonator is out of alignment with the explosive train. Should the detonator function prematurely, the force of the detonator will be dissipated upward through a hole in the firing pin guide and away from the explosive components.

- (2) Due to the delay in admission of gas from the rocket motor to the pressure chamber, the first stage in arming does not occur instantaneously after ignition of the motor. Total arming is not accomplished until acceleration has ceased. The burning distance, and therefore the arming distance, will vary with the temperature.
- (3) The lightweight aluminum arming plunger and the shear wire make the fuze in a full weight projectile safe from arming by accidental dropping from heights up to at least 40 feet.

g. The fuze is shipped installed in the base of the 11.75-inch rocket head. No safety wire is needed and no preparations are required to ready the fuze for use. In this respect, this fuze is comparable to a projectile base fuze. The shipping cover over the base of the head protects the exposed end of the fuze. This cover should be kept in place until the round is to be assembled, and should be replaced promptly if the round is disassembled. Before assembling the rocket motor onto the rocket head, check that the fuze is tight in place in the base of the head, and that the fuze inlet screen has not become dirty so as to clog the orifice.

h. In disposal of the head, in case of a motor failure or firing which does not result in a detonation, extreme care should be exercised. The fuze should be removed from an unexploded head only by qualified bomb disposal personnel. There is no way to determine by examination whether or not the fuze is armed.

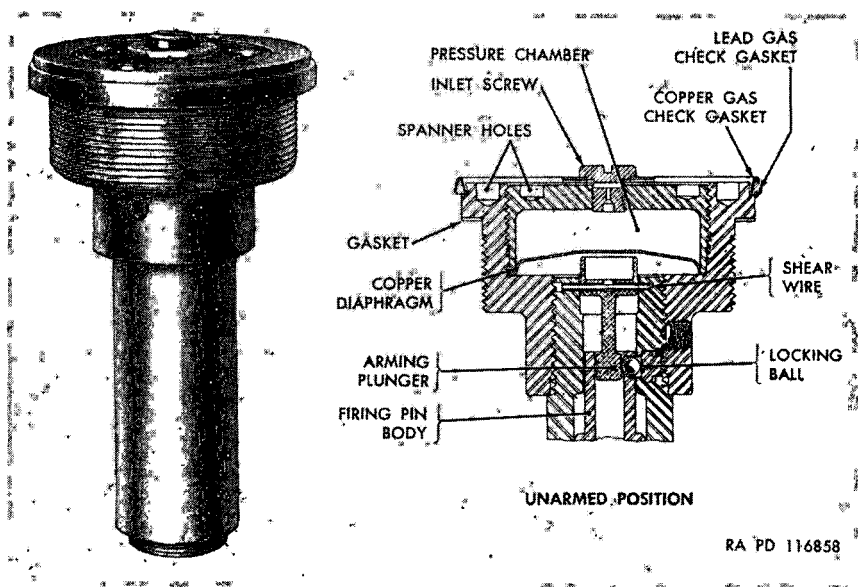


Figure 71. Fuze, rocket, base, MK 159 Mod 1—exterior view and section showing gas check gaskets.

If it is armed, the fuze will fire if the head is dropped on its nose or jarred so as to permit the firing pin to strike the primer in the delay detonator.

i. The following servicing precautions should be observed:

- (1) No lubricants or preservatives of any kind may be used on this fuze.
- (2) No disassembly of this fuze is authorized.
- (3) Reports of malfunctioning or any difficulties encountered with this fuze should be reported to the chief of the technical service concerned. The report should contain the lot number and the other markings of the fuze, as well as the complete detailed history of its failure to function (par. 2).

j. Fuzes will be shipped assembled with the rocket heads and protected by a shipping cover which is secured to the adapter ring by machine screws. The fuze is stamped with mark (Mk), modification (Mod), and lot number, the date of loading, and the loader's name or initials.

77. Fuze, Rocket, Base, MK 159 Mod 0 and 1

a. The Mk 159 series fuzes are modifications of the detonator-safe Mk 157 series to fulfill requirements for the high-velocity fin-established rocket with 5-inch head and 5-inch motor. The Mk 159 series incorporates a 0.0145-inch gas inlet orifice, a 0.064-inch diameter shear wire, a grooved gas inlet washer instead of a screen, arming at between 325 and 375 psi, and a 0.015-second delay. The fuze Mk 159 Mod 1 (fig. 71) has a flange head diameter of 3.2 inches, a length of 5.813 inches, and a projectile-type gas check is used. The Mk 159 Mod 0 is sealed in the rocket head by a copper gasket under the fuze head flange.

b. The fuze Mk 159 Mod 1 is used in the 5.0-inch general purpose fin-stabilized rockets (par. 66). Just prior to assembly of a round on aircraft, a nose fuze Mk 149 usually is installed in the head. The Mk 149 can be set "instantaneous" or "safe." Thus, the round is provided at the time of firing with instantaneous or 0.015-second delay action. The fuze Mk 149 Mod 1 arms and functions in an identical manner with the Mk 157 series and usually is used with rockets which are fired against light fortifications, tanks, locomotives, and similar targets.

78. Fuze, Rocket, Base, MK 163 Mod 0 and 1

This fuze (fig. 72) is a modification of the Mk 157 Mod 2 (par. 76). It has essentially the same functioning mechanism and provision for projectile-type gas checking as the Mk 157 Mod 2,

except that performance on heavy oblique impacts has been improved by certain internal modifications. The gap between the detonator and lead-in is reduced from 0.058 inch to 0.025 inch giving greater assurance of high order detonation of the rocket. The over-all length of the Mk 163 Mod 0 is 6.143 inches as compared with 5.813 inches for the Mk 159 Mod 1. When the inlet screen was replaced by a filter formed by compressed wire mesh and the inlet orifice and shear wire were replaced by those of the Mk 159 Mod 1, the fuze was designated Mk 163 Mod 1. These changes increased the arming pressure from 310 to 375 pounds and the arming delay. The Mk 163 Mod 0 and Mod 1 are used in the 11.75-inch fin-stabilized aircraft rocket which has three base fuzes (par. 70). The 11.75-inch rocket is used against shipping and heavy fortifications. The Mk 163 fuze has an 0.02-second delay and is detonator safe.

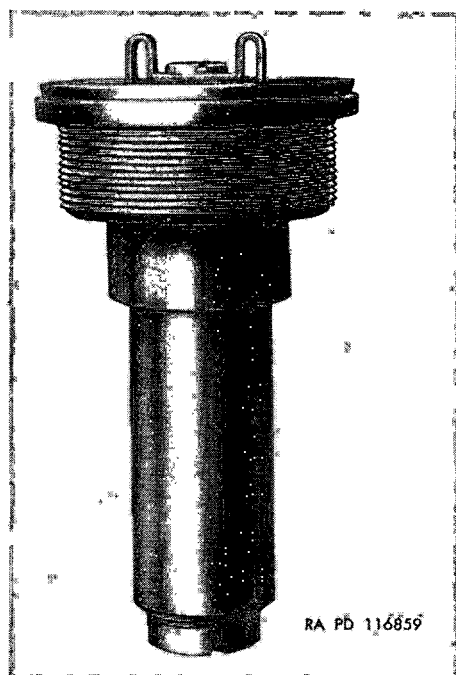


Figure 72. Fuze, rocket, base, MK 163 Mod 0.

79. Fuze, Rocket, Base, MK 164 Mod 0

This fuze (fig. 73) is essentially the same as the Mk 159 Mod 1 (par. 77) except certain internal modifications. The provision for projectile-type gas checking is similar. The gap between the detonator and lead-in is reduced from 0.058 inch to 0.025 inch for greater assurance of high order functioning. The Mk 164

Mod O has a mesh filter covered by a plain flat washer. It is used in 5.0-inch aircraft rockets. To provide for either instantaneous or 0.015-second delay action, an Mk 149 nose fuze which can be fired "instantaneous" or "safe" is assembled in the nose of the rocket head. The round which uses the Mk 164 Mod O fuze is used against tanks, locomotives, and gun emplacements. Functioning, arming, and performance on impact are the same as those of the detonator-safe Mk 163 Mod O.

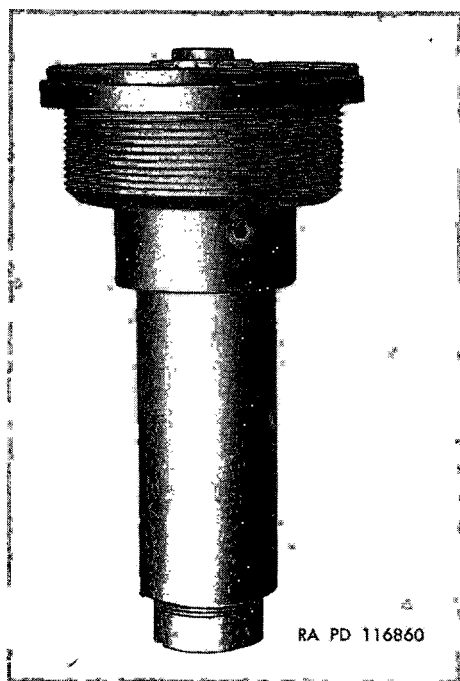


Figure 73. Fuze, rocket, base, MK 164 Mod 0.

80. Fuze, Rocket, Base, MK 165 Mod 0

This fuze (fig. 74) is a modification of Mk 157 Mod 0 (par. 76). The functioning mechanism is essentially the same except that it contains the improved shutter and lead-in, and shutter lock assembly as in the Mk 163 Mod 0. The fuze head and fuze-to-motor adapter are made in one piece to improve the seal between the rocket motor and interior of the rocket head. The Mk 165 Mod 0 is used in the 5.0-inch aircraft rocket (par. 66) which normally is fired with an Mk 149 nose fuze in the head to permit either instantaneous or 0.02-second delay action, or with the VT fuze. The round is used against personnel and light targets. Arming, functioning on impact and detonator-safety of the Mk 165 Mod 0 are the same as the Mk 164 Mod 0.

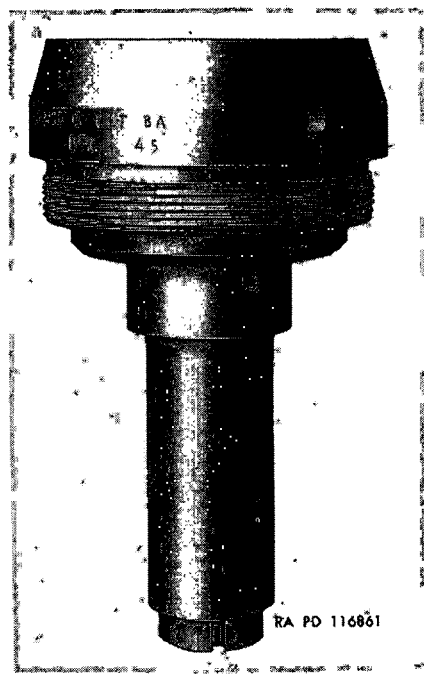


Figure 74. Fuze, rocket, base, MK 165 Mod 0.

Section III. VT FUZES FOR AIRCRAFT TYPE ROCKETS

81. General

For general description of VT fuzes, see paragraph 9.

82. Fuze, Rocket, VT, M403

a. GENERAL. The VT fuze M403 (Army) or Mk 172 Mod 0 (Navy) (figs. 75 and 76) is a proximity fuze used for plane-to-ground firing of the 5.0-inch AR and 5.0-inch HVAR rockets. This fuze is, in effect, an automatically set time fuze. Without any field adjustment, it functions automatically due to the proximity of the target, rather than by impact or time action, thereby causing an air burst to occur at a height determined by the fuze mechanism. Normally, functioning occurs at distances between 10 and 40 feet from the target (fig. 77), causing greatest lethal fragmentation against personnel without top cover, such as men in foxholes and slit trenches, and gun crews on shipboard. This fuze requires a special deep cavitized rocket head, as available in the 5.0-inch Mk 1 Mod 1 rocket head for use with the 5.0-inch aircraft rocket and in the 5.0-inch Mk 6 Mod 4 rocket head, for use with the 5.0-inch high-velocity aircraft rocket.

b. CHARACTERISTICS. The M403 VT fuze may be used either day or night and is not affected by clouds, fog, snow, or light rain. Normal fuze operation may be expected over the entire temperature range specified for the rockets.

(1) *Safety and arming.* Both mechanical and electrical safety measures (fig. 78) are embodied in the VT fuze M403. Safety is provided by—

(a) An interrupted explosive train, which is safe against dropping and rough handling after the arming wire has been withdrawn, and until the train is aligned at completion of acceleration through the combined effect of acceleration and air travel.

(b) An electrical delay system, initiated upon completion of acceleration and closure of fuze firing circuit, which provides detonator safety for an additional period (normally 0.6 to 1.2 seconds).

(c) A setback weight in the gear mechanism, operation of which requires approximately 300 feet of air travel under a minimum acceleration of 10g. The setback weight, actuated under proper acceleration, allows the arming shaft to rotate. If this air travel occurs without the required acceleration, the fuze will become a dud upon subsequent normal firing. Safety is not impaired.

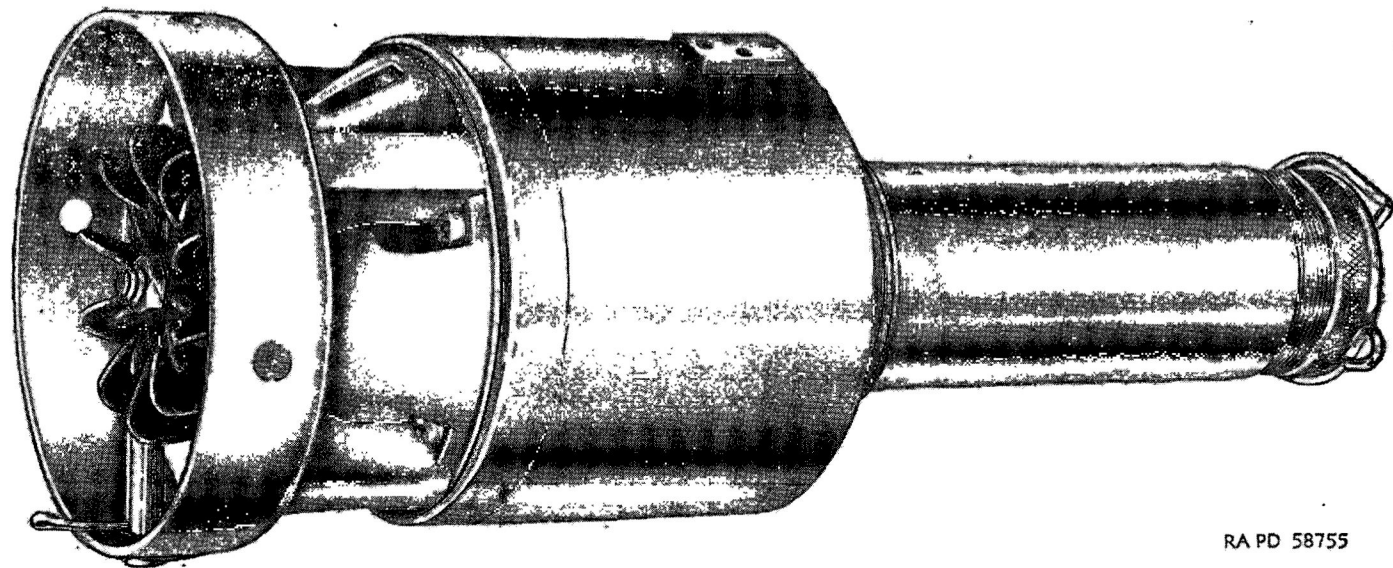
(2) *Visible indications of mechanical safety.* Various visible indications which will attest the mechanical safety of the VT fuze M403 are—

(a) The presence of a car seal installed at the loading plant, to insure that the arming vane has not been rotated or tampered with subsequent to loading and prior to use.

(b) A vane locking pin held in place by the arming wire until the moment of firing.

(c) A safety pin inserted alongside the booster cup indicates safe position of the detonator rotor (fig. 78). The pin extends through the tetryl lead plate and into the rotor. Since a failure of the arming shaft restraining devices would allow the spring-loaded shaft to turn into the armed position, the safety pin should be removed and reinserted and removed again, as instructions on the safety pin tag indicate. (If safety pin cannot be reinserted easily, reject and destroy the fuze.)

(3) *Burst height.* The burst height of the VT fuze M403 in the 5.0-inch rocket varies with dive angle and terrain



RA PD 58755

Figure 75. Fuze, rocket, VT, M403.

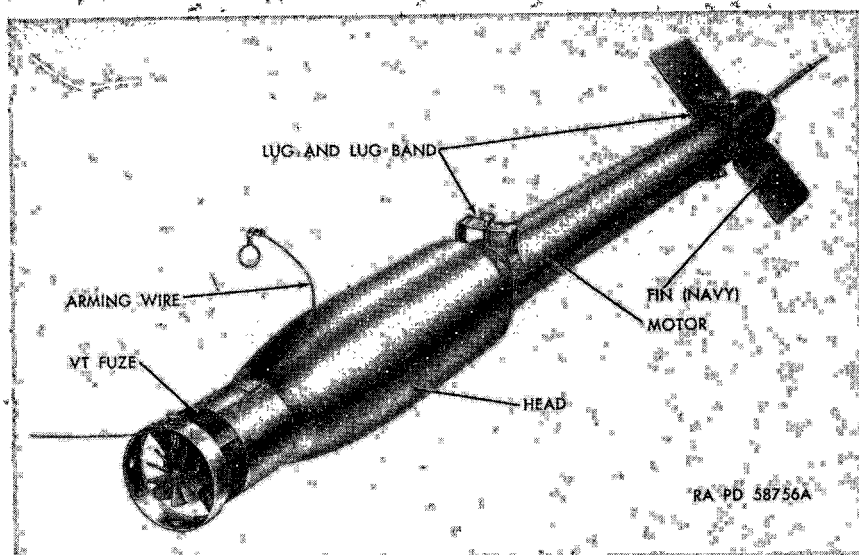


Figure 76. 5.0-inch aircraft rocket with VT fuze M403.

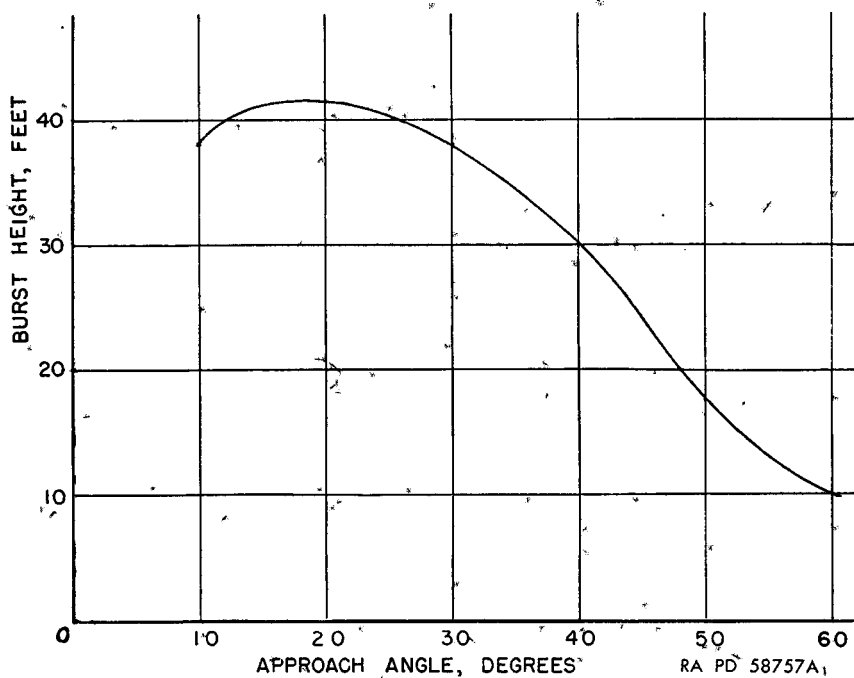
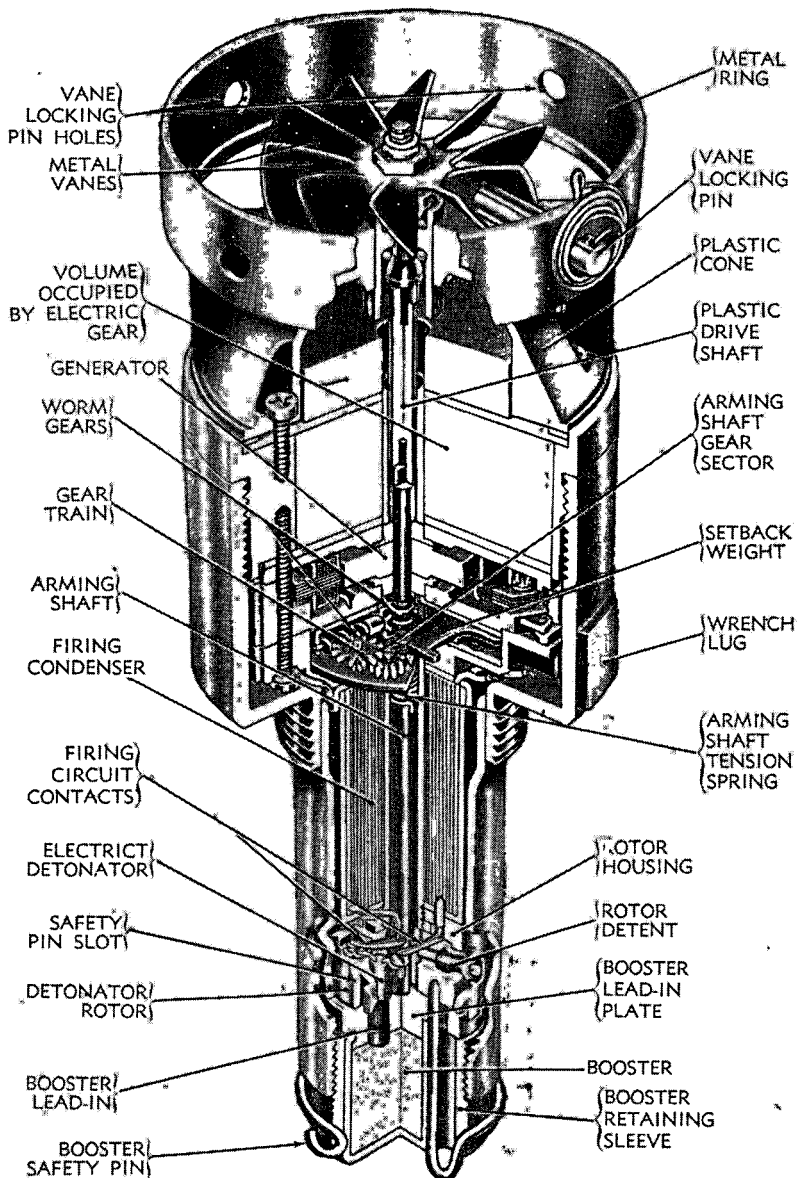


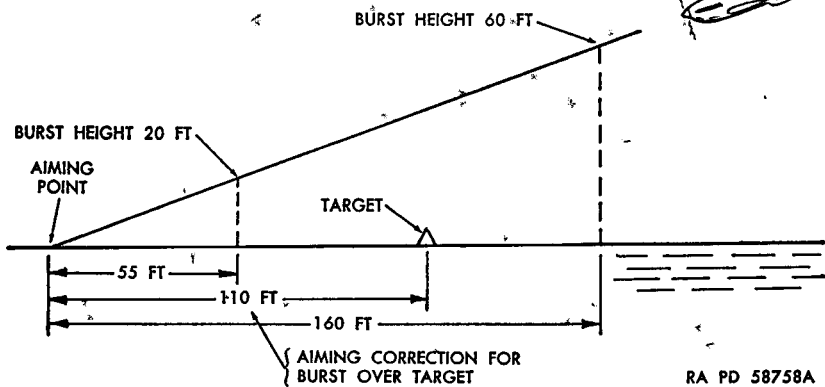
Figure 77. Burst height over average terrain.



NOTE: THE BOOSTER SAFETY PIN CANNOT BE IN POSITION WHEN THE ROTOR IS IN THE POSITION SHOWN. THE SAFETY PIN IS SHOWN FOR COMPLETENESS ONLY.

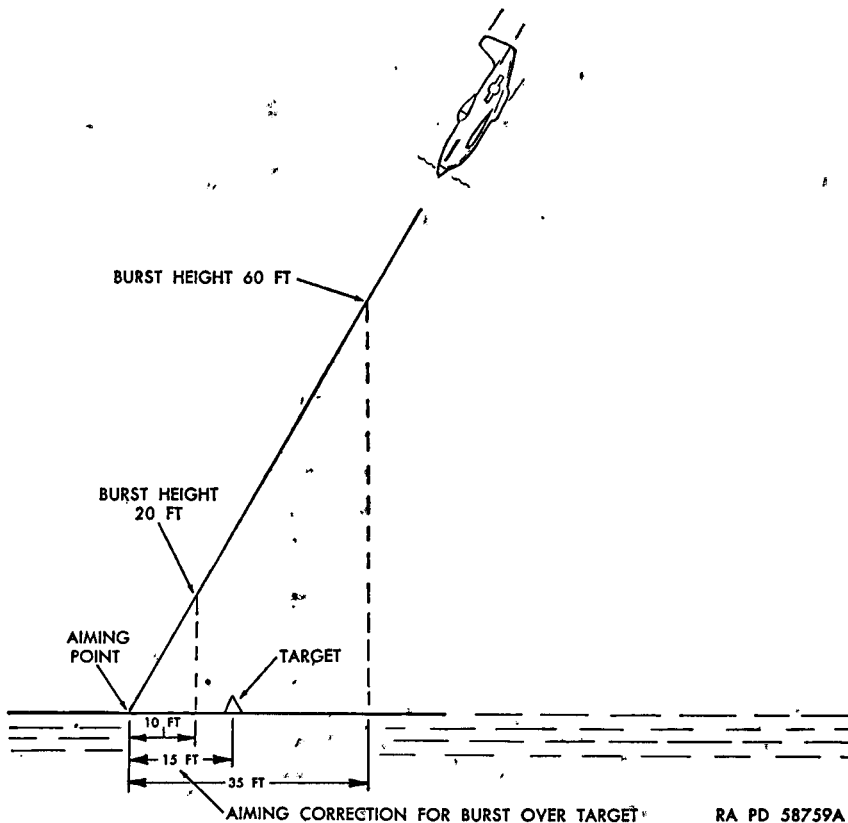
RA PD 58763

Figure 78. Fuze, rocket, VT, M403—detonator rotor in armed position.



RA PD 58758A

Figure 79. Effect of variation of burst height on range dispersion with 20-degree dive angle.



RA PD 58759A

Figure 80. Effect of variation of burst height on range dispersion with 60-degree dive angle.

characteristics; as a result of a manufacturing tolerances, there will be some variation in burst height between different fuzes for fixed dive angle and terrain conditions.

(a) The variation of average burst height with dive angle is shown graphically in figure 77. This curve is for approach to average terrain.

(b) Soil conditions will cause deviations from values of average height plotted in figure 77. Burst heights will be increased for a given angle over wet soil, metal fragments or water, and will be decreased on approach to dry soil. As an example, at 30° , burst height may average 20 feet over dry soil and 60 feet over wet soil or ground littered with metal fragments.

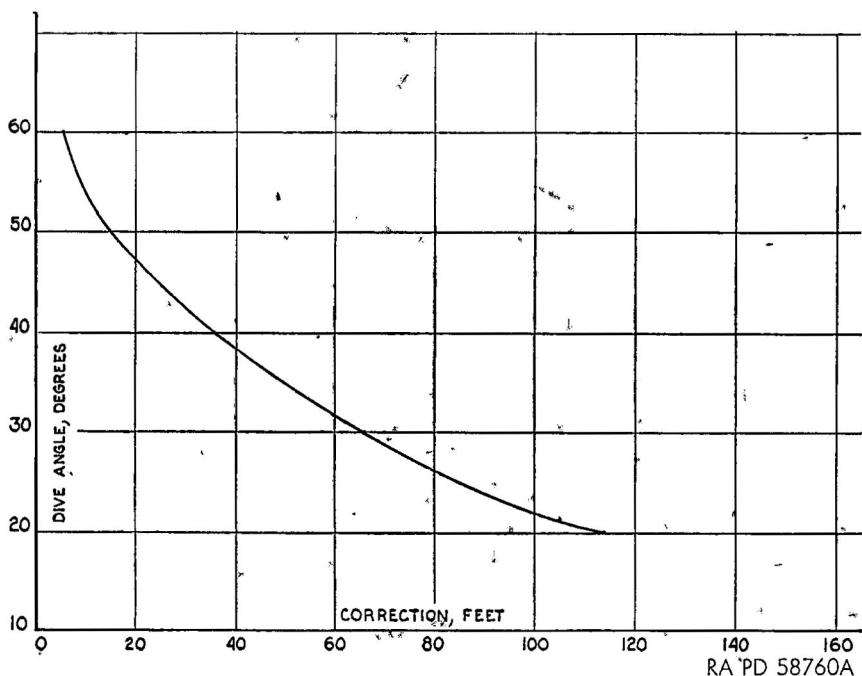


Figure 81. Aiming correction for various dive angles.

- (c) Terrain irregularities, such as trees, crests, streams, and material objects normally will cause fuze function at slightly greater heights than would occur over uniform terrain. Irregularities in terrain will cause unpredictable burst heights at low angles of approach.
- (4) *Range dispersion.* Figures 79 and 80 illustrate the manner in which burst height and approach angle affect range dispersion. Dispersion is small at approach angles

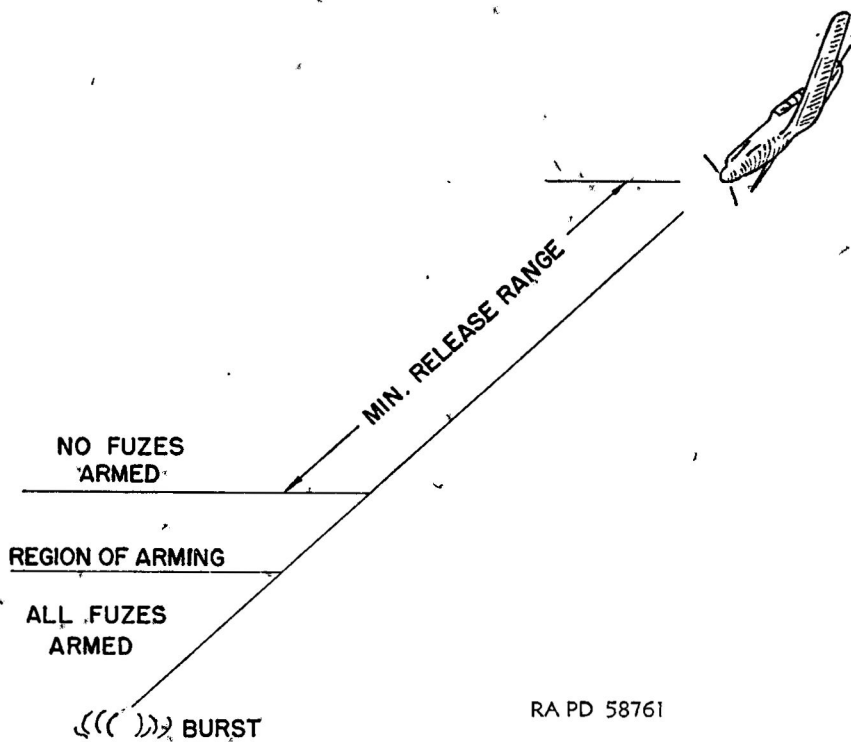
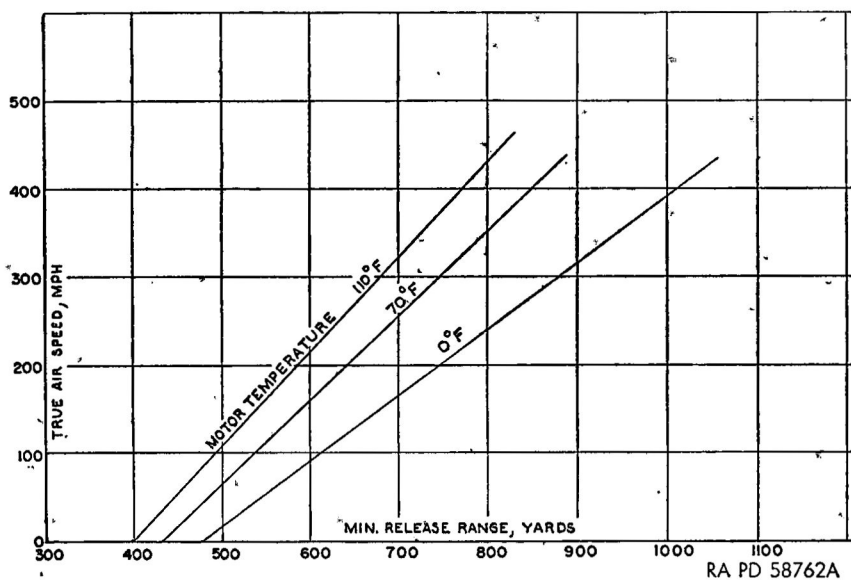


Figure 82. Minimum release range—region of arming.



RA PD 58762A

Figure 83. Minimum release range at various motor temperatures and air speeds.

greater than 30° but increases considerably at angles below 30° .

- (5) *Leading the target.* Leading the target is a method of aiming a rocket ahead of the target so that it is directly over the target when it functions (figs. 79, 80, and 81). The correct distance to lead a target (aiming correction), in order to place the most fragments on it is shown graphically in figure 81.
- (6) *Angle of approach.* It is recommended that the dive angle be as steep as practicable, preferably above 30° , when using the VT fuze M403.
- (7) *Reliability.* Approximately 85 percent of the VT fuzes M403 may be expected to function effectively at the target.
- (8) *Malfunctions.* The 15 percent malfunctions occurring in the use of the fuze may be due to—
 - (a) "Early" function—Detonation after arming has been completed but prior to approach to the target or other object.
 - (b) Dud—A failure to function. VT fuze duds will be partially compensated for by operation of the base fuze in the rocket head.
- (9) *Minimum release range.* An electrical delay is incorporated in this fuze, of such value that the earliest possible "early" function (as defined above), will occur with enough separation between the rocket and plane to present no hazard to the plane or pilot. Minimum release range is defined as the minimum distance, between plane and ground target at the instant of rocket release, required to insure that over-all (mechanical and electrical) arming is completed before arrival of the rocket at the target (fig. 82). The minimum release range will vary with plane speed and rocket temperature, and is shown graphically for the 5.0-inch AR in figure 83. The minimum release range when firing VT fuzed 5.0-inch HVAR should never be less than approximately 1,000 yards.

83. Use and care of VT Fuze M403

a. ASSEMBLY OF VT FUZE TO ROCKET.

- (1) Remove the fuze from its container and inspect for broken seal or defects, such as bent arming vane, loose parts, dents, etc.
- (2) Inspect the rocket assembly. See that the fuze well is free of dirt, rust, or other foreign material. See that

the head, motor, and fins are tight. Do not use rockets with bent or damaged fins.

- (3) Remove the rear safety pin from the booster cup (refer to instruction tag), and check to see that the pin is not bent or sheared. Reinsert the safety pin to check the unarmed position of the interrupter rotor. If the safety pin does not insert easily, reject the fuze and destroy it. Remove the safety pin again and retain it, since in case the round is to be disassembled, the pin will be required.
- (4) Install the fuze wrench-tight in the nose cavity of the rocket head, using the T4 special wrench (fig. 84) packed in each box of fuzes.
- (5) Remove the seal wire from the vane locking pin. If it is necessary to realine the vane locking pin to insert the arming wire properly with respect to the launcher,

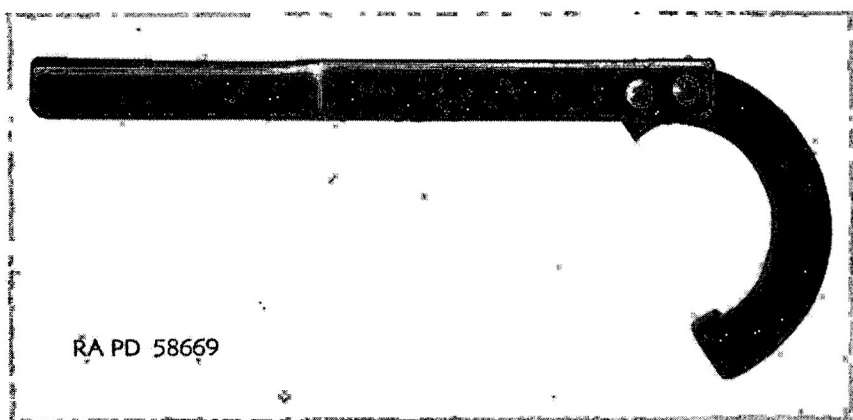


Figure 84. Wrench, fuze, T4.

remove the cotter pin from the vane locking pin and install the locking pin in any one of four holes on the nose ring of the fuze.

- (6) Install the arming wire through the hole from which the seal wire was removed (the hole inside, nearest the arming vane, fig. 85). Pull the arming wire through the hole until it extends 3 to 4 inches beyond the fuze; then remove the cotter pin from the vane locking pin, allowing wire to hold the vane locking pin in place.

Caution: Do not use Fahnestock clips with these fuzes.

b. DISASSEMBLY PROCEDURE. If use of the fuzed rocket is not likely for 48 hours, the fuze should be removed as follows:

- (1) Replace the cotter pin in the hole nearest the head of the vane locking pin. If necessary, press in on the head

of the vane locking pin to expose the hole. Remove the arming wire.

- (2) Remove the fuze from the rocket head, using the special wrench T4 (fig. 84). An unarmed fuze cannot fire and is entirely safe to handle and remove from rockets.
- (3) Replace the safety pin in the booster cup. If the pin cannot be inserted easily, destroy the fuze.
- (4) Replace the fuze in its shipping can and seal the lid of the can with friction tape.

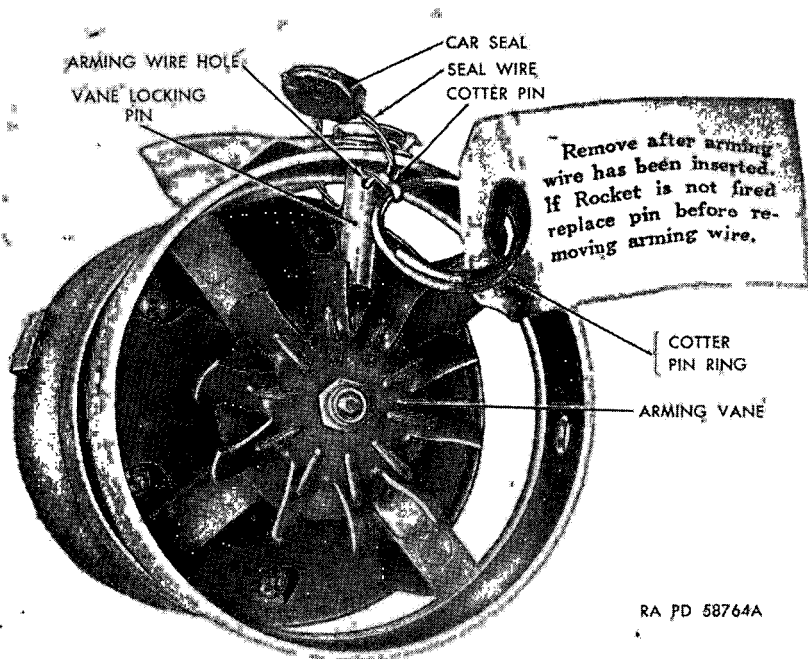


Figure 85. Fuze, rocket, M403—vane locking pin, seal wire with car seal, and cotter pin, in place as shipped in container.

c. STORAGE AND HANDLING.

- (1) *Packaged fuzes.* Fuzes may be stored for extended periods of time and are not affected adversely by temperatures between 40° and 140° F. when in the original containers and, if unopened.
- (2) *Unpackaged fuzes.* Exposure to high humidity atmosphere tends to deteriorate unpackaged fuzes. Fuzes should be unpacked only in quantity sufficient to meet the immediate need. Fuzes which are not to be used within 48 hours should be returned to storage, repacked in their original containers with the lids taped securely.

Such fuzes should be used first, before opening sealed containers.

- (3) *Handling.* VT fuzes M403, as originally packed, may be subjected to the same handling as other fuzes. Dropping normally will not damage a packaged fuze, but dropping may damage an unpackaged fuze. Rough or abusive handling of the fuzes may tend to increase malfunctions but will not decrease the safety of the fuze. Damaged fuzes should be destroyed.

d. DESTRUCTION OF VT FUZES. See paragraph 93.

e. DUD DISPOSAL.

- (1) VT fuze M403 will not fire unless the vane is turning rapidly (2,000 rpm or more), even though the fuze is armed. An armed VT fuze M403 which has been damaged while the vane was turning at high speed is dangerous and should not be handled until at least 60 minutes have elapsed with the vane at rest. Before the expiration of 60 minutes, the fuze may be sensitive to shock, jar, or approach.
- (2) Dud disposal should be accomplished by authorized bomb disposal personnel. It should never be attempted by unauthorized personnel.

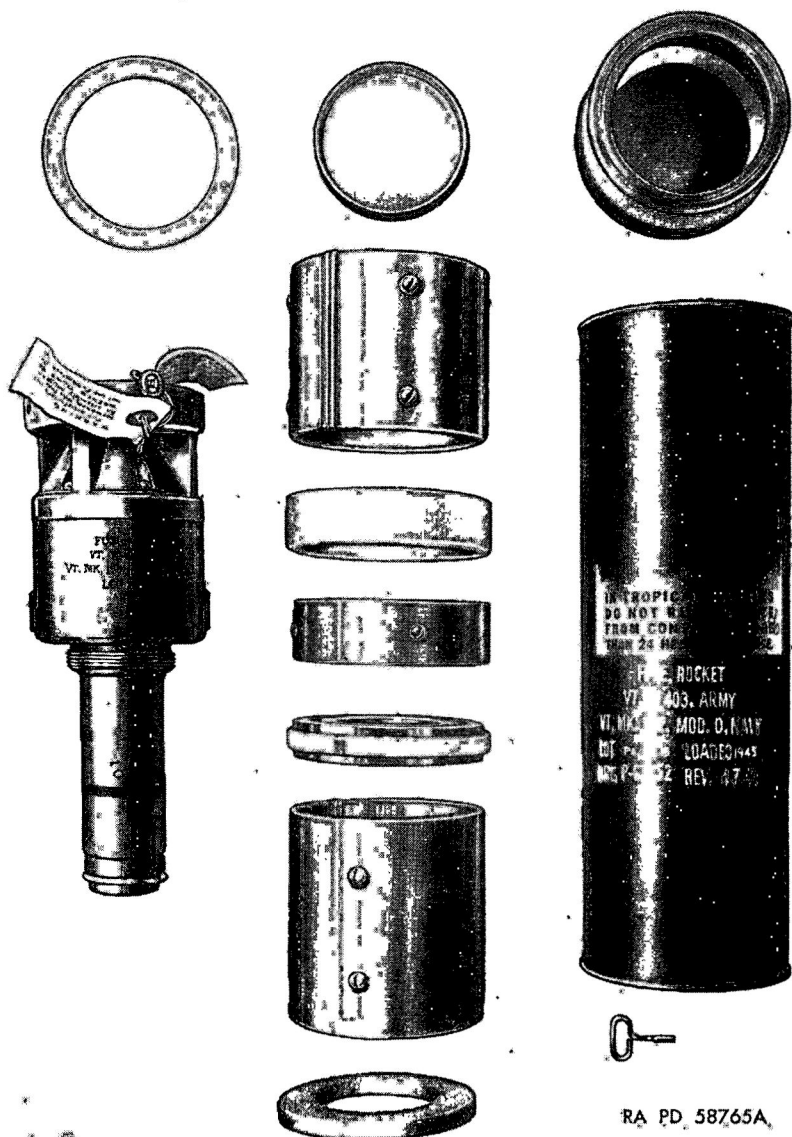
f. PACKING AND MARKING. VT fuzes M403 are packed in hermetically sealed cans. Nine such cans are packed per wooden box. A special fuze wrench is packed in each box to be used in assembly and disassembly of the fuze to the rocket head.

(1) *Packing data.*

Fuze weight	4.5 lb
Over-all diameter of fuze	3.4 in.
Over-all length of fuze	10.4 in.
Length of fuze extending beyond fuze well	5.0 in.
Number of fuzes in box	9
Weight of box	77 lb
Dimensions of box	14 x 15 ²⁷ / ₃₂ x 15 ¹ / ₂ in.
Volume of box	2 cu-ft

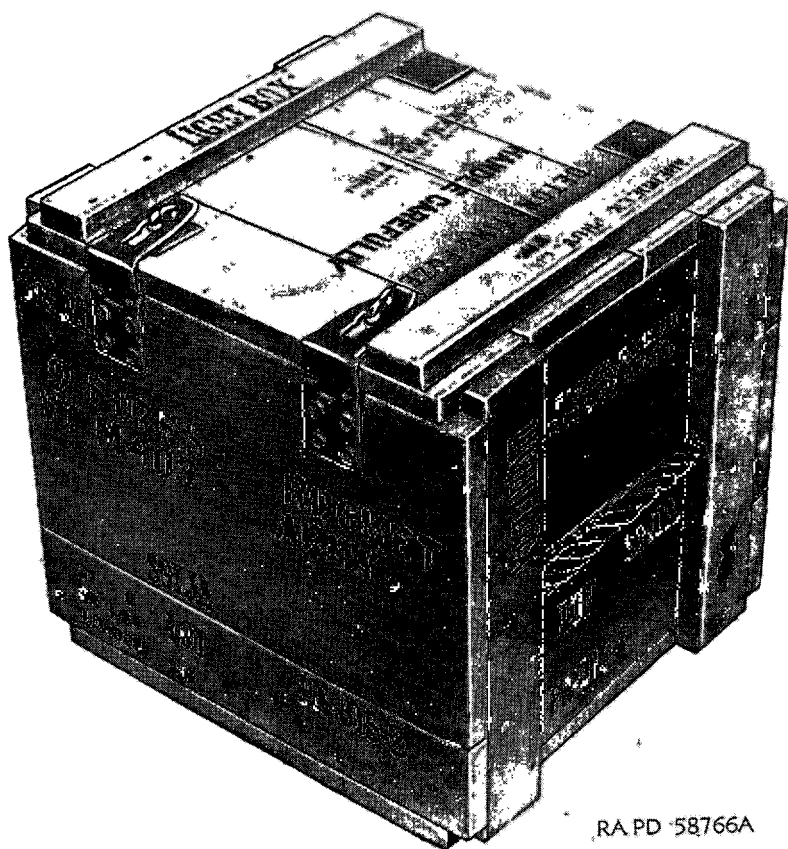
- (2) *Packaging.* Fuzes are supported within their respective metal containers (fig. 86) by rubber, plastic, and metal mountings. These mountings should be removed from the fuze before assembling it to a rocket projectile.
- (3) *Marking.*
- (a) Each packing box (fig. 87) is stamped with complete nomenclature, number of fuzes, lot number, date loaded, weight, cubage, and shipping data.

- (b) Each fuze and container is stamped with complete nomenclature, lot number, and date of loading. Instruction tags are attached to the vane locking cotter pin, the sealing wire, and the safety pin through the booster cup.



RA PD, 58765A

Figure 86. Fuze, VT, M403—with container and interior container mountings.



RA PD 58766A

Figure 87. Packing box for VT fuze M403.

CHAPTER 4

SOLID ROCKET PROPELLANTS

84. General

In order to utilize the principle described in paragraph 3, it is necessary to provide a gas-forming medium in the rocket motor. This medium is called the propellant. In large rockets it usually consists of a fuel such as alcohol and an oxidant such as liquid oxygen. These are burned in a reaction chamber to produce the gaseous products. This type of propellant is called liquid propellant. It is not used in combat rockets of the ordinary military type. Rockets treated in this manual are of the ordinary military type, which employ a solid gas-producing medium called solid propellant. In this type the fuel and the oxidizer are embodied in one chemical compound or several compounds which can be mixed and formed into a single propellant element called a grain.

85. Types

There are two types of solid propellants used in standard military rockets, solvent and nonsolvent. Both types consist essentially of nitrocellulose and nitroglycerin both of which are fuel and oxidizers. Other materials are added to impart physical and chemical properties required to insure the desired performance, chemical stability, and durability. Examples of the percentage composition of the two types are—

	<i>Solvent</i>	<i>Nonsolvent</i>
Nitrocellulose -----	54.60	56.50
Nitroglycerin -----	35.50	28.00
Dinitrotolylene -----	--	11.00
Ethyl centralite -----	0.90	<u>4.50</u>
		100.00
Carbon black -----	1.20	0.50 (Added)
Potassium perchlorate* -----	7.80	--
Potassium sulphate -----	--	1.50 (Added)
Candilla wax -----	--	0.08 (Added)
	<u>100.00</u>	

* Containing 0.5 percent added magnesium oxide and 0.5 percent magnesium stearate.

86. Solvent Propellants

a. GENERAL. When the thickness of the powder web is large, difficulty is encountered in removing the solvent completely from the powder. However, the powder manufacturing process is readily adaptable to producing powder of small web, that is, up to 0.30 inch. Therefore, solvent propellants are used when the desired size of grain is small. The propellant charge for the 2.36-inch rocket consists of 5 single-perforated grains (fig. 88) in the form of hollow sticks having a nominal length of 4.75 inches, an outside diameter of three-eighths inch, and a web thickness of 0.140 inch.

b. PROCESS OF MANUFACTURE. This type of powder is made by the standard process for making double-base artillery powders. The process is outlined as follows:

- (1) Water wet nitrocellulose is treated with alcohol to displace the water.
- (2) Excess alcohol is removed in a hydraulic press.
- (3) Alcohol wet nitrocellulose cake is loosely broken apart and placed in a bowl-type mechanically driven pre-mixer.
- (4) Nitroglycerin dissolved in acetone is added to the nitrocellulose and mixed.
- (5) The pre-mix then is placed in a sigma-blade dough-type mixer and the remaining constituents added and mixed thoroughly.
- (6) The mixed material is then blocked and hydraulically forced through screens.
- (7) The screened material then is blocked and forced through dies to form a perforated strand which is cut to the approximate desired length.
- (8) The cut sticks then are subjected to heated air currents to remove volatile solvents. During this drying, the diameter of the grains shrinks approximately 20 percent to the desired dimension.

87. Solventless Propellants

a. GENERAL. When it is desired to provide a propellant larger than those which can be produced by the solvent process, a solventless process is used, thus eliminating the need for removing a solvent. An example of this type (fig. 89) is the grain for certain models of 4.5-inch rockets. The charge which consists of 7 single-perforated grains 13.6 inches in length and 1.37-inch outside diameter, weighs 7.7 pounds, and has a web thickness of 0.56 inch.

b. PROCESS OF MANUFACTURE. The solventless process consists of the following steps:

- (1) Add nitroglycerin to a water slurry of nitrocellulose and mix.
- (2) Dinitrotoluene and ethyl centralite are mixed in and then the bulk of the excess water is removed by centrifuging.
- (3) The resulting paste is put in cotton bags and subjected to heated air currents to reduce the moisture content.
- (4) The remaining constituents are blended with the partly dried paste.
- (5) The material then is passed several times between heated steel rolls resulting in well-colloided dry sheets.
- (6) The sheets are cut into strips 5 inches wide which are wrapped spirally to form "carpet rolls."
- (7) The carpet rolls are placed in a hydraulic press and the solventless strand is formed by extrusion.
- (8) Strands are cut to the desired grain lengths.

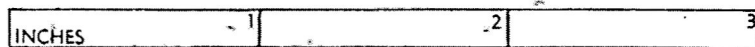
88. Large Rocket Propellant Grains

In addition to the propellants which are made by the solvent and solventless methods, rocket propellant grains may be made by casting. This method is suitable for making grains in excess of 6 inches in diameter. Casting methods are suitable for rocket propellants containing a binder which also serves as fuel and oxidizing material. These propellants are called composite compositions and contain no nitrocellulose or nitroglycerin.

89. Interior Ballistics

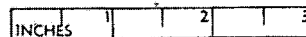
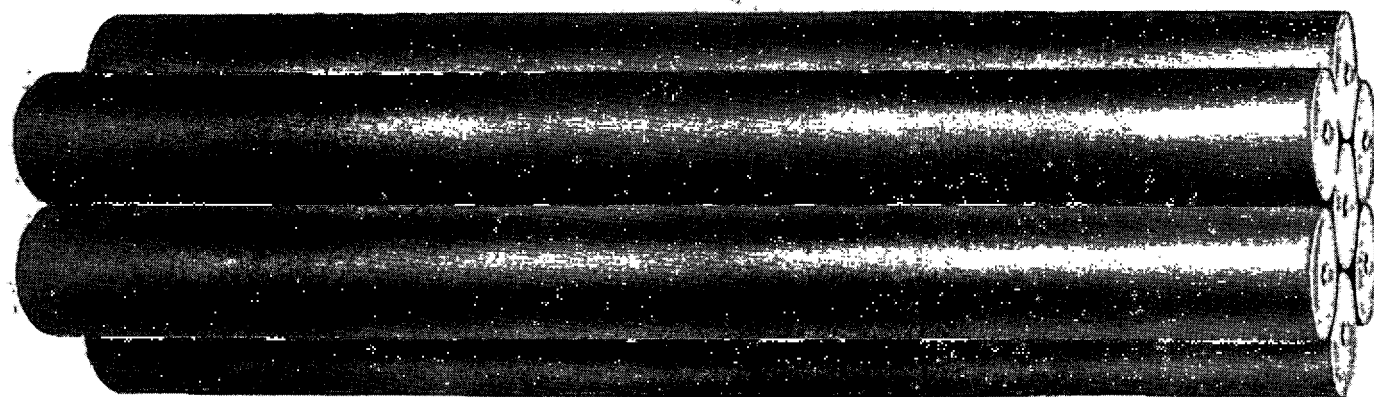
a. GENERAL. The flight of a rocket is determined by its size, shape, weight, manner of launching, and thrust developed by the burning of the propellant charge. The thrust (lb.), burning time (sec), burning rate (inch per second), pressure (psi), initial temperature ($^{\circ}$ F.) of the propellant, and ratio of burning surface of the propellant to the area of the nozzle orifice are among the factors known as interior ballistics.

b. BURNING CHARACTERISTICS. Nitrocellulose powder, which in conjunction with nitroglycerin is used as rocket propellant, is suited particularly for that purpose because of its chemical composition and its surface-burning property. When ignited, burning takes place over its exposed surface and progresses in a direction perpendicular to those surfaces. The burning time depends upon the chemical composition of the propellant, the initial temperature of the propellant, and the surrounding pressure. The burning rate increases with the increase of pressure and temperature. For example, with an initial propellant tem-



RA PD 116881

Figure 88. Propellant for 2.36-inch rockets.



RA PD 116882

Figure 89. Propellant for 4.5-inch rockets.

perature of 70° F., the burning rate may vary from 0.20 inch per second at atmosphere pressure to 1.30 inches per second at 1,000 psi pressure in a rocket motor.

c. GRAIN DESIGN. Since the burning rate of the powder is a surface phenomenon, the pressure developed within the motor may be controlled by the design of the grains of propellant powder. For example, if perforated grains, as shown in figures 88 and 89, were coated on the outside with a very slow burning substance and the inside were ignited, the inside surface would increase as burning progressed, and pressure would increase at an accelerated rate. This is known as progressive burning. If, on the other hand, the inside surface of the grain were coated, the outside surface would decrease as burning progressed, and pressure would increase at a decelerating rate. This is known as degressive burning. If neither the inside nor the outside were coated, the decrease in burning area on the outside would be offset by the increase in burning area on the inside, and the burning area would be constant. Thus, by grain design and by the use of coatings, called inhibitors or deterrents, it is possible to control the burning surface of the grains to obtain the desired burning time for the propellant charge, to obtain high density of propellant loading, and to protect the motor walls from the effects of intense heat. Cellulose acetate in a thin layer generally is used as an inhibitor in connection with star-perforated and cruciform (in cross section) grains in order that the burning area may remain constant, thus giving the desired burning characteristics and assuring true rocket flight and motor protection.

d. K FACTOR. The ratio of the propellant burning surface to the area of the rocket orifice is known as the K factor. In order to assure proper rocket action it is important that this factor be controlled, and this is done as explained above. If the K factor should increase appreciably as a result of voids or fissures in the propellant grains, grain rupture, or orifice stoppage, sufficient excess pressure might develop in the motor to burst it.

90. Rocket Testing

Static tests are made for the purpose of determining the burning time, thrust, and chamber pressure of rocket motors. The burning and ignition characteristics are determined from the thrust-time and pressure-time graphs obtained from indicating and recording equipment. Flight tests of rockets also are made to determine velocity, range, and uniformity. Personnel and property should be protected from motor bursts and erratic performance in all tests.

CHAPTER 5

DESTRUCTION TO PREVENT ENEMY USE

91. General

a. Destruction of rockets described herein, when subject to capture or abandonment, will be undertaken by the using arm *only* when; in the judgment of the unit commander concerned, such action is necessary in accordance with orders of, or policy established by, the army commander.

b. The information which follows is for guidance only. The conditions under which destruction will be effected are command decisions and may vary in each case dependent upon a number of factors such as the tactical situation, security classification of the ammunition (AR 380-5), quantity and location of ammunition, facilities for accomplishing destruction, and time. In general, destruction of rockets can be accomplished most effectively by burning or detonation, or a combination of these. Selection of the particular method of destruction requires imagination and resourcefulness in utilization of the facilities at hand under the existing circumstances. Time usually is critical.

c. If destruction to prevent enemy use is resorted to, rockets and their components must be so badly damaged that they cannot be restored to usable condition in the combat zone. Equally important, the *same* essential parts on all rockets must be destroyed so that the enemy cannot construct one complete rocket from several partly damaged rockets.

d. If destruction of rockets is directed, due consideration should be given to—

- (1) Accomplishment of the destruction in such a manner as to cause the greatest obstruction to enemy movement and also prevent hazard to friendly troops from fragments or uncontrolled flight of rockets.
- (2) Observance of appropriate safety precautions.

92. Destruction of Rockets

In planning and accomplishing the destruction of rockets, due consideration should be given to their characteristics, noting particularly that it is the reaction of the burning propellant in the motor assembled to the head, which projects the rocket in what-

ever direction pointed at the time the propellant is ignited. Thus, unless restrained as to direction, in which pointed at the time of ignition, rockets may be expected to be projected in unpredictable flight. Hence, suitable cover is important, not only from fragments but also from the rocket itself. To minimize or prevent such unpredictable flight, rockets to be destroyed should be pointed toward the enemy, or pointed downward—preferably in a trench or depression. The following methods, in order of preference, are considered the most satisfactory for destruction of rockets to prevent enemy use:

a. METHOD No. 1—BURNING. Stack rockets, either packed or unpacked, in piles pointing toward the enemy, or in a trench or depression head downward. Lay inflammable materials such as paper, rags, brush, and wood on, and at the motor end of, the piles. Pour oil and gasoline over the piles. Sufficient inflammable material must be used to insure a sufficiently hot fire to ignite the motor. Ignite and take to cover. The danger area will vary considerably, dependent principally upon the size and number of rockets and the manner in which they are prepared for destruction. For example, if rockets are placed in a trench or depression head downward and restrained to that position until the propellant burns, the danger area will be limited to that of the fragments. On the other hand, if the rockets are stacked in the open it is possible that an occasional rocket may be projected to its maximum range even though the majority may be expected to be destroyed in place. Hence, should destruction be contemplated in the vicinity of friendly troop areas, the maximum ranges for the particular rockets involved should be considered.

b. METHOD No. 2—DEMOLITION. More complete destruction will be accomplished if the rockets are removed from their packings and piled—preferably in a trench or depression. Place TNT charges equally distributed throughout the pile at the fuze end of the rocket. Use approximately $\frac{1}{2}$ pound of TNT per 100 pounds of rockets. If the rockets are to be destroyed "as packed," use approximately 1 pound of TNT per 100 pounds of packages. Prime each charge of TNT for simultaneous detonation in accordance with FM 5-25. If primed with safety fuse, light fuse and take cover; if arranged for electrical ignition, take cover and fire. For danger area, see a above.

93. Destruction of VT Fuzes

a. In the event that it becomes necessary to destroy classified VT fuzes to prevent enemy capture, they will be given as high a priority in order of destruction as possible, for security reasons. If possible, their destruction should be so complete that there

would be no residue of any fuze parts or pertinent literature that would be of any value to an enemy.

b. Unserviceable fuzes should be destroyed by one of the methods given below in order of preference.

(1) Remove cover from steel shipping box of fuzes. Take out one of the fuzes near the center of the box and insert a 1-pound block of TNT or nitrostarch and 5 feet of safety fuze with nonelectric blasting cap attached. Replace the fuze removed and detonate the explosive block. Electric detonation also may be used, in which case all boxes of fuzes should be prepared and detonated simultaneously. Suitable precautions must be taken to prevent injury to personnel. Bangalore torpedo M1, shaped charge M2A3, or other suitable demolition equipment, can be used to advantage for destroying fuzes.

(2) Individual cans of fuzes may be disposed of by dropping them in permanent bodies of water at locations where water is over 150 fathoms deep and at least 10 miles from shore. Before disposal in this manner, all cans containing fuzes must be punctured.

c. All instruction cards, pamphlets, manuals, bulletins, ammunition data cards, and similar material, should be torn into pieces, soaked in gasoline and burned.

APPENDIX

REFERENCES

1. Publications Indexes

The following publications indexes and lists of current issue should be consulted frequently for the latest changes or revisions of references given in this appendix and for new publications relating to ammunition covered in this manual:

- a. Index of administrative publications --- SR 310-20-5
- b. Index of Army motion pictures and film strips ----- SR 110-1-1
- c. Index of Army training publications --- SR 310-20-3
- d. Index of blank forms and Army personnel classification forms ----- SR 310-20-6
- e. Index of Ordnance publications (Navy) OP 0
- f. Index of technical manuals, technical bulletins, and supply bulletins ----- SR 310-20-4
- g. Introduction and index (supply catalog) ORD 1
- h. Military training aids ----- FM 21-8
- i. Ordnance major items and combinations, and pertinent publications ----- SB 9-1

2. Supply Catalogs

The following Department of the Army Supply Catalogs pertain to this ammunition:

- a. Ammunition surveillance, testing, and inspection equipment and supplies --- ORD 6 SNL N-10
- b. Cleaners, preservatives, and lubricants, recoil fluids, special oils, and related maintenance materials ----- ORD 3 SNL K-1
- c. General tools and supplies for ordnance ammunition company ----- ORD 10 SNL N-17
- d. Materials for renovating and packaging of Group S ammunition and miscellaneous items ----- ORD 11 SNL S-11
- e. Rockets, all types and components --- ORD 11 SNL S-9
- f. Special ammunition surveillance, testing, inspection, and renovation tools and supplies ----- ORD 5 SNL P-11

3. Other Publications

The following publications contain information pertinent to this ammunition and associated equipment:

a. AMMUNITION.

Ammunition condition report	00 Form 517
Ammunition: General	SB 9-AMM 1
Ammunition, general	TM 9-1900
Ammunition identification code (AIC)	SB 9-AMM 5
Ammunition inspection guide	TM 9-1904
Ammunition: Net prices	ORD 5-3-6
Ammunition renovation	TM 9-1905
Ammunition: Restricted or suspended	TB 9-AMM 2
Ammunition: Surveillance manual	OFSB 3-20
Artillery ammunition	TM 9-1901
Ballistic data, performance of ammunition	TM 9-1907
Explosives and demolitions	FM 5-25
Fuzes for rockets and projector charge	OP 1017 (Navy)
Inspection of ordnance matériel	TM 9-1100
Military explosives	TM 9-2900
Ordnance safety manual	00 Form 7224
Qualification in arms and ammunition training allowances	AR 775-10
Regulations for firing ammunition for training, target practice, and combat	SR 385-310-1
Rocket assemblies	OP 1415 (Navy) (SB 9-series (SB 9-AMM-series
Supply bulletins	
2.25-inch subcaliber rocket	OP 1187 (Navy)
3.5-inch rocket (3.25-inch motor)	OP 1157 (Navy)
4.5-inch rocket ammunition	OP 1111 (Navy)
5.0-inch rocket (5.0-inch motor)	OP 1239 (Navy)
11.75-inch rocket ammunition	OP 1227 (Navy)

b. LAUNCHERS.

(1) 2.36-inch:

Hand and rifle grenades, rocket, AT, HE, 2.36-inch	FM 23-30
2.36-inch rocket launchers M9, M9A1, and M18	TM 9-294

(2) 3.25-inch:

Target rocket projector M1	TM 9-856
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(3) 3.5-inch rocket launcher M20

TM 9-297

(4) 4.5-inch:

4.5-inch aircraft rocket matériel	TM 9-395
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4.5-inch multiple rocket launchers T66 and T66E2 -----	TM 9-392
4.5-inch rocket matériel for ground use -----	TM 9-394
4.5-inch rocket launcher Mk 2 Mod 1 -----	OP 1127 (Navy)
4.5-inch rocket launcher Mk 4 -----	OP 1128 (Navy)
4.5-inch rocket launcher Mk 10 Mod O -----	OP 1202 (Navy)

c. GENERAL.

Ammunition supply -----	FM 9-6
Ammunition: Restricted or suspended -----	TB 9-AMM 2
Ammunition: Supply within the Conti- nental United States -----	SB 9-AMM 6
Army marking directive -----	TM 38-414
Cleaning, preserving, sealing, and re- lated materials issued for ordnance matériel -----	TM 9-850
Decontamination -----	TM 3-220
Defense against chemical attack -----	FM 21-40
Dictionary of United States Army terms -----	TM 20-205
Firing tables (see SR 310-20-3) -----	
Graphical firing tables -----	TM 9-526
Instruction guide—Ordnance packag- ing and shipping (posts, camps, and stations) -----	TM 9-2854
Manual for the prediction of effective rocket temperatures in aircraft rockets -----	OP 1235 (Navy)
Military chemistry and chemical agents -----	TM 3-215
Ordnance service in the field -----	FM 9-5
Protection of Ordnance matériel in open storage -----	SB 9-47
Reports -----	SB 9-AMM 8
Safeguarding military information -----	AR 380-5
Safety:	
Reports of (accidents, fires, and explosions) -----	SR 385-310-40 series
Report of hazardous conditions in- volving military explosives or ammunition -----	SR 385-15-1
Targets, target material, and training course layouts -----	TM 9-855

4. Firing Tables and Range Tables

- a. 2.25-INCH ROCKETS. Firing data are published in OP 1355 (Navy).
- b. 2.36-INCH ROCKETS. Usual fire control by launcher sights. See also FT R2.36-B-1.
- c. 3.25-INCH TARGET ROCKET. Range data and diagrams are published in TM 9-856.
- d. 3.5-INCH ROCKETS. Firing data are published in OP 1355 (Navy).
- e. 4.5-INCH ROCKETS; FOLDING-FIN TYPE. RT 4.5C-2.
- f. 4.5-INCH ROCKETS, SPIN TYPE. Graphical firing table, T-2.
- g. 4.5-INCH ROCKETS, CIRCULAR-FIN TYPE (BR). Firing data are published in OP 1111 (Navy).
- h. 5.0-INCH ROCKETS (AR AND HVAR). Firing data are published in OP 1355 (Navy).
- i. 7.2-INCH ROCKETS. Firing data are published in TM 9-396.

Note. USAF operations analysts and gunnery officers may obtain aircraft gun firing tables and aircraft rocket firing tables by submission of requisition to the Commanding General, Aberdeen Proving Ground, Md., Attention: Ballistic Research Laboratory.

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