

TM 9-1901

Artillery Ammunition

1950

CONTENTS

	Paragraphs	Page
CHAPTER 1. GENERAL.		
<i>Section I.</i> Introduction	1-3	1
II. General discussion	4-17	4
CHAPTER 2. FIXED AND SEMIFIXED ROUNDS AND SEPARATE-LOADING PROJECTILES.		
<i>Section I.</i> Ammunition for 20-mm guns	18-28	69
II. Ammunition for 37-mm guns	29-45	78
III. Ammunition for 40-mm guns	46-52	96
IV. Ammunition for 57-mm guns	53-59	103
V. Ammunition for 57-mm rifles	60-72	108
VI. Ammunition for 60-mm mortars	73-80	115
VII. Ammunition for 75-mm guns	81-94	127
VIII. Ammunition for 75-mm howitzers	95-104	133
IX. Ammunition for 75-mm rifles	105-117	147
X. Ammunition for 76-mm guns	118-128	153
XI. Ammunition for 81-mm mortars	129-141	161
XII. Ammunition for 90-mm guns	142-156	174
XIII. Ammunition for 105-mm howitzers	157-170	187
XIV. Ammunition for 4.2-inch mortars	171-175	201
XV. Ammunition for 120-mm guns	176-180	207
XVI. Ammunition for 155-mm guns	181-188	211
XVII. Ammunition for 155-mm howitzers	189-200	218
XVIII. Ammunition for 8-inch guns	201-205	225
XIX. Ammunition for 8-inch howitzers	206-211	228
XX. Ammunition for 240-mm howitzers	212-216	231
XXI. Ammunition for subcaliber equipment	217-230	233
CHAPTER 3. FUZES, PROPELLING CHARGES, PRIMERS, AND OTHER COMPONENTS.		
<i>Section I.</i> Fuzes	231-276	242
II. Propelling charges	277-296	333
III. Primers and ignition cartridges	297-321	354
IV. Boosters, adapter and booster assemblies, and bursters	322-338	369
V. Eyebolt-lifting plugs, closing plugs, and grommets	339-341	381
CHAPTER 4. DESTRUCTION OF AMMUNITION TO PREVENT ENEMY USE		
	342-343	386
APPENDIX REFERENCES		388
INDEX		392

This manual supersedes TM 9-1901, 29 June 1944; section XIX, TM 3-320, 30 June 1945; TM 4-205, 17 February 1940, including C 1, 31 March 1942, and C 2, 26 October 1944; TB 9-1901-4, 4 September 1944; TB 9-1901-5, 17 October 1944; TB 9-1901-6, 26 December 1944; TB 9-1901-7, 28 December 1944; TB 9-1901-8, 28 February 1945; TB 9-1901-9, 15 March 1945; TB 9-1901-10, 21 June 1945; TB 9-1901-11, 22 June 1945; TB 9-1901-12, 1 November 1949; and TB ORD 76, 12 April 1944. Applicable information in TB ORD 169, 21 August 1944; TB ORD 248, 1 February 1945; TB ORD 295, 25 April 1945; and TB ORD 371, 21 December 1949, has been incorporated in this manual; however, these technical bulletins will remain in force until incorporated in all affected publications or specifically rescinded.

CHAPTER I

GENERAL

Section I. INTRODUCTION

I. Purpose

This manual is intended for instruction and the dissemination of such general and technical information concerning artillery ammunition, including mortar and recoilless rifle ammunition, and components thereof, as may be necessary for their intelligent care, handling, and use. This is a companion volume to TM 9-1900 (Ammunition, General); rocket information is published in TM 9-1950.

2. Scope

a. Ammunition for use in artillery weapons, including field, antiaircraft, aircraft, tank and antitank, recoilless, and in mortars, is described. This manual covers the general characteristics, specific data, means of identification, precautions in handling and use, and general information on packing and shipping. An additional chapter concerns destruction of ammunition in case of imminent capture by the enemy.

b. This manual differs from TM 9-1901, 29 June 1944, as follows:

- (1) Adds information on ammunition for—
 - (a) 20-mm gun M24.
 - (b) 57-mm rifles.
 - (c) 75-mm rifles.
 - (d) 4.2-inch mortars.
 - (e) Subcaliber weapons for 155-mm gun on seacoast mounts.
- (2) Adds information on—
 - (a) Fuzes of the M8, M9, M500, M501, M502, M503 series; modifications of the M48 and M51 series.



ALUMINUM



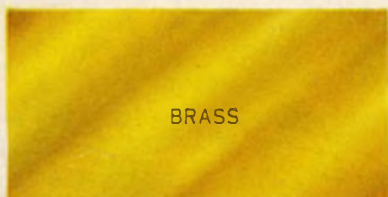
BEESWAX



BLACK POWDER (FLAKES
OR GRAINS)



BLACK POWDER (PRESSED)



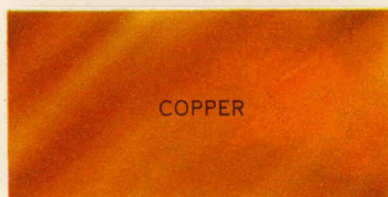
BRASS



CARDBOARD



CHIPBOARD



COPPER



CORK



EXPLOSIVE D



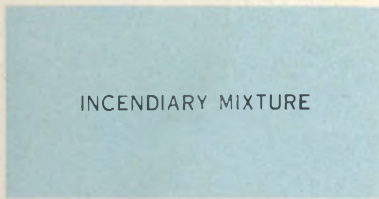
FELT



ILLUMINANT COMPOSITION

RA PD 15129

Chart I. Explanatory color chart (for sectional views).



INCENDIARY MIXTURE



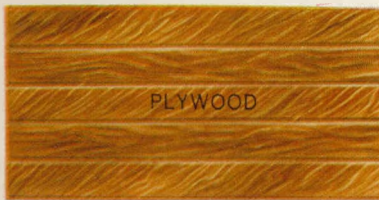
LEAD AZIDE



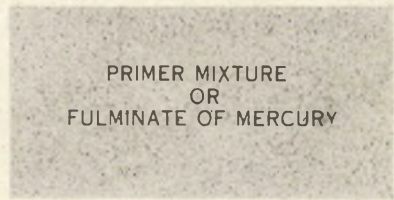
MUSTARD GAS



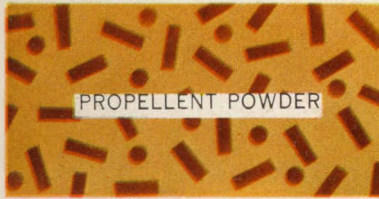
PLASTER OF PARIS



PLYWOOD



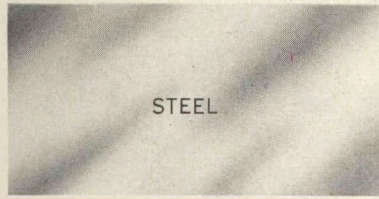
PRIMER MIXTURE
OR
FULMINATE OF MERCURY



PROPELLENT POWDER



SMOKE PRODUCING AGENT



STEEL



TETRYL



TNT



TRACER COMPOSITION

RA PD 15130

Chart I.—Continued.

- (b) VT fuzes and shell adapted for VT fuzes.
- (c) New ammunition items and components.
- (d) Detonators used in fuzes.
- (e) Fuze wrenches.
- (f) Fuze interchangeability chart.
- (g) Powder temperature indicators.
- (3) Revises data, descriptions, and illustrations to bring the information up to date.
- (4) Deletes information on ammunition for—
 - (a) 2-inch mortars.
 - (b) 75-mm aircraft guns.
 - (c) 3-inch guns.
 - (d) 105-mm guns.
 - (e) 4.5-inch guns.
- (5) Deletes the Complete Round Tables.
- (6) Deletes obsolete ammunition items and components, and ammunition for obsolete weapons.

3. Arrangement of Text

a. Chapter 1 covers general ammunition terms, classification of artillery ammunition, means of identification, explosive charges and chemical fillers, packing and marking for shipment, storage precautions, care in handling and use, and a general discussion of projectiles.

b. Chapter 2 presents specific data for and description of the rounds and projectiles used in artillery weapons and in mortars. Subcaliber ammunition is covered in this chapter.

c. Chapter 3 deals with the components, other than projectiles, of complete rounds: fuzes, propelling charges, primers, boosters, bursters, and adapter-boosters. Section V covers the components of separate-loading projectiles used in shipping: grommets and eyebolt-lifting plugs.

d. Chapter 4 describes the destruction of ammunition to prevent enemy use.

e. A list of references is given in the appendix.

Section II. GENERAL DISCUSSION

4. Definitions

a. *Ammunition* comprises that class of supplies usually containing explosives and intended for use in combat, simulated combat, or training. Artillery ammunition includes all ammunition used in weapons of caliber greater than 0.60 inch. Rocket information is published in TM 9-1950.

- A—FUZE
- B—BOOSTER
- C—FUZE WELL LINER
- D—SHELL
- E—OGIVE
- F—BOURRELET
- G—BURSTING CHARGE
- H—ROTATING BAND
- I—CRIMP
- J—BASE COVER
- K—CARTRIDGE CASE
- L—PROPELLING CHARGE
- M—PRIMER
- N—LIFTING RING
- O—GROMMET
- P—COTTER PIN WITH PULL RING
- Q—IGNITER
- R—CASED PROPELLING CHARGE
- S—CLOSING PLUG
- T—DISTANCE WAD
- U—IGNITER CHARGE ASSEMBLY

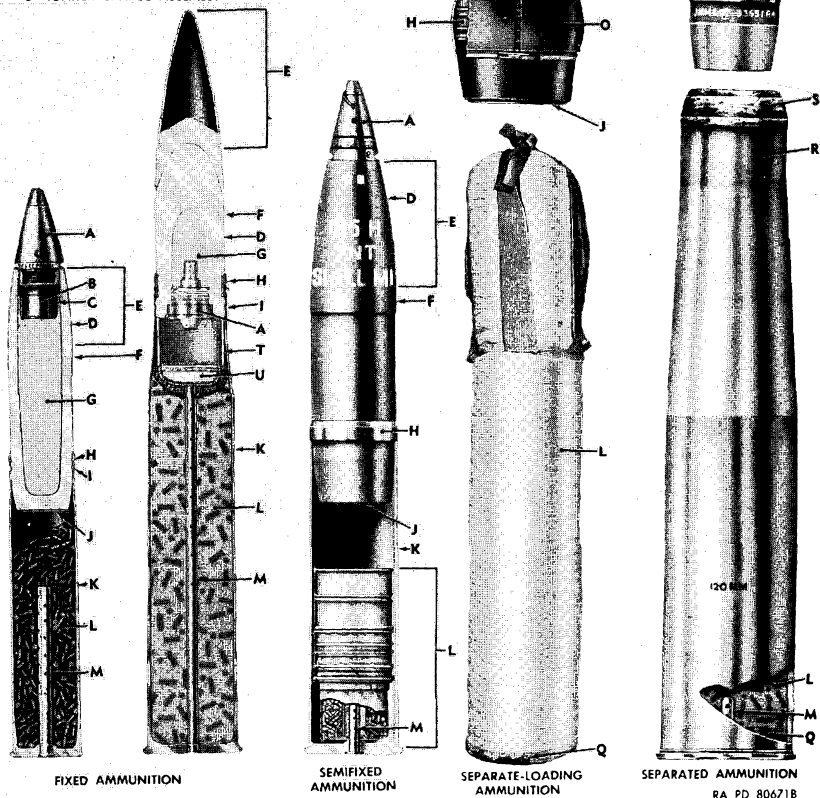


Figure 1. Ammunition terms—complete rounds.

b. A *round*, or *complete round*, of artillery ammunition comprises all of the components necessary to fire the weapon once. This includes the following: First, a *projectile*; second, a *propelling charge* to drive the projectile out of the weapon; third, a *primer* to initiate the burning of the propelling charge; and fourth, a *fuze* assembled to each projectile having high explosive or chemical content, to explode it at the time and under the conditions desired. For some projectiles, such as those of the solid type, fuzes are not required. Dependent on the manner in which these components are assembled for firing, complete rounds of artillery ammunition are known as *fixed*, *semifixed*, *separated*, and *separate-loading*. See figure 1 for these types of ammunition and for terms applied to their components.

c. In *fixed ammunition*, the propelling charge is fixed that is, not adjustable, and the complete round is loaded into the weapon as a unit. As usually designed, the propelling charge is assembled loosely in the cartridge case which is crimped rigidly to the projectile. The primer is fitted in the base of the cartridge case. The term *cartridge* has been used for complete rounds of fixed ammunition for the following weapons: 20-mm, 40-mm, and 57-mm guns; and 57-mm and 75-mm recoilless rifles.

d. *Semifixed ammunition* is characterized by an accessible propelling charge which may be adjusted for zone firing. Like fixed ammunition, it is loaded into the weapon as a unit. In this type of artillery ammunition, the cartridge case is a free fit over the projectile. The propelling charge is divided into sections, each containing propellant powder assembled in a bag. To adjust the charge, the projectile is removed from the cartridge case, the sections or increments not required are removed, and the projectile then is reassembled to the cartridge case. As in fixed ammunition, the primer is assembled in the base of the cartridge case. In certain rounds for the 105-mm howitzer, even though the charge is fixed, the cartridge case is a free fit over the projectile to facilitate packing for shipment. In the case of mortar ammunition which does not have a cartridge case, the increments of the propelling charge are accessible for adjustment when the round is removed from its packing.

e. *Separated ammunition* is characterized by the arrangement of the propelling charge and the projectile for loading into the gun—the propelling charge, contained in a primed cartridge case, sealed with a closing plug, and the projectile are loaded into the gun in one operation. Note that the mouth of the cartridge case does not fit over the base of the projectile as in fixed and semifixed ammunition, but that both propelling charge and projectile are

loaded into the gun in one operation, not separately as in separate-loading ammunition.

f. In separate-loading ammunition, the separate components—projectile, propelling charge, and primer—are loaded into the weapon separately, because the ammunition is too heavy and bulky to be handled as a unit. Ammunition larger than 105-mm caliber falls into this category. First, the projectile is inserted into the breech and rammed home so that the rotating band seats in the forcing cone; second, the propelling charge (usually in one or more cylindrical cloth bags) is placed in the powder chamber immediately to the rear of the projectile; and, third, after the breechblock has been closed and locked behind the charge, the primer is inserted into the firing mechanism of the breechblock.

5. Classification

Ammunition is classified according to use as service, practice, blank, or drill. It also may be classified according to type of filler as explosive, chemical, or inert.

a. SERVICE AMMUNITION. Service ammunition is fired for effect in combat. It also is fired for adjustment, registration, and service practice. Dependent upon type of projectile, it may be high-explosive (HE), high-explosive-antitank (HE, AT), armor-piercing (AP) or armor-piercing capped (APC) (with or without explosive filler), hypervelocity armor-piercing (HVAP), incendiary, chemical (gas or smoke), or illuminating. See paragraph 14 for description of these types of projectiles and figures 2 to 7, inclusive.

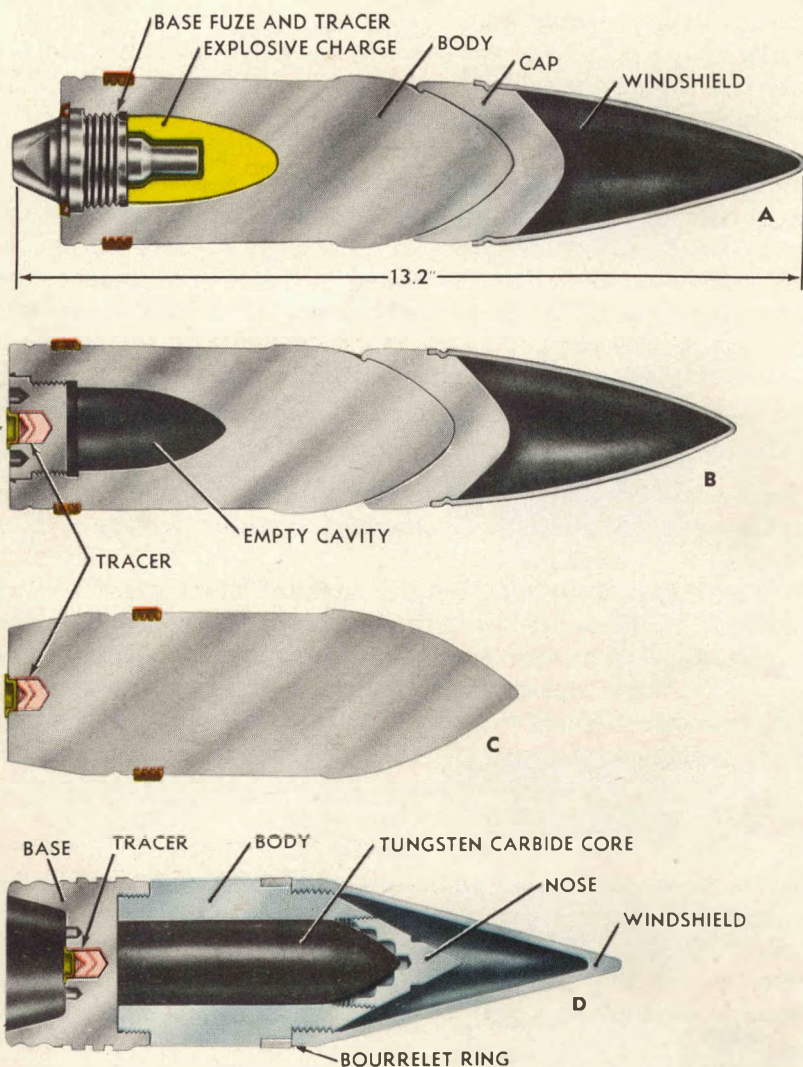
b. PRACTICE AMMUNITION. Practice ammunition is fired for effect in simulated combat and is provided for training in marksmanship. The projectile in this type of ammunition may have a small quantity of low-explosive filler to serve as a spotting charge, or the filler may be inert, or it may be an empty cast-iron projectile simulating a service projectile in ballistic properties. See paragraph 14c(7).

c. BLANK AMMUNITION. Blank ammunition is provided in small and medium calibers for such purposes as saluting and simulated fire. It has no projectile. See paragraph 15.

d. DRILL AMMUNITION. Drill or dummy ammunition is used for training in handling and loading ("service of the piece"), and similar purposes. It is completely inert. See paragraph 14c(8).

6. Nomenclature

Standard nomenclature is established in order that each item supplied may be identified specifically by name. It consists of the type, size, and model of each item; and its use for all purposes of



A-ARMOR-PIERCING-CAPPED PROJECTILE, WITH EXPLOSIVE FILLER

B-ARMOR-PIERCING-CAPPED PROJECTILE, EMPTY

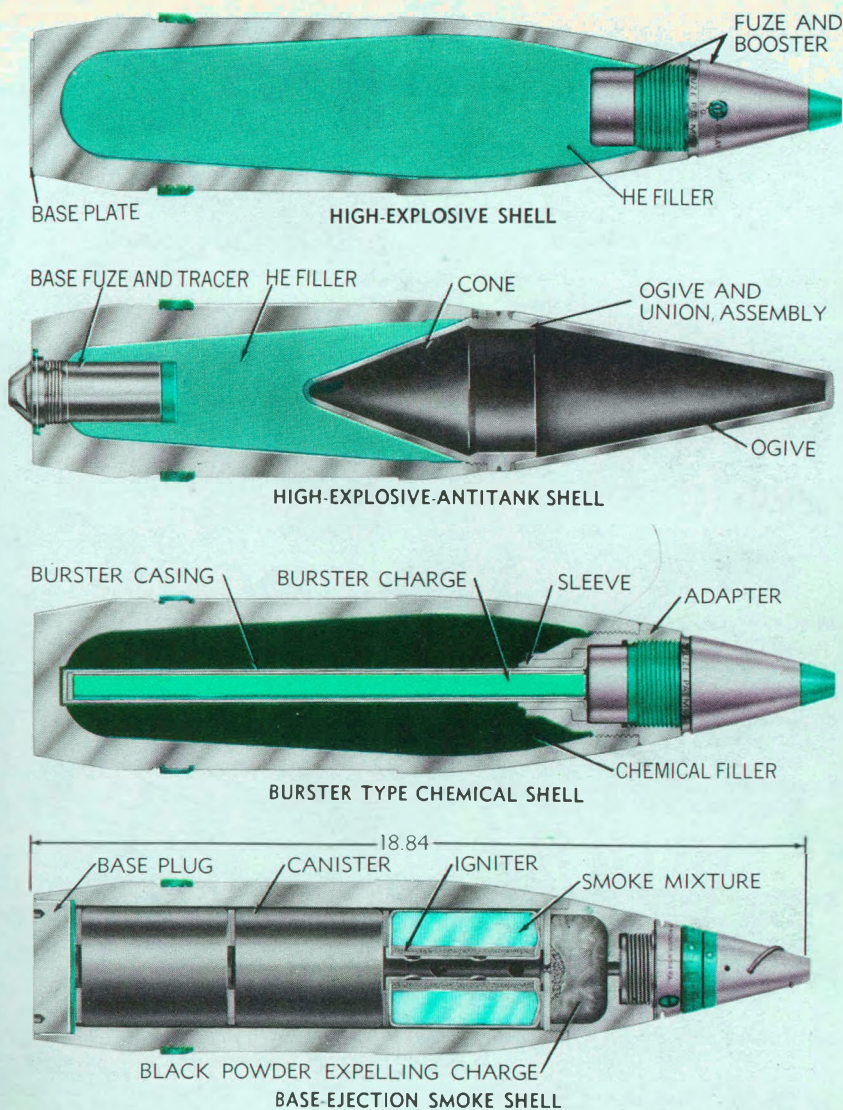
C-ARMOR-PIERCING SHOT

D-HYPERVELOCITY ARMOR-PIERCING SHOT

RA PD 97763B

Figure 2. Typical armor-piercing projectiles.

record is mandatory. This nomenclature is published in the Department of the Army Supply Catalog, groups P, R, S, and T, for use in connection with the shipping, storing, issue, and use of ammunition items.



RA PD 97762B

Figure 3. Typical high-explosive, high-explosive-antitank, and chemical projectiles.

7. Ammunition Identification Code Symbols

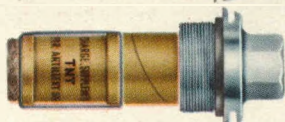
The Ammunition Identification Code (AIC) symbol has been established to facilitate the supply of ammunition in the field. Code symbols assigned to each item of ammunition in a specific packing are to be used in messages, requisitions, and records.

COMPONENTS ISSUED WITH DEEP-CAVITY FIXED AND SEMIFIXED SHELL

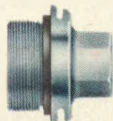
A — SUPPLEMENTARY CHARGE & PD OR TSQ FUZE, W/BOOSTER



B — SUPPLEMENTARY CHARGE, SPACER & PLUG

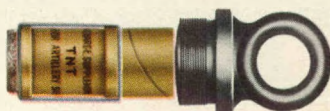


C — PLUG, ONLY

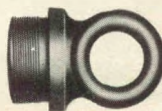


COMPONENTS ISSUED WITH DEEP-CAVITY SEPARATE-LOADING SHELL

A — SUPPLEMENTARY CHARGE, SPACER & PLUG

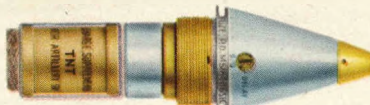


B — PLUG ONLY

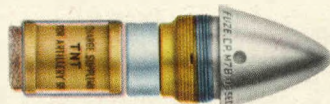


COMPONENT ASSEMBLIES FOR SERVICE USE WITH DEEP-CAVITY SHELL

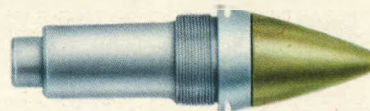
A — SUPPLEMENTARY CHARGE & PD OR TSQ FUZE, W/BOOSTER



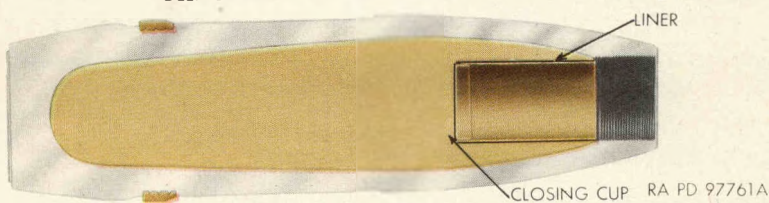
B — SUPPLEMENTARY CHARGE & CP FUZE, W/BOOSTER



C — VT FUZE, ONLY



DEEP-CAVITY HE SHELL



Typical deep-cavity high-explosive projectiles and components.

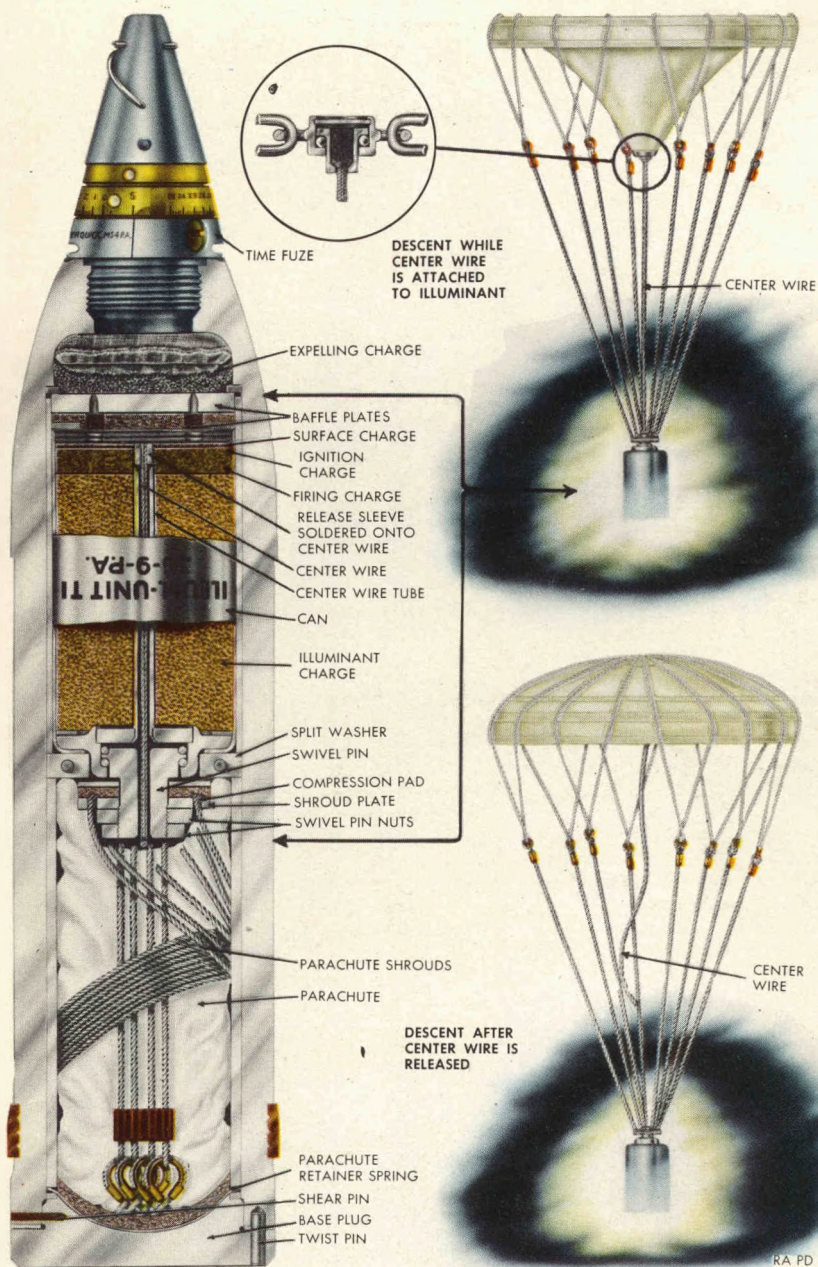
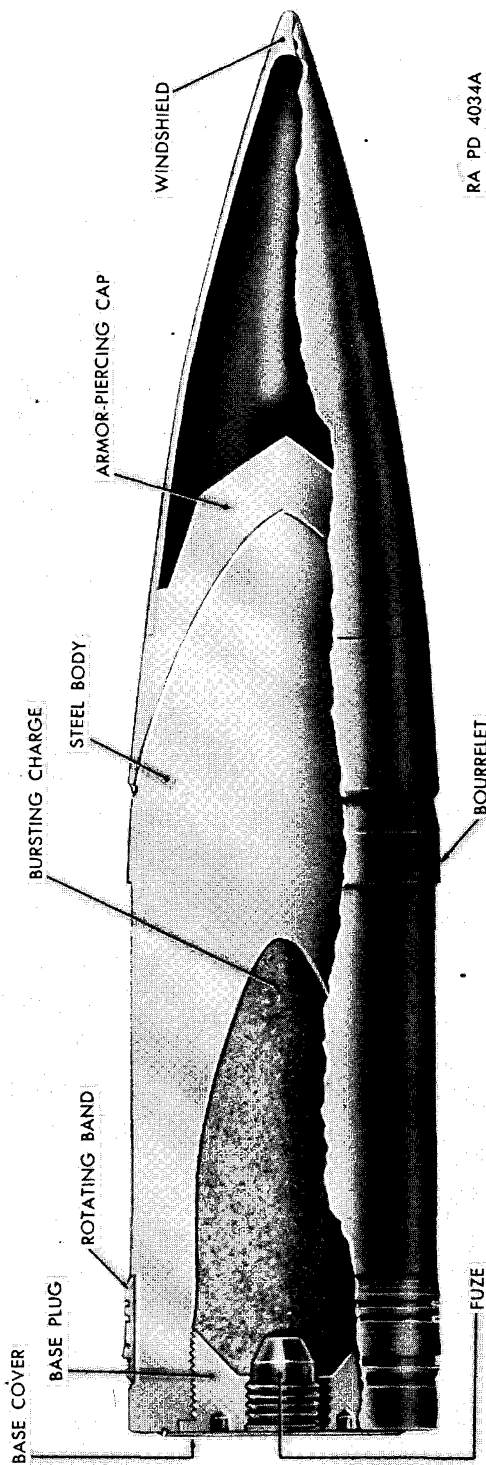
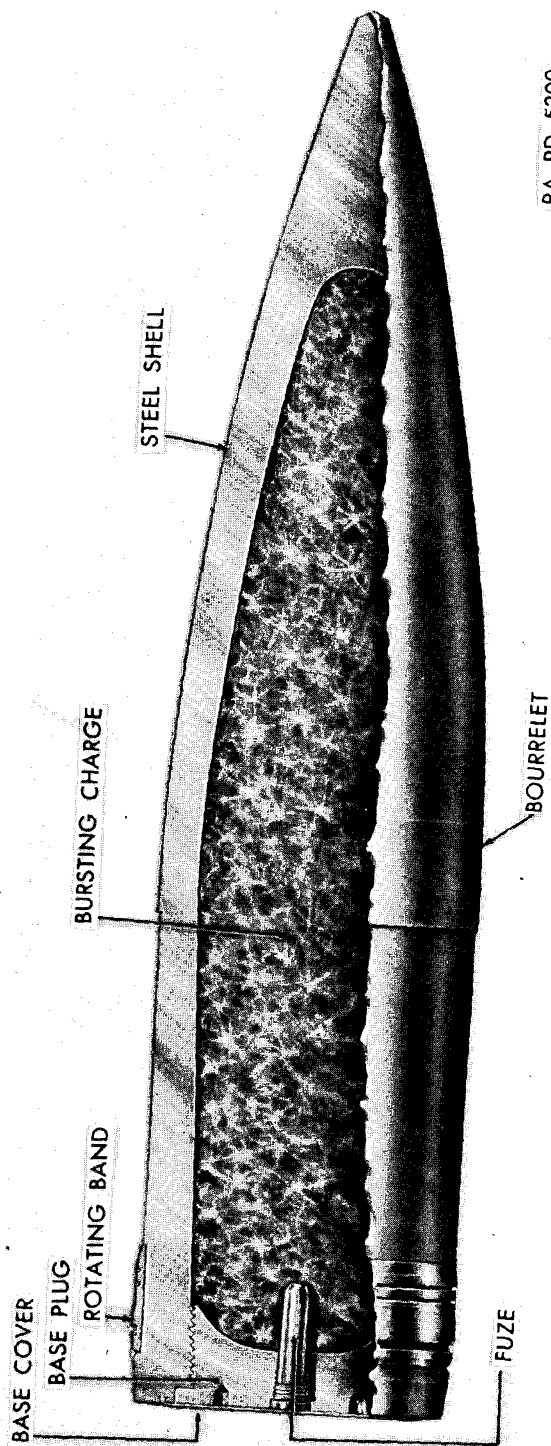


Figure 5. Typical illuminating projectiles.



RA PD 4034A

Figure 6. Typical large caliber armor-piercing projectile.



RA PD 5300

Figure 7. Typical large caliber high-explosive projectile.

These code symbols are published in ORD 11 SNL's of groups P, R, S, and T. For further information, see SB 9-AMM 5.

8. Grades of Ammunition

a. Each lot of ammunition other than small-arms ammunition is graded as a result of surveillance tests into one of four grades dependent upon serviceability (SB 9-AMM 1).

b. A system of grading also has been established for aircraft artillery ammunition. However, to the present time, this system has not been put into effect. The purpose of this system of grading is to provide for higher performance by aircraft ammunition than is required of ammunition acceptable for use in ground guns. These grades are applicable to ammunition for use in 20-mm guns, 37-mm guns AN-M9 and M10, and 75-mm guns AN-M5A1 and M10. The grades are as follows:

Grade AIR—for use in any situation.

Grade NA —for use in any situation except air combat
(primarily for training).

c. Steel case rounds or resized case rounds will not be used in aircraft weapons.

9. Explosives in Ammunition

a. GENERAL. In order to deliver the projectile at the target and to cause it to function properly on arrival, it is necessary to employ different kinds of explosives, each of which has a specific part to play in the functioning of the round of ammunition. The characteristics of various types of explosives are given in TM 9-1900 and in TM 9-2900.

b. EXPLOSIVE TRAIN. The arrangement of a series of explosives beginning with a small amount of sensitive explosive and ending with a large amount of comparatively insensitive explosive, is termed an explosive train. In general, there are two such trains: the propelling charge explosive train and the bursting charge explosive train. These two trains are illustrated in figure 8 for a complete round of fixed artillery ammunition.

c. CLASSIFICATION. For military purposes, explosives are divided into two basic groups: *propellants* (or low explosives) and *high explosives*. One of the chief differences between these two groups is in the nature of the characteristic reactions. The propellant is considered to react by burning, the rate of which depends upon such factors as pressure, grain form, grain size, composition, etc. The high explosive, on the other hand, is used

for its detonating properties which are visualized as resulting from a detonation wave traveling through the high-explosive charge at an extremely high velocity (22,000 to 27,500 fps). The velocity of detonation of a particular high explosive is directly proportional to its density. The low limit of velocity of detonation is considered to be approximately 13,000 fps.

(1) *Propellants.*

- (a) Propellants are used to propel the projectile out of the weapon at a prescribed velocity. Those currently used have a nitrocellulose base and are commonly known as smokeless powders. These powders are distinguished by such terms as *single base*, those which contain nitrocellulose (NC) but no nitroglycerin, and *double base*, those which contain both nitrocellulose and nitroglycerin. They may produce a flash or be flashless, depending upon the composition of powder and the conditions of use. They are assigned model numbers, for example, M1, which is not to be confused with the M numbers assigned to propelling charges. Black powder (or gunpowder) has been superseded almost completely as a propellant by smokeless powder. The usual form of smokeless powder in artillery ammunition is a cylindrical grain with one or more perforations (sec. II, ch. 3).
 - (b) Rounds of certain caliber, such as 76-mm and 90-mm, are designated as "flashless," "smokeless," or "flashless-smokeless," dependent upon flash and smoke characteristics upon firing. These designations are marked on the ammunition and on their packing containers.
 - (c) Whether ammunition upon firing is flashless, smokeless, or both, depends upon the weapons in which used, the type of ignition used, weapon wear, the temperature of the tube of the weapon, and the quantity and design of the propellant powder. "Flashless" and "smokeless" are relative terms and have been defined as follows: Flashless ammunition does not flash more than 5 percent of the time in weapons having average wear under average conditions; smokeless ammunition produces less than half the amount of smoke produced by ammunition not so designated. A complete round having both these characteristics is designated "flashless-smokeless."
- (2) *High explosives.* High explosives, because of their extremely rapid rate of detonation, have a powerful disruptive action. The action, or shattering power, is

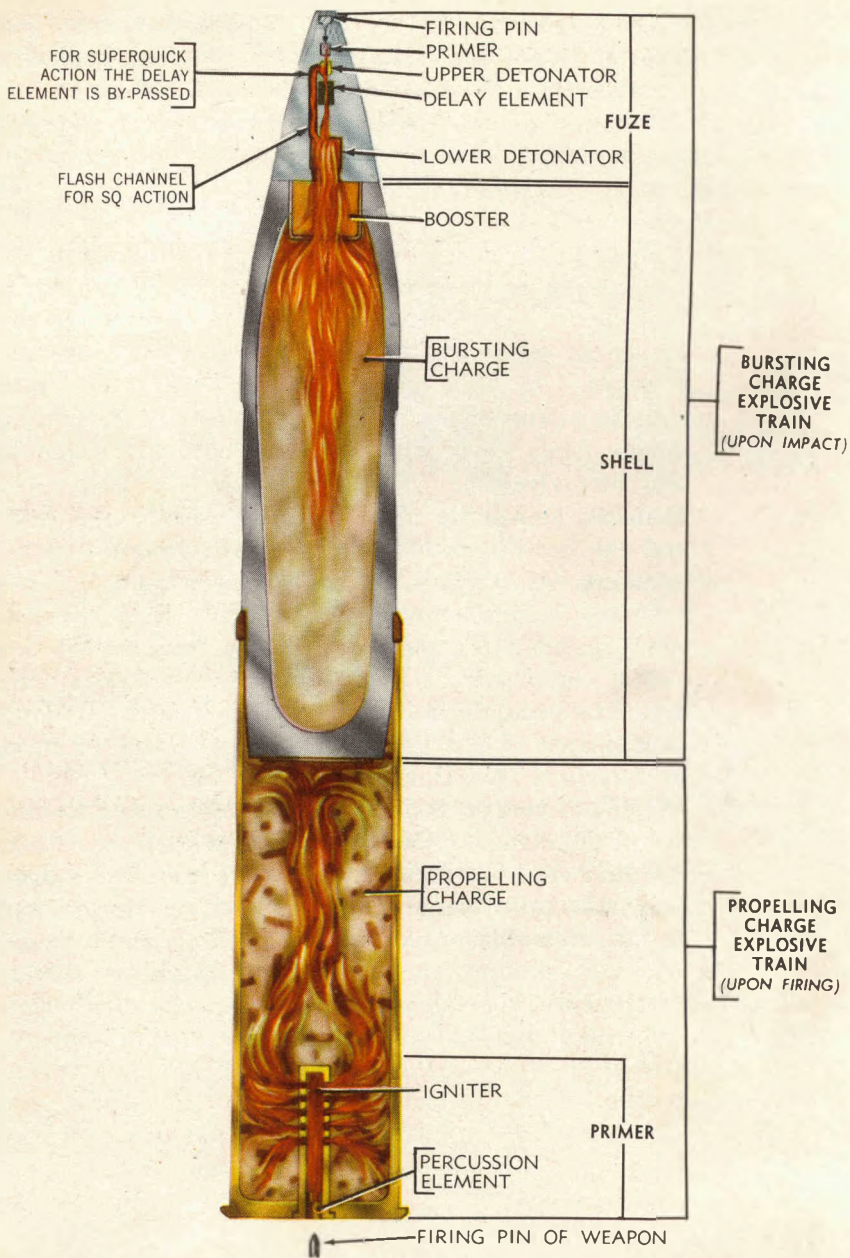


Figure 8. Explosive trains—artillery ammunition.

known as "brisance" and varies for different explosives. The high explosives more sensitive to impact are used as initiators in primers or detonators, whereas the high explosives less sensitive to impact are used as bursting

charges in shell. The explosives most commonly used for bursting charges in shell include TNT, explosive D, composition A, composition B, pentolite, and tetryl. Tetryl has more brisance than TNT but also is more sensitive; hence, it is used only as a bursting charge for small projectiles of 20-mm, 37-mm, and 40-mm caliber and as a booster in other calibers to initiate the detonation of TNT or explosive D. Pentolite is the standard filler for HE, AT ammunition. Explosive D is the high explosive least sensitive to impact and therefore is used as the bursting charge in armor-piercing projectiles where severe impact is expected.

10. Chemical Fillers

Some shell contain a chemical agent. A chemical agent is a substance which, by its ordinary and direct chemical action and in concentrations attainable in the field, produces a toxic or an irritating (harassing) physiological effect, a screening smoke, an incendiary action, or any combination of these. The most common gas used as a chemical filler is mustard gas, a casualty gas denoted by the symbol "H." This is a persistent gas; that is, it remains effective at the point of release for more than 10 minutes. The most commonly used smoke filler is white phosphorus (WP) which, in addition to producing a dense white smoke, also has an incendiary action. Phosphorus is a solid which melts at 110° F. A substitute for phosphorus is FS smoke. This is a sulfur trioxide chlorsulfonic acid mixture; no mask is required for the FS smoke, the smoke being harmless except in very heavy concentrations. In some base-ejection smoke shell, HC smoke is used. This is a hexachlorethane-zinc mixture for which no protection of personnel or matériel is required. The chemical filler, CNS, is a nonpersistent, irritant, harassing gas consisting of a solution of chloracetophenone (CN), and chlorpicrin (PS), in chloroform. Further information on chemical filler will be found in FM 3-5, TM 3-215, and TM 9-1900.

11. Identification

a. GENERAL. Ammunition is identified completely, except as to grade, by painting and marking (which includes the ammunition lot number) on original packing containers. Once removed from its packing, ammunition may be identified by painting and marking on ammunition items. The muzzle velocity of projectiles may be obtained from the firing tables and ammunition data cards; in

case of some rounds of smaller caliber, the muzzle velocity also appears on the packing box.

b. MARK OR MODEL. To identify a particular design, a model designation is assigned at the time the model is classified as an adopted type. This model designation becomes an essential part of the nomenclature and is included in the marking of the item. Prior to World War I, the year in which the design was adopted (preceded by an M) was used as the model designation; for example, M1914. From World War I to 1 July 1925, it was the practice to assign mark numbers; that is, the word "mark," abbreviated "Mk," followed by a Roman numeral. The modification was indicated by the addition of MI to the mark number, the second by MII, etc. However, the use of Roman numerals has been discontinued and all future reference and records will be in Arabic numerals. The present system of model designation consists of the letter "M" followed by an Arabic numeral, for example, "M1." Modifications are indicated by adding the letter "A" and the appropriate Arabic numeral. Thus, "M1A1" indicates the first modification of an item for which the original model designation was "M1." Wherever a "B" suffix appears in a model designation, it indicates an item of alternative (or substitute) design, material, or manufacture.

c. AMMUNITION LOT NUMBER. When ammunition is manufactured, an ammunition lot number is assigned in accordance with pertinent specifications. As an essential part of the marking, this lot number is stamped or marked on the item, size permitting, as well as on all packing containers. It is required for all purposes of record, including reports on condition, functioning, and accidents, in which the ammunition is involved. To provide for the most uniform functioning, all of the components in any one lot are manufactured under as nearly identical conditions as practicable. Complete rounds of any one lot are similarly manufactured and consist of components, each type of which is of one lot. For example, in the case of fixed and semifixed ammunition, all of the rounds in any one ammunition lot consist of projectiles of one lot number (one type and weight zone), fuzes of one lot number, propellant powder of one lot number, and primers of one lot number. Hence, insofar as the ammunition is concerned, to obtain the greatest accuracy when firing fixed or semifixed ammunition, successive rounds should be of the same lot number; when firing separate loading-ammunition, successive rounds should consist of projectiles of one lot number, propelling charges of one lot number, fuzes of one lot number, and primers of one lot number.

d. PAINTING AND MARKING.

(1) *Painting.* Ammunition is painted primarily to prevent

rust. Secondary purposes are to provide, by the color, a ready means of identification and, by the use of lusterless paint, for camouflage. The color scheme is as follows (fig. 9) :¹

High-explosive-----Olive-drab; marking in yellow.

Armor-piercing

containing high

explosive-----Olive-drab; marking in yellow.

Armor-piercing

without explo-

sive-----Black; marking in white.

Chemical-----Grey; one green band indicates nonpersistent toxic gas; two green bands indicate persistent toxic gas; one red band indicates irritant harassing gas; and one yellow band indicates smoke. Marking on the ammunition is in the same color as the band.

Illuminating shell---Grey; one white band and marking in white. Older shell of Navy procurements have two white stars in lieu of white band on slate colored shell.

Practice-----Blue; marking in white.²

Dummy or drill

(inert)-----Black; marking in white.³

(2) *Marking.* The components of artillery rounds are marked as follows (figs. 10 to 14, inclusive) :^{4, 5}

(a) *Projectiles.*

1. *Stenciled on the body.*

Ammunition Identification Code (AIC) symbol on separate-loading shell.

Caliber and type of cannon in which fired ("75 H," etc).

Kind of filler ("TNT," "WP SMOKE," "H GAS," etc).

¹ An exception to the basic color scheme is the case of 20-mm projectiles. The high-explosive-incendiary projectile has a red body and a yellow ogive.

² There are on hand some target practice projectiles of larger caliber which have been painted black. It is contemplated that, when replacement or repainting is required, they will be painted blue in agreement with the basic color scheme.

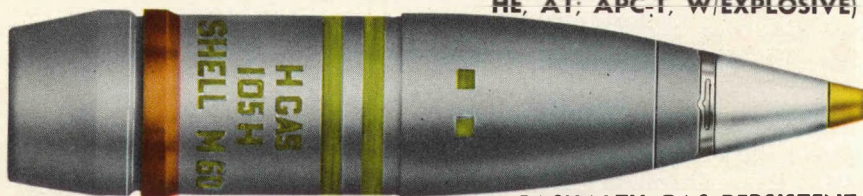
³ Nonferrous metal parts or assemblies (such as of brass or bronze) are not painted.

⁴ In addition to the identification listed, chemical shell also are marked with color bands indicating the type of filler ((1) above).

⁵ Navy projectiles are marked in accordance with Navy practice.



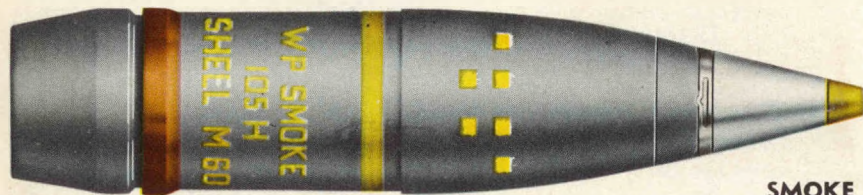
HIGH EXPLOSIVE (HE;
HE, AT; APC-T, W/EXPLOSIVE)



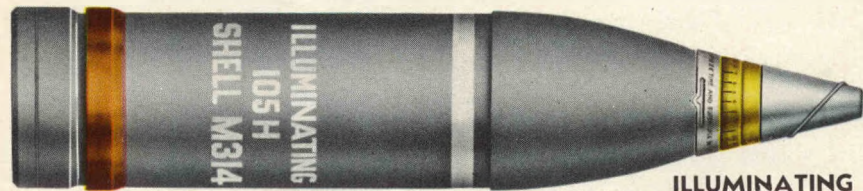
CASUALTY GAS PERSISTENT



HARASSING GAS



SMOKE



ILLUMINATING



PRACTICE



INERT (HVAP-T; DUMMY;
AP-T; APC-T, W/O EXPLOSIVE)

RA PD 97767B

Figure 9. Color identification of artillery projectiles.

Type and model of projectile with "T" to indicate presence of a tracer ("SHELL M60," "PROJ. APC-T M61A1," etc).

"W/SUPPL CHG" when projectile has a deep cavity and contains a supplementary bursting charge.

"FOR VT FUZE," "FOR FUZE M92 (T74E6)," or "FOR FUZE M97 (T80E6)," as applicable when projectile has a deep cavity for receiving a VT fuze and does not contain a supplementary charge.

"W/SPOTTING CHG" when a spotting charge is present. The letter "S" stenciled just above the bourrelet on large caliber shell indicates the presence of a smoke producer mixed with the high explosive to facilitate observation of fire.

Lot number of loaded projectile. For fixed and semi-fixed rounds, the lot number is stenciled below the rotating band, in which position it is covered by the neck of the cartridge case.⁶

Ammunition lot number, in the case of 20-mm, 37-mm, and 40-mm projectiles only.

Weight zone (crosses or squares) or weight to nearest pound of loaded projectile, for 75-mm and larger caliber. Exceptions are armor-piercing projectiles which are components of fixed rounds, and base-ejection smoke shell.

2. *Stamped on or forward of the rotating band.*

Lot number of empty shell.

Manufacturer's initials or symbol.

Caliber and model of shell.

Year of manufacture.

(b) *Cartridge case.*

1. *Stenciled on the base.*

Ammunition lot number and loader's initials. For 20-mm, 37-mm, and 40-mm rounds, this ammunition lot number appears on the projectile instead of the base of the cartridge case.

Type and model of shell.

For 75-mm and 76-mm gun rounds: "NORMAL" below one diametral stripe, indicating normal propelling charge; "REDUCED" and two diametral stripes at right angles, indicating reduced charge; "SUPER," indicating supercharge.

For 76-mm, and 90-mm rounds: FLASHLESS (or

⁶ In older types and lots, the lot number of loaded projectile may not be below the rotating band.

FLHLS), SMOKELESS (or SMKLS), or FLASHLESS-SMOKELESS (or FLHLS-SMKLS).

2. *Stenciled on the side of the cartridge case.*

For 75-mm and 76-mm gun rounds: "Normal" below one stripe, indicating normal propelling charge; "REDUCED" between two stripes, indicating reduced charge; "SUPER," indicating supercharge.

For 37-mm gun, M9, APC M59, round: "37 G, M9, MV 2,800," to distinguish this from the similar round for the M1A2 gun.

For HVAP-T rounds: In red, "HYPERVELOCITY MV ."

3. *Stamped in the metal on the base.*

Caliber and model of cartridge case. "B1" after the model designation indicates a steel case.

Lot number of cartridge case. An "X" appearing after the lot number indicates a steel case.

Manufacturer's initials and year of manufacture.

(c) *Propelling charges (sec. II, ch. 3):*¹

1. *Stenciled on each charge or section thereof.*

Designation of section; for example, "1/8 CHG," "BASE," "INCR" or "INCREMENT," "CHARGE 2," etc.

Model of charge; for example, "CHARGE M1A1."

Caliber and models of cannon for which adapted.

Weight of charge or section.

Weight or weights of projectiles with which charge may be used.

Powder lot (includes type of powder, the word "LOT," initials of manufacturer, serial number of lot, and year of manufacture).

Zone number of each section on the top end.

2. *Stenciled on igniter.*

Weight, grade, and kind of igniter powder.

"IGNITER."

Caliber and models of cannon in which fired.

Month and year of loading.

¹ To distinguish green bag charges from white bag charges, the cartridge bag cloth for the green bag charges is dyed green; that for white bag charges is white. The cloth used for igniters is dyed a bright red; this is to show clearly the location of the igniter and to indicate the presence of black powder (low explosive). Igniters of older manufacture will be found in service made from uncolored cloth. In this case, the stenciling and the quilting which holds the black powder in place will serve to locate the end of the propelling charge which contains the igniter.



Figure 10. Typical marking of fixed ammunition.



Figure 11. Marking on fired ammunition to indicate reduced, normal, and supercharges.



- A · CALIBER AND DESIGNATION OF WEAPON.
- B · TYPE AND MODEL OF SHOT.
- C · MUZZLE VELOCITY.
- D · AMMUNITION LOT NUMBER.
- E · CALIBER AND MODEL OF CASE.
- F · LOT NUMBER OF CASE.
- G · YEAR OF MANUFACTURE.
- H · TYPE AND MODEL OF SHOT.
- I · PERFORMANCE OF ROUND UPON FIRING.



RA PD 97759A

Figure 12. Typical marking of HVAP-T rounds.

(d) *Fuzes (stamped on the body).*

Type and model of fuze.

Manufacturer's initials.

Lot number of fuze and year of manufacture.

Action of fuze; for example, "DELAY" and length of delay in seconds, "SQ" (superquick), or time in seconds on a graduated time ring.

(e) *Primers (stamped on the base).*

Loader's initials, lot number, and year of loading.

Model designation.

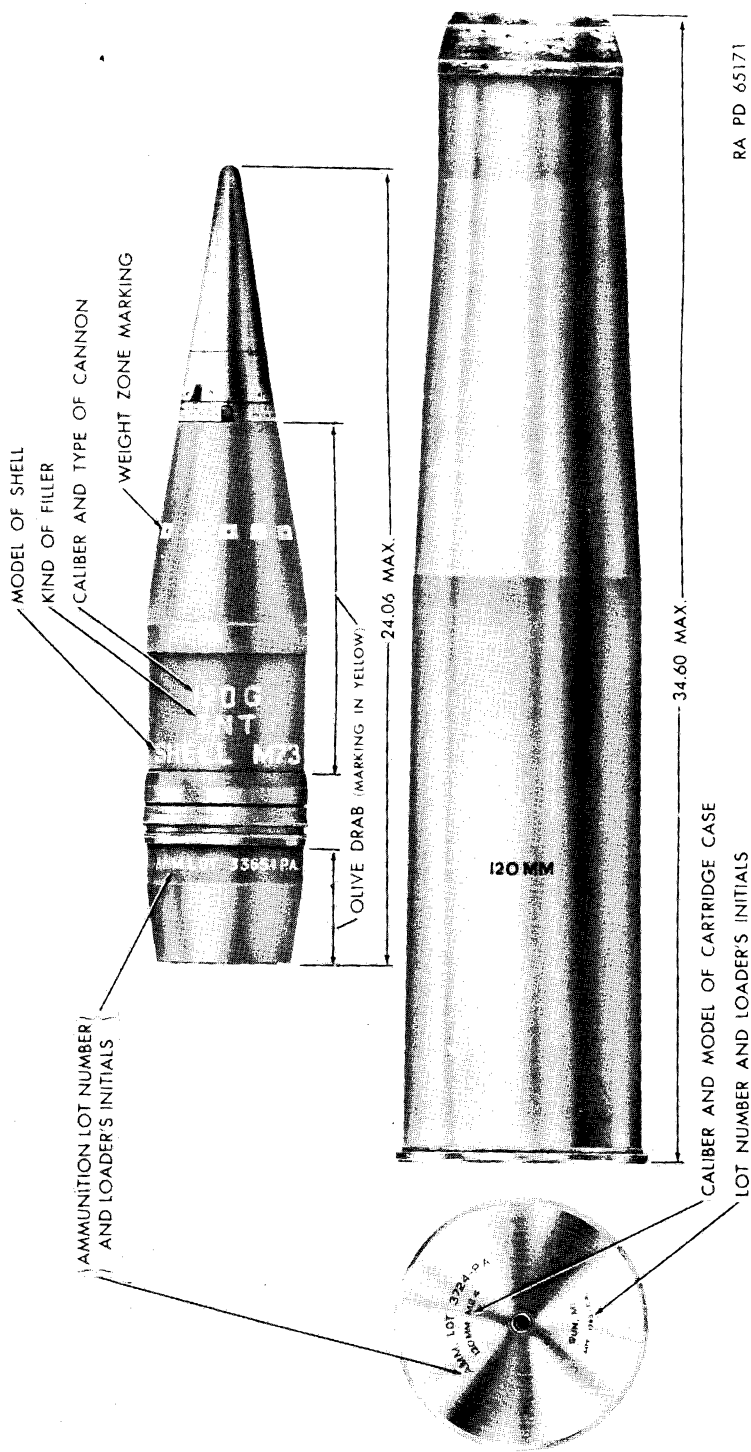
(3) *Weight or weight-zone markings.*

- (a) Variations in weight are inherent in the manufacture of shell containing explosives or chemical agents. Hence, where a high degree of accuracy is required for artillery firing, the projectiles are marked to indicate the weight; data are provided in firing tables in order that proper ballistic corrections may be made. For some caliber and types of separate loading projectiles, the weights are stenciled on the projectile to the nearest pound; for others, the projectiles are grouped within weight limits and the corresponding weight zones stenciled on the projectiles. Fixed and semifixed shell are grouped similarly in weight zones. For 75-mm projectiles, the weight zones are indicated by one, two, three, or more crosses marked on the projectile in the same color as the other marking. Weight zones lighter than one cross are indicated by one "L" or more, as required. For 76-mm projectiles and larger, squares are used rather than crosses. The weight zone markings for "standard" or "normal" weight projectiles are as follows (no ballistic corrections are required for projectiles of these weight zones):

Caliber of projectile "Standard" or "normal" weight zone

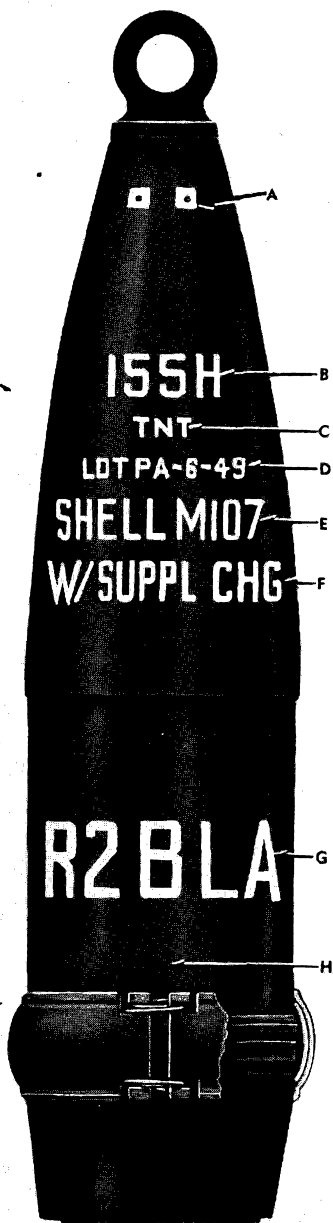
75-mm	-----	2 crosses
76-mm	-----	1 square
90-mm, 105-mm, 4.2-in	-----	2 squares
120-mm, 155-mm, 8-in how, 240-mm how	-----	4 squares
8-in gun	-----	None (weight to nearest pound used)

- (b) Small-caliber (under 75-mm) projectiles, 60-mm and 81-mm mortar rounds, high-explosive-antitank rounds, armor-piercing less than 105-mm caliber, and base-ejection smoke projectiles do not require weight-zone markings. Armor-piercing projectiles, 8-inch caliber and above, have weights to the nearest pound.



RA PD 65171

Figure 13. Typical marking of separated ammunition.

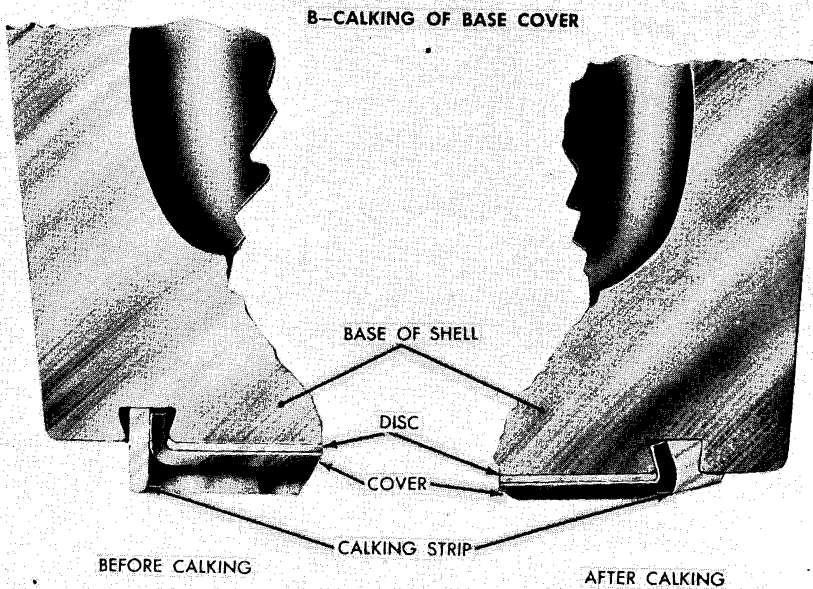
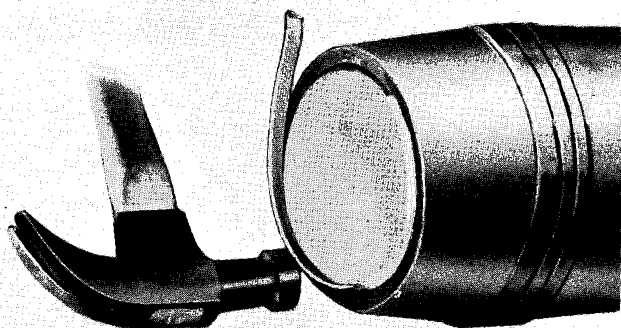
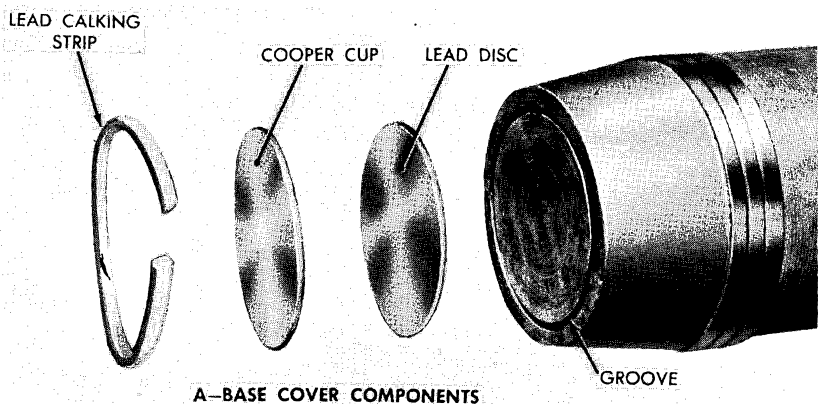


- A** - WEIGHT ZONE MARKING
- B** - CALIBER AND TYPE OF WEAPON
- C** - KIND OF FILLER
- D** - LOT NUMBER OF LOADED SHELL
- E** - TYPE AND MODEL OF SHELL
- F** - FOR DEEP-CAVITY SHELL
CONTAINING SUPPLEMENTARY
CHARGE.
FOR DEEP-CAVITY SHELL W/O
SUPPLEMENTARY CHARGE,
"FOR VT FUZE" OR
"FOR FUZE, M ____."
- G** - AMMUNITION IDENTIFICATION
CODE (AIC)
- H** - STAMPED IN THE METAL
UNDER THE PAINT:
LOT NUMBER OF EMPTY SHELL,
YEAR OF MANUFACTURE, CALIBER
AND DESIGNATION OF SHELL.

RA PD 97757B

Figure 14. Typical marking of separate-loading projectiles, 155-mm through 240-mm.

- (4) *Identification of dummy or drill ammunition.* Dummy or drill ammunition is identified by the marking stenciled or stamped on the item. Some drill rounds are made up of metal parts of components of service ammunition. In



RA PD 104854

Figure 15. Calked type of base cover for shell with explosive filler.

such cases, holes are drilled in any part which, as a component of service ammunition, contains an explosive, in order positively to identify that part as being inert. Thus, for fixed and semifixed rounds made up of such parts, holes appear in the projectile, in the fuze and booster if present, in the cartridge case, and through the base of the primer.

12. Care, Handling, and Preservation

a. Ammunition is packed to withstand conditions ordinarily encountered in the field, moisture-resistant containers and suitable packing boxes or crates being used to provide the desired protection for shipment and storage. Care must be observed to keep packing boxes from becoming broken or damaged. All broken boxes must be repaired immediately and careful attention given to the transfer of all markings to the new parts of the box. When the packing box contains a metal liner, the liner should be air-tested and sealed, provided equipment for this work is available. This air-testing also is applicable to cartridge storage cases for propelling charges.

b. Since explosives are affected adversely by moisture and high temperature, due consideration should be given to the following:

- (1) Do not break the moisture-resistant seal until ammunition is to be used. Ammunition removed from the airtight container, particularly in damp climates, is apt to corrode, thereby causing the ammunition to become unserviceable.
- (2) Protect the ammunition, particularly fuzes and propelling charges, from sources of high temperatures, including the direct rays of the sun. More uniform firing is obtained if the rounds are at the same temperature.

c. Ammunition and ammunition components should be protected from mud, sand, dirt, and water. Wet or dirty ammunition should be wiped off at once, and any verdigris or light corrosion removed. Ammunition should not be polished, however, to make it look better or brighter.

d. *Explosive ammunition, or components containing explosives, MUST be handled with appropriate care at all times. The explosive elements in primers and fuzes are particularly sensitive to shock and high temperature. The adoption of high explosives such as composition B, pentolite, and tetrytol, makes it even more necessary to follow the precautions prescribed for handling ammunition as stated herein and in TM 9-1900.*

e. Ammunition, or components of ammunition, prepared for

firing but not fired will be returned to their original condition and packings, and appropriately marked. Such ammunition will be used first in subsequent firings in order that stocks of opened packings may be kept at a minimum.

f. Do not attempt to disassemble any fuze into its components. Any alteration of loaded ammunition except by the technical service concerned and under the supervision of a commissioned officer of that service is hazardous and therefore is prohibited (par. 2e., SR 385-310-1).

g. Do not remove protection or safety devices from fuzes until just before use.

h. Cartridge cases are dented easily and should be protected from hard knocks and blows. A dented cartridge case may result in loss of obturation, jamming in the chamber, and difficulties in extraction.

i. Do not remove the eyebolt-lifting plug from unfuzed projectiles until the fuze is to be assembled thereto. The plug is provided to keep the fuze opening free of foreign matter as well as for convenience in handling. When separate-loading projectiles are stored in the field, frequent inspection of the plugs must be made for evidence of corrosion. At the first sign of corrosion, the threads must be coated with a *thin* film of light, rust-preventive compound, to prevent the plug from sticking or "freezing" in the projectile.

Caution: This lubrication must be done very sparingly.

j. Blank ammunition with loose or broken closing cup will not be used or fired but will be reported to the ordnance officer for disposition.

k. Do not handle duds. Because their fuzes are armed, and hence extremely dangerous, duds will not be moved or turned, but will be destroyed in place in accordance with TM 9-1900.

l. Flarebacks have occurred in 90-mm gun M3 when firing SMOKELESS ammunition (HE M71 and smoke M313 rounds having a propelling charge of M6 propellant powder *without* potassium sulfate).

(1) *General.*

- (a) Flarebacks may occur also when firing SMOKELESS ammunition in the 90-mm gun M3A1 (fitted with a bore evacuator). However, should a flareback occur in this gun, the objectionable effects will be offset largely if not entirely by the action of the bore evacuator which will cause the flame to be drawn back into the chamber as the combustion gases are expelled at the muzzle.

- (b) Flarebacks have not been reported when firing FLASHLESS ammunition in either the M3 or M3A1 guns. This ammunition has a propelling charge of M6 propellant powder *with* potassium sulfate.
 - (c) The M6 propellant powder *without* potassium sulfate was developed to meet requirements for a propellant which would produce minimum smoke, thereby providing for best observation in direct fire as well as concealment during daylight firing. This type of powder is used for the propelling charge of 90-mm high-explosive and smoke ammunition fitted with ground impact fuzes and intended primarily for daylight firing. Such ammunition is identified by "SMOKELESS" stenciled on the cartridge case. M6 propellant powder *with* potassium sulfate was developed to meet requirements for minimum flash thereby providing for optimum concealment during night firing. This powder is used for the propelling charge of other types of 90-mm ammunition intended primarily for night firing. Such ammunition is identified by "FLASHLESS" stenciled on the cartridge case. A more recently developed propellant powder, which is both smokeless and flashless, will be used, when available, for the propellant charge for the above SMOKELESS ammunition. Such rounds will be marked "FLASHLESS-SMOKELESS."
- (2) *Causes of flarebacks.*
- (a) When a cannon is fired, some of the combustible in the propelling charge burns incompletely to form inflammable gases which, as they escape from the muzzle and mix with air, burn to produce a muzzle flash. Although most of such gases escape from the muzzle before the breech is opened, it sometimes happens that, if the breech is opened immediately after firing, inflammable gases remaining in the bore may ignite upon mixing with air and flash to the rear. This is called a flareback.
 - (b) Although many factors contribute to the occurrence of flarebacks, in general, the greater the power of the gun, the greater the volume and the higher the temperature of the combustion gases; hence, the greater the possibility of a flareback. This is offset in part by the addition of a flash reducer, such as potassium sulfate, which tends to lower the temperature of the gases but also tends to increase the smoke. Other factors,

such as a high rate of fire or a head wind, also tend to increase the occurrence of flarebacks.

(3) *Precautions.* Because flarebacks, in general, are unpredictable but do occur occasionally, it is essential that—

(a) Personnel keep clear of the path of a possible flareback as they do from the path of recoil.

(b) Ammunition and other inflammable material be kept beyond the point of accidental ignition should a flareback occur.

m. VT fuzes of certain lots, as issued, have a wax coating on the plastic ogive. This wax coating, applied at the time of manufacture, is necessary for the proper functioning of the fuzes of such lots. Removal of this coating usually will result in malfunctioning of the fuze. VT fuzes should be used as issued; that is, with the wax coating on the plastic ogive, if so issued, or without a wax coating, if issued without the coating.

n. Precautions in handling, including procedures to be taken in case of misfires, will be found in TM 9-1900 and in the various technical manuals and field manuals on the weapon.

13. Storage Precautions

a. When necessary to leave ammunition in the open, raise it on dunnage at least 6 inches from the ground and cover it with a double thickness of paulin. Wherever possible, dunnage should be used between each row to permit full air circulation. Suitable trenches should be dug to prevent water from flowing under the pile. Paulin should be arranged to permit free circulation of air through the pile. The paulin should be kept at least 6 inches from the pile on top, ends, and sides.

b. Separate detonating fuzes may be stored and transported separate from other explosive ammunition.

c. Primer boxes and containers should be stored with the top side up. Labels or marking on boxes and containers may indicate which side should be up.

d. Shell containing phosphorus, or rounds having phosphorus-filled shell, preferably should be stored or transported on their bases. Should such ammunition be stored or transported on their sides and the temperature reach the neighborhood of 100° F., the melting point of phosphorus, this filler may flow to one side of the shell and thereby cause erratic ballistics.

e. Fires involving fuzed ammunition generally can be fought for approximate the first 10 minutes of the fire. This may allow sufficient time in which to bring the fire under control.

f. In addition to general precautions with regard to protection

against heat and moisture, further efforts should be made when practicable to protect ammunition against heat and moisture when stored in hot, humid weather and against low temperatures and moisture stored under extremely cold conditions, remembering that accuracy of fire and safety conditions are best when ammunition is kept clean, dry, and at moderate and uniform temperatures. For further storage precautions, see TM 9-1900 and the Ordnance Safety Manual (OO Form 7224).

14. Discussion of Projectiles

a. GENERAL. An artillery projectile may be either solid or hollow. When hollow, the projectile may be empty, or it may be filled partly or completely with explosive. It is fitted with a fuze for the purpose of detonating the explosive. Service types of projectiles are mentioned in paragraph 5a. These types are described more fully in this paragraph. With the exception of base-ignition smoke shell and proof projectiles, artillery projectiles, although differing in characteristic details, are of the same general shape in that they have a cylindrical body and an ogival head. The projectiles vary in length from 2 to 11 calibers, that is, 2 to 11 times the diameter. Their principal characteristic differences are in—

- (1) Location of fuzes—point or base.
- (2) Radius of ogive—smaller for low-velocity, larger for high-velocity projectiles.
- (3) Rotating band—narrow for low-velocity, wide for high-velocity projectiles.
- (4) Base—tapering (“boat-tailed”) or cylindrical (“square” base).
- (5) Armor-piercing cap—only for certain armor-piercing projectiles.
- (6) Windshield, ballistic cap, or false ogive—when required for improved ballistics.

b. COMPONENTS OF PROJECTILES. Typical projectiles with principal parts named are shown in figures 2 to 7. These parts are described briefly in (1)–(12) below. Additional information will be found in TM 9-1900.

- (1) *Location of fuzes.* High-explosive shell generally require point detonating fuzes, concrete piercing fuzes, time fuzes, or VT fuzes located in the nose of the shell. The high-explosive shell shipped unfuzed are fitted with eyebolt-lifting plugs (sec. V, ch. 3) to protect the fuze hole threads and to provide for ease in handling. Armor-piercing projectiles with explosive filler and certain HE,

AT ammunition require base detonating fuzes with delay action.

- (2) *Ogive*. The curved portion of the projectile from the point to the bourrelet is called the ogive. The curve of the ogive usually is the arc of a circle whose center is located in a line perpendicular to the axis of the projectile and whose radius generally is 6 to 11 calibers in length for modern projectiles. Compound radii are employed occasionally. Since armor-piercing projectiles have a short radius of ogive for purposes of better penetration, a ballistic cap, often called a *false ogive* or *wind-shield*, is placed over the armor-piercing head to increase the ability to overcome air resistance.
- (3) *Bourrelet*. The bourrelet is an accurately machined cylindrical surface, of diameter slightly larger than the body, which bears on the lands of the bore. It centers the projectile in the bore and guides it in its travel through the bore. Generally, it is at the forward end of the body but, in certain shell, it may extend from the ogive to the rotating band. Some projectiles of large caliber have a front and rear bourrelet. The bourrelet generally is about one-sixth caliber in width. The difference between the diameter of the bourrelet and that of the bore of the weapon is known as the *clearance* and varies in a new gun from 0.005 inch for small calibers to 0.02 inch for large calibers.
- (4) *Body*. The main portion of the projectile ordinarily is called the body. The term "body diameter," however, is used to designate that dimension of the cylindrical portion of the projectile between the bourrelet and the rotating band. The body diameter is smaller than the diameter of the bourrelet or the rotating band in order to prevent contact with the lands of the bore.
- (5) *Bursting charge*.
 - (a) The high explosives fill the entire cavity in the shell except for space into which the booster or the fuze fits. In the case of chemical shell, the bursting charge of tetryl or tetrytol is contained in a narrow cylindrical burster tube in a burster casing in the center of the shell. This burster for chemical shell ruptures the shell sufficiently to allow the chemical filler to escape without excess dispersion. The percentage of explosive in shell varies with the type of shell and the following figures generally are applicable:

<i>Type of shell</i>	<i>Percent of weight of high explosive (approx)</i>
HE shell, used in gun or howitzer..	7.5-18
HE shell, used in mortar:	
Light.....	12-18
Heavy.....	30-40
AP projectile.....	0.9-2.5
Chemical shell.....	0.34-0.55

- (b) Bursting charges for HE, AT shell (c(3) below) are conical or hemispherical at the front end, for special penetration effect against armored targets. These charges also are referred to as "shaped charges" or "hollow charges."
- (c) Certain bursting charges for HE shell have deep booster cavities to adapt them for VT fuzes. A supplementary bursting charge may or may not be present in the shell as issued.
- (6) *Rotating band.* The rotating band is a cylindrical ring of comparatively soft material, usually copper or gilding metal, pressed into a knurled or roughened groove near the base of the projectile. On some HVAP projectiles, however, the band is steel and is an integral part of the base. It affords a snug seat for the projectile in the forcing cone and centers the base in the bore. As the projectile moves forward, the rotating band is engraved by the lands of the bore. Metal thereby displaced flows into cannellures, or grooves, cut in the rotating band. Since rifling of the weapon has a helical twist, rotation is imparted to the moving projectile by the engraved rotating band. In addition, the rotating band helps prevent the escape of the propellant gases forward of the projectile by completely filling the grooves of the rifling.
- (7) *Type of base.* When the surface to the rear of the rotating band is cylindrical, the projectile is said to have a "square" base; when tapered or conical, it is known as "boat-tailed." From a velocity of 2,500 fps to velocities below that of sound, the boat-tail decreases the retardation due to air resistance, by reducing the vacuum-forming eddy currents of air in the wake of the projectile, thereby increasing the range. Accordingly, the boat-tailing is more effective at velocities of 2,500 fps or less. The taper of boat-tailed bases varies from 5° to 9°.
- (8) *Base plug.* Armor-piercing projectiles are closed at the base with a heavy steel plug, a base detonating fuze, or both. In the larger calibers, the large base opening is

partly closed by a base plug which is machined to accommodate a fuze. In the smaller calibers, if an explosive charge is loaded in the cavity of the projectile, only a base detonating fuze is required. In the smaller calibers, the base plug, or base fuze, contains a tracer element.

- (9) *Base cover.* Shell containing high explosive usually are provided with a base cover to prevent the hot gases of the propelling charge from coming in contact with the explosive filler of the projectile through possible flaws in the metal of the base. Small and medium caliber armor-piercing projectiles with high-explosive filler and base fuzes ordinarily are not provided with base covers. Base covers may be crimped, calked, or welded to the base of the projectile (fig. 15).
- (10) *Armor-piercing cap.* Some armor-piercing projectiles are fitted with an armor-piercing cap for use especially in penetrating face-hardened armor plate. The cap is made of heat-treated alloy steel. On impact, the hardened cap destroys the hardened face of the armor plate while preventing the initial shock from being concentrated on the point of the projectile body by distributing the impact stresses over a large area of the head. See also c(4) below, describing armor-piercing projectiles.
- (11) *Windshield.* The windshield, also known as the false ogive or ballistic cap, is made of steel or aluminum and is secured to the armor-piercing cap or the head of the projectile to give improved exterior ballistics.
- (12) *Tracer.* For observation of fire, some shell are fitted with a tracer in the base. In some anti-aircraft and aircraft gun projectiles, the tracer ignites a pellet which, after burning a prescribed number of seconds, detonates the explosive filler, should the fuze fail to operate against a target. This type of tracer is known as "shell-destroying" (SD).

c. TYPES OF PROJECTILES. Dependent upon type of projectile, ammunition may be classified as indicated in paragraph 5. Typical service projectiles are illustrated in figures 2 to 7, inclusive. More complete descriptions of the various types of projectiles are given below and in TM 9-1900.

(1) *High-explosive (HE) shell.*

- (a) This projectile (figs. 3 and 7) of forged steel, has comparatively thin walls and a large bursting charge of high explosive. It is used against personnel and matériel targets, producing blast effect and fragmentation at the target. It may be fitted with either a time,

impact, inertia, or proximity type fuze according to the action desired. Time fuzes are point detonating fuzes of either the powder train or mechanical type. Impact fuzes are point detonating or base detonating fuzes of the superquick and delay, time and superquick, or concrete piercing type. Inertia fuzes are base detonating fuzes which depend indirectly on impact. Proximity fuzes are point detonating fuzes which are actuated by nearness to a target. Type of action may be time after firing, superquick, supersensitive superquick, nondelay, proximity, or delay (short or long). (see fig. 16.) Certain projectiles containing high explosive are fitted with a base cover (b (9) above).

- (b) High-explosive shell of recent production usually have a deep fuze cavity (fig. 4) so that they can be used with (proximity) VT fuzes. These shell are adapted for use with standard time or impact fuzes by a supplementary bursting charge placed in the deep cavity. The deep cavities are lined with a cardboard tube and bottom cup which help to support the HE filler. The supplementary charge consists of TNT in a cylindrical fiber container to which is fastened a felt cushion at the back end and a cloth tape loop at the front end (see *e* below).
- (2) *High-explosive-antitank (HE, AT) shell.* This is a special type of high-explosive shell (figs. 3 and 65) used against armored targets. Its effect is dependent upon the type and shape of the high-explosive charge (often termed a "shaped charge" or "hollow charge"), the metal cone or hemisphere which shapes the charge, the stand-off distance, the rotation (if present), and the limitations of the fuze employed. When the shell is detonated, the cone collapses and a jet is formed which perforates the target. The jet consists of particles of molten metal from the cone traveling at very high velocity. The remainder of the cone metal follows as a slug at a much slower speed. It is important that sufficient "standoff," that is, the distance between the target surface and the base of the cone or hemisphere at the time the charge is detonated, be provided in order that the jet will have an opportunity to form. The proper standoff is two or three times the diameter of the cone or hemisphere. In order to maintain this distance and decrease the effect of rotation on the penetration effect of the jet, these shell generally are fired at low or medium velocities.

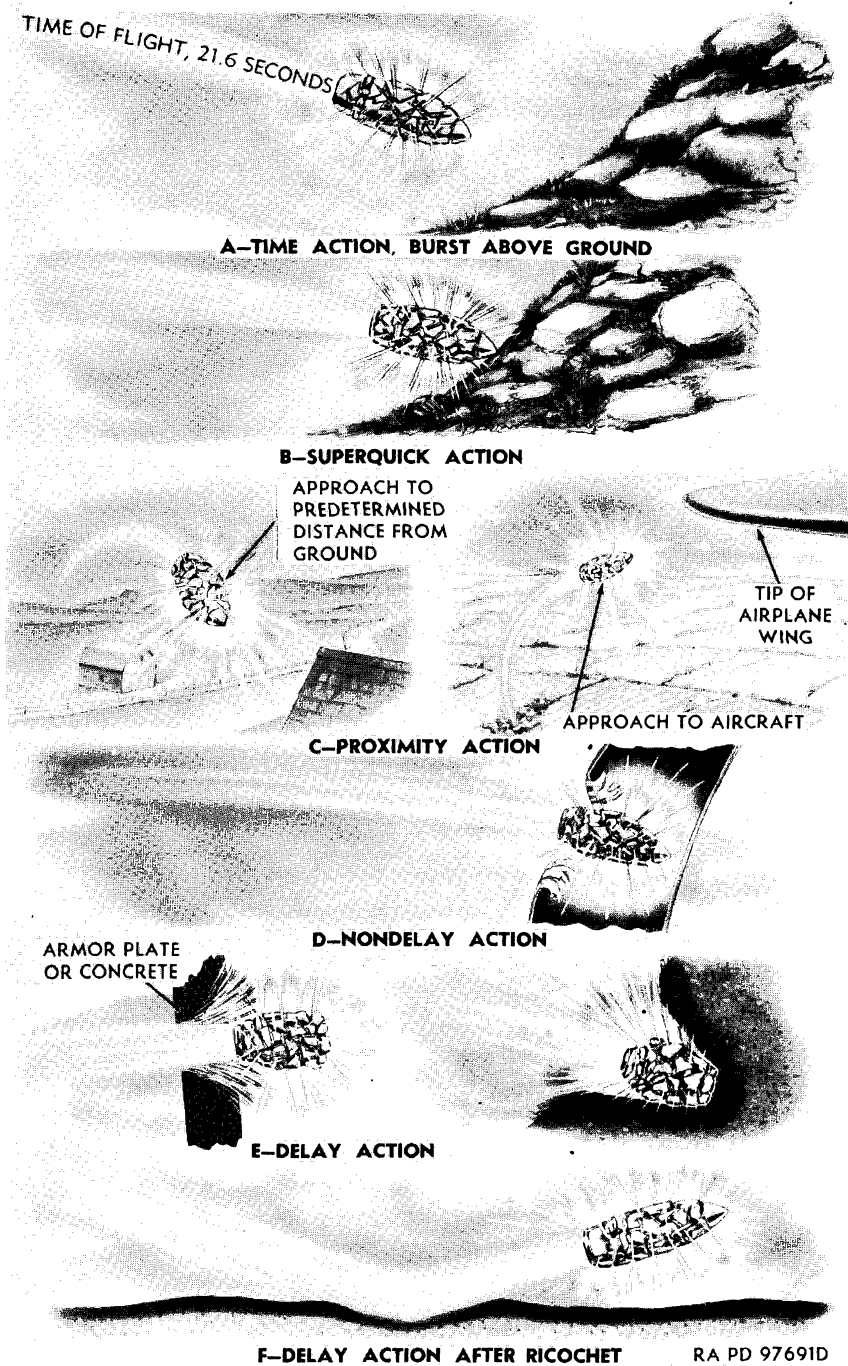


Figure 16. Action of ammunition at the target.

(3) *Armor-piercing (AP or APC) projectile.*

- (a) Armor-piercing projectiles (figs. 2 and 6) are made of heat-treated high carbon alloy steel. The head is very hard for penetration of armor and the body is tough so that it will withstand the strains imposed by the bending action of the projectile at angles of impact other than normal. To aid in overcoming face-hardened armored plate, an armor-piercing cap (*b*(10) above) is attached to the head of the projectile. Some armor-piercing projectiles are of solid metal, whereas some contain a small cavity which may be either empty or filled with explosive D and fitted with a base detonating fuze having a delay action. The solid projectiles are identified as "SHOT," whereas the term "PROJECTILE" ordinarily is used to identify the explosive carrying missiles. A steel or aluminum windshield generally is attached to the body or to the armor-piercing cap by screw threads or crimping. A tracer may be present in the base plug or in the base end of the fuze.
- (b) At one time, armor-piercing projectiles for harbor and seacoast defense were subclassified as "armor-piercing shot" and "armor-piercing shell." The armor-piercing shot applied to a projectile with relatively thick walls and a corresponding small explosive charge. It was intended for use exclusively against vertical armor (belts, turrets, conning tower, etc.) of capital ships, at ranges where perforation can be expected, with subsequent penetration into the vitals of the ship. The armor-piercing shell is applied to a projectile with thinner walls and a greater explosive charge than the armor-piercing shot. This shell was intended for use at those ranges where perforation through the vertical armor into the vitals of capital ships cannot be realized, but where perforation of the lighter armor of the superstructure and upper works can be expected. These subclassification terms no longer are applied to modern projectiles, the term "armor-piercing projectile" being used commonly. The modern design of armor-piercing projectiles follows more closely the design of the old armor-piercing shot. The present application of the term "shot" is to those armor-piercing projectiles which are solid. This includes the solid one-piece (monobloc) type and the solid APC type.
- (4) *Hypervelocity armor-piercing (HVAP) shot.* The

HVAP shot (fig. 2) is lighter than other armor-piercing projectile of the same caliber and is fired at higher velocities. The HVAP shot contains a pointed cylindrical core of tungsten carbide which has a hardness rating of 9-10 (on the hardness scale in which talc is 1, steel is 5-8.5, and diamond is 10). The core has great density and compressive strength. This extremely hard core is enclosed in a light body and cap assembly, generally of aluminum, which is threaded to fit into a steel base, which has an integral steel rotating band and which carries a tracer element. A conical cavity open to the rear is present in the base. A bourrelet, consisting of a steel ring, and a threaded aluminum windshield complete the assembly of the HVAP shot. The windshield screws on to the body.

- (5) *Chemical shell.* There are three general types of chemical shell (fig. 3), the burster, the base-emission, and the base-ejection types. The burster type is very similar to high-explosive shell, except for type of filler (par. 10), and the absence of a base cover, this cover not being required. This is because there is no danger of the shell exploding from possible leakage of hot gases from a burning propelling charge into the shell, the shell filler not an explosive. A large booster charge, termed a burster (*b*(5) above), is used to break the shell body and aid in dispersion of the chemical filler. In older types of chemical shell, the nose is fitted with tapered threads to form a gastight joint with the adapter. Modern types use standard threads with silver soldering for the adapter and a force fit for the burster casing. Base-ejection shell do not have a burster, but have an expelling charge of black powder, adjacent to the time fuze, which ignites and blows the three or four smoke canisters out through the base of the shell. The base-emission type has a blunt nose; its smoke filler is ignited by powder gases. When it lands it is burning and emitting smoke through a hole in its base.
- (6) *Illuminating shell.* These shell (fig. 5) contain parachute and illuminant assemblies which are ejected by an expelling charge adjacent to the time fuze. The illuminant burns, lighting up a target area. In addition to the parachute shrouds attached to the illuminant candle, a center wire, shorter than the shrouds, connects the candle to the center of the parachute. This center wire keeps the center of the parachute tucked in so that the

rate of descent initially is fast. After a predetermined time, the center wire is released and allows the parachute to open completely and drop more slowly. Thus, sudden strain upon the parachute on first opening is avoided.

- (7) *Target practice projectiles.* Target practice projectiles (fig. 17) simulate service projectiles and have the same dimensions, weight, and center of gravity as the service projectiles. Some target practice projectiles are cast iron, others are essentially empty service projectiles which must be sand-loaded to bring them up to standard weight. Stearic acid, plaster of paris, and other materials also are used for inert loading. Target practice shell (fig. 18), including those used in subcaliber firings, sometimes contain a black powder spotting charge. A typical cast-iron type target practice projectile is shown sectioned in figure 17.
- (8) *Dummy projectiles.* Drill or dummy (inert) projectiles are used with fixed, semifixed, and separate-loading drill rounds for training purposes. Those which are part of fixed and semifixed rounds (drill cartridges) are usually inert service projectiles, with or without modifications. Separate-loading dummy projectiles are of two types: sliding-ring type and internal-plunger type. In the sliding-ring type, a rear ring on a cylindrical sliding assembly simulates the rotating band. After the rear band is seated in the forcing-cone of the bore, the dummy projectile can be pulled sharply to the rear for a short distance by means of an extractor inserted in the base end of the dummy projectile. In the internal-plunger type, an internal plunger, held to the rear by a spring, moves forward against the spring when the projectile is rammed home. The plunger then snaps back loosening the projectile in its seat so that it can be extracted more easily. These two types of dummy projectiles are illustrated sectioned in figures 19 and 20.

d. ARMOR-PENETRATION DATA.

- (1) The penetration data of specific projectiles are given in chapter 2. Certain general armor-piercing data for projectiles are given herein. *Penetration* generally refers to any piercing of armor plate, whereas *perforation* indicates complete penetration of the target to the extent that light may be seen through the hole made.
- (2) Approximate thickness of armor penetrated by different

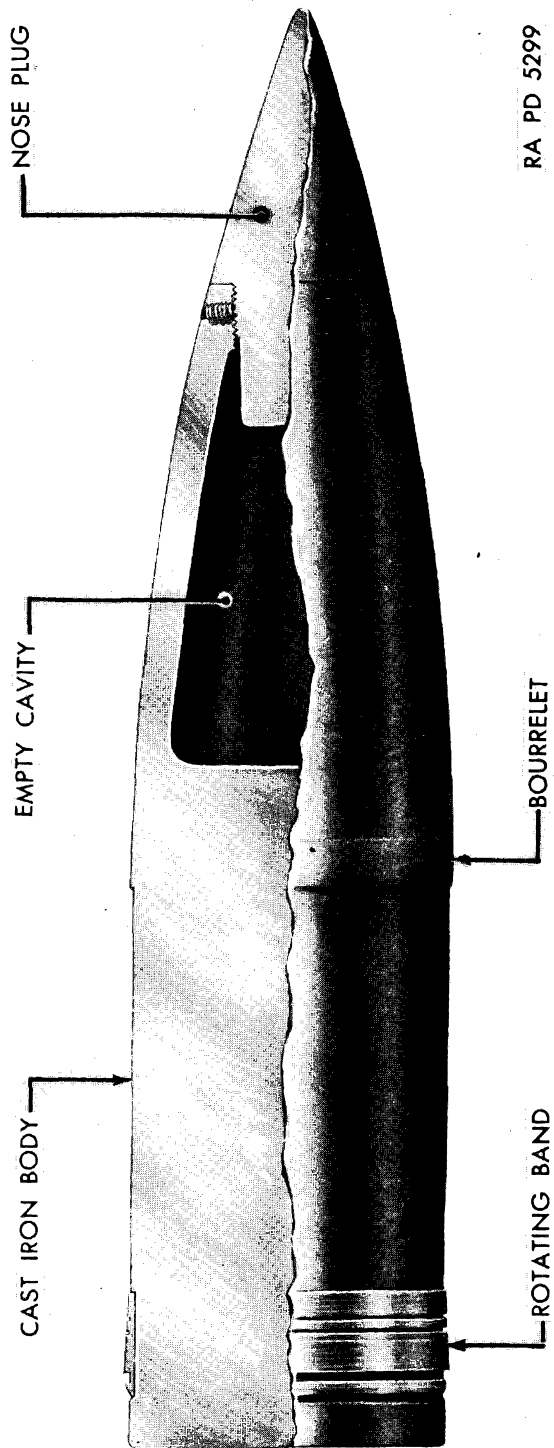


Figure 17. Typical cast-iron type target practice projectile.

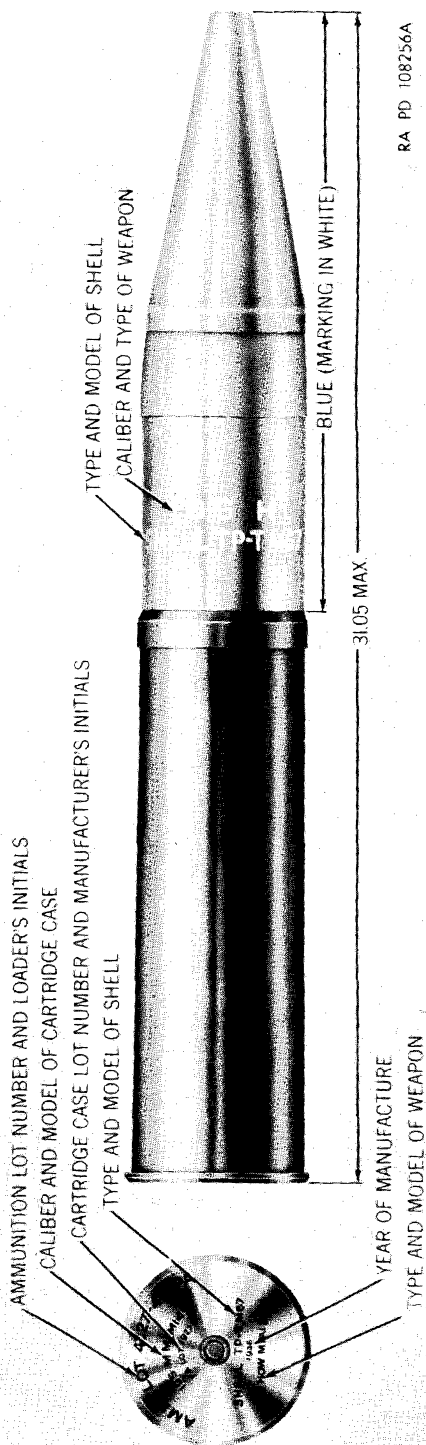
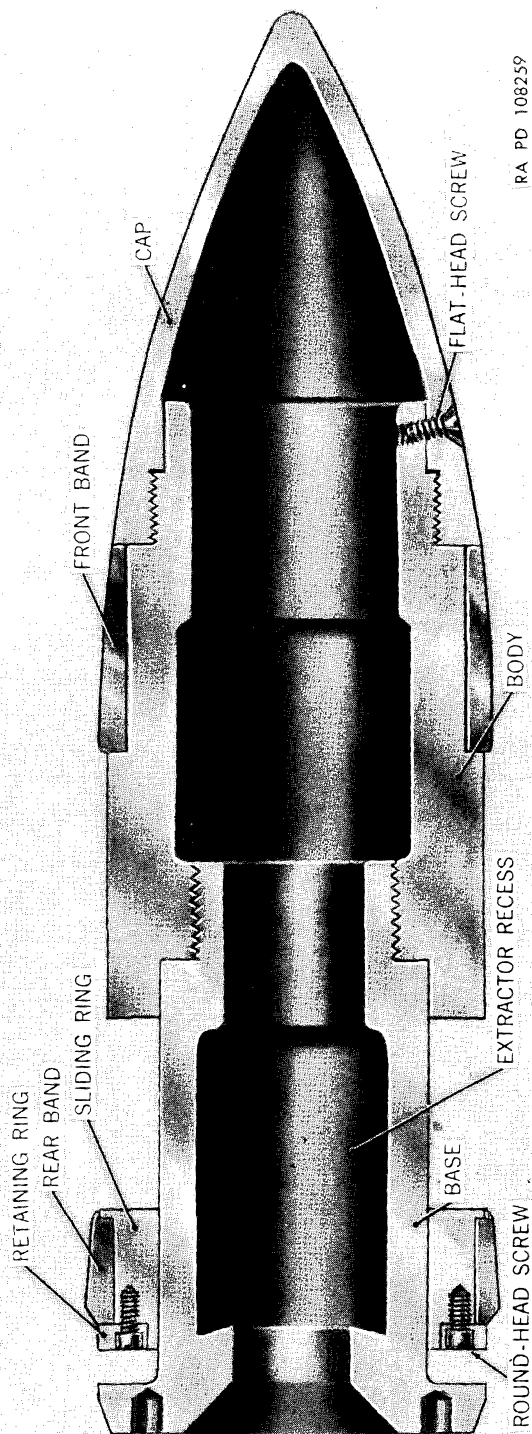
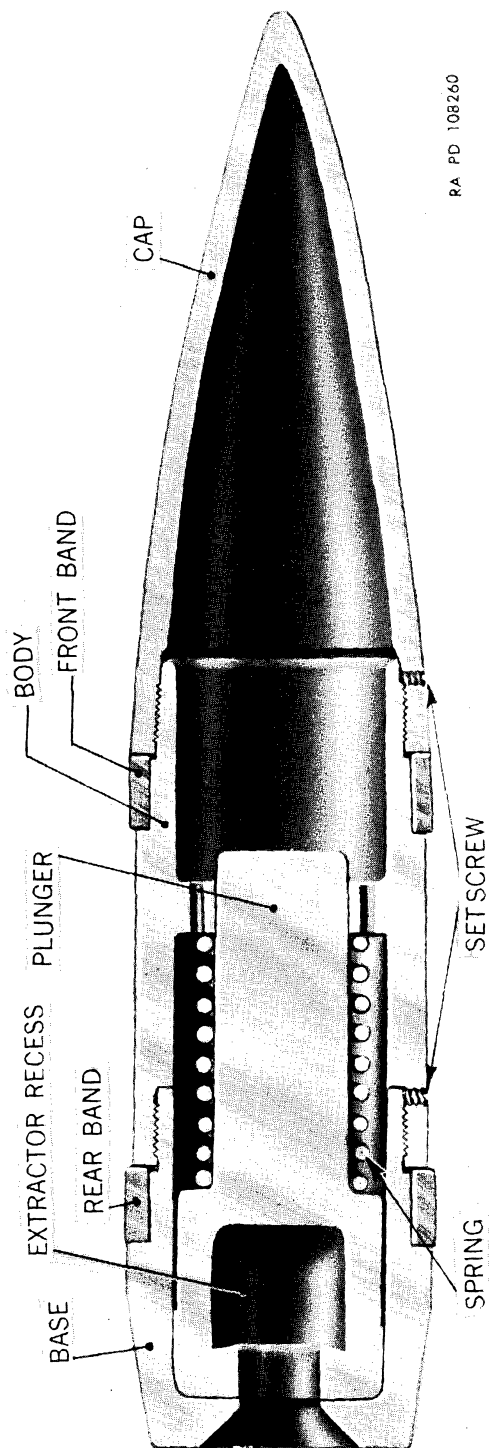


Figure 18. Typical field artillery target practice shell.



RA PD 108259

Figure 19. Typical sliding-ring type dummy projectile.



RA PD 108260

Figure 20. Typical internal-plunger type dummy projectile.

caliber armor-piercing projectiles is given in table I. For more complete data, see TM 9-1907.

Table I. Armor Penetration Table

Caliber	Aprx inches of penetration of armor plate at 1,000 yards (normal impact)		Caliber	Aprx inches of penetration of armor plate at 1,000 yards (normal impact)	
	Homo-geneous plate	Face-hardened plate		Homo-geneous plate	Face-hardened plate
20-mm AP-----	0.6	0.5	76-mm APC-----	4.5	4.7
37-mm AA, APC-----	0.8	0.8	76-mm HVAP-----	7.2	—
37-mm AT, APC-----	2.5	2.2	90-mm APC-----	5.5	6.0
40-mm AP-----	1.8	1.8	90-mm HVAP-----	10.2	—
57-mm APC-----	3.5	3.75	105-mm HE, AT-----	*4.0	—
75-mm APC-----	3.0	3.6	155-mm AP-----	7.5	—
75-mm HE, AT-----	*3%	—			

* At any range.

- (3) The angle of impact is important in armor penetration. Once the perforation is known at normal impact, the perforation at any angle can be estimated as follows:

Angle (deg)	Percentage lost in perforation	Angle (deg)	Percentage lost in perforation
0	0	25	15
5	1½	30	20
10	4	35	26
15	7	40	33
20	10	45	41

e. ARTILLERY SHELL FOR VT FUZES.

- (1) *General.* These shell have been mentioned briefly in c(1)(b), above. Details are presented here for use, care, handling, and fuzing of rounds.
- (2) *Description.* Fixed and semifixed HE shell of 75-mm, 90-mm, and 105-mm caliber and separate-loading HE shell of 120-mm, 155-mm, 8-inch, and 240-mm caliber may be provided with deep cavities for use with VT fuzes. The manner in which the various components are issued and assembled is summarized in figure 4. The deep fuze cavity for these shell is 4.95 inches deep, or 2.75 inches deeper than shell used only with standard time and impact fuzes. The supplementary bursting charge, which may be present in deep-cavity shell as issued, consists of a charge of TNT in a cylindrical fiber container to which is fastened a ¾-inch thick felt cushion at the back end and a cloth tape lifting loop at the front

end; over-all length is approximately 2.9 inches and diameter is 1.75 inches. When properly seated in the deep fuze cavity, the top of the supplementary charge should be 2 to $2\frac{1}{8}$ inches below the nose of the unfuzed shell. When standard time and impact fuzes are used, the supplementary charge must be present in the fuze cavity. When VT fuzes are used, the supplementary charge must be removed. Spacers and closing plugs are used when deep-cavity shell containing supplementary charges are not issued with standard fuzes assembled thereto (fig. 4). The deep cavities are lined with a cardboard tube and bottom cup which help to support the HE filler. This lining will not be removed at any time. Complete rounds assembled with deep-cavity shell and deep-cavity separate-loading shells are identical in all other respects with ammunition adapted only for standard time and impact fuzes.

(3) *Rounds of older manufacture.*

- (a) Deep-cavity 75-mm HE shell M48, 90-mm HE shell M71, and 105-mm shell M1, when issued fuzed, are assembled with supplementary charge and a time or impact fuze (M43, M48, M51, M54, or M55 series) to which usually is staked the booster M21 or M24 series. The fuze and booster are staked or secured together with a setscrew so that they may be removed as a unit when adapting the shell for use with VT fuzes. Staking is a slight crushing of the metal with a hammer and prick punch at the line of contact of two members which are screwed together, so that they cannot be unscrewed except with considerable extra force. The setscrew which held the booster in the nose of the shell of earlier manufacture is omitted and the setscrew hole is plugged with wax. Do not remove this wax plug.
 - (b) Deep-cavity HE fixed and semifixed shell in early lots may have been issued unfuzed. These unfuzed rounds may or may not contain a supplementary charge.
 - (c) Deep-cavity separate-loading shell in early lots may not contain a supplementary charge.
- (4) *Use of deep-cavity shell with time or impact fuzes.*
- (a) Any deep-cavity shell may be used with time or impact fuzes *only if the supplementary charge is properly in place below the booster*. Omission of the supplementary charge may cause premature detonation be-

cause of crushing action on the HE filler due to its collapse on setback into the vacant space which should be occupied by the supplementary charge, or may result in the shell's exploding at the target with low order detonation or becoming a dud.

- (b) *Fuzed* fixed, semifixed, and separated shell marked "W/SUPPL CHG" may be fired as received.
- (c) *Unfuzed* fixed, semifixed, and separated shell, and separate-loading shell, marked "W/SUPPL CHG," are prepared by the using troops for assembly with time or impact fuzes by removing the closing or lifting plug and spacer. Inspect the fuze cavity to be sure that the supplementary charge is properly in place and that the side walls of the cavity are not damaged. Remove any loose material from the cavity. If the HE filler around the cavity appears to be broken, reject the shell. If any HE is found adhering to the threaded portion of the shell throat, remove it with a pointed tool made of nonferrous metal, such as aluminum or brass, or hard wood. Assembly with time or impact fuzes then will follow standard practice for fuzing separate-loading shell. *Staking of time fuzes may be necessary if mechanical fuze setters are to be used.*
- (d) Rounds or separate-loading shell marked "FOR VT FUZE," "FOR FUZE T74E6," or "FOR FUZE T80E6," may be prepared by the using troops for assembly with time or impact fuzes by removing the closing or lifting plug and gasket, inspecting the fuze cavity, *inserting the supplementary charge*, and assembling the fuze as described in (c) above.
- (5) *Use of deep-cavity high-explosive shell with VT fuzes.*
 - (a) Fuzed rounds marked "W/SUPPL CHG" are prepared for VT fuzes by first removing the time or impact fuze, using a fuze wrench. The fuze is staked to the shell and it will be found necessary to loosen it by striking the handle of the wrench sharply. With fuze up, turn in counterclockwise direction because the fuze is secured to the shell by *right-hand threads*. Use fuze wrench M18 (fig. 144). Remove the supplementary charge by means of its cloth tape loop. Then follow (d) below.
 - (b) Prepare unfuzed rounds, separated and separate-loading shell, marked "W/SUPPL CHG," by removing the

closing or lifting plug and gasket. Remove the supplementary charge by means of its cloth tape handle. Then follow (d) below.

(c) Prepare rounds and separate-loading shell marked "FOR VT FUZE," "FOR FUZE T74E6," or "FOR FUZE T80E6," by removing closing or lifting plug and gasket. Then follow (d) below.

(d) The following instructions apply to all three cases cited above:

1. Inspect the cavity for damage. Remove any loose material from the cavity. If the HE filler around the cavity appears to have been broken, reject the shell. If any HE is found adhering to the threaded portion of the shell throat, remove it with a pointed tool made of nonferrous metal such as aluminum or brass, or hard wood.
2. Screw in VT fuze by hand, making certain that the fuze fits properly. If binding occurs, inspect the fuze cavity and threads of both fuze and shell to determine cause. Reject fuze or shell, whichever is at fault.
3. Tighten the fuze to the shell with the fuze wrench supplied in boxes of VT fuzes or the fuze wrench M18. *Use only manual force. Do not hammer on wrench or use an extension handle.* If the fuze cannot be tightened to form a good seat between shell and fuze, reject the component which is at fault. Any large shocks transmitted to VT fuzes during the assembly operations may increase the percentage of duds obtained. *Do not stake fuze to shell under any circumstances.*

(6) *Repacking of rounds and components after fuzing.*

- (a) Time and impact fuzes and supplementary charges removed from shell will be packed in the containers from which VT fuzes have been removed. The containers, properly marked to identify contents, will be returned to appropriate ordnance personnel for disposition.
- (b) When fuzes are changed in rounds and the rounds subsequently returned to their containers and boxes, care must be taken to change the markings on the containers and boxes to conform with the change in ammunition. Semifixed shell, fuzed with VT fuzes, must be padded specially when returned to their fiber containers. The U-shaped support which normally

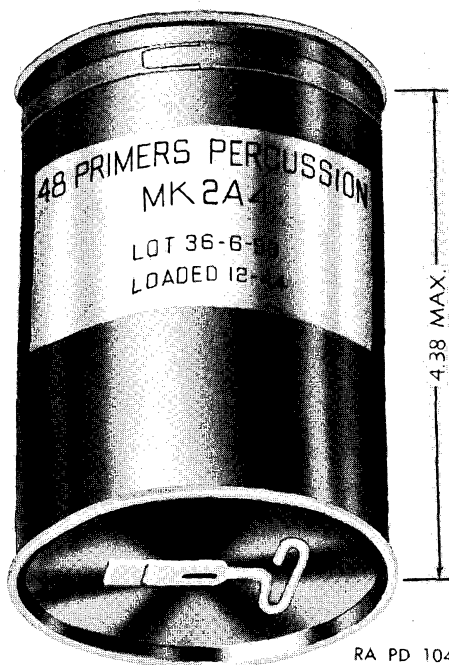
engages the wrench slots of time or impact fuzes will not fit the slots in current VT fuzes and, therefore, must be omitted. The play that results is taken up by placing extra corrugated board pads under the base end of the projectile before closing the container.

- (c) *If shell fuzed with VT fuzes are to be transported considerable distances*, it is recommended that the VT fuzes be removed from the shell and that the fuzes be returned to their original, correctly marked containers. Supplementary charges and applicable time or impact fuzes (or supplementary charges, closing plug, gaskets, and spacer) should be reassembled to the shell. *Replace the supplementary charge properly*, with the felt pad toward the base of the shell and the cloth tape loop in position for easy withdrawal of the charge. Fixed and semifixed ammunition may be returned to *properly marked* containers and boxes. VT-fuzed ammunition may be transported short distances safely if normal care in handling is used.
- (7) *Storage and handling*. Rounds assembled with time or impact fuzes or unfuzed rounds assembled with closing plugs will be handled and stored in accordance with standard practice. VT-fuzed ammunition requires some additional protection. Temperature of storage space should be between -20° F. and 130° F. because injury to the fuzes may result from exposure to extreme temperatures. Long exposure to high humidity may prevent proper fuze operation, and the ammunition therefore must be kept as dry as possible. VT fuzes should be protected against excessive jolting and shocks.
- (8) *Weather conditions*. See paragraph 234h(2).

15. Blank Ammunition

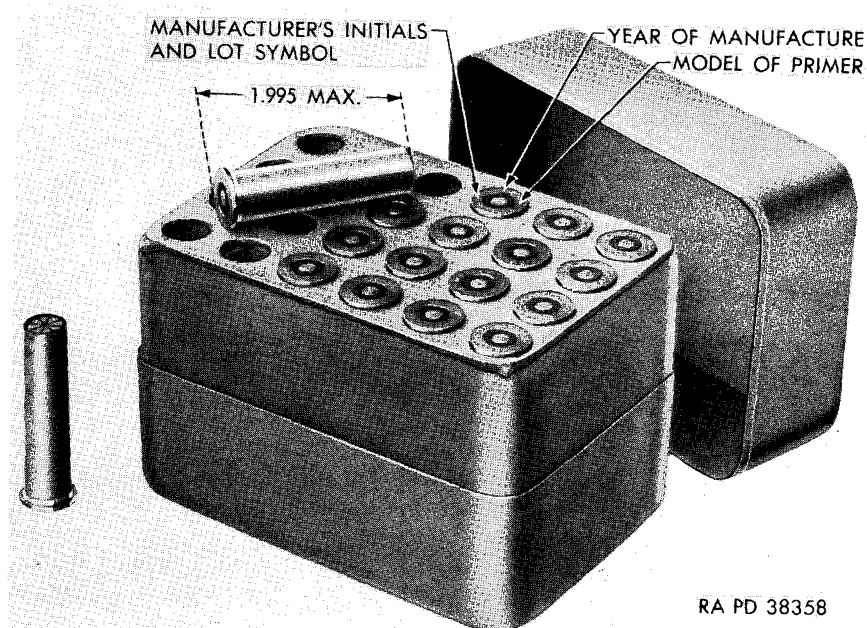
a. GENERAL. Blank ammunition is made up for cannon of calibers up to and including 105-mm for practice purposes in maneuvers, in firing the morning and evening gun, and for saluting purposes.

b. COMPLETE ROUND. A complete round of blank ammunition consists of a black powder charge contained in either a loose fitting cloth bag which sags around the primer or in one or two compressed cylindrical pellets wrapped in cellophane fitting around the primer, assembled in a brass cartridge case. The cartridge case is essentially a shortened service case. A chipboard closing cup or palmetto pulp plug is inserted in the mouth of the case and



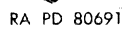
RA PD 104832

Figure 21. Metal container for separate-loading percussion primers.



RA PD 38358

Figure 22. Metal container for combination electric and percussion primers.



53

sealed to hold the charge in place and to prevent powder from leaking out. A 10-gage blank cartridge, with a suitable adapter made from a service cartridge case, is used for blank firing of 37-mm weapons. Regulations governing use of blank ammunition are given in AR 600-25 and AR 600-30.

16. Packing and Marking for Shipment

a. GENERAL. Moisture-resistant containers are used for practically all ammunition, except separate-loading projectiles. These packing containers are marked to furnish all essential information. Specific packing data for each ammunition item will be found in ORD 11 SNL's of groups P, R, S, and T.

b. PACKING. Separate-loading projectiles do not require any outer packings; they are shipped unfuzed with an eyebolt-lifting plug in the nose and a grommet to protect the rotating band (sec. V, ch. 3). Exceptions are those projectiles having a wind-shield and dummy projectiles which are shipped in a crate or box (fig. 23), and the 8-inch shell M103 which is shipped in wooden box. Separate-loading percussion primers are packed 48 to a sealed metal can (fig. 21), and these cans are packed in a wooden box. The metal can for separate-loading combination electric and percussion primers is shown in figure 22. Other components and rounds of artillery ammunition are packed in a slip cover fiber container of the mailing tube type. For further protection, rounds of 75-mm, 76-mm, and 105-mm calibers assembled with point-fuzed projectiles may have U-shaped packing stops fitted into the fuze wrench slots. *These must be removed before firing.* All fiber containers are packed in wooden boxes or in metal containers. For typical packing boxes, see figures 24 and 25; for fiber containers, including the inverted 105-mm type, see figure 26. Some of these packing boxes have a carriage bolt and rod holding and reinforcing the two ends of the box. Separate-loading propelling charges are packed in airtight metal cartridge storage cases (fig. 27). An igniter protector cap made of cloth or paper, serves as protection to the igniter end of propelling charges as shipped. Metal containers (figs. 28 and 29) are the latest type of packing for four or eight rounds of mortar ammunition. Metal containers (figs. 30 to 32, incl.) are used for packing single rounds of artillery ammunition under certain conditions when specifically authorized. Rounds for the 75-mm and 105-mm howitzers, 60-mm and 81-mm mortars are packed in standard fiber containers prior to packing in the metal container. Eight 60-mm mortar rounds, four light 81-mm mortar rounds, or one heavy 81-mm mortar round are placed in one metal container. The one-round metal containers

MARKED ON REVERSE:
 CONSIGNOR, CONSIGNEE AND
 SHIPPING DOCUMENT NUMBER
 (THIS MAY BE OMITTED ON CARLOAD SHIPMENTS)

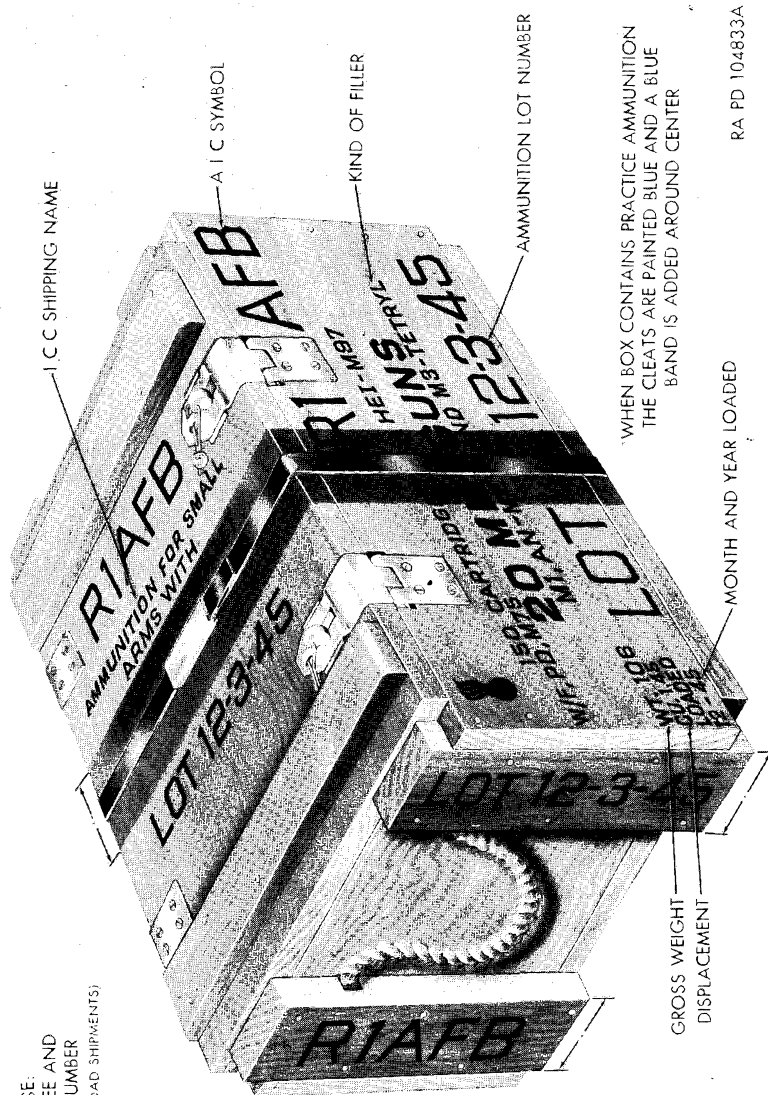


Figure 24. Typical packing box for small caliber fired ammunition.

RA PD 104833A

*CLEATS AND STRIPE ARE PAINTED BLUE WHEN BOX CONTAINS PRACTICE AMMUNITION

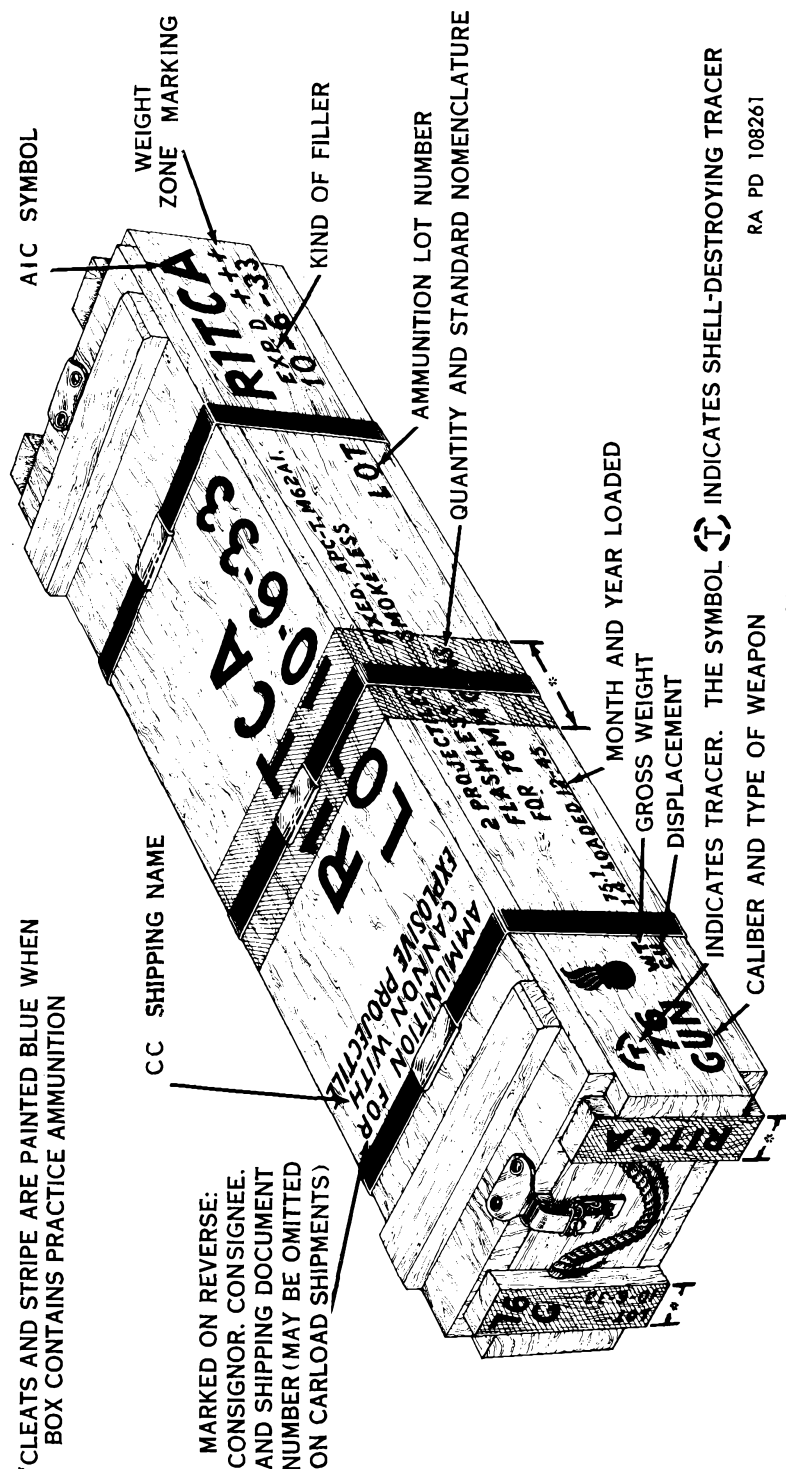
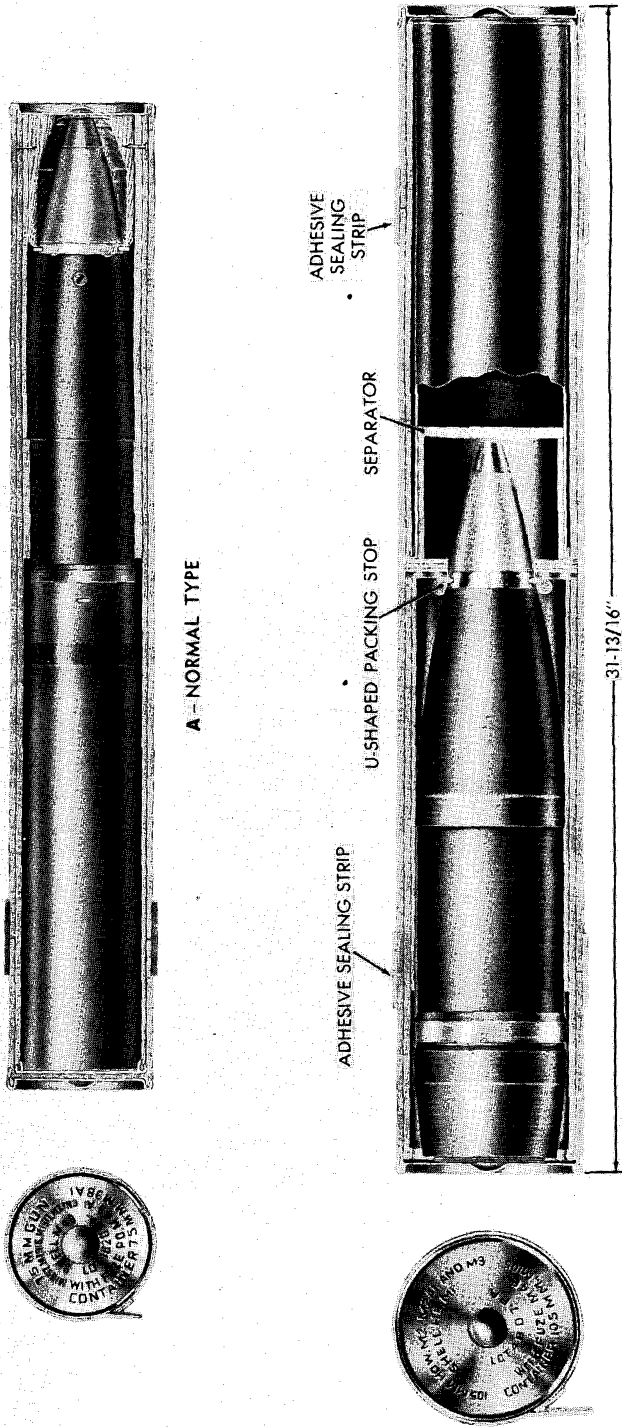


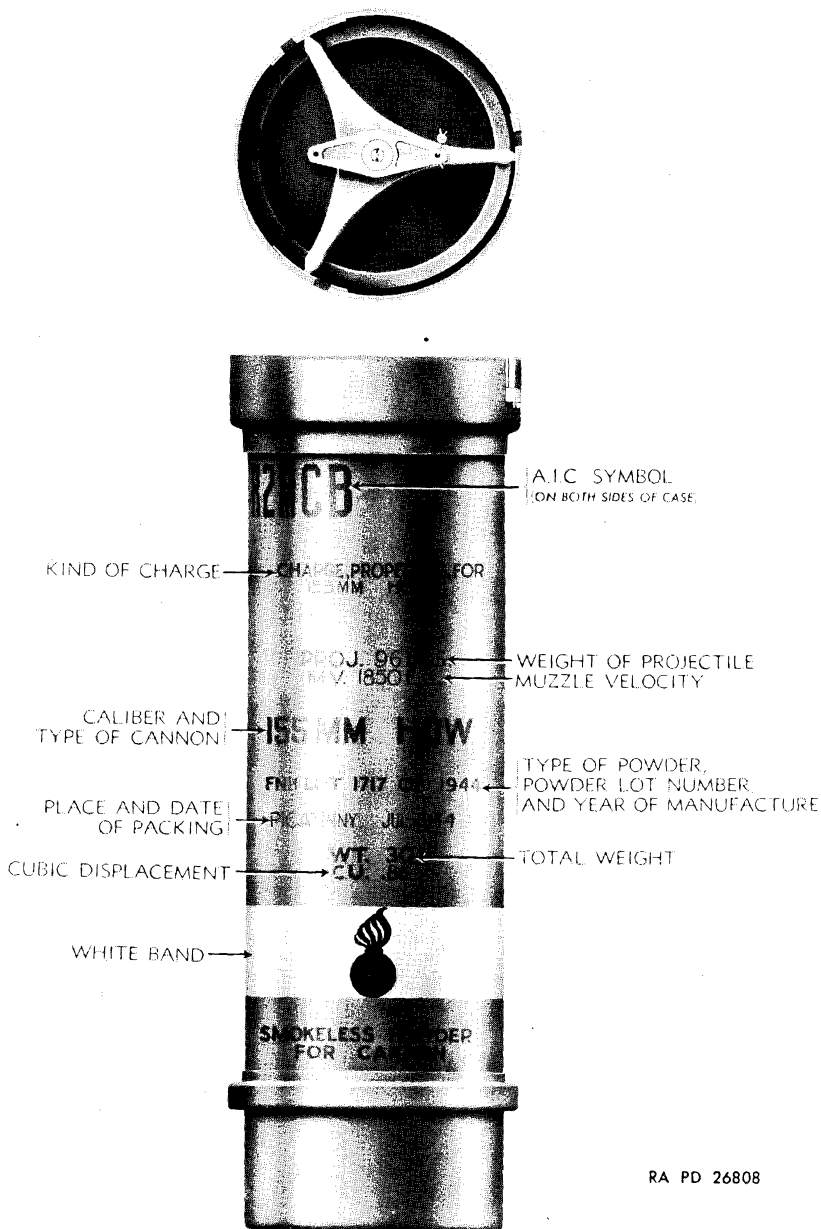
Figure 25. Typical 2-round packing box.



RA PD 80684

B - INVERTED TYPE

Figure 26. Fiber containers.



RA PD 26808

Figure 27. Typical cartridge storage case.

(figs. 30 to 32, incl.) are cylindrical, made of steel, and sealed against moisture by a rubber gasket in the sealing cover. A screw and pressure plate cover assembly hooks under a locking ring on the metal container and provides pressure over the sealing cover and gasket. Cork and felt pads are included to provide a snug fit

for the round or the fiber container in which the round is packed. Metal containers are painted olive drab. All components of two complete rounds of 4.2-inch mortar ammunition are packed in a wooden box. Propelling charges and fuzes also are shipped in bulk.

c. **SEALING.** Each container, after the contents are packed properly, is sealed in some manner which will indicate whether or not the container has been tampered with. Where metal strapping is used around boxes, paper seals are not necessary and no longer are used.

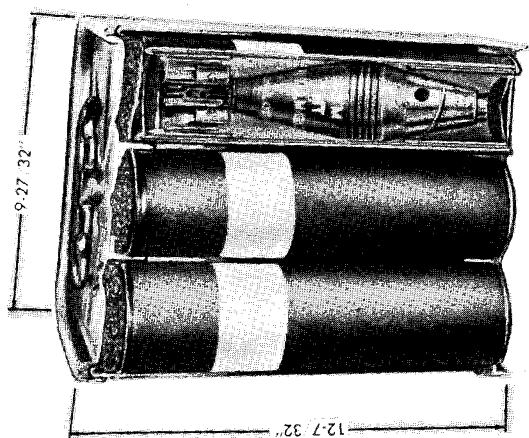
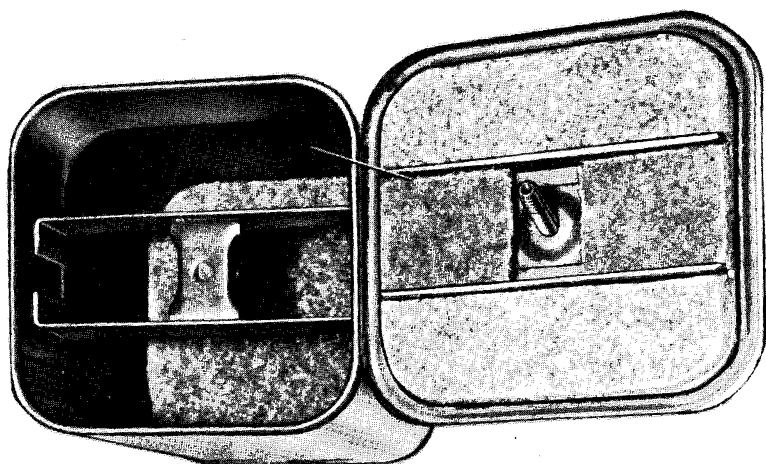
d. **JUNGLE PACKS.** Packings known as jungle (method 1A2) packs, contain additional waterproof containers or envelopes so that the ammunition may better withstand hot humid climates.

e. **PALLETIZATION.** Palletization (fig. 33) has been authorized to reduce handling time and save man-hours in storing and shipping certain types of ammunition.

f. **MARKING FOR SHIPMENT.**

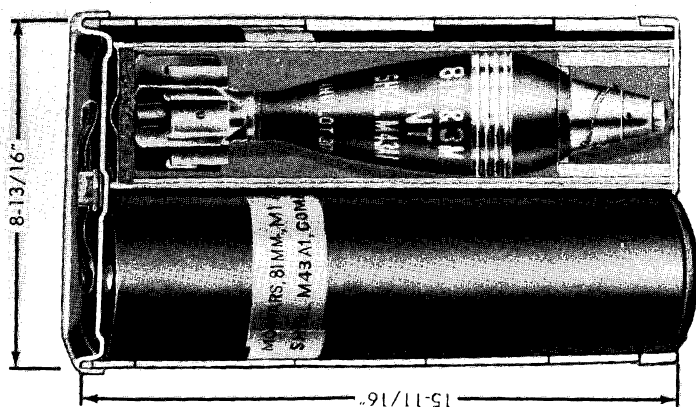
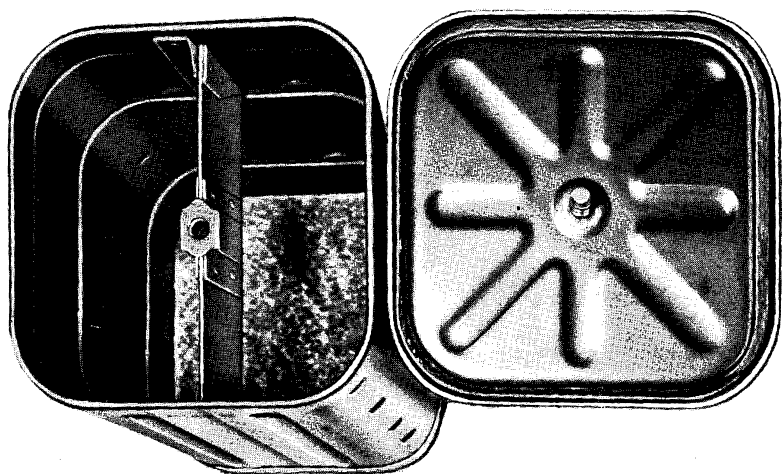
- (1) Ammunition items are marked as described in paragraph 11. Packing containers are marked in accordance with Army Regulations, Military Specifications, and ICC Regulations.
- (2) Each package of supplies turned over for shipment on a Government bill of lading is marked with the following:
 - (a) Name and address of destination or port officer (or code marking) preceded by word "To."*
 - (b) Name and address of ultimate consignee, preceded by word "For."*
 - (c) List and description of contents.
 - (d) Ammunition code symbol, published in ORD 11 SNL's.
 - (e) Gross weight in pounds, displacement in cubic feet.
 - (f) The number of the package or shipping ticket.*
 - (g) The letters "U. S." in several conspicuous places.
 - (h) Order number or contract number.
 - (i) Ordnance insignia.
 - (j) Name or designation of consignor preceded by the word "From."*
 - (k) Lot number.
 - (l) Month and year packed.
 - (m) Inspector's stamp.
- (3) The adhesive sealing strips on fiber containers are in the same color as ammunition item, in accordance with basic color scheme. Thus, blank ammunition has sealing strips in red to indicate low explosive (black powder). It will

* May be omitted on individual packages in carload shipments of packages of standard weights and dimensions containing standard quantities.



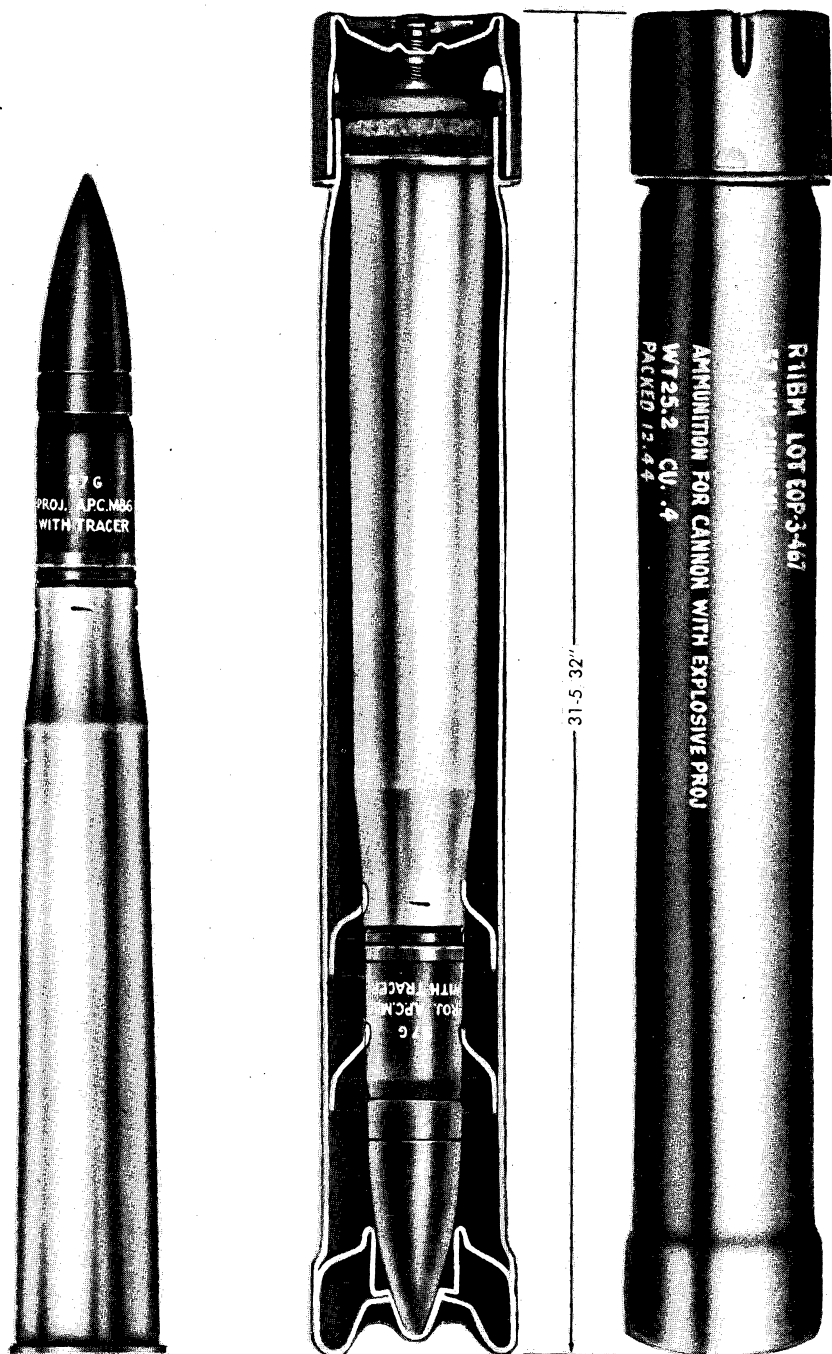
RA PD 97687A

Figure 28. Metal container M139A1, for 60-mm mortar ammunition.



RA PD 97686

Figure 29. Metal container M140A1, for 81-mm mortar ammunition.



RA PD.97685A

Figure 30. Metal container M175A2, for 57-mm APC-T rounds.



RA PD 97690A

Figure 31. Metal container M173A2, for 75-mm howitzer rounds.

- be noted, however, that for rounds with high-explosive projectiles, the strips are yellow. (See fig. 34.)
- (4) Wooden packing boxes are unpainted with marking in black. (See fig. 35.)
 - (5) Metal containers are painted olive drab with marking in yellow. (See fig. 35.)
 - (6) Containers for green bag propelling charge, white bag propelling charge, or section of propelling charge con-

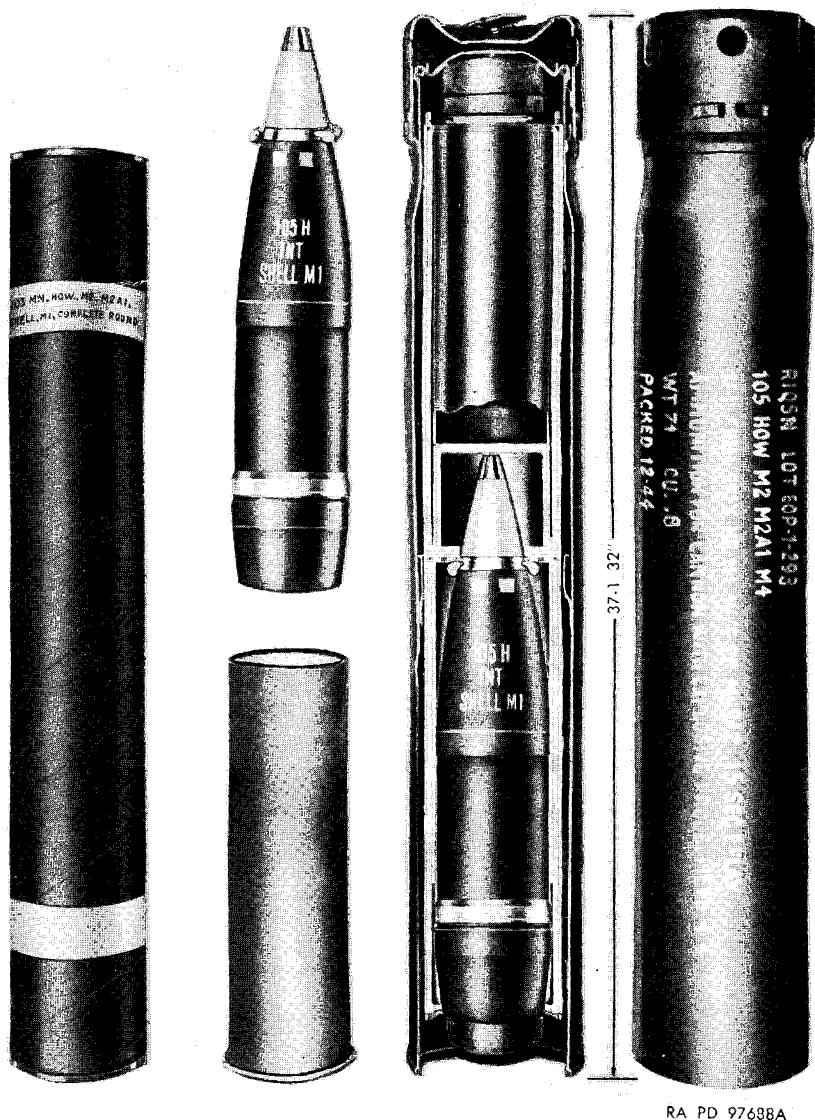
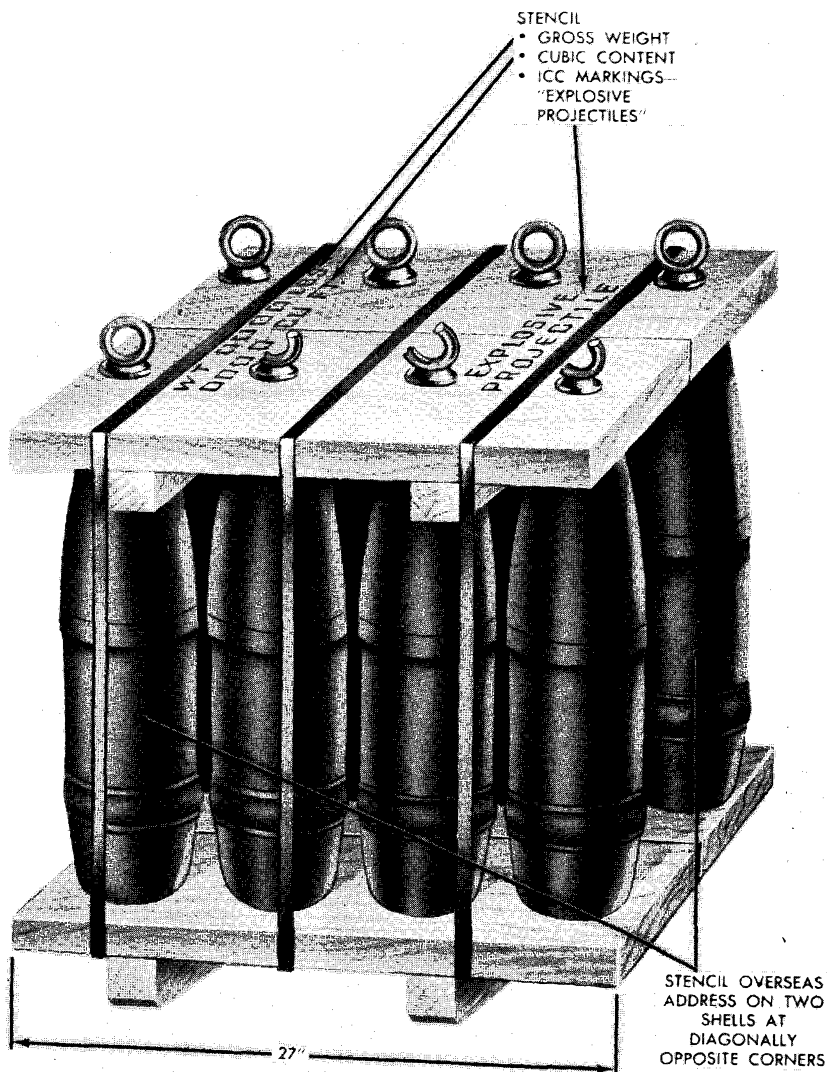


Figure 32. Metal container M152A2, for 105-mm howitzer rounds.

- taining the black powder igniter, are painted with green, white, and red stripes, respectively. (See fig. 34.)
- (7) The muzzle velocity of some rounds of smaller caliber is indicated on the packing box.
 - (8) To distinguish rounds assembled with brass cartridge cases from those with steel cartridge cases, the words "STEEL CASE" are marked on those boxes containing steel case rounds.



RA PD 89384

Figure 33. Pallet for separate-loading projectiles.

- (9) For 76-mm and 90-mm ammunition, FLASHLESS, SMOKELESS, or FLASHLESS-SMOKELESS — or FLHLS, SMKLS, or FLHLS-SMKLS only where space is limited—is marked on packing containers.
- (10) For rounds containing deep cavities and supplementary bursting charges, "W/SUPPL CHG."
- (11) Linen data tags, containing pertinent information, are

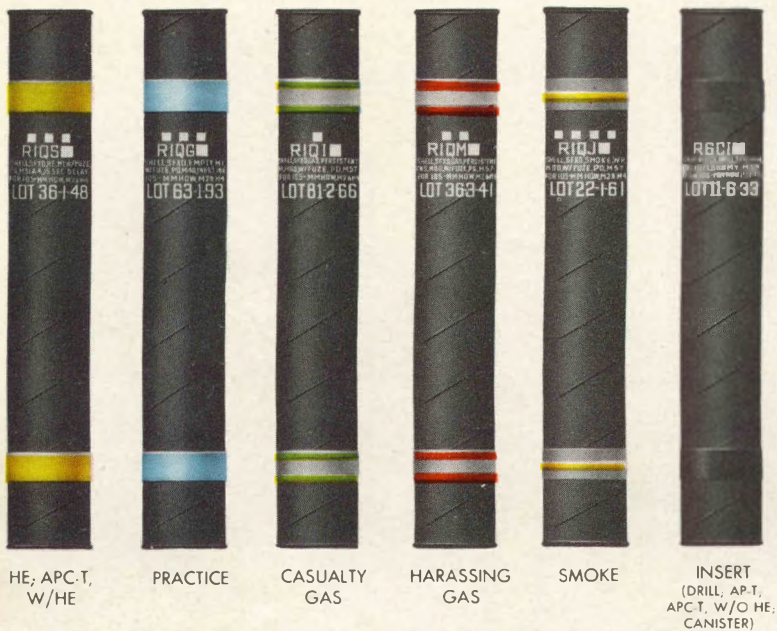
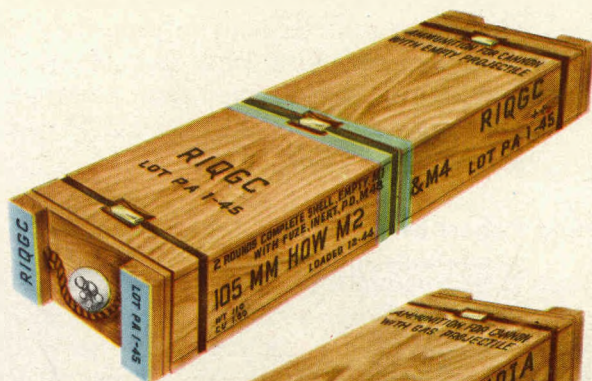
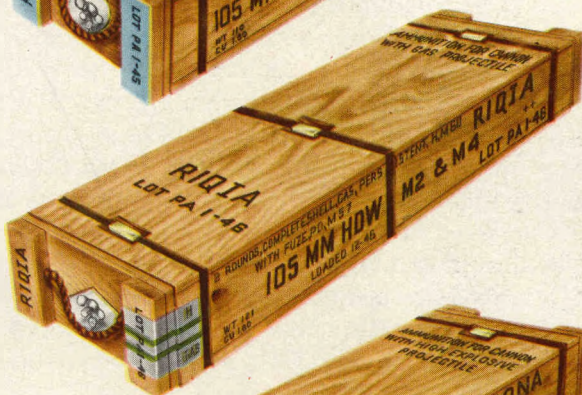


Figure 34. Color identification of fiber containers and cartridge storage cases.

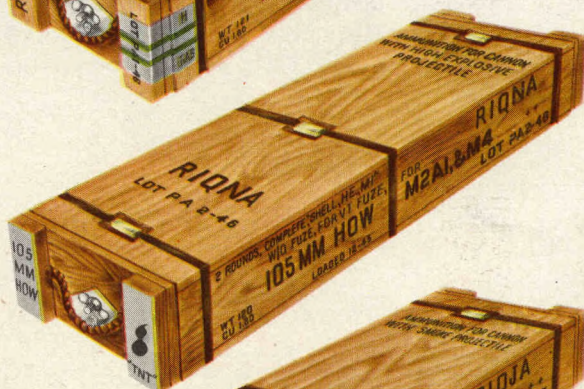
**FOR PRACTICE
AMMUNITION**



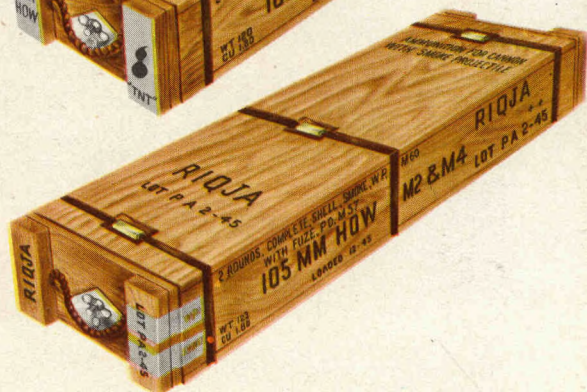
**FOR CASUALTY
PERSISTENT GAS
AMMUNITION**



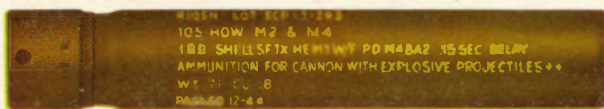
**FOR HIGH
EXPLOSIVE
AMMUNITION**



**FOR SMOKE
AMMUNITION**



**METAL
CONTAINER**



RA PD 97765A

Figure 35. Color identification of packing boxes and metal containers.

attached to separate-loading propelling charges. Ammunition data cards for other ammunition accompany shipping tickets for ammunition packings. Firing table cards are inclosed in the packings of complete rounds of mortar ammunition.

17. 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 and then report the occurrence and all pertinent facts of the accident 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.

CHAPTER 2

FIXED AND SEMIFIXED ROUNDS AND SEPARATE-LOADING PROJECTILES

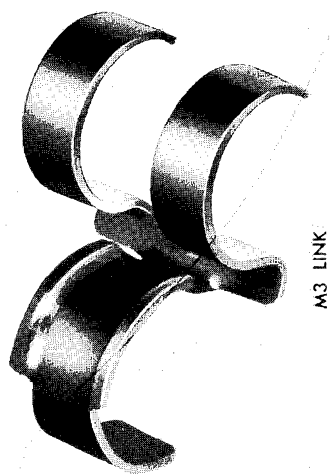
Section I. AMMUNITION FOR 20-mm GUNS

18. General

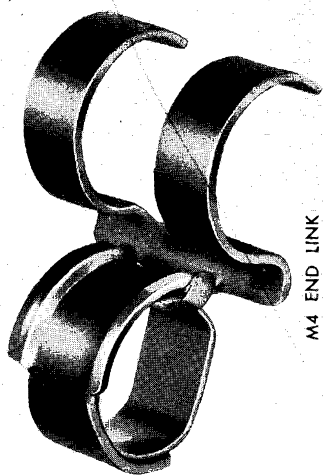
a. GENERAL DISCUSSION. The present 20-mm guns AN-M2 and M3 are automatic aircraft cannon for use against aircraft and ground targets. There are several types of these guns, dependent upon the type of mount used. However, since they are chambered similarly, it is possible to use the same ammunition. The automatic gun M24 is the basic weapon equipped with an electrical belt assembly capable of synchronized firing and close fire interruption from the battery position. This weapon utilizes ammunition which is identical with that fired in 20-mm guns AN-M2 and M3, except that the M52A2 electric primer replaces the M36A1 percussion primer.

Warning: Percussion-primed ammunition CANNOT be fired in the M24 gun. Electric-primed ammunition CANNOT be fired in the AN-M2 and M3 guns.

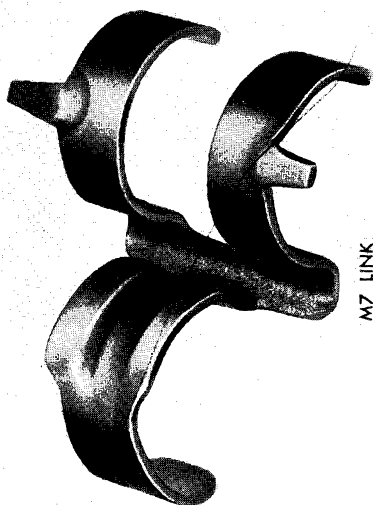
Electric-primed cartridges can be identified by the designation "ELEC" stamped into the head of the cartridge case. Ammunition manufactured in the United States for guns other than M24 must be proof-fired in British guns to determine whether the lot develops sufficiently low chamber pressure for acceptance for firing in British weapons. If the ammunition is accepted by both United States and British services, the words "COMMON AMMN" are marked or printed on the packing boxes. The ammunition is fed into the guns by means of link belts (fig. 36) or a 60-round drum-type magazine. High-explosive-incendiary (HEI), armor-piercing with tracer (AP-T) incendiary, target practice, and drill ammunition types are provided for the guns, all issued in the form of fixed complete rounds known as "cartridges." The standard rounds have matched ballistics (at 1,000 yds.). The shape, length, and weight of these rounds are approximately the same; all have a purple annulus about the primer at the head of the cartridge case. The trajectories of these rounds cross at 1,000 yards, at which range the time of flight for each projectile is approximately 1.66 seconds when fired from a stationary weapon (British guns) with a muzzle velocity of 2,800 fps. The incen-



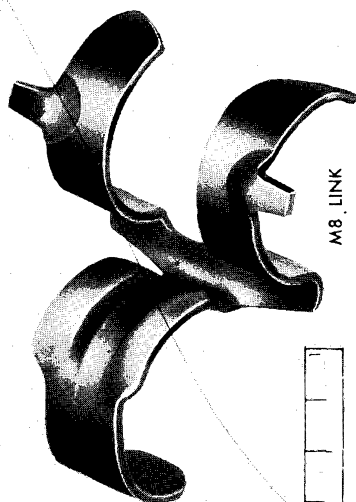
M3 LINK



M4 END LINK



M7 LINK



M8 LINK



RA PD 956308

Figure 36. 20-mm disintegrating belt links.

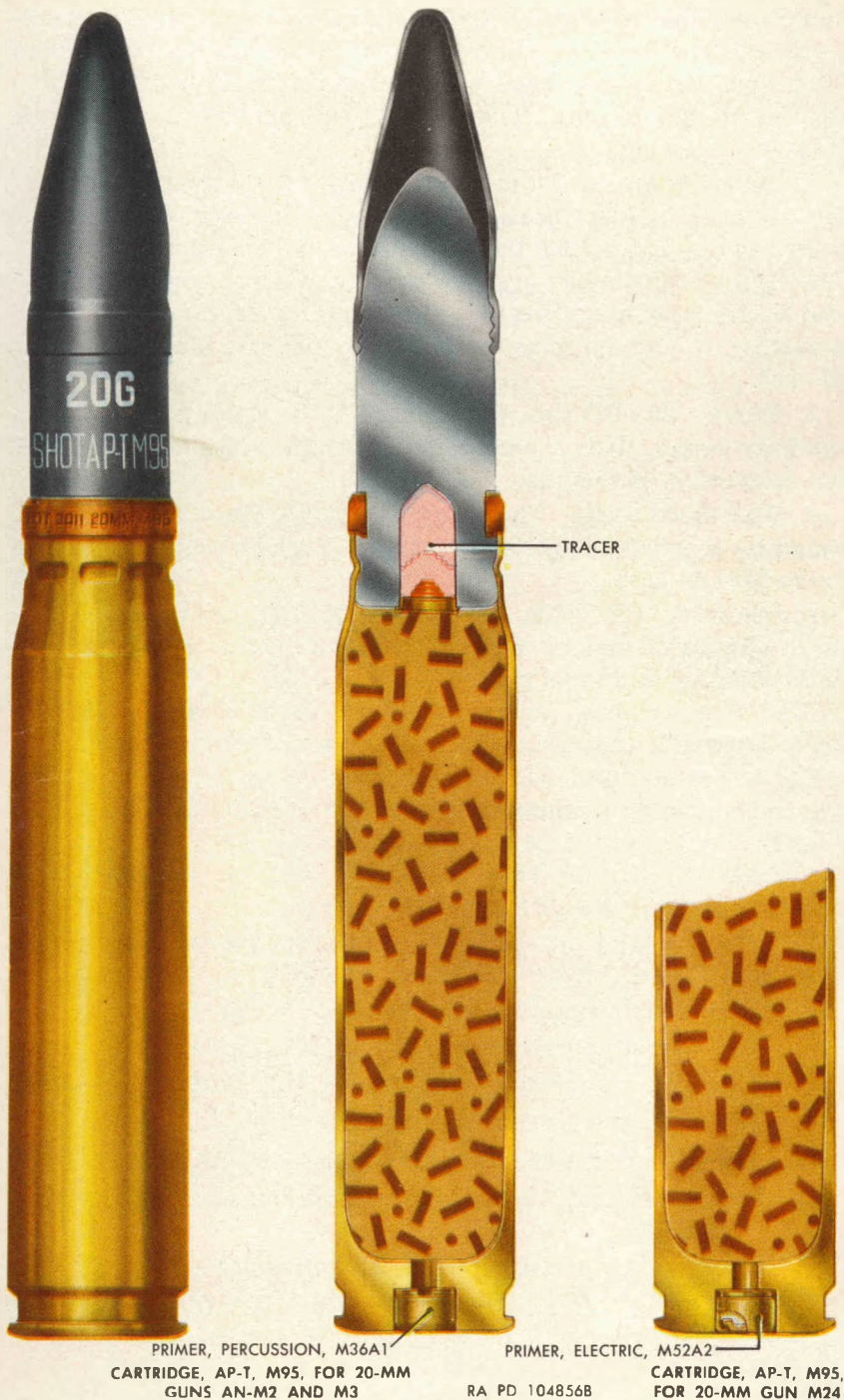


Figure 37. Cartridge, AP-T, M95, for 20-mm guns AN-M2 and M3; and cartridge, AP-T, M95, for 20-mm gun M24 (w/electric primer M52A2).

diary cartridge is slightly lighter in weight than the other projectiles, hence has a muzzle velocity of 2,840 fps. In the M3 and M24 guns, the rounds have velocities approximately 120 fps less than in the British gun. The M18A2 drill cartridge simulates the HEI M97 cartridge.

b. IDENTIFICATION. Painting and marking of 20-mm cartridges for purposes of identification differ from the basic color scheme prescribed in TM 9-1900 but all essential information is provided. The HEI projectile has a yellow ogive and a red body; the AP-T and target practice projectiles are painted black; the incendiary projectile is painted gray with the tip painted blue. (See figs. 37-41.)

c. FUZES. The PD fuze M75 is used with the high-explosive incendiary round. It is a percussion type. See section I, chapter 3, for description of this fuze.

d. CARTRIDGE CASES. The standard cartridge case is the M21A1, weighing approximately 0.205 pound. A single vent is provided in the M21A1 case.

e. PRIMERS. PRIMER, percussion, M36A1, containing a 2.1-grain charge of primer mixture, is standard for the 20-mm ammunition fired in 20-mm guns AN-M2 and M3. PRIMER, electric, M52A2 is a standard for ammunition fired in 20-mm guns M24. See section III, chapter 3, for description of these primers.

f. DISINTEGRATING BELT LINKS. These links, center and end, are considered as ammunition components similar to small-arms ammunition links (fig. 36). They are stored, issued, and reviewed in ORD 11 SNL R-1. They are issued when right- or left-hand feed mechanisms AN-M1 and T15 are required and the M7 and M8 links are issued for the M2 and T15 feed mechanisms. Their nomenclatures and piece marks are as follows:

LINK, disintegrating belt, 20-mm, M8, 7230430

LINK, disintegrating belt, 20-mm, M7, 7225949

LINK, disintegrating belt, 20-mm, M3, C70661 (9)

LINK, disintegrating belt, 20-mm, M3A1, C70661

LINK, end, disintegrating belt, 20-mm, M4, B163774

LINK, end, disintegrating belt, 20-mm, M5 (alternative),
B163775

The M8 link as compared with the M7 link is designed to prevent belt separation and to increase flexibility of the belt.

19. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL's R-1 and R-6.

20. Cartridge, AP-T, M95, for 20-mm Guns AN-M2 and M3 (fig. 37)

a. GENERAL. This cartridge is a standard round for use against armored targets. The projectile is a solid shot made from bar or forged steel. A drawn steel windshield is crimped into annular grooves in the projectile body, the portion of the windshield over the crimping acting as the bourrelet of the projectile. The base of the projectile contains a red tracer composition, sealed in by means of a metal closing cup. The tracer burns for about 2.25 seconds, equivalent to a range of about 1,400 yards. Minimum burning time of tracer is 2.0 seconds, equivalent to a range of 1,270 yards. The cartridge case contains primer M36A1.

b. DATA.

Weight of complete round.....	0.57 lb
Length of complete round.....	7.23 in
Length of projectile.....	3.27 in
Length of cartridge case.....	4.34 in
Width of rotating band.....	0.203 in
Type of base.....	square
Radius of ogive.....	2.3 cal.
Muzzle velocity.....	2,800 fps*
Maximum range.....	5,900 yd
Penetration (at 0° obliquity of face-hardened plate at 400 yd).....	3/4 in
Penetration (at 0° obliquity of homogeneous plate at 400 yd).....	7/8 in

* British gun.

21. Cartridge, AP-T, M95 for 20-mm Gun M24 (w/Electric Primer M52A2 (fig. 37)

This cartridge is identical with the preceding item except that the electric primer M52A2 replaces the M36A1.

22. Cartridge, HEI, M97, w/Fuze, PD, M75, for 20-mm Guns AN-M2 and M3 (fig. 38)

a. GENERAL. This cartridge is a standard round for use against aircraft and light matériel targets, functioning with both explosive and incendiary effect. The explosive filler is tetryl and the incendiary mixture is located in the base of the shell. The weight of the high-explosive-incendiary filler is 0.017 pound. After the shell penetrates the target, its filler is detonated, the shell shat-

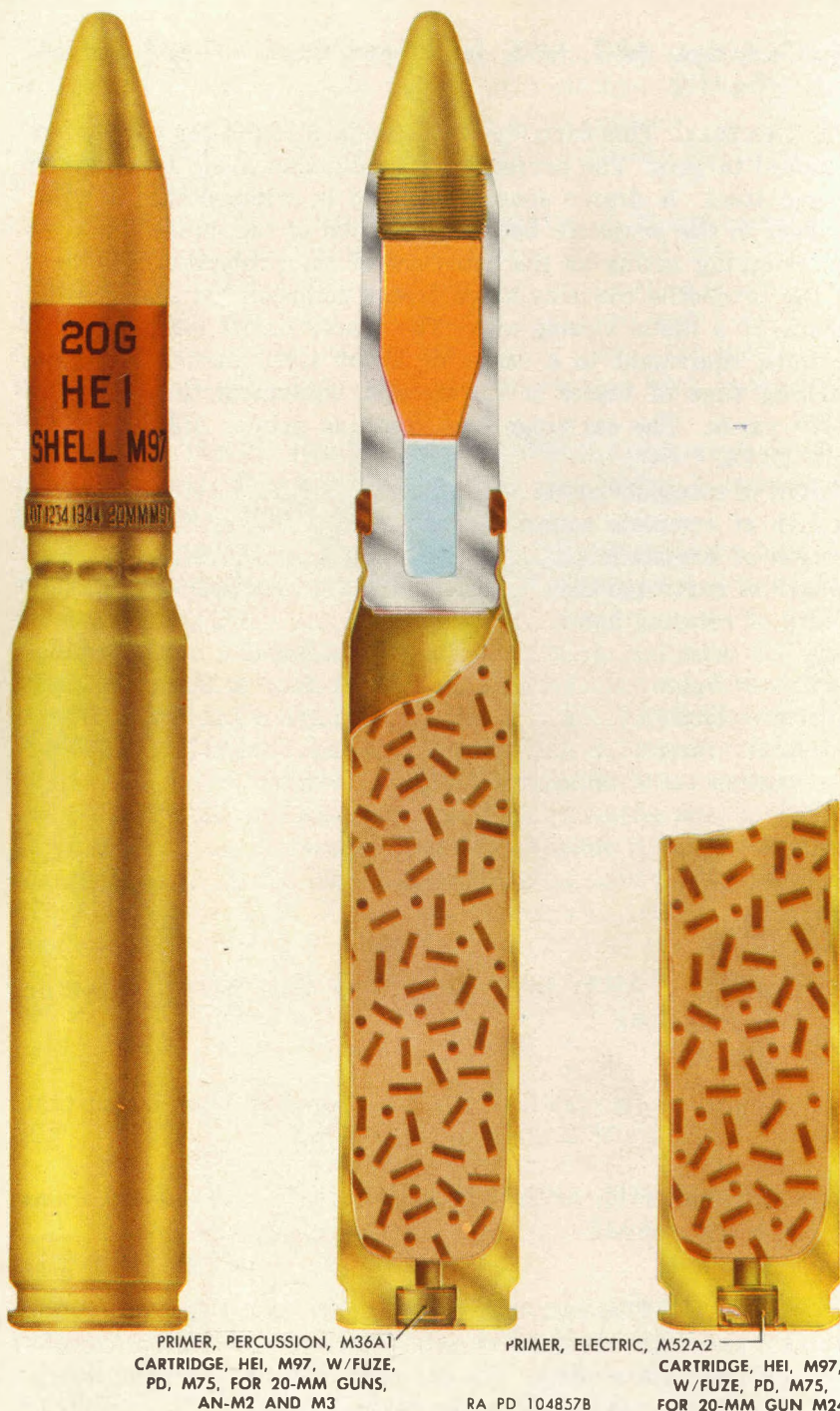


Figure 38. Cartridge, HEI, M97, w/fuze, PD, M75, for 20-mm guns AN-M2 and M3; and cartridge, HEI, M97, w/fuze, PD, M75, for 20-mm gun M24 (w/electric primer M52A2).



PRIMER, PERCUSSION, M36A1
CARTRIDGE, INCENDIARY, M96,
FOR 20-MM GUNS AN-M2 AND M3

PRIMER, ELECTRIC, M52A2
CARTRIDGE, INCENDIARY,
M96, FOR 20-MM
GUN M24

RA PD 104855B

Figure 39. Cartridge, incendiary, M96, for 20-mm guns AN-M2 and M3; and cartridge, incendiary, M96, for 20-mm gun M24 (w/electric primer M52A2).

tered, and the incendiary composition ignited. Its fuze is an instantaneous percussion fuze of the impact type. The thickness of the base is approximately 0.2 inch, and a base cover is welded thereon for additional protection. The cartridge case contains primer M36A1.

b. DATA.

Weight of complete round.....	0.57 lb
Length of complete round.....	7.23 in
Length of fuzed projectile.....	3.28 in
Length of cartridge case.....	4.34 in
Width of rotating band.....	0.203 in
Type of base.....	Square
Radius of ogive.....	2.55 cal.
	(to 0.7 diam, then conical ogive)
Muzzle velocity.....	2,800 fps*
Maximum range.....	5,750 yd

* British gun.

23. Cartridge, HEI, M97, w/Fuze, PD, M75, for 20-mm Gun M24 (w/Electric Primer M52A2) (fig. 38)

This cartridge is identical with the preceding item except that the electric primer M52A2 replaces the M36A1.

24. Cartridge, Incendiary, M96, for 20-mm Guns AN-M2 and M3 (fig. 39)

a. GENERAL. This cartridge is a standard round for use against aircraft, functioning with incendiary effect. The body is made of cold-drawn steel. The nose, threaded to screw into body, is made of a die-cast zinc alloy; it is painted light blue for identification similar to small-arms cartridges. Both the body and nose are filled with incendiary composition. This round does not require a fuze, as functioning is initiated by impact of nose upon target. The cartridge case contains primer M36A1.

b. DATA.

Weight of complete round.....	0.55 lb
Length of complete round.....	7.18 in
Length of projectile.....	3.225 in
Length of cartridge case.....	4.34 in
Width of rotating band.....	0.203 in
Type of base.....	Square
Radius of ogive.....	2.55 cal.
	(to 0.7 diam, then conical ogive)

Muzzle velocity..... 2,840 fps*
 Maximum range..... 5,700 yd

* British gun.

**25. Cartridge, Incendiary, M96, for 20-mm Gun M24 (w/Electric Primer M52A2)
 (fig. 39)**

This cartridge is identical with the preceding item except that the electric primer M52A2 replaces the M36A1.

**26. Cartridge, TP, M99, for 20-mm Guns AN-M2 and M3
 (fig. 40)**

a. GENERAL. This cartridge is a standard round for practice firing. The projectile is similar in shape and ballistic properties to the M96 incendiary shell but is hollow and contains no explosive. The nose consists of a zinc die casting as in the M96 incendiary but its weight is adjusted to give the projectile a weight of 2,000 grains (0.29 lb). The projectile body is made of cold-drawn steel. The cartridge case contains primer M36A1.

b. DATA.

Weight of complete round..... 0.57 lb
 Length of complete round..... 7.23 in
 Length of projectile..... 3.27 in
 Length of cartridge case..... 4.34 in
 Width of rotating band..... 0.203 in
 Type of base..... Square
 Radius of ogive..... 2.54 cal.
 (to 0.7 diam, then conical ogive)

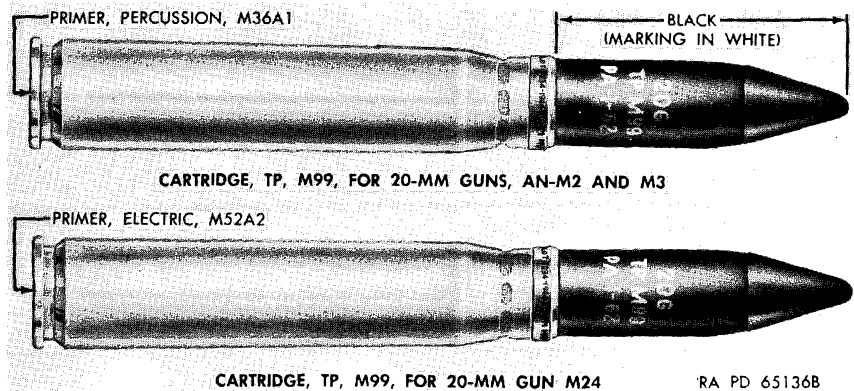


Figure 40. Cartridge, TP, M99, for 20-mm guns AN-M2 and M3; and cartridge, TP, M99, for 20-mm gun M24 (w/electric primer M52A2).

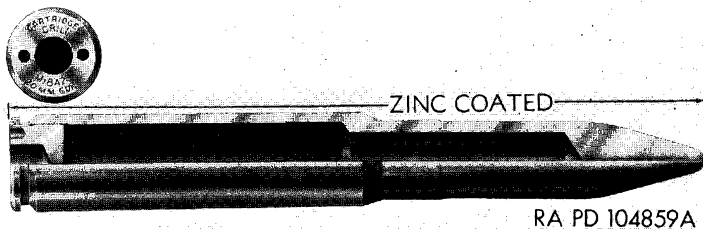


Figure 41. Cartridge, drill, M18A2, for 20-mm guns AN-M2, M3, and M24.

Muzzle velocity----- 2,800 fps*
 Maximum range----- 5,750 yd

* British gun.

**27. Cartridge, TP, M99, for 20-mm Gun M24 (w/Electric Primer M52A2)
 (fig. 40)**

This cartridge is identical with the preceding item except that the electric primer M52A2 replaces the M36A1.

**28. Cartridge, Drill, M182, for 20-mm Guns AN-M2, M3, and M24
 (fig. 41)**

This cartridge is a completely inert assembly intended to provide a simulated service cartridge for drill purposes and for testing the feed mechanism of the weapon. The standard service projectile and cartridge case are simulated by a one-piece zinc-coated casing made of steel, cold-drawn to size, shape, and weight of the standard round. The base is threaded to hold a steel base plug, flanged to provide an extractor groove like that on service ammunition. Alternative manufacturing designs for this drill cartridge have a steel body plug secured in the nose of the cartridge. Weight is 0.57 pound; length is 7.22 inches.

Section II. AMMUNITION FOR 37-mm GUNS

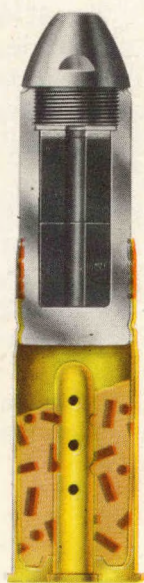
29. General

a. GENERAL DISCUSSION: Based on type of cartridge case used, there are four basic types (fig. 42) of 37-mm ammunition:

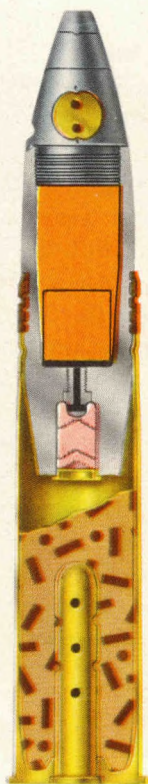
- (1) Rounds for 37-mm guns M1A2 and AN-M9, using cartridge case M17.
- (2) Rounds for 37-mm gun M6, using cartridge case M16.

- A M92 PRACTICE ROUND FOR 37-MM SUBCALIBER GUNS
- B M54 HE ROUND FOR 37-MM GUN, M10
- C M54 HE ROUND FOR 37-MM GUNS, M1A2 AND AN-M9
- D M63 HE ROUND FOR 37-MM GUNS, M3 AND M6

INCHES 1 2 3



A



B



C



D



RA PD 80699B

Figure 42. Comparison of 37-mm ammunition.

(3) Rounds for 37-mm gun M10, using cartridge case Mk 3A2.

(4) Rounds for 37-mm subcaliber guns M1916, M12, M13, M14, and M15, using cartridge case Mk 1A2 (sec. XXI of this ch.).

b. IDENTIFICATION. Painting and marking for identification is in accordance with the basic color scheme prescribed in TM 9-1900.

c. FUZES. FUZE, PD, M56, is fitted to all high-explosive 37-mm ammunition employed against aircraft and similar targets. This is a superquick fuze which is supersensitive since it will function on impact with light matériel targets. For other high-explosive 37-mm rounds, a direct-action inertia-type BD fuze M58 is fitted into shell of current manufacture. The FUZE, PD, M74, is provided for use with the M92 practice shell; the FUZE, dummy, M50, for use with M55A1 TP-T shell and drill cartridges. (See sec. I, ch. 3.)

d. CARTRIDGE CASES. CASE, cartridge, 37-mm, M17, is 8.75 inches long and has an extractor groove near the head. The M16 cartridge case also is 8.75 inches long but has an extractor rim instead of the extractor groove. The Mk 3A2 cartridge case is 5.69 inches long and has an extractor rim. The Mk 1A2 case for 37-mm subcaliber guns is described in section XXI of this chapter. All standard cases are made of brass.

e. PRIMERS. PRIMER, percussion, M38, M38A1, or M38B2, a 55-grain primer, has superseded the 20-grain M23A2 primer for use with 37-mm ammunition. However, until present stocks are exhausted, target practice rounds are to be assembled with M23A2 primer. SHELL, fixed, TP, M63 Mod 1, for 37-mm subcaliber guns, uses the M23A2 primer only. (See sec. III, ch. 3.)

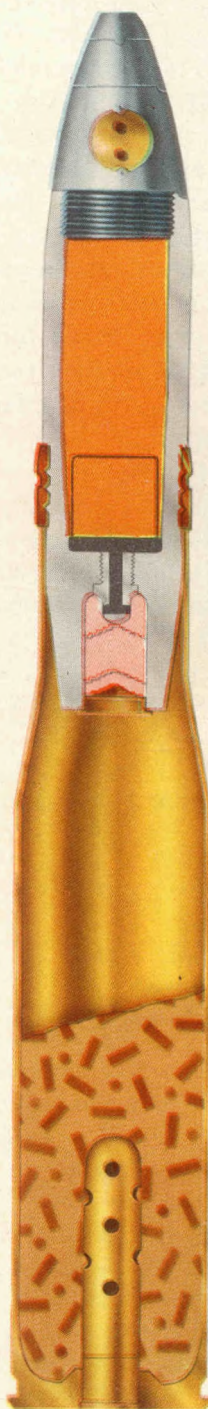
f. LINK. LINK, metallic belt, M6 (T35), D69427, is used in conjunction with rounds for the 37-mm aircraft guns AN-M9 and M10.

30. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL's P-5, P-8, R-1, R-5, and R-6.

31. Shell, Fixed, HE-T, SD, M54, w/Fuze, PD, M56, for 37-mm Guns M1A2 and AN-M9 (fig. 43)

a. GENERAL. This shell is provided for use in the M1A2 and AN-M9 guns for firing against aircraft, hence is fitted with a supersensitive type of superquick fuze. The same shell and fuze



RA PD 80706B

Figure 43. Shell, fixed, HE-T, SD, M54, w/fuze, PD, M56, for 37-mm guns M1A2 and AN-M9.

also are used with the M10 aircraft gun with a different cartridge case, the Mk 3A2. When fired from the M1A2 and AN-M9 guns, the round is assembled with the M17 cartridge case, or with the M17B1 or substitute standard. The projectile consists of a relatively thin-walled shell body, a tetryl bursting charge, FUZE, PD, M56, and a shell-destroying tracer. The nose is threaded to receive the fuze and the "boat-tailed" base is threaded to receive a tracer assembly containing a relay housing, an igniter charge, and a relay igniting charge. These charges connect the tracer with a black powder pellet in the base end of the bursting charge cavity. The tracer burns for about 8 seconds, equivalent to about 3,500 yards, whereupon the relay pellet is ignited and causes the bursting charge to detonate if prior functioning has not been caused by impact.

b. DATA.

Weight of complete round	2.67 lb
Length of complete round	12.81 in
Length of fuze projectile	5.89 in
Length of cartridge case	8.75 in
Width of rotating band	0.74 in
Type of base	Boat-tailed
Degree of taper base	8° 45'
Radius of ogive	4.34 cal.
Muzzle velocity	2,600 fps
Maximum range	3,500 yds*

* Limited by shell-destroying tracer. Theoretical maximum is 9,050 yards, horizontal, and 6,300 yards, vertical.

32. Shot, Fixed, APC-T, M59A1, for 37-mm Gun M1A2 and AN-M9 (fig. 44)

a. GENERAL. This shot is adapted from the M51 shot (par. 36) to provide armor-piercing ammunition for the 37-mm gun M1A2, and for the AN-M9 gun. The shot body, armor-piercing cap, and tracer are similar to the corresponding parts of the M51 armor-piercing shot, but the windshield is omitted. This gives the M59A1 shot a blunt flat-nosed appearance, in contrast to the long, tapered shape of the M51 shot. Penetrating qualities are not affected, so that both projectiles are about equally effective against the same types of armor plate. However, the effective range is less than that of the M51 shot. The M59A1 shot differs from the earlier M59 shot only in the contour and method of attaching the armor-piercing cap to the projectile body, which is by means of a



RA PD 80707B

Figure 44. Shot, fired, APC-T, M59A1, for 37-mm guns M1A2 and AN-M9.

360° crimp. The cap corner is rounded off in the M59A1 design to prevent interference in the gun feed mechanism and to prevent scoring of the gun chamber.

b. DATA.

Weight of complete round.....	3.17 lb
Length of complete round.....	12.88 in
Length of projectile.....	4.71 in
Length of cartridge case.....	8.75 in
Width of rotating band.....	0.74 in
Type of base.....	Square
Muzzle velocity.....	2,050 fps*
Maximum range.....	5,790 yds*
Penetration (at 0° obliquity of face-hardened plate at 1,000 yd)	0.8 in*

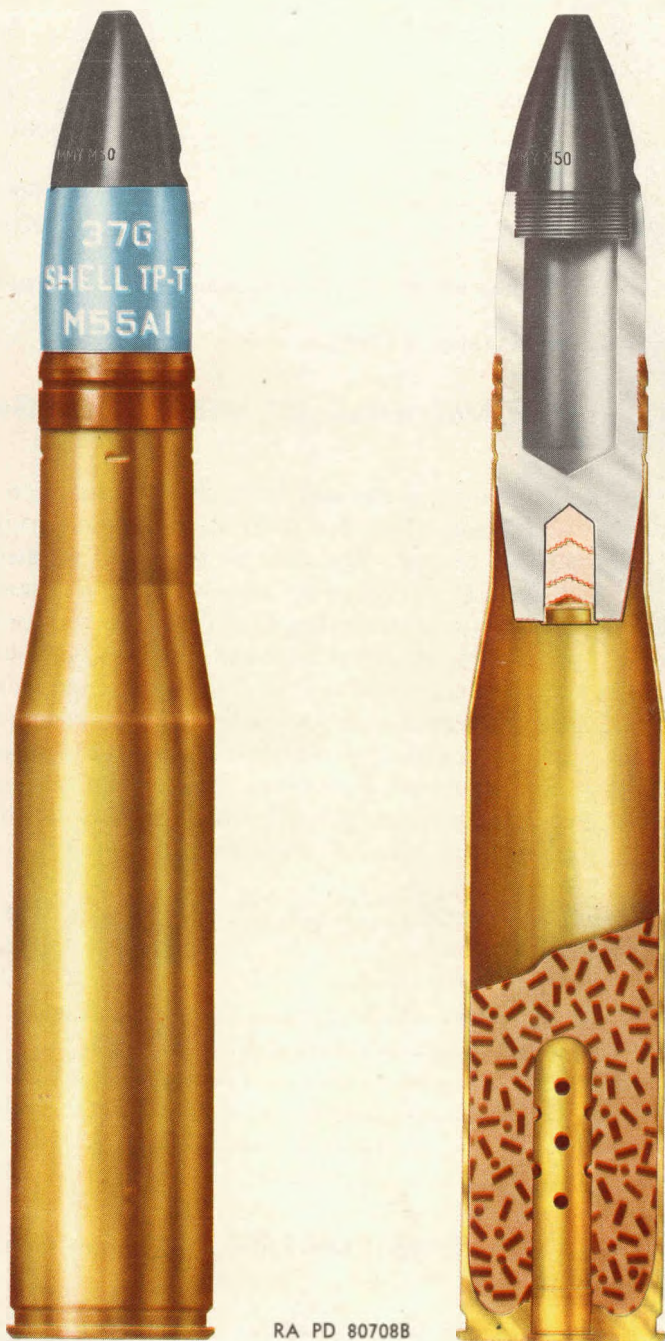
* Data for M1A2 gun: Maximum vertical range is 4,000 yd. Muzzle velocity for AN-M9 gun is 2,800 fps.

33. Shot, Fixed, APC-T, M59A1, for 37-mm Gun AN-M9 (fig. 44)

This shot differs from the round described in paragraph 32 only in the propelling charge, the muzzle velocity, and the marking on the cartridge case which is "37G, AN-M9, MV 2,800." The propelling charge for this round weighs 0.52 pound as compared with 0.31 pound for the propelling charge for the M1A2 gun round. Armor penetration for this projectile in the AN-M9 gun is much greater than when fired in the M1A2 due to the greater muzzle velocity. Weight of the complete round is 3.38 pounds.

34. Shell, Fixed, TP-T, M55A1, MV 2,600, w/Fuze, Dummy, M50, for 37-mm Guns M1A2 and AN-M9 (fig. 45)

a. GENERAL. This shell provides practice ammunition for these guns, with the same ballistic characteristics as the high-explosive service round M54 (par. 31). The M17 (brass) or M17B1 (steel) cartridge case and a service primer and propelling charge are used. The projectile is similar in contour to the M54 shell and of the same weight, but has no bursting charge and is fitted with a dummy-fuze. In addition, the shell-destroying tracer of the service round is replaced by a composition for tracing purposes only. The tracer, consisting of a red tracer composition and an igniter composition, burns for about 8 seconds, or 3,500 yards. FUZE, dummy, M50, simulates the M56 service fuze but has no explosive elements.



RA PD 80708B

Figure 45. Shell, fired, TP-T, M55A1, MV 2,600, w/fuze, dummy, M50, for 37-mm guns M1A2 and AN-M9.

b. DATA.

Weight of complete round.....	2.67 lb
Length of complete round.....	12.81 in
Length of fuze'd projectile.....	5.87 in
Length of cartridge case.....	8.75 in
Width of rotating band.....	0.74 in
Type of base.....	Boat-tailed
Degree of taper of base.....	8° 45'
Muzzle velocity.....	2,600 fps*
Maximum range.....	9,050 yd**

* Current manufacture; earlier rounds were loaded for 2,800 fps muzzle velocity.

** Horizontal; vertical range is 6,300 yd.

**35. Shell, Fixed, HE, M63, w/Fuze, BD, M58 for 37-mm Gun M6
(fig. 46)**

a. GENERAL. This shell is for use with 37-mm tank gun when fragmentation and blast effect are desired. The shell body is a relatively heavy steel casing. The nose is solid and formed to a long ogive. The base is threaded to receive the M58 base fuze which functions with nondelay action. This construction provides a maximum distribution of metal forward of the TNT bursting charge and for some penetration before detonation, increasing the effectiveness against targets such as sheltered or entrenched personnel, trucks, and light armored vehicles. The round is assembled with both brass and steel cartridge cases. Present muzzle velocity is 2,600 fps, but rounds of earlier manufacture may be encountered which are loaded to give 2,700 fps muzzle velocity.

b. DATA.

Weight of complete round.....	3.08 lb
Length of complete round.....	14.09 in
Length of fuze'd projectile.....	6.02 in
Length of cartridge case.....	8.75 in
Width of rotating band.....	0.74 in
Type of base.....	Square
Radius of ogive.....	8.97 cal.
Muzzle velocity.....	2,600 fps
Maximum range.....	9,500 yd

**36. Shot, Fixed, APC-T, M51, MV 2,900, for 37-mm Gun M6
(fig. 47)**

a. GENERAL. This shot is provided for use in 37-mm tank gun against light armor and similar matériel targets. The shot de-



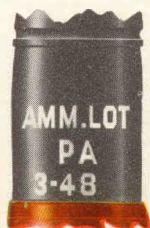
RA PD 80711B



Figure 46. Shell, fixed, HE, M63, w/fuze, BD, M58, for 37-mm gun M6.



SHOT ROTATED
180°



RA PD 104852A

Figure 47. Shot, fixed, APC-T, M51, MV 2,900, for 37-mm gun M6.

pendes for its effect upon the force of its impact and penetration; the use of an armor-piercing cap especially adapts it for combating face-hardened plate. Three types of projectile—M51, M51B1, and M51B2—have been manufactured for the round. The M51B1 differs from the alternative M51B2 in that the armor-piercing cap is pointed, whereas the cap of the M51B2 is rounded at the front end. The M51, an earlier design, has a pointed cap, but differs from both the M51B1 and M51B2 in that the tracer cavity is closed by a steel washer crimped to the base of the projectile. The tracer cavities of the M51B1 and M51B2 are closed by a metal disk. In other respects, construction is similar, the projectile being made up of a hard steel core or body, the harder steel armor-piercing cap, and a lightweight windshield or false ogive which is crimped or screwed onto the armor-piercing cap. There is no bursting charge, the projectile being solid except for the small cavity in the base. This holds a red tracer composition which burns for approximately 3 seconds, equivalent to about 2,300 yards.

b. DATA.

Weight of complete round	3.46 lb
Length of complete round	14.55 in
Length of projectile	6.36 in
Length of cartridge case	8.75 in
Width of rotating band	0.74 in
Type of base	Square
Radius of ogive (false ogive)	8.97 cal.
Muzzle velocity	2,900 fps*
Maximum range	12,850 yd
Penetration (at 0° obliquity of face-hardened plate at 1,000 yd)	2.1 in
Penetration (at 0° obliquity of homogeneous plate at 1,000 yd)	2.3 in

* For rounds with brass cartridge cases. Rounds of earlier manufacture have muzzle velocity of 2,600 fps. Identification provided by marking on packing boxes.

37. Shot, Fixed, TP-T, M51A2, for 37-mm Gun M6 (fig. 48)

a. GENERAL. This shot simulates SHOT, fixed, APC-T, M51, for practice firing from the tank gun. Components are the same as for the service round (par. 36), except that the projectile body is a solid slug having the same over-all dimensions as combined body and armor-piercing cap of service shot. The windshield is attached to the body instead of the cap as in the M51 APC shot.



RA PD 80713A

Figure 48. Shot, fixed, TP-T, M51A2, for 37-mm gun M6.

The M51A2 TP shot supersedes an M51A1 TP design which was similar except that no windshield was present.

b. DATA.

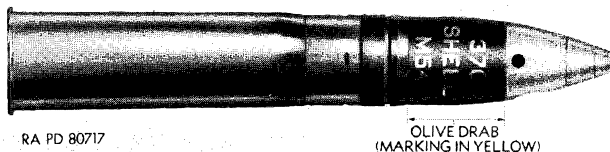
Weight of complete round	3.39 lb
Length of complete round	14.55 in
Length of projectile	6.36 in
Length of cartridge case	8.75 in
Width of rotating band	0.74 in
Type of base	Square
Radius of ogive (false ogive)	8.97 cal.
Muzzle velocity	2,900 fps
Maximum range	12,850 yd

38. Shell, Fixed, HE-T, SD, M54, w/Fuze, PD, M56, for 37-mm Gun M10 (fig. 49)

a. GENERAL. This round has the same shell as used in rounds for M1A2 and AN-M9 automatic guns (par. 31), and is adapted for use in the M10 aircraft gun by assembling it with the Mk 3A2 cartridge case. Because of lower muzzle velocity, the shell-destroying element functions at about 2,000 yards. The propelling charge is entirely different in design and weight from those used in the M1A2 and AN-M9 guns.

b. DATA.

Weight of complete round	2.67 lb
Length of complete round	9.75 in
Length of fuzeed projectile	5.89 in
Length of cartridge case	5.69 in



RA PD 80717

Figure 49. Shell, fixed, HE-T, SD, M54, w/fuze, PD, M56, for 37-mm gun M10.

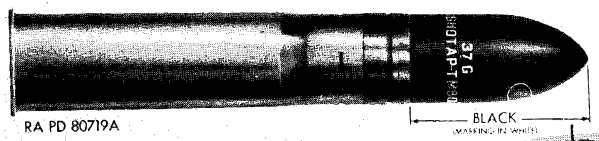


Figure 50. Shot, fixed, AP-T, M80, MV 1,825, for 37-mm gun M10.

Width of rotating band.....	0.74 in
Type of base	Boat-tailed
Degree of taper.....	8° 45'
Radius of ogive.....	4.34 cal.
Muzzle velocity	2,000 fps

39. Shot, Fixed, AP-T, M80, MV 1,825, for 37-mm Gun M10 (fig. 50)

a. GENERAL. This shot is the same as that for the automatic gun AN-M9, except for the cartridge case. For the M10 gun, the Mk 3A2, loaded with a smaller propelling charge, is used in the round.

b. DATA.

Weight of complete round.....	2.29 lb
Length of complete round.....	9.35 in
Length of projectile.....	4.24 in
Length of cartridge case.....	5.69 in
Width of rotating band.....	0.74 in
Type of base.....	Square
Radius of ogive.....	1.62 cal.
Muzzle velocity	1,825 fps
Maximum range	6,700 yd
Penetration (at 0° obliquity of face-hardened plate at 1,000 yd).....	0.6 in
Penetration (at 0° obliquity of homogeneous plate at 1,000 yd).....	0.8 in

40. Shell, Fixed, TP-T, M55A1, w/Fuze, Dummy, M50 for 37-mm Gun M10 (fig. 51)

a. GENERAL. This shell differs from that described in paragraph 34 only in that the Mk 3A2 cartridge case, and a smaller propelling charge are used. It provides practice ammunition for the M10 gun with ballistic properties similar to those of the M54 HE round.

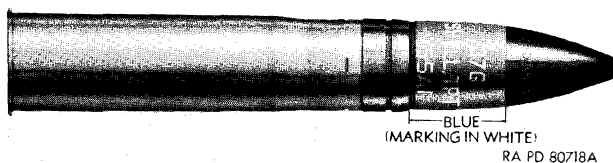


Figure 51. Shell, fixed, TP-T, M55A1, w/fuze, dummy, M50, for 37-mm gun M10.

b. DATA.

Weight of complete round.....	2.00 lb
Length of complete round.....	9.75 in
Length of fuzed projectile.....	5.87 in
Length of cartridge case.....	5.69 in
Width of rotating band.....	0.74 in
Type of base.....	Boat-tailed
Degree of taper.....	8° 45'
Radius of ogive.....	4.34 cal.
Muzzle velocity	2,000 fps

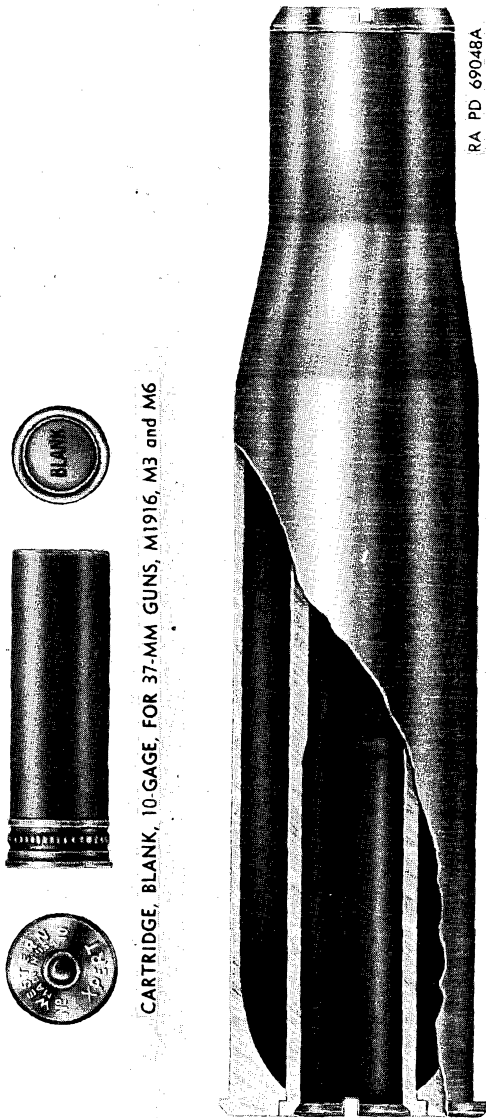
41. Cartridge, Blank, 10-Gage, 37-mm Gun M6 (fig. 52)

This cartridge consists of a commercial 10-gage blank shotgun shell loaded with 8 grains of black powder and containing dry felt wads. For firing with the M1916 gun, the blank cartridge is used with ADAPTER, M1; in the M6 gun, the cartridge is used with ADAPTER, M2.

a. Both adapters are made up of three parts—a modified service cartridge case; a liner of steel tubing which extends through the cartridge case and acts as a seat for the blank cartridge; and an aluminum or steel bushing. The bushing serves to seat the liner firmly in position and to protect the neck of the cartridge case during handling and loading into the gun as well as to protect gun parts from damage during firing.

b. The M16 cartridge case is used to make up ADAPTER, M2, the primer hole being enlarged to seat the liner. This liner extends through the cartridge to a distance just short of the mouth of the case. The front end is threaded and screws into the steel bushing. When fully seated, this bushing protrudes approximately one-quarter inch beyond the cartridge case mouth.

c. A modified Mk 1A2 cartridge case is used to make up the M1 adapter. In this adapter, the bushing extends approximately 1¾ inches beyond the cartridge case mouth; hence, when this ammunition is loaded into the gun, it extends into the bore of the gun for approximately that distance. In firing with either the

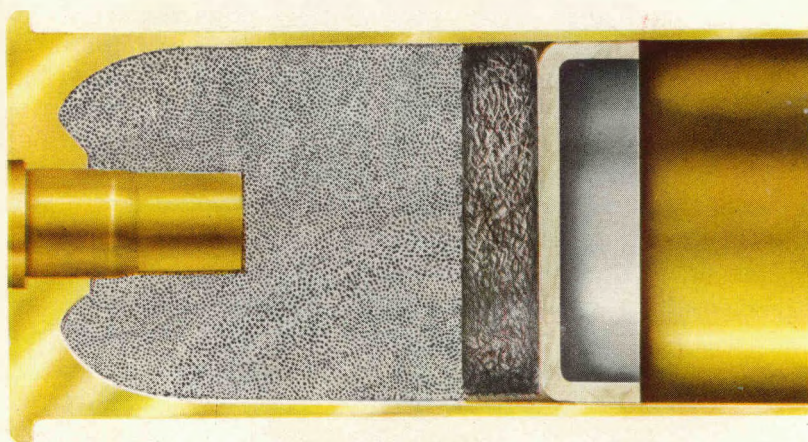


CARTRIDGE, BLANK, 10-GAGE, FOR 37-MM GUNS, M1916, M3 and M6

ADAPTER, M2, FOR 37-MM GUNS, M3 AND M6

RA PD 69048A

Figure 52. Adapter and blank cartridge for 37-mm guns.



RA PD 80715B

Figure 53. Ammunition, blank, for 37-mm gun M6.

M1 or the M2 adapter, the percussion element of the blank shot-gun cartridge serves as the primer.

d. DATA ARE AS FOLLOWS:

	<i>M1916 gun</i>	<i>M6 gun</i>
Weight of adapter, w/o cartridge.....	0.87 lb	2.00 lb
Weight of adapter, w/cartridge.....	0.91 lb	2.04 lb
Length of adapter.....	6.00 in	9.00 in
Length of cartridge case.....	3.64 in	8.75 in
Length of blank cartridge.....	2.85 in	2.85 in

42. Ammunition, Blank, for 37-mm Gun M6 (fig. 53)

This ammunition is for simulated fire and for saluting purposes. It consists of a brass or steel cartridge case, 4 inches long, which contains a service primer and a 3.2-ounce charge of loose black powder. The powder charge is held in position around the primer by a closing cup made up of a felt inner padding and a thin pulpboard front surface. The closing cup is sealed in position with Pettman cement about five-eighths inch from the front of the cartridge case.

43. Cartridge, Drill, M21, w/Fuze, Dummy, M50B2, for 37-mm Guns M1A2 and AN-M9 (fig. 54)

This cartridge simulates the M54 HE round for M1A2 and AN-M9 guns. It consists of the steel cartridge case M17B1, assembled with an empty M54 shell and an M50B2 (one-piece, steel) dummy fuze. The shell and case are held together by means of a steel retaining rod, one end of which is inserted into the enlarged tracer cavity in the base of the shell. The other end is screwed into a cartridge case plug assembly which takes the place of the primer. This plug assembly is inserted with a free fit in the primer hole. A copper plug is assembled in the base of the plug assembly so that the firing pin of the weapon will not be injured in simulated

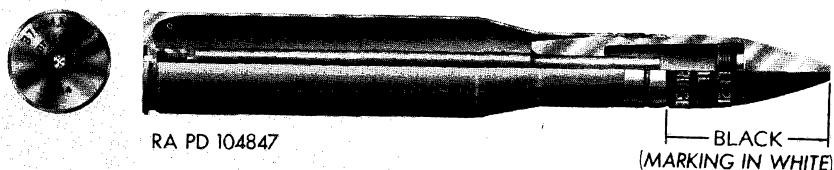


Figure 54. Cartridge, drill, M21, w/fuze, dummy, M50B2, for 37-mm guns M1A2 and AN-M9.

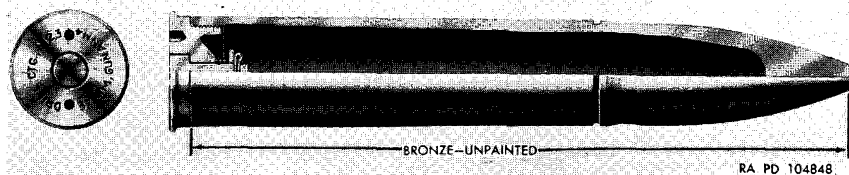


Figure 55. Cartridge, drill, M23, for 37-mm gun M10.

firings. Weight of complete round is 2.67 pounds; length of complete round is 12.81 inches.

44. Cartridge, Drill, M23, for 37-mm Gun M10 (fig. 55)

This cartridge simulates the M54 HE round for the 37-mm gun M10. It consists of a one-piece bronze body which simulates the fuze, shell, and cartridge case of the M54 round and a steel base which is screwed into the body. The base contains a copper plug held therein by a steel spring, steel washer, and cotter pin. The plug is made of copper so that the firing pin of the weapon will not be injured during simulated firings. Weight of complete round is 1.93 pounds; length of complete round is 9.75 inches.

45. Cartridge, Drill, M13, for 37-mm Gun M6 (fig. 56)

This cartridge is a completely inert cartridge which simulates the M51 service round for use in drill. It consists of a modified M51A2 target practice shot (which, in turn, closely resembles the M51 APC service shot for these guns), an M16 or M16B1 cartridge case, and a steel retaining bar with a naillike head and a threaded forepart. The retaining bar extends the length of the cartridge case and screws into the base of the projectile when the drill cartridge is assembled. The projectile is modified for this purpose by lengthening the tracer cavity of the target practice shot to approximately 2 inches and threading the drilled hole. Weight of complete round is 3.30 pounds; length of complete round is 14.54 inches.

Section III. AMMUNITION FOR 40-mm GUNS

46. General

a. GENERAL DISCUSSION. Sometimes referred to as the "Bofors" gun, GUN, automatic, 40-mm, M1, is primarily a rapid-fire automatic gun for antiaircraft defense, but can be set for a single

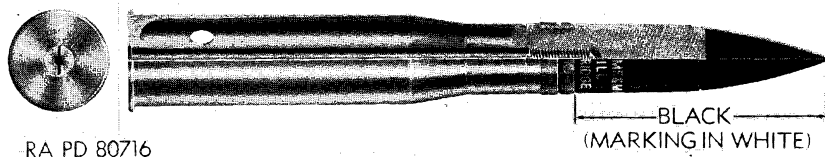


Figure 56. Cartridge, drill, M13, for 37-mm gun M6.

shot. The gun is fed by an automatic mechanism into which 4-round charger clips are loaded by hand. Use of the word "cartridge" to indicate a complete round of 40-mm fixed ammunition resulted from a joint agreement of the United States Army, the United States Navy, and the British.

b. INTERCHANGEABILITY. Since the Army guns are basically the same as Navy and British 40-mm guns, the ammunition may be interchanged.

c. IDENTIFICATION. Rounds of Army procurement are painted and marked for identification in accordance with basic color scheme prescribed in TM 9-1900 and illustrated in figures 57 through 61. In other cases, painting and marking may follow practices of other services.

d. FUZES. The supersensitive point detonating fuze Mk 27 is used with 40-mm high-explosive shell (sec. I, ch. 3, and pars. 49 and 50).

e. CARTRIDGE CASES. CASE, cartridge, 40-mm, M25 or M25B1, is used with 40-mm ammunition of Army procurement. The M25B1 case, made of steel, differs from the standard brass M25 case in having a thinner head and primer seat; the M25 weighs 1.942 pounds and the steel case approximately 0.31 pound less. Ammunition of Navy design will have the Mk 2 or Mk 2 Mod 1 brass case or the Mk 3 steel case; the brass case weighs 1.89 pounds and the steel case weighs 0.36 pound less.

f. PRIMERS. PRIMER, percussion, M38A1, a 55-grain primer, is standard for rounds of Army procurement, but the earlier standard 20-grain M23A2 primer still may be found in rounds of less recent manufacture. Alternative primers are the Mk 22 Navy primer and the M38B1 and the M38B2 percussion primer. For descriptions of these primers, see section III, chapter 3.

47. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL's P-5 and P-8.



RA PD 80721A

Figure 57. Cartridge, AP-T, M81A1, for 40-mm guns.

48. Cartridge, AP-T, M81A1, for 40-mm Guns (fig. 57)

a. GENERAL. This cartridge is provided for the 40-mm guns for firing against armored targets. The projectile is a monobloc type, of solid steel. A tracer cavity in the base holds a red tracer composition. The nose of the body proper is shaped to a relatively blunt ogive. However, a long false ogive is provided for better ballistics, by securing a lightweight windshield or false ogive to the shot body by a 360° crimp just forward of the bourrelet. The M81A1 shot has no armor-piercing cap. The length of trace is 12 seconds. The M81A1 shot differs from the earlier M81 model in that the windshield is crimped directly to the body, whereas, in the M81, the windshield is secured to the shot body by means of an adapter.

b. DATA.

Weight of complete round.....	4.58 lb
Weight of projectile, as fired.....	1.96 lb
Length of complete round.....	17.602 in
Length of projectile.....	6.19 in
Length of cartridge case.....	12.24 in
Width of rotating band.....	0.64 in
Type of base.....	Square
Radius of ogive.....	5.96 cal.
Muzzle velocity.....	2,870 fps
Maximum range.....	9,600 yd
Penetration (at 0° obliquity of face-hardened plate at 1,000 yd).....	1.8 in
Penetration (at 0° obliquity of homogeneous plate at 1,000 yd).....	1.8 in

49. Cartridge, HE-T, SD MK 11, MK 2, MV 2,870, w/Fuze, PD, MK 27, for 40-mm Guns (fig. 58)

a. GENERAL. This cartridge consists of the M25 brass or M25B1 alternative steel cartridge case, with the M38A1 primer. The case is crimped rigidly to a Mk 2 high-explosive shell fitted with the Mk 27 supersensitive fuze. The Mk 2 shell consists of three principal parts—a hollow steel casing containing a high-explosive bursting charge of pressed TNT, the point detonating fuze, and a shell-destroying (SD) tracer (fig. 59). The nose of the shell is conical, with a 7° 15' taper, and is cut and threaded internally to receive the fuze. The base is boat-tailed (conical) with a 7° 45'

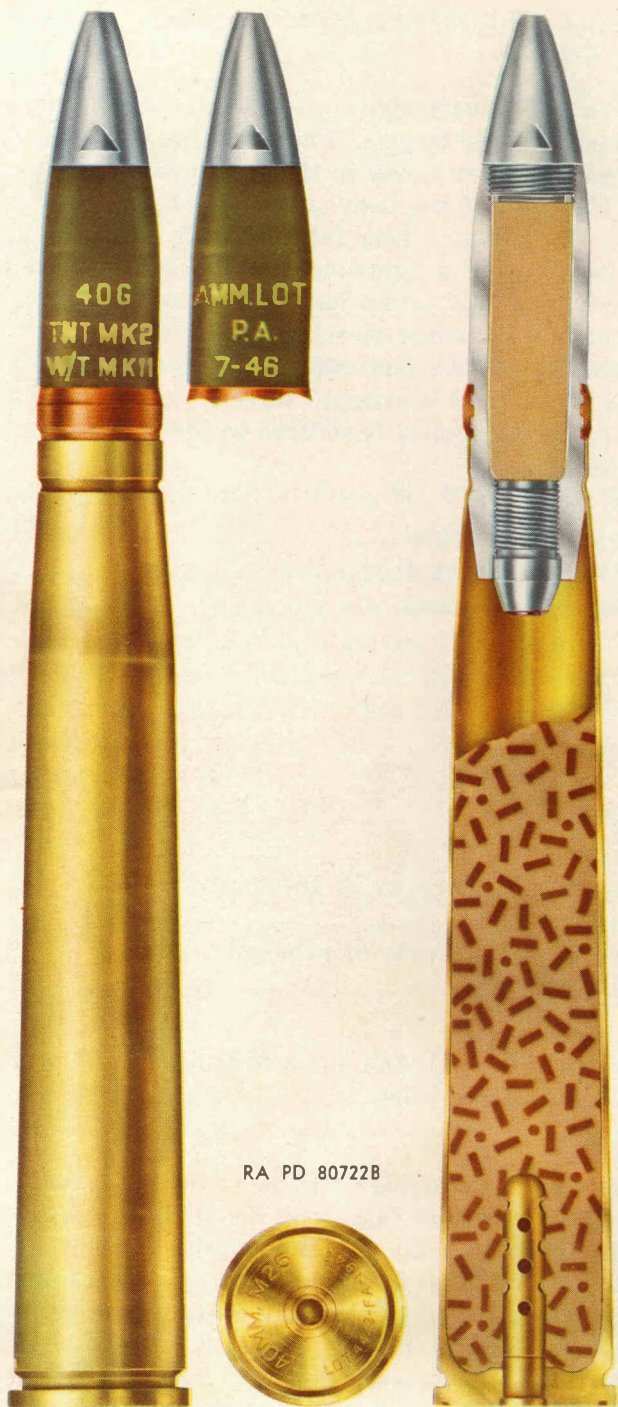
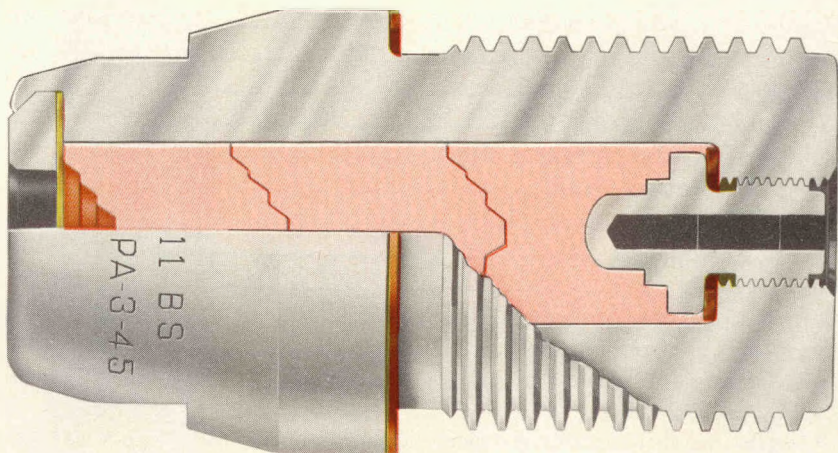
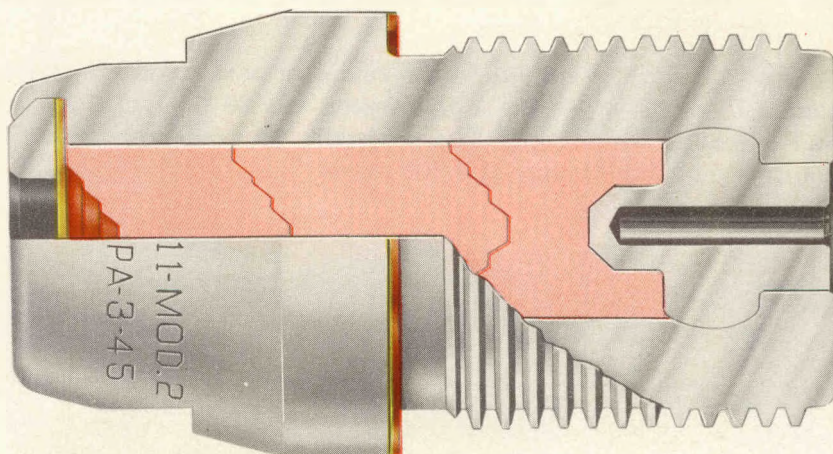


Figure 58. Cartridge, HE-T, SD, MK 11, MK 2, MV 2,870, w/fuze, PD, MK 27, for 40-mm guns.



A—SD TRACER MK 11



B—SD TRACER MK 11-MOD 2

RA PD 104858A

Figure 59. Shell-destroying tracers for 40-mm HE shell MK 2.

taper, and is threaded internally to accommodate the shell-destroying tracer assembly Mk 11 or Mk 11 Mod 2, of Navy origin, which protrudes beyond the base of the shell for approximately 0.56 inch. The tracer consists of an igniting charge, a red tracer composition, and a relay igniting charge of black powder. The red tracer composition burns with a visible trace for 8 to 10 seconds, equivalent to a range of 3,800 to 4,300 yards. As the tracer burns out, the relay igniting charge is ignited, detonating the bursting charge of the shell unless prior detonation has been caused by functioning of the fuze.

b. DATA.

Weight of complete round.....	4.75 lb
Weight as fired.....	1,985 lb
Length of complete round.....	17.602 in
Length of fuzeed projectile.....	7.64 in
Length of cartridge case (M25).....	12.24 in
Width of rotating band.....	0.64 in
Type of base.....	Boat-tailed
Degree of taper.....	7° 45'
Muzzle velocity.....	2,870 fps
Maximum range, horizontal.....	5,200 yd*
Maximum range, vertical.....	5,100 yd*
Propellant (M1 powder).....	0.72 lb

* Limited by shell-destroying tracer. Theoretical maximum: 11,000 yards, horizontal, and 7,800 yards, vertical.

50. Cartridge, HE-T, SD M3A1, MK 2, MV 2,870, w/Fuze, PD, MK 27, for 40-mm Guns

This cartridge is similar to the round in paragraph 49 except that the projectile has the M3A1 tracer, is 7.88 inches in length, and is loaded with tetryl. The projectile, as fired, weighs 2.061 pounds; maximum range is 5,700 yards.

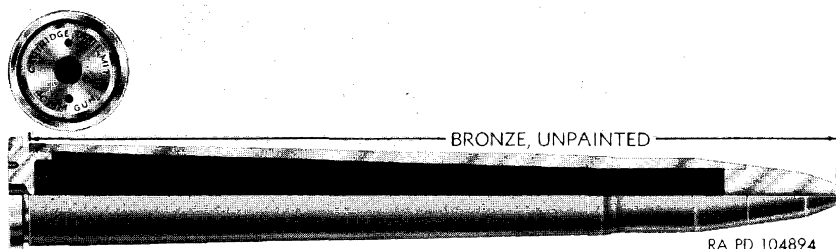


Figure 60. Cartridge, drill, M17, for 40-mm guns.

**51. Cartridge, Drill, M17, for 40-mm Guns
(fig. 60)**

This cartridge is a completely inert assembly for drill purposes. The body is shaped in the general form of a service projectile and a fixed cartridge case. The nose end of the assembly may be left open and threaded to hold an iron plug resembling a service fuze, or the body and nose may be made in one piece. The base end of the body is closed by an iron base plate which screws into the body (iron or bronze) and has a flange to pro-

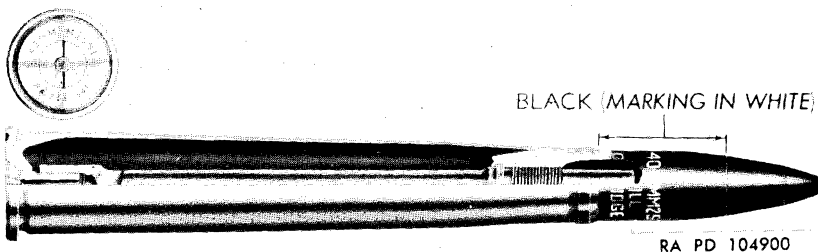


Figure 61. Cartridge, drill, M25, w/fuze, dummy, M69, for 40-mm guns.

vide for extraction of the cartridge after loading in the gun. The complete cartridge weighs approximately 4.75 pounds; length is 17.602 inches.

52. Cartridge, Drill, M25, w/Fuze, Dummy, M69, for 40-mm Guns (fig. 61)

This cartridge is provided as an alternative drill round for 40-mm guns. It consists of a modified Mk 2 service shell body and a modified M25B1 steel cartridge case held in assembled position by a steel retaining rod. The cartridge case is modified by enlarging the primer hole to seat a steel plug threaded at the forward end. A copper rivet pressed into the rear of the plug gives a simulated primer head. In assembling the two major parts, the retaining rod screws onto the plug assembly of the cartridge case. The shell, which has a specially drilled and threaded base, screws onto the forward end of the retaining rod. Dummy fuze M69B1 completes the assembly. The complete cartridge weighs 4.75 pounds; length is 17.60 inches.

Section IV. AMMUNITION FOR 57-mm GUNS

53. General

a. GENERAL DISCUSSION. All 57-mm guns now in use are primarily antitank weapons. Various types of mounts are in use, and the British 6 Pr. Mk 3 is further distinguished from American makes by a shorter barrel. However, all present types are chambered alike and therefore fire the same ammunition. The 57-mm ammunition is in the form of complete fixed rounds or cartridges. Ammunition with explosive filler is shipped fuze. Ammunition and components for 57-mm guns now are classified as limited standard.

b. IDENTIFICATION. Painting and marking for identification is in accordance with the basic scheme prescribed in TM 9-1900. Typical painting and marking on the rounds are illustrated in figures 62 and 63.

c. FUZES. FUZE, BD, M72, is used with explosive-containing armor-piercing-capped (APC-T) projectiles. This fuze functions with delay action and has a tracer in its base which operates independently of the fuze mechanism. High-explosive shell employ the M85 or M86 fuze. These are single-action point detonating fuzes which function with superquick action on impact. See section I, chapter 3.

d. CARTRIDGE CASES. CASE, cartridge, 57-mm, M23A2, is the standard cartridge case for 57-mm ammunition.

e. PRIMERS. PRIMER, percussion, M1B1A2, is the standard primer for ammunition in this caliber. PRIMER, percussion, M1A2, is an alternative primer (sec. III, ch. 3).

54. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL's R-1 and R-6.

55. Cartridge, APC-T, M86, w/Fuze, PD, M72, for 57-mm Guns (fig. 62)

a. GENERAL. This cartridge is provided for use against armor-protected targets. The complete round consists of the standard cartridge case, primer, and propelling charge, assembled to a loaded armor-piercing-capped projectile. Construction of the projectile is similar to that of corresponding armor-piercing-capped projectiles in larger calibers. The projectile body is of hardened steel, and has a square base and an ogival nose. The hardened steel cap, crimped to the nose, increases the effectiveness against face-hardened plate. For better ballistics, a lightweight ogival windshield is secured to the cap by crimping. An M72 base detonating fuze is fitted to the base to explode the small high-explosive charge of explosive D. The fuze has incorporated in it the M17 detonator assembly which detonates the explosive D and tetryl pellet bursting charge. The fuze functions with delay action and has a tracer in its base which operates independently of the fuze mechanism. The tracer burns for approximately 4.5 seconds after being ignited by the propelling charge, providing a visible trace for observation purposes over a range of about 3,000 yards.



Figure 62. Complete round of 57-mm armor-piercing-capped ammunition.

b. DATA.

Weight of complete round.....	13.73 lb
Length of complete round.....	26.72 in
Length of fuzeed projectile.....	11.24 in
Length of cartridge case.....	17.40 in
Width of rotating band.....	0.79 in
Type of base.....	Square
Radius of ogive.....	7.13 cal.
Muzzle velocity.....	2,700 fps*
Maximum range.....	13,555 yd**
Penetration (at 0° obliquity of face-hardened plate at 1,000 yd).....	3.6 in
Penetration (at 0° obliquity of homogeneous plate at 1,000 yd).....	3.5 in

* Muzzle velocity in the British 6 Pr. Mk 3 gun is 2,580 fps.

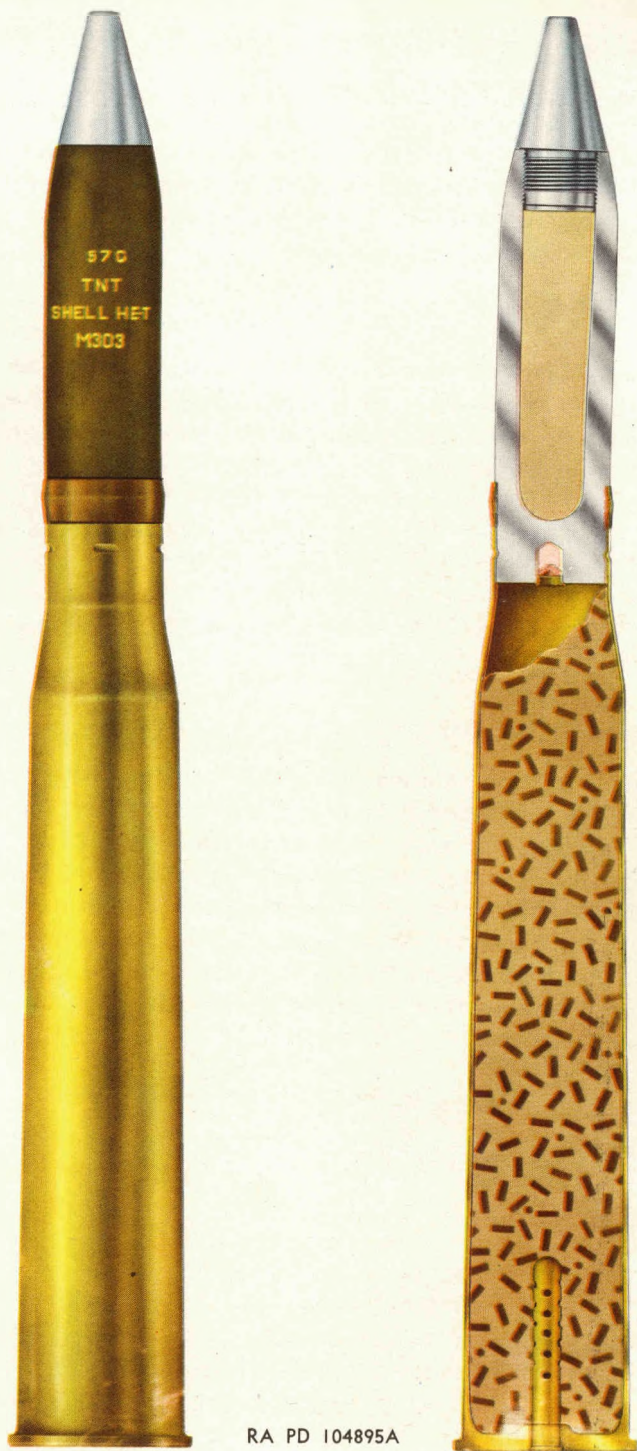
** Maximum range in the British 6 Pr. Mk 3 gun is 13,100 yards.

56. Cartridge, HE-T, M303, w/Fuze, PD, M86, for 57-mm Guns (fig. 63)

a. GENERAL. This cartridge provides for blast and fragmentation effect. The round, which is slightly longer than the APC-T round, consists of the M303 shell with assembled M86 fuze and a standard M23A2 or M23A2B1 cartridge case with M1B1A2 or alternative primers and a propellant charge of M1 powder for 2,720 fps muzzle velocity. At this velocity, the M303 shell has approximately the same ballistic values as the APC-T projectile up to about 1,500 yards range. The shell consists of a relatively thick-walled steel casing with deep cavity, holding a 0.44 pound TNT bursting charge. The comparatively heavy base contains a red tracer which, upon initiation as the round is fired, burns for approximately 6½ seconds, equivalent to about 4,000 yards range. The M86 fuze provides for superquick action with supersensitive effect on comparatively light impact.

b. DATA.

Weight of complete round.....	12.88 lb
Length of complete round.....	26.99 in
Length of fuzeed projectile.....	10.63 in
Length of cartridge case.....	17.40 in
Width of rotating band.....	0.79 in
Type of base.....	Square
Radius of ogive.....	4.47 cal.
Muzzle velocity.....	2,720 fps
Maximum range.....	12,670 yd



RA PD 104895A

Figure 63. Cartridge, HE-T, M303, w/fuze, PD, M86, for 57-mm guns.

57. Cartridge, HE-T, M303, w/Fuze, PD, M85, for 57-mm Guns

This cartridge is identical, tactically, with the round described in paragraph 56. Components are the same except for the fuze. The M85 fuze differs from the M86 fuze in mechanical details which do not affect tactical use. The M85 fuze is essentially the M56 supersensitive fuze for 37-mm shell contoured to give a suitable sweep to the 57-mm shell nose.

58. Cartridge, Drill, M22, for 57-mm Guns

This cartridge, provided for drill purpose, consists of a solid steel projectile resembling the obsolete AP-T M70 shot and a modified service steel (M23A2B1) cartridge case, held in assembled position by a retaining rod. The cartridge case is modified for the purpose by enlarging and countersinking the primer hole to fit a steel plug. The plug, a free fit in the cartridge case, is threaded at one end to receive the appropriately threaded retaining rod which, in assembly, screws into the base of the projectile. The complete cartridge weighs approximately 12.56 pounds and is 23.22 inches long.

59. Cartridge, Drill, M24, for 57-mm Guns

This drill cartridge simulates the APC-T M86 round in weight and shape. A bronze or iron nose plug screws into the head of the case and has the same contour as the ogive of the APC-T M86 projectile. The bronze case or the alternative malleable iron case (M24B1 drill cartridge) also contains a steel base held in an iron sleeve by a rod, Belleville spring, castle nut, and cotter pin assembly. A setscrew secures the sleeve against withdrawal from the base end and another setscrew secures the nose in the front end. Weight of complete round is 13.73 pounds and length is 26.72 inches.

Section V. AMMUNITION FOR 57-mm RIFLES

60. General

a. GENERAL DISCUSSION. The 57-mm rifle M18 is a recoilless, portable weapon, manually loaded and trigger-operated, which can be fired from the shoulder, a bipod, or the caliber .30 machine gun tripod mount. Essentially an infantry weapon, the rifle has approximately 40 percent of the muzzle velocity and maximum range of the 57-mm gun (sec. IV, this ch.). Recoil is eliminated in the rifle by providing for controlled escape of propellant gases

to the rear through openings in the breechblock. To assist in producing the required interior ballistics, ammunition for the rifle has a perforated cartridge case and a preengraved rotating band. The round is assembled and issued in the form of fixed ammunition.

b. IDENTIFICATION. Ammunition for the rifle can be distinguished readily from fixed ammunition of other types by the perforated cartridge case and preengraved rotating band. Painting and marking for identification are in accordance with basic scheme prescribed in TM 9-1900. See also figures 64 through 67.

c. FUZES. The FUZE, PD, M89; FUZE, PI, M90; and the FUZE, PD, M503 which replaces the M89, are used with 57-mm rifle ammunition. All three of these fuzes function with super-quick action. For a description of them, see section I, chapter 3.

d. CARTRIDGE CASES. Cartridge cases M30 and M30A1 are used for 57-mm rifle ammunition. Made of steel, these cases differ from conventional cartridge cases in that there are 400 circular perforations in the side walls. The perforations are for interior ballistic purposes and are arranged in a uniform staggered pattern. A shoulder on the forward end of the cartridge case serves as a guide to facilitate proper engagement of the preengraved rotating band with the rifling of the weapon and also as a stop to insure the proper chambering of the round, when loaded. For the M30 cartridge case, this shoulder is formed by shrinking a gilding metal band on the case; for the M30A1 case, the shoulder is formed by expanding the wall of the cartridge case to form a ring at this point. The M30 case has a paper liner which covers the holes to prevent leakage of the propelling charge; a plastic bag is used for the same purpose in the M30A1 case. Upon firing, the paper or plastic burns, thus permitting escape of the propellant gases. The M30 case weighs 1.63 pounds; the M30A1, 1.65 pounds.

e. PRIMERS. Percussion primer M46 is standard for 57-mm rifle ammunition. This 200-grain primer is described in detail in section III, chapter 3.

61. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL R-1.

62. Cartridge, HE, M306A1, w/Fuze, PD, M503, for 57-mm Rifles

a. GENERAL. Designed for blast and fragmentation effects, the shell of this round consists of a thin-walled steel body with a 0.52

pound bursting charge of TNT. The shell body has a square base, short ogival nose and a modified crimping groove. The preengraved rotating band, an integral part of the shell body, contains 24 grooves to mate with the rifling of the weapon. A bourrelet to rear of the ogive and another immediately in front of the rotating band provide the bearing surfaces of the shell during its travel through the rifle bore. The modified crimping groove in the M306A1 shell provides for a stronger crimp of cartridge case to shell. The relatively large nose hole is threaded internally to seat the M503 point detonating fuze, which completes the shell assembly. Cartridge case M30A1 used for this round is provided with the plastic bag liner described in paragraph 60*d*.

b. DATA.

Weight of complete round.....	5.60 lb
Weight of projectile, as fired.....	2.75 lb
Weight of explosive filler.....	0.52 lb
Length of complete round.....	17.54 in
Length of fuzed projectile.....	6.47 in
Length of cartridge case.....	12.0 in
Width of rotating band.....	0.37 in
Type of base.....	Square
Muzzle velocity.....	1,200 fps
Maximum range.....	4,860 yd

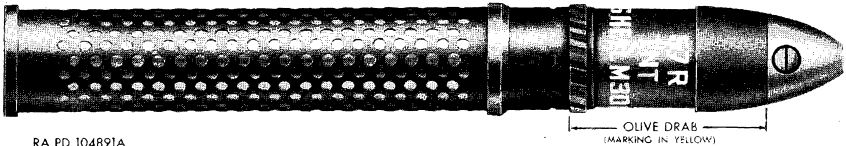


Figure 64. Cartridge, HE, M306, w/fuze, PD, M89, for 57-mm rifles.

63. Cartridge, HE, M306, w/Fuze, PD, M89, for 57-mm Rifles (fig. 64)

The principal differences between this round and the M306A1 (par. 62) are in the shell and fuze, and in the cartridge case. The M306 shell has the conventional crimping groove and is fitted with the M89 fuze. The M30 cartridge case is used with this round.

64. Cartridge, HE, AT, M307A1, w/Fuze, PI, M90, for 57-mm Rifles

a. GENERAL. This round, similar in appearance to that shown in figure 65 except for the expanded shoulder on the cartridge case M30A1 (par. 60*d*), is intended for use against armored tar-

gets. The shell of this round contains a shaped charge in the rear portion of the shell cavity. The 0.39 pound 50-50 cast pentolite charge is loaded to the rear of a hemispherical, funnel-shaped copper liner which is positioned about midway in the shell by crimping into a groove in the interior wall. A steel sleeve, assembled to the neck of the liner, extends rearward through the bursting charge and provides a passage from the fuze to a small tetryl booster pellet loaded in a well in the base end of the bursting charge. The thin-walled steel shell body is square at both the base and the front end. The preengraved rotating band, an integral part of the shell body, contains 24 grooves to mate with the rifling of the weapon. The threaded opening in the base of the shell is closed with an aluminum alloy closing plug and a copper gasket. A modified crimping groove in the M307A1 shell provides for a stronger crimp of cartridge case to shell. The M90 fuze, a point initiating type with booster in the base of the shell, completes the shell assembly. Functioning is initiated upon impact, the flash from the primer and detonator in the fuze fires the booster in the base of the shell which in turn causes detonation of the main bursting charge. The desired concentration of blast is obtained by the shape of the forward end of the bursting charge. The space forward of the liner provides for necessary "stand-off" for maximum penetration of the target. The cartridge case M30A1 with the plastic liner described in paragraph 60*d* is used in this round.

b. DATA.

Weight of complete round.....	5.60 lb
Weight of projectile, as fired.....	2.75 lb
Weight of explosive filler.....	0.39 lb
Length of complete round.....	18.78 in
Length of fuze projectile.....	7.85 in
Length of cartridge case.....	12.0 in
Width of rotating band.....	0.37 in
Type of base.....	Square
Muzzle velocity.....	1,200 fps
Maximum range.....	4,760 yd
Penetration (at any range) (Homogeneous armor plate) (angles of incidence up to 30°).....	3.0 in

65. Cartridge, HE, AT, M307, w/Fuze, PI, M90, for 57-mm Rifles (fig. 65)

This cartridge closely resembles the M307A1 (par. 64). The principal difference between the two cartridges is in the cartridge case. The M30 cartridge case is used with this round.



66. Cartridge, Smoke, WP, M308A1, w/Fuze, PD, M503, for 57-mm Rifles

a. GENERAL. Provided for spotting purposes, this round has the same ballistic values as the high-explosive round described in paragraph 62. Like the high-explosive shell, the shell body consists of a thin-walled steel casing with preengraved rotating band, improved crimping groove, and front and rear bourrelets. However, the shell body ends just forward of the front bourrelet and is fitted with a steel adapter to accommodate the fuze and the forward end of a burster assembly. The burster assembly, comprising a steel sleeve and tubing holding a 74-grain charge of tetryl, extends the full length of the shell cavity and fits in a well in the base of the shell. The modified crimping groove in the M308A1 shell provides a strong crimp of cartridge case to shell. Functioning of the superquick fuze M503 on impact causes detonation of the tetryl charge. This detonation bursts the shell body and disperses the 0.37-pound main charge of white phosphorus, which ignites spontaneously on contact with the air, creating dense white smoke.

b. DATA.

Weight of complete round	5.60 lb
Weight of projectile, as fired	2.75 lb
Weight of filler:	
Tetryl	0.01 lb
White phosphorus	0.37 lb
Length of complete round	17.54 in
Length of fuze	5.71 in
Length of cartridge case	12.0 in
Width of rotating band	0.37 in
Type of base	Square
Muzzle velocity	1,200 fps
Maximum range	4,860 yd

67. Cartridge, Smoke, WP, M308A1, w/Fuze, PD, M89, for 57-mm Rifles

This round, except for fuze, is similar to the round described in paragraph 66. See section I, chapter 3, for description of fuze.

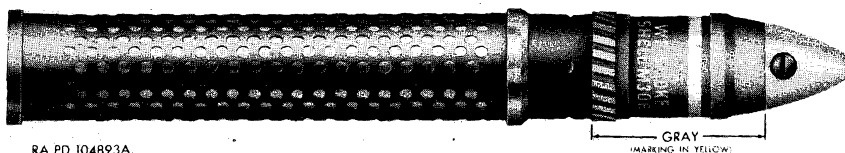


Figure 66. Cartridge, smoke, WP, M308, w/fuze, PD, M89, for 57-mm rifles.

68. Cartridge, Smoke, WP, M308, w/Fuze, PD, M89, for 57-mm Rifles
(fig. 66)

The principal difference between this round and the M308A1 (par. 67) is in the shell and cartridge case. The M308 shell is one-half inch shorter than the M308A1 shell. The M308 round uses the M30 cartridge case.

69. Cartridge, TP, M306A1, w/Fuze, PD, M503, for 57-mm Rifles

This is a practice round assembled from service components adapted for the purpose. The projectile is similar to the high-explosive shell described in paragraph 62, but is loaded with a black powder pellet and inert material to the required weight. The black powder serves as a spotting charge. A service cartridge case, primer, and propelling charge complete the round. Dimensions and other data given in paragraph 62 are applicable to this round.

70. Cartridge, TP, M306A1, w/Fuze, PD, M89, for 57-mm Rifles

This round differs from that described in paragraph 69 only in the use of the M89 fuze instead of the M503.

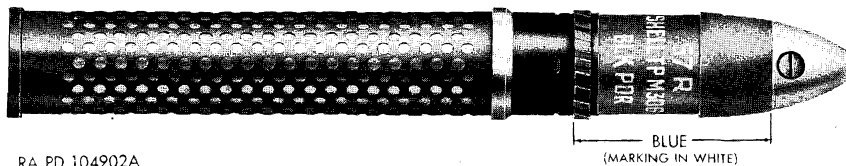


Figure 67. Cartridge, TP, M306, w/fuze, PD, M89, for 57-mm rifles.

71. Cartridge, TP, M306, w/Fuze, PD, M89, for 57-mm Rifles
(fig. 67)

This round differs from the M306A1 (par. 70) principally in the length of shell and the cartridge case. The M306 shell has the conventional crimping groove and the M30 cartridge case is used with this round.

72. Cartridge, TP, M306 (T22), w/Fuze, PD, M89 (T119E1), Inert, or Fuze, Dummy, T126, for 57-mm Rifles

This round differs from the round described in paragraph 71 in that the shell contains no spotting charge and the fuze is inert.

Section VI. AMMUNITION FOR 60-mm MORTARS

73. General

a. GENERAL DISCUSSION. The 60-mm mortars are used primarily in missions where high angles of fire are needed. The 60-mm mortar M19 is a smooth-bore weapon. It has a firing mechanism permitting selective firing by tripper and lanyard arrangement, or in the conventional manner by dropping the round in the muzzle of the mortar, in both ground emplacement and on standard mounts. The 60-mm mortar M2, also a smooth-bore weapon, can be converted to the M19 by replacing the original base cap with the combination base cap and firing mechanism. Ammunition for the 60-mm mortar falls within the classification of semi-fixed ammunition since the propelling charges are in increments permitting adjustment for zone fire. Ammunition for these mortars is issued in the form of fuzed complete rounds except those for training. A complete round consists of a fuzed projectile with a fin assembly, a propelling charge comprising a number of increments (maximum, 4) and an ignition cartridge, and a percussion primer. The rounds need no preparation for firing, once removed from packing containers, other than the adjustment of the propelling charge as described in *d* below. See figure 68 for illustration of mortar shell being fired.

b. IDENTIFICATION. The characteristic shape resulting from the use of a fin to obtain stability in flight distinguishes mortar ammunition (except 4.2-inch mortar ammunition (sec. XIV, this ch.)) from conventional artillery types of ammunition. Painting and marking provides for complete identification of the round and the components thereof (figs. 69 through 73), in accordance with the basic principles prescribed in TM 9-1900.

c. FUZES. Two types of point fuzes are used with 60-mm mortar ammunition: impact and time. The impact types used are the M52A1 and M52A1B1 single-action superquick fuzes which differ primarily in the material used in construction of the body and booster cup, and the M82 point detonating fuze used with smoke rounds. The FUZE, time (fixed), M65 or M65A1, is fitted to the 60-mm illuminating shell. This is a fixed powder-train time fuze which has a time delay of approximately 14 seconds. See section I, chapter 3, for further details of fuzes.

d. PROPELLING CHARGES. The ignition cartridge M5A1 serves as the propelling charge for the shortest ranges. For longer ranges, the M3A1 propelling charge increments are provided. One or more of these increments are used to provide for zone firing. To prepare the charges for firing inner zones, it is neces-

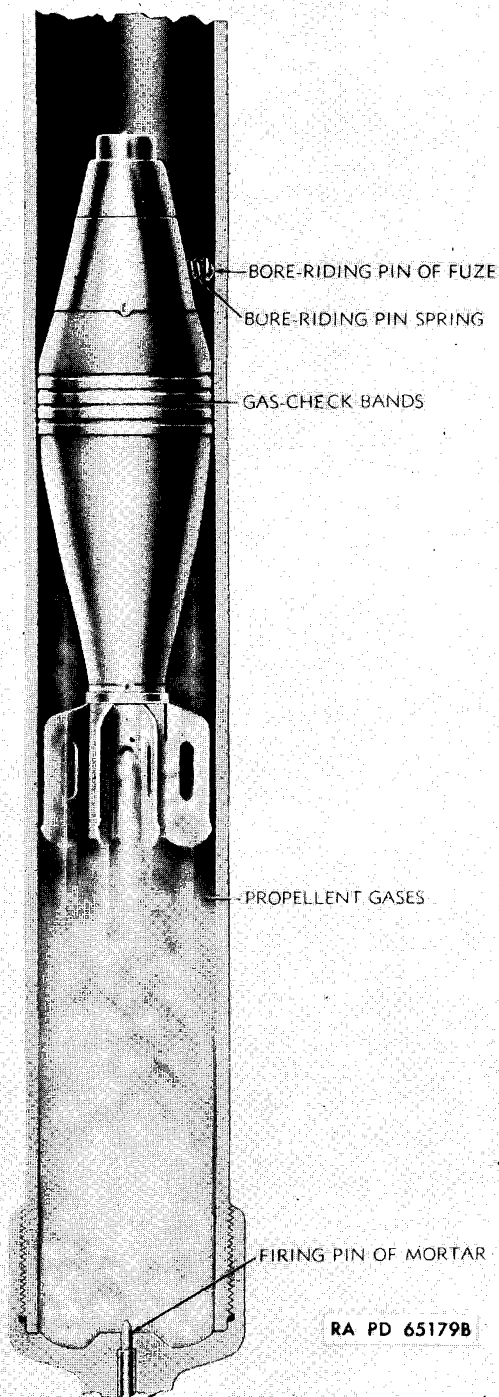


Figure 68. 60-mm mortar shell being fired.

sary only to remove those increments not required, according to the appropriate firing tables. The increments consist of stitched bundles of sheet powder having a hole in the center of each increment. Each of the M3A1 increments is sealed in a cellophane bag for protection from moisture. Four such increments or bundles, and the ignition cartridge, comprise a full charge for all 60-mm mortar rounds, one increment being fitted into each of the spaces within the blades of the fin. Earlier practice, since discontinued, was to place the increments between the fins.

e. PRIMERS AND IGNITION CARTRIDGES. For all current manufacture, PRIMER, percussion, M32, is used in conjunction with CARTRIDGE, ignition, M5A1, to ignite the M3A1 propelling charge increments. M4 increments formerly were used with the M83 illuminating shell, but have been replaced by the M3A1 type increments, for the M83A1 shell. The ignition cartridge also acts as the propelling charge for the shorter ranges. The older M5 ignition cartridge is unsafe for use. See section III, chapter 3.

f. FINS. Formerly, propellant increments were placed *between* the fin blades. This has resulted, in some instances, in the loss of fins in flight causing erratic trajectories and dangerously short ranges. To overcome this, the present practice is to place the increments *within* the blades of the fins. In the new production of 60-mm mortar ammunition, the increment holder has been redesigned so that the increments will be placed within the fins. Also, the web between the fin blades has been increased from 38° to 52°. The fin assembly M2 is described further in paragraph 75. Fin M5 is provided for use with training shell M69.

74. Packing and Shipping Data

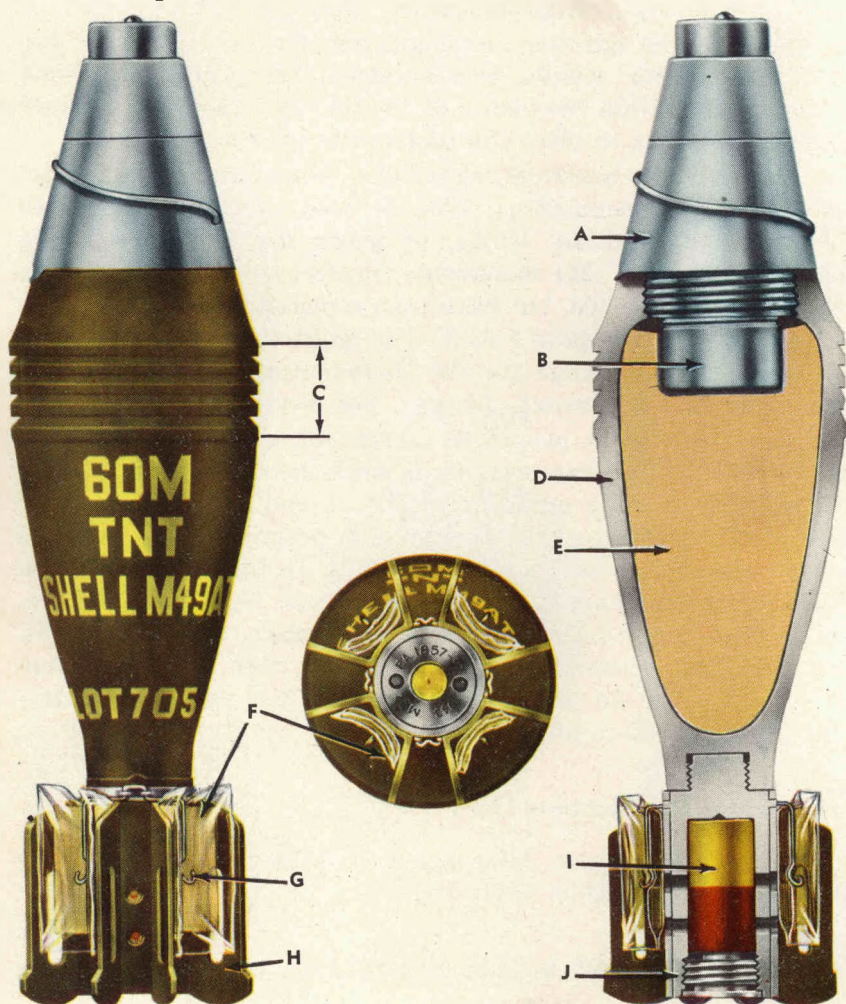
Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL R-4.

75. Shell HE, M49A2, w/Fuze, PD, M52A1, for 60-mm Mortars (fig. 69)

a. GENERAL. This shell is the standard high-explosive round provided for the 60-mm mortars. A complete round consists of six components—the M49A2 high-explosive shell, an M52A1 fuze, an M2 fin assembly, an M3A1 (4-increment) propelling charge, an M5A1 ignition cartridge, and an M32 percussion primer. All are issued and shipped assembled in a complete round which is ready for firing except for adjustment of the propelling charge. The shell body consists of a thin-walled steel casing formed in a pear or tear-drop shape and threaded at both ends, at the nar-

A — FUZE
B — BOOSTER
C — GAS-CHECK BAND
D — SHELL BODY
E — EXPLOSIVE FILLER

F — PROPELLENT INCREMENT
G — INCREMENT HOLDER
H — FIN ASSEMBLY
I — IGNITION CARTRIDGE
J — PERCUSSION PRIMER



RA PD 80729A

Figure 69. Shell, HE, M49A2, w/fuze, PD, M52A1, for 60-mm mortars.

row base end to hold the fin assembly and at the nose end to hold the M52A1 fuze with its booster. The TNT shell filler is shaped at the forward end to provide a suitable well for the booster. The M2 fin assembly consists of a 2½-inch long steel cylinder to which are welded four double-bladed fins. The hollow shaft is threaded externally at the fore end to screw into the shell base,

where it is staked in position. The rear is threaded internally to hold the M32 primer. This primer, which consists of a threaded head containing the percussion element and a short housing holding the primer mixture, is screwed into the shaft after insertion of the ignition cartridge. The M5A1 ignition cartridge is a cartridge paper tube approximately five-eighths inch in diameter, closed at both ends by a chipboard disk, and holding 40 grains of propelling powder. This is the propelling charge for the short ranges. For the longer ranges, the increments of the M3A1 (cellophane-wrapped) propelling charge are provided in addition to the ignition cartridge. As shipped, each increment is inserted in one of the four spaces within the fins and held in position there by the spring clip of the increment holder. Any or all of the increments may be removed as required.

b. DATA.

Weight of complete round----- 3.07 lb
 Muzzle velocity----- 518 fps
 Length of complete round----- 9.59 in
 Maximum range----- 1,990 yd*

* For charge 4 (cartridge plus 4 increments). Corresponding data for other charges are—

	<i>Muzzle velocity</i> (fps)	<i>Maximum range</i> (yd)
Charge 0 (ignition cartridge M5A1 only)-----	189	332
Charge 1 (cartridge and 1 increment)-----	292	784
Charge 2 (cartridge plus 2 increments)-----	377	1,204
Charge 3 (cartridge plus 3 increments)-----	449	1,594

76. Shell, HE, M49A2, w/Fuze, PD, M52A1B1, for 60-mm Mortars

a. GENERAL. This shell differs from the round described in paragraph 75 only with respect to the fuze and a reduction in complete round and projectile weight due to the lighter weight M52A1B1 fuze.

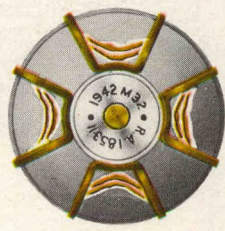
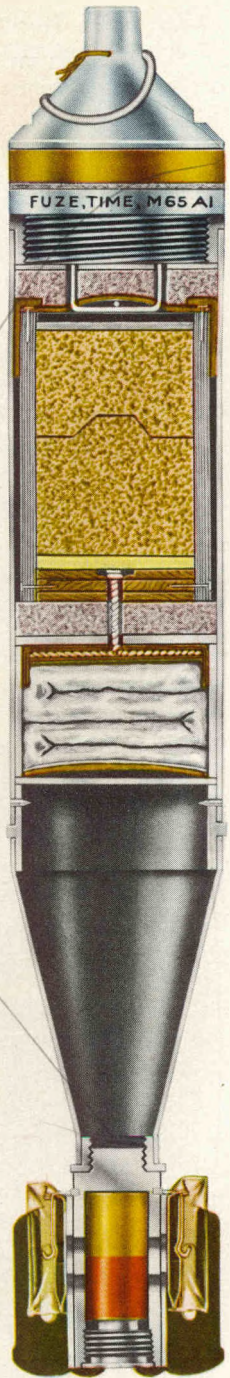
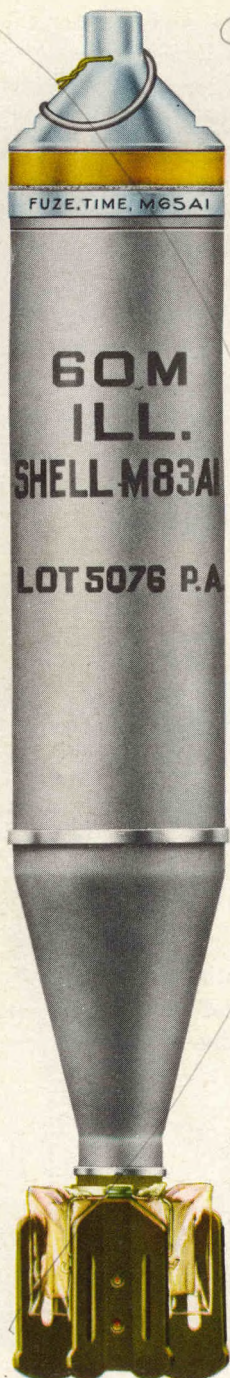
b. DATA.

Weight of complete round----- 2.95 lb
 Length of complete round----- 9.59 in
 Muzzle velocity----- 518 fps
 Maximum range----- 1,990 yd*

* For charge 4 (cartridge plus 4 increments). Corresponding data for other charges are—

	<i>Muzzle velocity</i> (fps)	<i>Maximum range</i> (yd)
Charge 0 (ignition cartridge M5A1 only)-----	189	332
Charge 1 (cartridge and 1 increment)-----	292	784
Charge 2 (cartridge plus 2 increments)-----	377	1,204
Charge 3 (cartridge plus 3 increments)-----	449	1,594

C-1-S



RA PD 80728B

Figure 70. Shell, illuminating, M83A1, w/fuze, time (fixed), M65A1, for 60-mm mortars.

77. Shell, Illuminating, M83A1, w/Fuze, Time (Fixed), M65A1, for 60-mm Mortars (fig. 70)

a. GENERAL. This shell is intended for use in night missions requiring illumination for purposes of observation. The complete round consists of six components—the M83A1 shell, an M65A1 time fuze, an M2 fin assembly, an M3A1 (cellophane-wrapped) propelling charge, an M5A1 ignition cartridge, and an M32 primer. These components are assembled into the complete round, before shipment, in the same manner as the M49A2 high-explosive round. The fin assembly, primer, and ignition cartridge are the same, and function alike, in both types of round. The M83A1 shell supersedes the M83, some rounds of which are on hand assembled with four M4 increments. The M4 increments consist of 28 grains of powder each, as compared with 35 grains each for the M3A1 increments. The M83A1 shell is made up of four major parts: a body tube assembly, illuminant assembly, a parachute assembly, and a tail assembly. The body assembly is a thin-walled steel tubing to the front end of which is welded a steel adapter or collar threaded internally to seat the fuze. The base end is closed by the tail assembly. The tail assembly is a light-weight metal cone fitted at the front end with a coupling or collar which is inserted in the body tube and held in position there by four equally spaced shear pins. The base end of the cone is fitted with an adapter which holds the fins, ignition cartridge, and primer. The illuminant assembly consists of a quickmatch, a black powder priming or expelling charge, a first-fire composition, and the main charge of illuminant composition held in a boxboard casing. This casing is attached to the parachute by a suspension wire 18 inches long. In functioning, the fuze ignites the quickmatch (after approximately 14 seconds), the quickmatch in turn igniting the black powder charge. This charge expels the parachute and illuminant charge assemblies from the shell, at the same time igniting the illuminant charge. The illuminant composition burns for at least 25 seconds, with a minimum candlepower of 145,000 candles. It drops at the rate of 10 fps.

b. DATA.

Weight of complete round.....	3.77 lb
Length of complete round.....	14.28 in
Length of projectile, w/fin.....	14.28 in
Muzzle velocity	434 fps

- A—ADAPTER
B—BURSTER CASING, M8
C—BURSTER CHARGE, M19
D—WP SMOKE FILLER

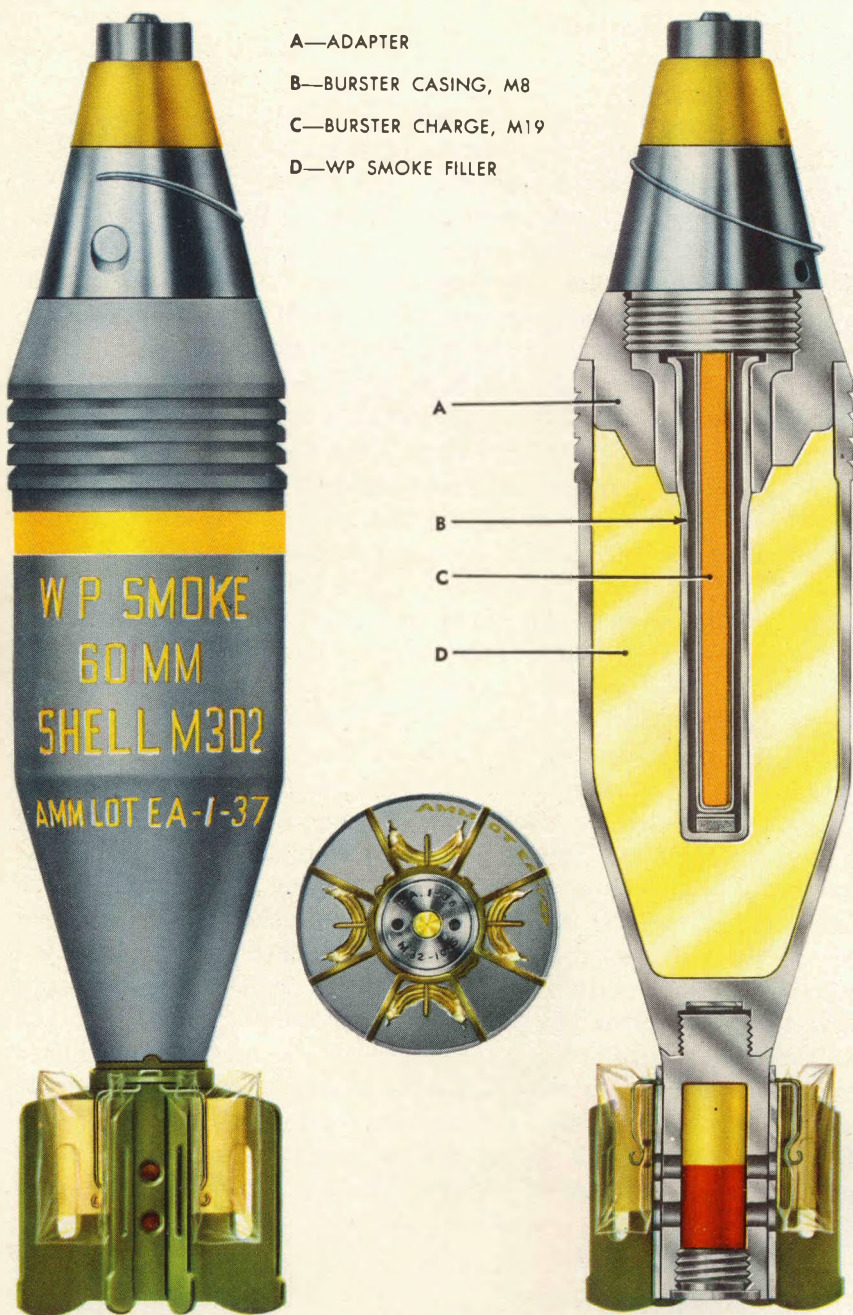


Figure 71. Shell, smoke, WP, M302, w/fuze, PD, M82, for 60-mm mortars.

Maximum range:

Horizontal	1,100 yd*
Height of burst	153 yd*

* For charge 4 (ignition cartridge plus 4 increments).

78. Shell, Smoke, WP, M302, w/Fuze, PD, M82, for 60-mm Mortars (fig. 71)

a. GENERAL. This shell is provided for spotting and screening purposes. It is made up of six major components—the M302 shell, and M82 fuze, a standard fin assembly, an M3A1 propelling charge of four increments, an M5A1 ignition cartridge, and an M32 primer—assembled in the same manner as the M49A2 high-explosive round. The fin assembly, primer, and ignition cartridge are the same, and function alike, in both types of round. The M302 shell is a thin-walled steel casing with cylindrical side walls, and a conical base which has a threaded drill hole to receive the shaft of the fin assembly. The front end of the shell is closed by a steel adapter which holds the fuze and the sleeve of the M8 burster casing which contains the M19 burster charge. The burster casing and charge is made up of the seating sleeve, and a 4-inch, $\frac{1}{2}$ -inch diameter steel tubing containing a 120-grain bursting charge of tetrytol within an aluminum tube. In functioning, the burster, which extends about three-quarters the length of the shell cavity, bursts the steel casing, releasing and scattering the 0.765-pound main filler of white phosphorus. The phosphorus ignites and burns spontaneously on contact with the air. The M82 fuze has the same mechanism as the M52 series fuzes used with the high-explosive shell and functions with superquick action. However, it contains a small booster charge (10 grains), whereas the M52 series fuzes have a 256-grain booster charge.

b. DATA.

Weight of complete round	4.04 lb
Length of complete round	11.07 in
Muzzle velocity	439 fps
Maximum range	1,610 yd*

* For charge 4 (cartridge plus 4 increments). Corresponding data for other charges are—

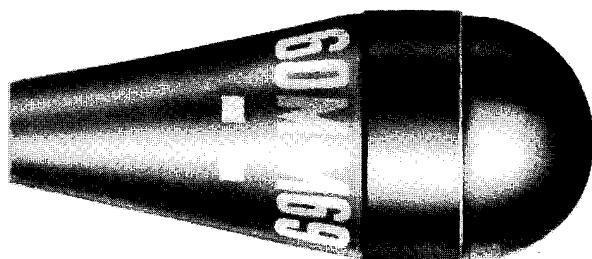
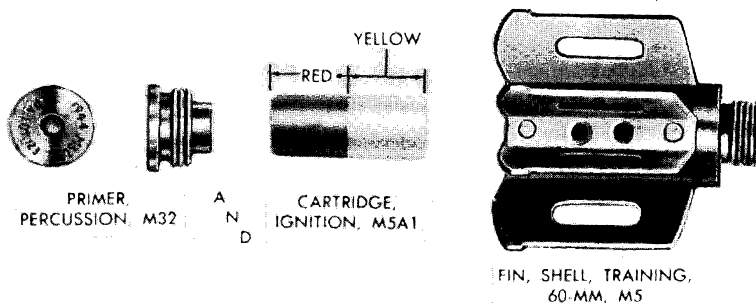
	Muzzle velocity (fps)	Maximum range (yd)
Charge 0 (ignition cartridge only)	156	225 at 56 $\frac{1}{4}$ °
Charge 1 (cartridge and 1 increment)	244	550 at 52°
Charge 2 (cartridge plus 2 increments)	316	900 at 48 $\frac{3}{4}$ °
Charge 3 (cartridge plus 3 increments)	380	1,250 at 47 $\frac{3}{4}$ °



Figure 72. Shell, TP, M50A2, w/fuze, PD, M52A1, for 60-mm mortars.

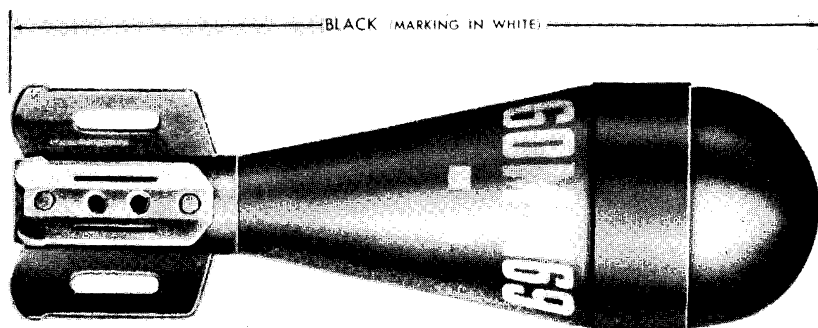
79. Shell, TP, M50A2, w/Fuze, PD, M52A1, for 60-mm Mortars (fig. 72)

This shell is a practice round provided for the 60-mm mortars by adapting service items for this purpose. Components of the M50A2 practice round are the same as are used in the M49A2 service round except for the high-explosive shell filler. The M50A2 projectile has a filler of inert material (plaster of paris and stearic acid, and a black powder pellet (0.05 lb), adjacent to the



SHELL, TRAINING, M69, W/O FIN ASSEMBLY, FOR 60-MM MORTARS

A-COMPONENTS



B-ASSEMBLED

RA PD 26817C

Figure 73. Shell, training, M69, for 60-mm mortars.

booster of the M52A1 fuze. The M52A1 or M52A1B1 fuze is a superquick fuze and causes the shell to function upon impact. The black powder pellet and booster charge provide a spotting charge for observation purposes. The shell is loaded to the same weight as the service round, thereby providing for the

same ballistic values. The M52A1B1 fuze is approximately 0.13 pound lighter than the M52A1 fuze. The data in paragraphs 75 and 76 are applicable to this round and to similar rounds fuzed with the various modifications of the M52 series fuzes.

80. Shell, Training, M69, w/o Fin Assembly, for 60-mm Mortars (fig. 73)

a. GENERAL. This shell is a training round provided for drill in loading and firing the mortar. The projectile differs from that in the practice ammunition in that it is completely inert and has no fuze. It consists of a solid cast-iron body of pear or teardrop shape, drilled at the base end to hold a service-type fin M2 or M5 assembly. No propelling charge increments are provided for the round, but the combination of the M5A1 or M4 ignition cartridge and M32 percussion primer is issued for use in firing the projectile. Unlike the other ammunition for the mortar, the body, fin, cartridge, and primer are issued and shipped separately, to facilitate replacement of damaged or worn-out parts and the procurement of additional ignition cartridges. Ten training shells and accessories are packed in an equipment training kit for field use. To overcome difficulties encountered in extracting fired ignition cartridges after firing the round, modification of the M2 fin assembly is authorized for field operation. The modification consists of drilling a $\frac{3}{8}$ -inch diameter hole longitudinally through the fore end of the fin shaft (the threaded end). The M5 fin has this hole in it as issued. When the M32 cartridge is used in firing, the cartridge is removed with long-nose pliers which are issued for the purpose. When using modified fins, the lead seals of ignition cartridges may lodge in the threaded recess in the base of the shell, resulting in progressive filling of the recess. Insecure seating of the fin and excessive vibration as a result may, under such conditions, cause the threaded portion at the base of the shell to break off or crack. The condition can be corrected by cleaning out the shell recess or prevented by inserting a thin steel disk ahead of the ignition cartridge.

b. DATA.

Weight of complete round.....	4.43 lb
Weight of shell, w/o fin.....	3.95 lb
Length of complete round.....	7.695 in
Length of shell, w/o fin.....	5.55 in
Muzzle velocity.....	152.5 fps
Maximum range.....	235 yd

Section VII. AMMUNITION FOR 75-mm GUNS

81. General

a. GENERAL DISCUSSION. The 75-mm gun is used as a tank weapon. Tank models are the M3, M6, and the M17, which is identical ballistically with the M6 except for differences caused by the muzzle velocity and greater weight. All models of 75-mm guns are chambered alike so that they are capable of firing the same ammunition. Target practice shell for 75-mm subcaliber guns are described in section XXI of this chapter.

b. IDENTIFICATION. Shell are painted and marked as prescribed in TM 9-1900 and illustrated in figures 74 to 80, inclusive. For 75-mm gun high-explosive ammunition, markings to indicate weight zones are in the form of crosses. Rounds which are loaded with either the supercharge, normal charge, or reduced charge, have special marking on the side and base of the cartridge case to signify the particular type of propelling charge used (fig. 11). A reduced propelling charge is indicated by the word "REDUCED," supercharge is indicated by the word "SUPER," and a normal charge by the word "NORMAL." Letters and figures on brass-cased ammunition are in black, and on steel-cased, in white.

c. FUZES. High-explosive shell are fitted for shipment with one of the following types of fuze: selective superquick or delay fuzes of the M48 or M51 series; selective powder train time or superquick fuze of the M54 or M55 series; selective mechanical time or superquick fuze of the M500 or M501 series; or a single-action superquick fuze M57. In future manufacture, high-explosive shell for the 75-mm guns will be fitted with the M48A3 or the M51A5 which have an improved delay plunger assembly and an 0.05-second delay element, or with the M500 or the M501 mechanical time and superquick fuzes. Note that the M48 series, the M54, and the M501 fuzes have no booster, and that the M51 series, the M55 series, and M500 fuzes are fitted with booster. In future manufacture, chemical shell will be fitted with the M48A3. Armor-piercing projectiles containing a high-explosive filler are fitted with the delay-action base fuze M66A1. The concrete-piercing fuze M78 is authorized for supercharge HE rounds. Fuzes for practice and drill ammunition are either dummy fuzes which resemble corresponding service types, or inert service fuzes (sec. I, ch. 3).

d. CARTRIDGE CASE. CASE, cartridge, 75-mm, M18, made of brass, is standard for all 75-mm gun ammunition. CASE, cartridge, 75-mm, M18B1, made of steel, is substitute standard. The

steel case has a thinner head and primer seat, and is approximately 0.22 pound lighter than the standard M18 brass case. The M9A1 case is used for blank ammunition.

e. PRIMERS. Two types of primers are used with 75-mm gun ammunition. For rounds loaded with a supercharge of propelling powder, modifications of the M31 primer are assembled to the cartridge case. This primer contains 150 grains of black powder. For other rounds, the 65-grain M22A3 primer is standard.

82. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL's R-1, R-5, and R-6.

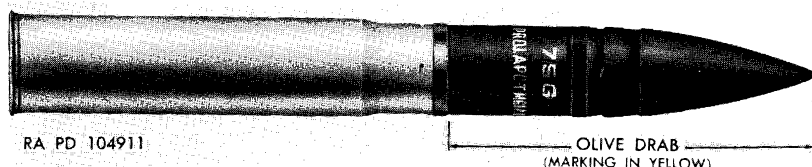


Figure 74. Projectile, fixed, APC-T, M61A1, for 75-mm guns.

83. Projectile, Fixed, APC-T, M61A1, for 75-mm Guns (fig. 74)

a. GENERAL. This projectile is authorized for use in all 75-mm guns. The complete round consists of a brass or steel cartridge case containing a 2-pound (supercharge) propelling charge and M31 type primer crimped to a fused projectile. The projectile is intended to give both penetration and explosive effect against armored targets. It is effective against medium tank fronts up to about 1,000 yards, and against the sides up to about 3,000 yards. The projectile consists of three parts: a hard and tough steel body which contains a small cavity for a charge of explosive D, a harder steel armor-piercing cap, and a lightweight steel or aluminum windshield. The base is drilled and threaded to accommodate the base fuze M66A1. This fuze functions with delay action, providing for penetration before detonation occurs. The base of the fuze protrudes about three-fourth inch beyond the rear of the projectile. This portion of the fuze contains a red tracer composition which operates independent of the fuze mechanism. When the tracer is ignited by the flame of the propelling charge upon firing, it burns for a minimum of 3 seconds, thereby providing a visible trace during 1,800 yards of flight for observation purposes.

b. DATA.

Weight of complete round	19.91 lb
Length of complete round	26.29 in
Length of projectile	14.04 in*
Length of cartridge case	13.82 in
Width of rotating band	0.49 in
Type of base	Square
Radius of ogive (false ogive)	7.17 cal.
Muzzle velocity	2,030 fps
Maximum range	13,870 yd
Penetration (at 0° obliquity of face-hardened plate at 1,000 yd)	3.5 in
Penetration (at 0° obliquity of homogeneous plate at 1,000 yd)	3.0 in

* 14.17 in with aluminum windshield.

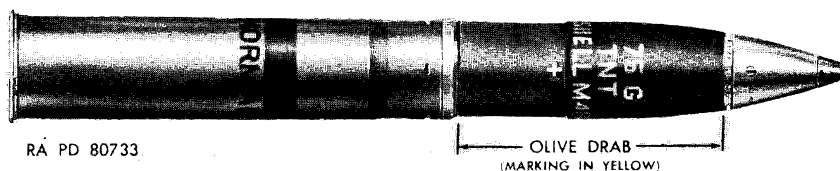


Figure 75. Shell, fixed, HE, M48, normal charge, w/fuze, PD, M51A4 (M48A2), 0.15-sec delay, for 75-mm guns.

84. Shell, Fixed, HE, M48, Normal Charge, w/Fuze, PD, M51A4 (M48A2), 0.15-Sec Delay, for 75-mm Guns (fig. 75)

a. GENERAL. This shell has the M48 projectile which also is assembled with other types of fuzes, and in rounds having super and reduced propelling charges as well as the normal charge. The shell body is a relatively thin-walled forged-steel cylinder. Efficient flight characteristics are obtained by boat-tailing the base to an 8° 45' taper and forming the nose to a long ogive of approximately 7½ caliber radius. The bursting charge of TNT is loaded to provide a well at the forward end of the charge. In shell of current assembly, the well accommodates the BOOSTER, M21A4, which is a component of the M51A4 or M51A5 fuze. In shell of earlier assembly, BOOSTER, M20A1, was inserted into the well and secured in position by a setscrew. The M48A2 or M48A3 fuze is used with such shell. Shell now being manufactured omit the setscrew hole near the nose of the shell or have the hole sealed with sealing wax. All fuzes used with this shell are alike

in contour and weight, but vary as to the manner of functioning. As assembled with the M51A4, M51A5, M48A2, or M48A3 fuze, the shell may be fired for fragmentation and blast effect with either superquick action giving a surface burst, or with a delay of as much as 0.15 second to permit penetration before detonation. Note that the M51A4 and M48A2 fuzes are provided with either 0.05- or 0.15-second delay, and that the M51A5 and M48A3 are provided with only the 0.05-second delay which is the standard delay. The 65-grain M22A3 percussion primer or modifications thereof is used with the normal charge round.

b. DATA.

Weight of complete round.....	18.74 lb
Length of complete round.....	26.63 in
Length of fuzeed projectile.....	15.04 in
Length of cartridge case.....	13.82 in
Width of rotating band.....	0.49 in
Type of base.....	Boat-tailed
Degree of taper.....	8° 45'
Radius of ogive.....	7.47 cal.
Muzzle velocity	1,520 fps
Maximum range	11,290 yd

85. Shell, Fixed, HE, M48, Supercharge, w/Fuze, PD, M51A4 (M48A2), 0.15-Sec Delay, for 75-mm Guns

This shell differs from that in paragraph 84 in that it has a supercharge of propelling powder and uses the 150-grain M31 type primer. Due to the larger propellant powder charge, the complete round is somewhat heavier, weighing 19.55 pounds. Muzzle velocity with this charge is 1,980 fps. Maximum range is approximately 14,000 yards. In all other respects, description and data given in paragraph 84 apply to this round, as well as other similar rounds fitted with fuzes having a 0.15-second delay.

86. Shell, Fixed, HE, M48, Reduced Charge, w/Fuze, PD, M51A4 (M48A2), 0.15-Sec Delay, for 75-mm Guns

This round has the same shell, fuze, and cartridge case as the round described in paragraph 84. However, the cartridge case contains a reduced charge (0.59 lb) of propelling powder. Rounds with this reduced charge weight approximately 18.18 pounds and have a muzzle velocity of 960 fps. Maximum range is 6,990 yards. Rounds of older manufacture may be assembled with M48A1 or M48 fuzes. Other description and data given in paragraph 84 apply to this round.

87. Shell, Fixed, HE, M48, Normal Charge, w/Fuze, TSQ, M55A3 (M54), for 75-mm Guns

This round has components similar to those described in paragraph 84 except for the fuze. FUZE, TSQ, M55A3, is a combination time and superquick fuze which can be set for functioning up to 25 seconds. The superquick action is always operative after firing and will function on impact unless prior functioning has been caused by the time action. The shell can be fired, therefore, for time fire for effect or for surface burst on impact, and may be used for high-burst ranging. Data given in paragraph 84 are applicable to this round also. Some rounds were assembled with the FUZE, TSQ, M54. The fuze M55A3 has the booster attached.

88. Shell, Fixed, HE, M48, Supercharge, w/Fuze, TSQ, M55A3 (M54), for 75-mm Guns

This round has a propelling charge similar to that described in paragraph 85 and also uses the 150-grain M31 type primer. Data given in that paragraph and in paragraph 84 apply equally to this round. The fuze is the same as that for the round in paragraph 87.

89. Shell, Fixed, HE, M48, Reduced Charge, w/Fuze, TSQ, M55A3 (M54), for 75-mm Guns

This shell has the same fuze as that described in paragraph 87, but is loaded with a reduced propelling charge similar to that in the M48 round with M51A4 fuze (par. 86). Description and data in that paragraph and in paragraph 87 apply to this round.



Figure 76. Shell, fixed, smoke, WP, M64, w/fuze, PD, M48A2, 0.05-sec delay, for 75-mm guns.

90. Shell, Fixed, Smoke, WP, M64, w/Fuze, PD, M48A2, 0.05-Sec Delay, for 75-mm Guns (fig. 76)

a. GENERAL. This shell is a standard round for 75-mm guns for spotting and screening purposes. It also has a very limited incendiary effect. Components are M18 or M18B1 cartridge case; the

M31 type 150-grain primer; a 2-pound propelling charge; and the M64 projectile, which is also used in 75-mm howitzers, fuze with the M48A2 fuze (superquick or 0.05-sec delay). The projectile is similar to, and has the same ballistics as the M48 high-explosive shell. The nose is cut and threaded to hold an adapter which screws into the body. The adapter serves three purposes: to provide a tight seal for the chemical contents of the shell; to hold the fuze; and to provide a seat for the forward end of the burster. A thin-walled steel tubular burster casing M6 extends nearly the length of the filler cavity. The burster casing contains initiator burster M1 and burster charge M8 consisting of 455.3 grains of tetryl to rupture shell and disperse chemical contents.

b. DATA.

Weight of complete round	20.20 lb
Length of complete round	26.63 in
Length of fuze projectile	15.04 in
Length of cartridge case	13.82 in
Width of rotating band	0.49 in
Type of base	Boat-tailed
Degree of taper	8° 45'
Radius of ogive	7.47 cal.
Muzzle velocity	1,980 fps
Maximum range	14,000 yd

91. Ammunition, Blank, Single Pellet Charge, for 75-mm Guns or Howitzers (fig. 77)

This ammunition is provided for saluting purposes and simulated firing and consists of an M9A1 cartridge case containing an M1B1A2 (100-grain) primer and a single pellet of black powder weighing 0.43 pound. The M9A1 cartridge case may be a service (M18) case cut to a 7.25-inch length (about 60 percent of the service length). the black powder charge is pressed and formed to required size, with a hole through its center for inserting the primer. The pellet is wrapped in cellophane for protection and is held firmly in position against the cartridge case base by a chip-board tube which in turn is held in position by a closing cup assembly. The closing cup is inserted and cemented in position about $2\frac{3}{4}$ inches from the cartridge case mouth with Pettman cement. Rounds with a damaged or loose closing cup never should be fired. The complete round weighs 2.68 pounds and is 7.25 inches in length.

92. Ammunition, Blank, Double Pellet Charge, for 75-mm Guns or Howitzers
(fig. 78)

This round consists of the same components as used for the round described in paragraph 91 except for the black powder charge and the chipboard tube. The charge in this ammunition is in the form of two pellets weighing 0.87 pound in all. The complete round weighs 3.07 pounds and is 7.25 inches in length.

93. Cartridge, Drill, M7, w/Fuze, Combination, 21-Sec, M1907M, Inert, for 75-mm Guns
(fig. 79)

This cartridge is a completely inert assembly provided for the 75-mm aircraft and tank guns for simulating the handling of service ammunition during training of gun crews. The cartridge case and projectile of a service round are simulated by a formed one-piece unit made of bronze and steel. The cartridge case base is a sliding fit, held in normal closed position by a steel rod and spring. The cartridge may be fitted with an inert 21-second combination fuze M1907M, or may be adapted for the inert M46 or M47 or similar inert fuzes by use of a Mk 3 adapter. The ammunition is packed either as a complete round with the 21-second combination fuze M1907M, or as a drill cartridge kit containing three cartridges, the various types of inert service fuzes, and spare parts. See ORD 11 SNL R-6 for list of contents. This drill cartridge is a limited standard item. The fuzed round weighs 20.38 pounds and is 23.42 inches in length.

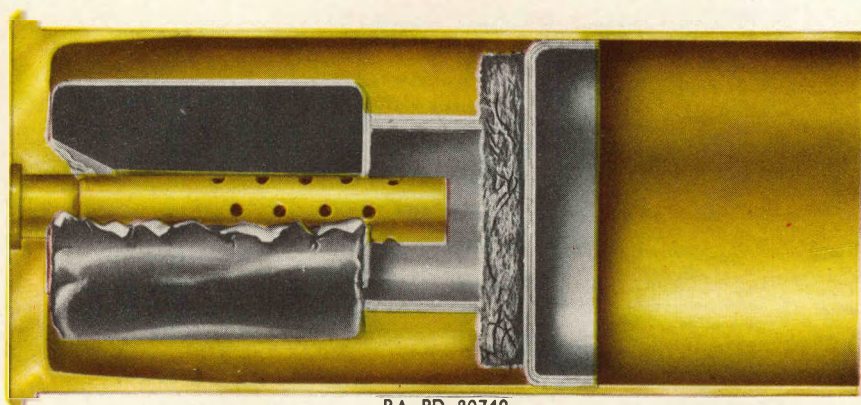
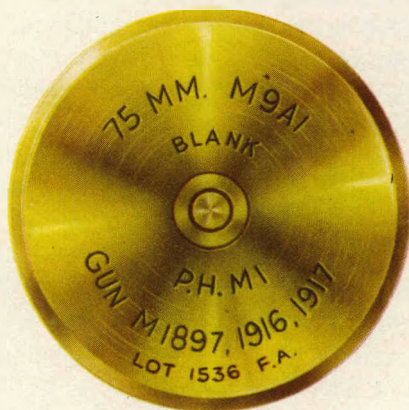
94. Cartridge, Drill, M16, w/Fuze, Dummy, M59, for 75-mm Guns
(fig. 80)

This cartridge is functionally similar to that described in paragraph 93 and also is fitted with a sliding-type spring-held base. This drill cartridge is a standard item. The body is made of bronze (M16) or malleable iron (M16B1) and is fitted with FUZE, dummy, M59. This fuze simulates the selective-type M48 and M51 series fuzes. The fuzed round weighs 18.75 pounds and is 26.25 inches in length.

Section VIII. AMMUNITION FOR 75-mm HOWITZERS

95. General

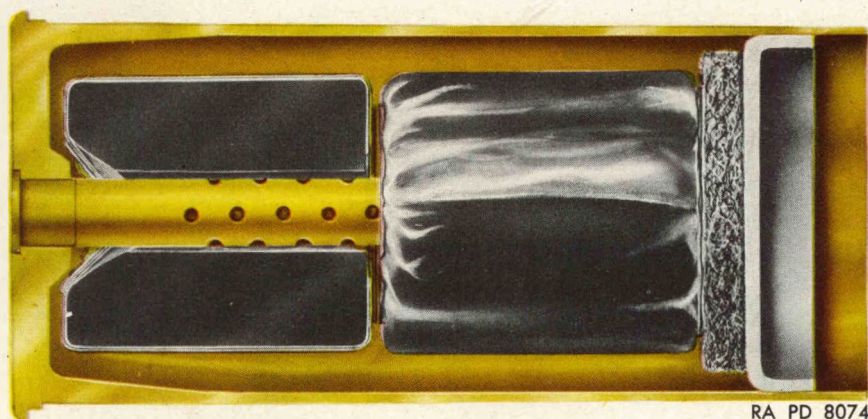
a. GENERAL DISCUSSION. Two models of 75-mm howitzer are now in use. The M1A1 howitzer with the M8 carriage is used for



RA PD 80740

Figure 77. Ammunition, blank, single pellet charge, for 75-mm guns or howitzers.

BLANK CHARGE
WEIGHT 13.8 0Z.
75 MM. G.
M1897, M1916. & M1917
& 75 MM. H. M1
LOT 1606



RA PD 80741

Figure 78. Ammunition, blank, double pellet charge, for 75-mm guns or howitzers.

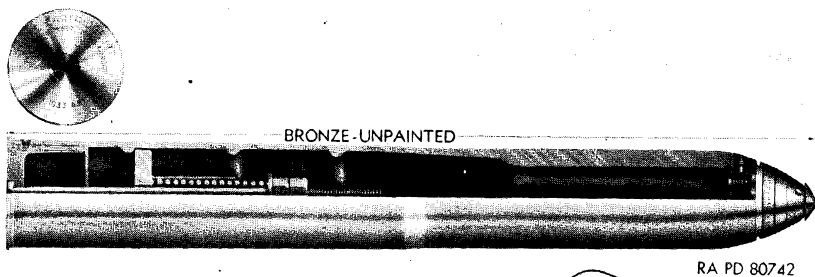


Figure 79. Cartridge, drill, M7, w/fuze, combination, 21-sec, M1907M, inert, for 75-mm guns.

airborne, pack, or truck-drawn artillery batteries but use different lists of equipment for each requirement. The M3 is mounted in combat vehicles for tank support and antitank defense. Since the chamber design is alike in both models, they fire the same ammunition. High explosive and chemical burster type 75-mm howitzer ammunition is issued in the form of semifixed rounds, with propelling charge arranged to permit adjustment in the field for zone firing. The 75-mm howitzer HE, AT-T rounds are issued as fixed ammunition, that is, with propelling charge not adjustable and the cartridge case crimped to the projectile. Two types of high-explosive projectile are provided—a normal-cavity shell, and a deep-cavity shell which permits interchangeable use of conventional and VT fuzes.

b. IDENTIFICATION. Painting and marking for identification are in accordance with the basic color scheme prescribed in TM 9-1900. Weight zones of the shell are indicated by crosses; two crosses signify “normal” or “standard” weight. A weight zone lighter than one cross is indicated by “L.” HE, AT-T rounds do not have weight-zone markings.

c. FUZES. The fuze BD M91 is assembled in the base of the HE,

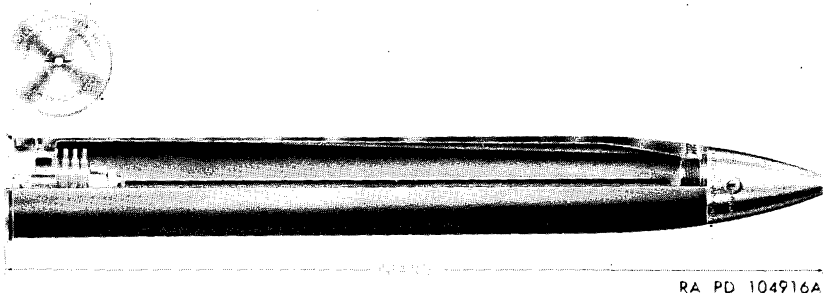
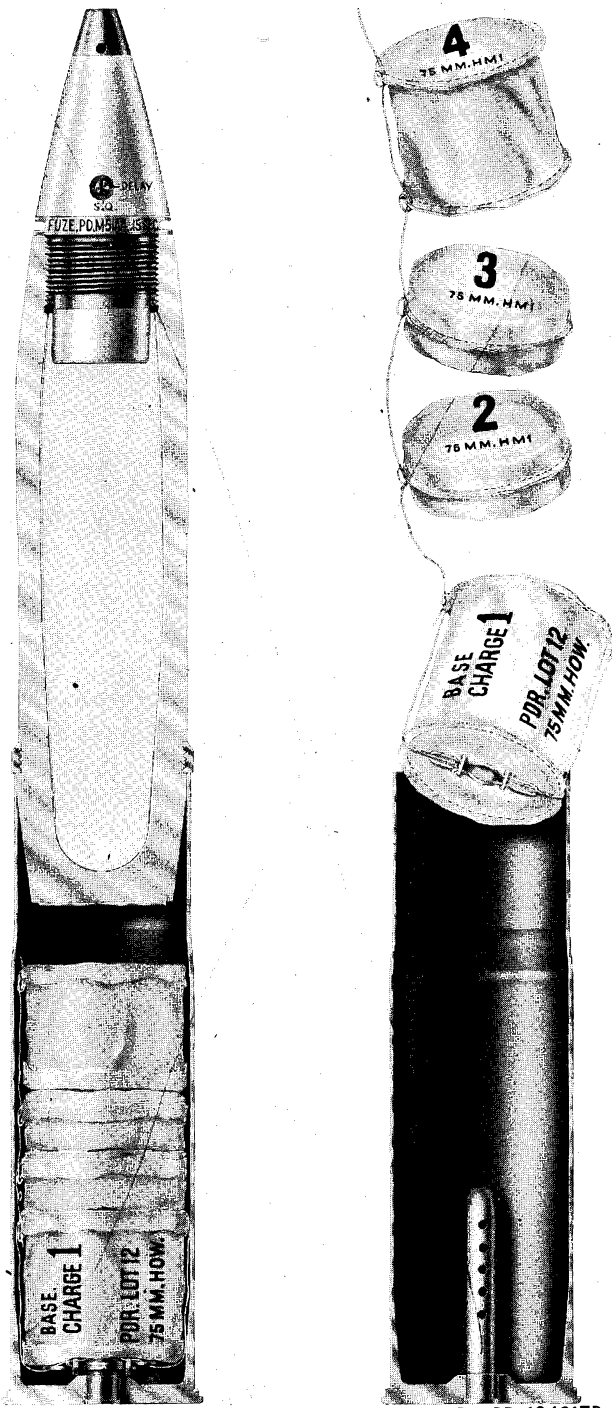


Figure 80. Cartridge, drill, M16, w/fuze, dummy, M59, for 75-mm guns.

AT-T shell M66. This is a boresafe base detonating fuze with a tracer. It functions with nondelay action. Some rounds on hand are fitted with the base detonating fuze M62A1 which does not have a tracer. High-explosive shell which are fuze for shipment are assembled with M48, M51, or M500 series fuzes. The M48 and M51 series are selective superquick-delay types which differ principally in that M51 models incorporate the booster whereas the M48 models are used with boosters which are manufacturing components of the shell. The M54 and M55 series also are alike except that the M55 models incorporate the booster. They are a combination time and superquick type in which the superquick action is always operative. The M500 fuze is a mechanical time superquick type. The VT fuze M97A1 (T80E9) is provided for use with deep-cavity HE shell, being issued separately for assembly in the field. It is a special type which provides for functioning of the fuze and shell at effective distances from the target without prior setting and is approximately 0.25 pound heavier than above fuzes and supplementary charge. The concrete-piercing fuze M78 also is authorized for use with HE shell against appropriate targets. The PD fuze M48A3 with burster initiator M1 is used with chemical shell. Some shell on hand have the M48A2 or the M57 fuze. For a complete description of the fuzes, see section I, chapter 3.

d. CARTRIDGE CASES. CASE, cartridge, 75-mm, M5A1 (type 1), and CASE, cartridge, 75-mm, M5A1B1 (type 1), are standard and substitute standard, respectively, for all semifixed 75-mm howitzers rounds. Fixed 75-mm howitzer rounds are assembled with CASE, cartridge, 75-mm, M5A1 (type 2), the standard case, or the substitute standard CASE, cartridge, 75-mm, M5A1B1 (type 2). The type 1 case has a slightly larger mouth and a less sharp taper at the shoulder than the type 2 to provide a free fit when assembling the round. This is not necessary with the type 2 case which is crimped rigidly to the projectile when the round is assembled. All standard cases are made of brass. Some steel cartridge case rounds are on hand. The steel cartridge cases have thinner heads and primer seats, and are about 0.27 pound lighter than the standard brass case.

e. PROPELLING CHARGES. The fixed HE, AT-T rounds have a nonadjustable propelling charge which is loaded loosely in the cartridge case. Propelling charges of *all other* rounds are divided into sections to permit adjusting for zone firing (fig. 81). The full charge consists of four sections—a base charge and three increments. Each is assembled in a cloth bag on which is marked the number of the charge. The base charge (charge 1) is fastened in the bottom of the cartridge case. The first increment, which is



RA PD 104917B

Figure 81. 75-mm howitzer semifixed ammunition.

marked charge 2, is tied to the base section with a long twine. The other increments, in numerical order, are tied to each other with short twine. This permits withdrawal of the sections, except the base charge, to the mouth of the cartridge case where those increments not required may be removed by cutting or breaking the twine; then the increments to be used are assembled readily in the cartridge case in numerical order, with the increment having the number corresponding to the charge to be fired uppermost. The increments are of unequal weights, hence are not interchangeable. All sections up to and including the number of the charge to be fired are required to fire the charge called for. Thus, to fire charge 3, the base charge (marked "1") and the increments marked "2" and "3," in numerical order, must be used.

f. PRIMER. PRIMER, percussion, 100-grain, M1B1A2, is standard for all 75-mm howitzer ammunition except for the fixed HE, AT-T round for which primer M23A2 is standard. The alternative is PRIMER, percussion, 100-grain, M1A2 (sec. III, ch. 3).

96. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL's R-1, R-5, and R-6.

97. Normal-Cavity High-Explosive Shell for 75-mm Howitzers

a. The term "normal cavity" as applied to the high-explosive shell refers to the type of fuze cavity. In all other respects the loaded shell is similar to the deep-cavity type provided for these howitzers (par. 98). In the normal-cavity shell, the well formed at the forward end of the bursting charge during manufacture is made only large enough (0.81 in long by 1.73 in diam) to accommodate the boosters manufactured for use with point fuzes. The shell bursting charge is TNT. The shell body is a relatively thin-walled shell with boat-tailed base. The nose is formed to a long ogive and threaded to hold a point fuze. The fuze contour continues the long sweep of the shell nose, maintaining throughout, the streamlined effect which is characteristic of shell of modern design.

b. The normal-cavity HE shell for 75-mm howitzers is the M48. The shell is assembled with the cartridge case M5A1 or M5A1B1 fitted with the M1B1A2 (or alternative) primer and four-section propelling charge, and various fuzes.

- (1) *SHELL, semifixed, HE, M48, w/fuze, MTSQ, M500, for 75-mm howitzers.* Fuzed with the M500 mechanical time superquick fuze, the round is adaptable for high-burst ranging, or for air burst or functioning on impact with

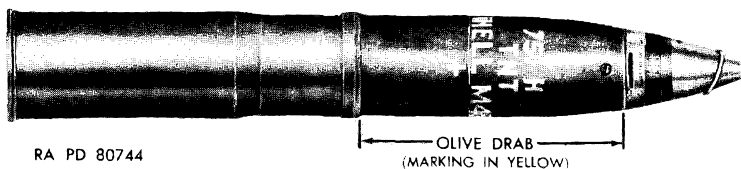


Figure 82. Shell, semifixed, HE, M48, w/fuze, TSQ, M55A3 (M54), for 75-mm howitzers.

fragmentation and blast effect. Some rounds on hand are fitted with time and superquick fuze designated TSQ M55A3 (M54) (fig. 82). The fuzed projectile of this round is identical with that in the corresponding round for 75-mm guns. However, the round as assembled for the 75-mm howitzer is 3.13 inches shorter than the gun round and has a sectioned, instead of fixed, propelling charge. Gun and howitzer rounds therefore are *not* interchangeable. Data are as follows:

Weight of complete round	18.24 lb
Length of complete round	23.50 in
Length of fuzed projectile	15.04 in
Length of cartridge case	10.69 in
Width of rotating band	0.49 in
Type of base	Boat-tailed
Degree of taper	8° 45'
Radius of ogive	7.47 cal.
Muzzle velocity	1,250 fps*
Maximum range	9,620 yd*

* Charge 4 (full charge) propelling charge. Corresponding data for other charges are—

	Muzzle velocity (fps)	Maximum range (yd)
Charge 3	950	6,930 (at 43°)
Charge 2	810	5,360 (at 43° 35')
Charge 1	700	4,190 (at 43° 35')

- (2) *SHELL, semifixed, HE, M48, w/fuze, PD, M51A5, 0.05-sec delay, for 75-mm howitzers.* This round, except for the fuze, is similar to that described in (1) above. Data given therein apply equally to this round. FUZE, M51A5, is a selective superquick-delay type, with a delay of 0.05 second. Some rounds on hand are fitted with the fuze M51A4 (M48A2). When assembled with the M48A2 fuze, the M20A2 booster is used. However, instead of being a manufacturing component of the shell, which is

the usual practice when this booster is used, the booster is staked to the fuze to facilitate removal of these assemblies. The M51A4 has the M21A4 booster assembled to the fuze as a component. In either case, the setscrew is not used to secure the booster to the shell, the setscrew hole, when present, being sealed with wax. These fuzes adapt the shell for firing with either surface or delay burst.

98. Deep-Cavity High-Explosive Shell for 75-mm Howitzers

a. GENERAL. The deep-cavity shell is identical with the normal-cavity shell described in paragraph 97 except for a deep fuze well which makes the shell adaptable for use with VT fuzes or, by insertion of a supplementary charge, with standard fuzes and boosters. For use with the VT fuzes, the shell loading provides a fuze well 2.95 inches in depth. The cavity is lined with a thin cardboard tube and bottom cup or with an aluminum cup which help to support the HE filler. It is not intended that this lining be removed. A supplementary charge consisting of a charge of TNT in a cylindrical fiber or aluminum container with a felt cushion at one end and a lifting loop at the other (see fig. 4), upon insertion in the fuze well, adapts the shell for standard fuzes and boosters. Originally, the shell was shipped unfuzed, in some cases without supplementary charge, and in other cases with it. Subsequently, all shell were assembled with the supplementary charge and a standard fuze and booster. Earlier assemblies will have a setscrew hole near the nose end which is permanently sealed with sealing wax; in current manufacture, the setscrew hole is omitted. This type of shell has been assembled with the standard cartridge case, primer, and four-section propelling charge.

b. FUZED ROUNDS AS SHIPPED.

- (1) *SHELL, semifixed, HE, M48, w/suppl chg and fuze, PD, M51A5, 0.05-sec delay, for 75-mm howitzers.* In tactical respects, this round is similar to the round with normal-cavity shell described in paragraph 97b(2), and equally adaptable for firing for fragmentation and blast effect on surface burst, or after penetration or on ricochet. Some rounds on hand are fitted with the fuze M51A4 (M48A2).
- (2) *SHELL, semifixed, HE, M48, w/suppl chg and fuze, M500, for 75-mm howitzers.* This round compares tactically with the round described in paragraph 97b(1). Some rounds on hand are fitted with the fuze TSQ M55A3 (M54). Data are—

Weight of complete round	18.02 lb
Length of complete round	23.50 in
Length of fuzeed projectile	15.04 in
Length of cartridge case	10.69 in
Width of rotating band	0.49 in
Type of base	Boat-tailed
Degree of taper	8° 45'
Radius of ogive	7.47 cal.
Muzzle velocity	1,250 fps*
Maximum range	9,620 yd*

* Charge 4 (full charge) (propelling charge). Corresponding data for other charges are—

	Muzzle velocity (fps)	Maximum range (yd)
Charge 3	950	6,930 (at 43°)
Charge 2	810	5,360 (at 43° 35')
Charge 1	700	4,190 (at 43° 35')

c. UNFUZED ROUNDS AS SHIPPED. SHELL, semifixed, HE, M48, w/suppl chg, w/o fuze, for 75-mm howitzers, is issued unfuzed, with the fuze hole protected by a closing plug. The shell may be encountered in the field without supplementary charge (earlier manufacture) or with the charge and spacers inserted in the deep cavity. Removal of these, when present, in the manner described in paragraph 14e, makes the shell suitable for VT fuze M97A1 (T80E9). This fuze functions when the shell approaches the target (sec. I, ch. 3). Other components are similar to those assembled to normal-cavity shell rounds for the 75-mm howitzers, described in paragraph 97. Data are as follows:

Weight of complete round	16.37 lb*
Length of complete round	20.99 in*
Length of fuzeed projectile	15.04 in
Length of cartridge case	10.69 in
Width of rotating band	0.49 in
Type of base	Boat-tailed
Degree of taper	8° 45'
Radius of ogive	7.51 cal.
Muzzle velocity	1,250 fps**
Maximum range	9,620 yd**

* Unfuzed, with supplementary charge and closing plug. Weight without supplementary charge is 15.94 pounds.

** Charge 4 (full charge) (propelling charge). Corresponding data for other charges are—

	Muzzle velocity (fps)	Maximum range (yd)
Charge 3	950	6,930 (at 43°)
Charge 2	810	5,360 (at 43° 35')
Charge 1	700	4,190 (at 43° 35')



Figure 83. Shell, fixed, HE, AT-T, M66, for 75-mm howitzers.

99. Shell, Fixed, HE, AT-T, M66, for 75-mm Howitzers (fig. 83)

a. GENERAL. This shell is provided for the 75-mm howitzers for use against tanks and other heavy matériel. The effect of the projectile is obtained by the force of the detonation of its high-explosive filler rather than from striking velocity. The construction of the shell differs materially, therefore, from the standard types of armor-piercing projectile. The shell body is a thin-walled casing containing a shaped high-explosive filler and closed off at the forward end by a ballistic cap in the form of a thin steel cone. The base is boat-tailed and fitted with base detonating fuze M91 which functions with nondelay action. The M91 fuze contains a tracer in its base end which burns for about 7.5 seconds. The cartridge case is the M5A1 or M5A1B1. These are "type 2" designed especially for fixed 75-mm howitzer rounds to provide a case with a smaller neck and mouth suitable for crimping to the projectile. The case is fitted with the primer M23A2 and has a nonadjustable propelling charge. Some rounds on hand, designated HE, AT, are fitted with base detonating fuze M62A1 which has no tracer.

b. DATA.

Weight of complete round.....	16.26 lb
Length of complete round.....	23.47 in
Length of fuzed projectile.....	15.90 in
Length of cartridge case.....	10.69 in
Width of rotating band.....	0.49 in
Type of base.....	Boat-tailed
Degree of taper.....	8° 45'
Degree of nose taper.....	22° 50'
Muzzle velocity.....	1,000 fps
Range (7.5 sec time of flight).....	2,300 yd
Range (at 9° 35').....	3,000 yd
Maximum range.....	7,900 yd
Penetration (homogeneous armor plate, at any range) (aprx)	3 $\frac{5}{8}$ in

100. Shell, Semifixed, Smoke, WP, M64, w/Fuze, PD, M48A3, 0.05-Sec Delay, for 75-mm Howitzers (fig. 84)

a. GENERAL. This is a smoke-producing shell for spotting and screening purposes. It also has very limited incendiary effects. Cartridge case, primer, and propelling charge are the same as those used with the high-explosive rounds. The projectile is similar to, and has the same ballistics as the M48 high-explosive shell (par. 97). The nose is cut and threaded to hold an adapter

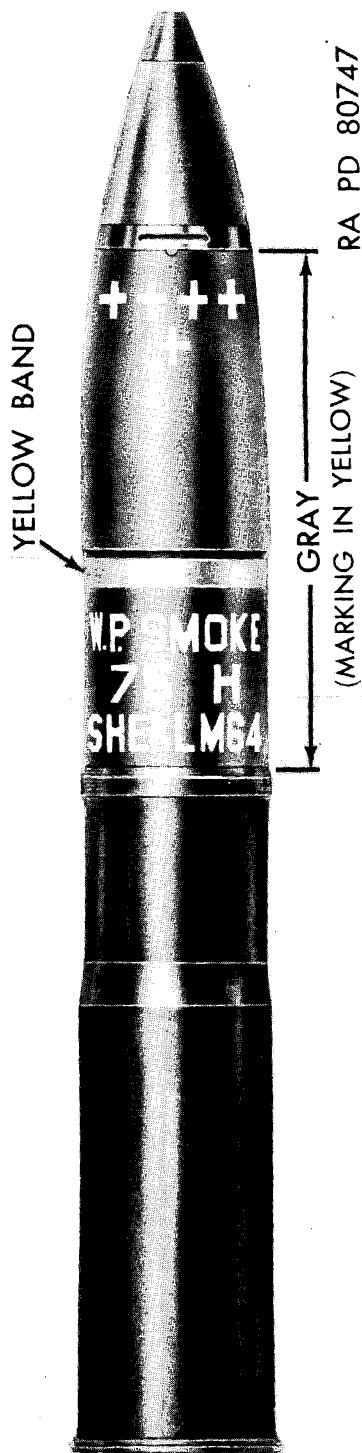


Figure 84. Shell, semiself-detonating, WP, M64, w/fuze, PD, M18A3, 0.05-sec delay, for 75-mm howitzers.

which screws into the body. The adapter serves three purposes: to provide a tight seal for the chemical contents of the shell, to hold the fuze, and to provide a seat for the forward end of the burster. Burster casing M6 is a thin-walled steel tubular casing extending nearly the length of the filler cavity and contains burster initiator M1 and burster charge M8 consisting of 455.3 grains of tetryl to rupture the shell and disperse the chemical contents. Some rounds on hand are fitted with the fuze M48A2, 0.05-sec delay, and some with the single-action fuze M57.

b. DATA.

Weight of complete round.....	18.89 lb
Length of complete round.....	23.50 in
Length of fuzeed projectile.....	15.04 in
Length of cartridge case.....	10.69 in
Width of rotating band.....	0.49 in
Type of base.....	Boat-tailed
Degree of taper.....	8° 45'
Radius of ogive.....	7.47 cal.*
Muzzle velocity	1,250 fps*
Maximum range	9,620 yd*

* Charge 4 (full charge).

101. Shell, Semifixed, Smoke, FS, M64, w/Fuze, PD, M48A3, 0.05-Sec Delay, for 75-mm Howitzers

This shell contains FS filler, a liquid smoke-producer which produces a smoke similar to that from white phosphorus. The complete round weighs approximately 19.05 pounds. In other respects it is similar to the round described in paragraph 100, and data given therein apply equally to this round. Some rounds on hand are fitted with M48A2 (0.05-sec delay) fuze with the single-action fuze M57.

102. Ammunition, Blank, Single Pellet Charge, for 75-mm Guns or Howitzers

This ammunition is described in paragraph 91 and illustrated in figure 77.

103. Ammunition, Blank, Double Pellet Charge, for 75-mm Guns or Howitzers

This ammunition is described in paragraph 92 and illustrated in figure 78.

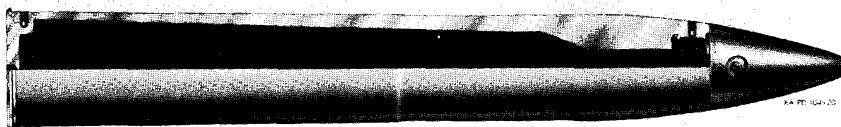
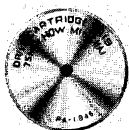


Figure 85. Cartridge, drill, M19, w/fuze, dummy, M59, for 75-mm howitzers.

104. Cartridge, Drill, M19, w/Fuze, Dummy, M59, for 75-mm Howitzers (fig. 85)

This cartridge simulates the M48 service round for use in training. It is of one piece with a detachable base and nose threaded for a point fuze. The assembly is a malleable iron casting and is fitted with FUZE, dummy, M59. CARTRIDGE, drill, M19B1, is a substitute standard for the M19 and differs only in the body being made from a bronze casting. The M59 fuze simulates the M48 and M51 series selective type and has a similar setting pin arrangement. The weight of the cartridge is 18.25 pounds; length is 23.49 inches.

Section IX. AMMUNITION FOR 75-mm RIFLES

105. General

a. GENERAL DISCUSSION. The 75-mm rifle M20 (T25) is a portable recoilless weapon fired from the machine gun tripod mount, caliber .30, M1917A1. Essentially an infantry weapon, it is an air-cooled single-loading weapon with a manually operated breech and percussion-type firing mechanism. It has about one-half the muzzle velocity and maximum range of the standard guns of the same caliber (sec. VII of this ch.). Recoil is eliminated in the rifle by providing for controlled escape of propellant gases to the rear through openings in the breechblock. To assist in producing the required interior ballistics, ammunition for the rifle has a perforated cartridge case and a preengraved rotating band. The round is assembled and issued in the form of fixed ammunition.

b. IDENTIFICATION. Ammunition for the rifle can be distinguished readily from fixed ammunition of other types by the perforated cartridge case and the preengraved rotating band. Painting and marking for identification is in accordance with the basic scheme prescribed in TM 9-1900. (See figs. 86, 87, and 88.)

c. FUZES. The HE cartridges use the FUZE, PD, M51A5; or M51A4, or M48A3 or M48A2, with booster. The HE, AT cartridge uses the FUZE, BD, M62A1; the HE, AT-T, the FUZE, BD, M91. The smoke cartridges use the FUZE, PD, M48A3, M48A2, or M57, with booster initiator M1. The TP cartridges use the FUZE, PD, M51A5, PD M51A4, or the FUZE, dummy, M73. See section I, chapter 3.

d. CARTRIDGE CASES. Cartridge cases M31 and M31A1 are used for 75-mm rifle ammunition. Made of steel, these cases differ from conventional cartridge cases in that they are perforated, for ballistic purposes, in a uniform pattern about the circumference and for about three-quarters of the length. The interior of the M31 case has a paper liner secured to the inner wall of the case by a coating of lacquer and positioned to cover the perforations and prevent leakage of the propelling charge grains. The M31A1 case has a rayon liner within a plastic liner in lieu of the paper. The plastic liner is a flexible plastic cylinder with a formed plastic bottom which fits snugly in the primed cartridge case. A tight-fitting ring in the formed bottom is pushed over the primer during assembly. This keeps the liner in place and seals the bottom end. After the propellant is loaded into the liners, the top of the plastic liner is tied or sealed. Upon firing, the liner, paper or plastic, burns away, permitting escape of the propellant gases through the perforations in the cartridge case. The weight of the cases is approximately 4.23 pounds; length is 16 inches.

e. PRIMERS. Percussion primer M47 is standard for 75-mm rifle ammunition. An ignition charge, and a charge of M10 propellant powder with distant wad, are used with the M47 primer. Rounds of earlier manufacture were assembled with M2 propelling powder; current manufacture is with M10 powder. See section III, chapter 3.

106. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Supply Catalog, ORD 11 SNL R-1.

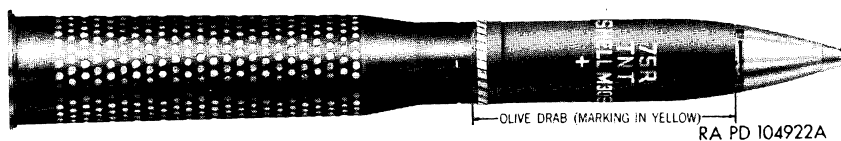


Figure 86. Cartridge, HE, M309A1, w/fuze, PD, M51A5, 0.05-sec delay, for 75-mm rifles.

107. Cartridge, HE, M309A1, w/Fuze, PD, M51A5, 0.05-Sec Delay, for 75-mm Rifles (fig. 86)

a. GENERAL. This cartridge consists of the M31A1 cartridge case with M47 primer, 2.9-pound charge of M10 propellant powder, distance wad, and 300-grain ignition charge—crimped to the M309 projectile. The projectile has an improved crimping groove. The M309A1 projectile is similar to the M48 shell issued for other 75-mm weapons except for the narrow, preengraved, gilding metal, rotating band, and a base of somewhat smaller diameter to suit the neck of the M31A1 cartridge case. In other respects, including the 1.49-pound TNT bursting charge, the M309A1 is like the shell described in paragraph 84. With the M51A5, or with the M48A3 fuze and a booster, the round can be fired for fragmentation and blast effect with either superquick action, giving surface burst, or with a 0.05-second delay, for ricochet effect or after partial penetration.

b. DATA.

Weight of complete round	21.98 lb
Weight of projectile, as fired	14.40 lb
Length of complete round	28.92 in
Length of fuzed projectile	15.04 in
Length of cartridge case	16.0 in
Width of rotating band	0.35 in
Type of base	Boat-tailed
Degree of base taper	8° 45'
Radius of ogive	7.47 cal.
Muzzle velocity	990 fps
Maximum range	6,960 yd

108. Cartridge, HE, M309 (T38), w/Fuze, PD, M51A4, (M48A2) 0.05-Sec Delay, for 75-mm Rifles

This round closely resembles M309A1. However, it has the conventional crimping groove, cartridge case M31, and fuze M51A4.

109. Cartridge, HE, AT-T, M310A1, w/Fuze, BD, M91, for 75-mm Rifles

a. GENERAL. This cartridge provides the 75-mm rifle with low velocity ammunition suitable for use against tanks and similarly armored matériel. The complete round consists of the M31A1 cartridge case—with M47 primer, a 2.80-pound charge of M10 propellant powder, distance wad, and 300-grain ignition charge—crimped to a base-fuzed high-explosive projectile. The projectile

is similar to the same type provided for 75-mm howitzers (par. 99) except that the base of the projectile is turned down to a slightly smaller diameter and the rotating band is narrowed and preengraved for use in the rifle. It has the improved crimping groove. In other details, the projectiles are alike, including the base detonating fuze M91 (with tracer), which provides for functioning with nondelay action.

b. DATA.

Weight of complete round.....	20.66 lb
Length of complete round.....	28.92 in
Length of fuzed projectile.....	15.9 in
Length of cartridge case.....	16.0 in
Width of rotating band.....	0.35 in
Type of base.....	Boat-tailed
Degree of base taper.....	8° 45'
Degree of nose diameter taper.....	22° 50'
Muzzle velocity.....	1,000 fps
Range (at 11° 58').....	3,500 yd
Maximum range.....	7,300 yd
Penetration (in. of plate, at any range) (aprx).....	3 $\frac{5}{8}$ in

110. Cartridge, HE, AT, M310 (T39), for 75-mm Rifles

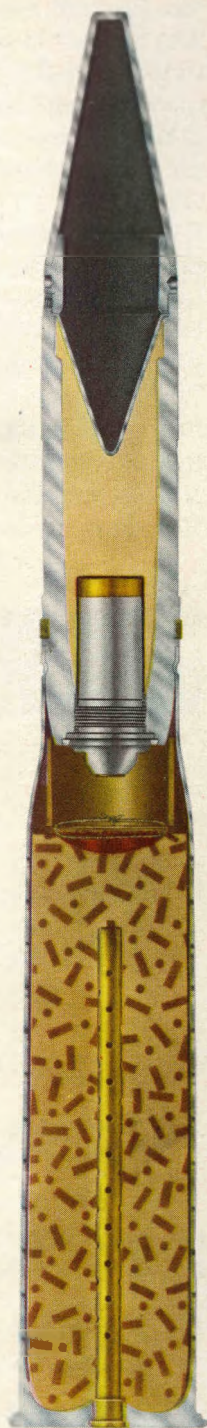
This round is similar to the M310A1, HE, AT-T round differing principally in certain of the components comprising the assembly. The round consists of the M310 shell fitted with the base detonating fuze M62A1 (without tracer), the M31 cartridge case with M28A2 primer, and a 2.80-pound propelling charge of M2 powder.

111. Cartridge, HE, AT-T, M310, for 75-mm Rifles (fig. 87)

This round differs principally from the M310A1 (par. 109) in the use of the M31 cartridge case. The projectile has the conventional crimping groove.

112. Cartridge, Smoke, WP, M311A1, w/Fuze, PD, M48A3, 0.05-Sec Delay, for 75-mm Rifles

a. GENERAL. The shell of this round is similar to the phosphorus-filled chemical shell M64 issued for other 75-mm caliber weapons (par. 90); essential differences are a base turned to slightly smaller diameter and a narrower preengraved rotating band for use in 75-mm rifles. The nose of the shell is cut and threaded to hold an adapter which screws into the shell body to provide a tight seal for the 1.35-pound phosphorus filler, to seat



RA PD 104921A

Figure 87. Cartridge, HE, AT-T, M310, for 75-mm rifles.

the forward end of the burster casing M6, and to seat the fuze. The burster is made up of the M8 burster charge and burster initiator M1 held in the M6 burster casing, a thin-walled cylindrical casing extending nearly the length of the filler cavity. With the M48A3 fuze set superquick, a surface burst is obtained on impact; set delay, a burst after penetration or ricochet results.

b. DATA.

Weight of complete round.....	22.78 lb
Length of complete round.....	28.92 in
Length of fuzed projectile.....	15.04 in
Length of cartridge case.....	16.0 in
Width of rotating band.....	0.35 in
Type of base.....	Boat-tailed
Degree of base taper.....	8° 45'
Radius of ogive.....	7.47 cal.
Muzzle velocity	990 fps
Maximum range	7,020 yd

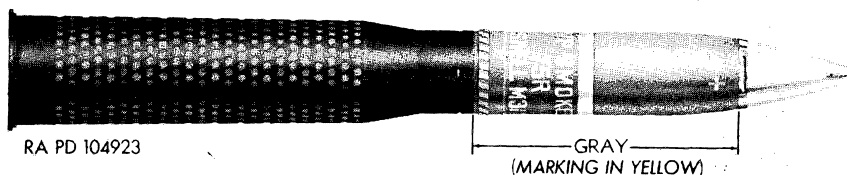


Figure 88. Cartridge, smoke, WP, M311, w/fuze, PD, M48A2, 0.05-sec delay, for 75-mm rifles.

113. Cartridge, Smoke, WP, M311, w/Fuze, PD, M48A2, 0.05-Sec Delay, for 75-mm Rifles (fig. 88)

This round differs principally from the M311A1 round (par. 112) in the fuze and cartridge case. The M311 round is fitted with cartridge case M31.

114. Cartridge, Smoke, WP, M311 (T40), w/Fuze, PD, M57, for 75-mm Rifles

This round uses FUZE, PD, M57 which is single-action superquick and cannot be set for delay. In other respects, the round is similar to the M311 round fitted with fuze M48A2.

115. Cartridge, TP, M309A1, w/Fuze, PD, M51A5, 0.05-Sec Delay, for 75-mm Rifles

This round is provided for target practice purposes by the use of service items, except for the projectile. The projectile is similar

to the service projectile described in paragraph 107, which it is intended to simulate, but is loaded with a 0.22-pound black powder spotting charge and inert filler to the required weight. M31A1 cartridge case, M47 primer, charge of M2 or M10 propellant powder, distance wad, and 300-grain igniting charge are used in this round. Dimensions and other data are given in paragraph 107, except for total weight of 22.56 pounds.

116. Cartridge, TP, M309, w/Fuze, PD, M51A4, 0.05-Sec Delay, for 75-mm Rifles

This round is similar to TP M309A1 round (par. 115) except that it is fitted with fuze M51A4 and cartridge case M31. It is used for the same purposes.

117. Cartridge, TP, M309, w/Fuze, Dummy, M73, for 75-mm Rifles

This round is an earlier type target practice round than that described in paragraph 116. It has a completely inert filler and a dummy fuze. Other components are the service cartridge case and propelling charge and the M28A2 primer. Dimensions and other data are given in paragraph 107.

Section X. AMMUNITION FOR 76-mm GUNS

118. General

a. GENERAL DISCUSSION. The 76-mm guns M1A1C and M1A2 are lightweight high-velocity tank and antitank guns. The 76-mm gun is a composite of the 3-inch gun tube (obsolete) and the 75-mm tank gun breech ring and mechanism. The base diameter of the 76-mm gun actually is 76.2 millimeters, or 3 inches. All 76-mm ammunition is issued in the form of fixed complete rounds. Rounds requiring fuzes are shipped fuzed. See paragraph 9c for discussion of flashless and smokeless rounds.

b. IDENTIFICATION. Painting and marking for identification is in accordance with the basic color scheme prescribed in TM 9-1900, and includes marking to indicate the characteristics of the propelling charge in firing—that is, “Flashless-Smokeless,” “Flashless,” “Smokeless,” or abbreviations thereof.

c. FUZES. FUZE, BD, M66A1, a base detonating fuze which functions with delay action, is fitted in the base of 76-mm armor-piercing-capped projectiles. This fuze is not considered to be of the boresafe type since the fuze explosive train is not interrupted. For impact fire, high-explosive shell, including the reduced charge

round, are fitted with the M51A5 fuze, giving selective superquick or 0.05-second delay; some rounds on hand are fitted with the M51A4 or the M48A2, both with same delay. For high-burst ranging or for time fire, high-explosive shell are fitted with the M500 MTSQ; some rounds on hand are fitted with the M55A3 TSQ fuze. The smoke shell is fitted with the M48A3 fuze which is to be set for superquick action when used with this shell. Some rounds on hand are fitted with the single-action M57 fuze which provides for superquick action on impact. The concrete-piercing fuze M78, with booster M25, is authorized for HE rounds. This fuze is issued separately for field assembly.

d. CARTRIDGE CASES. CASE, cartridge, 76-mm, M26 is standard for 76-mm ammunition. This is a brass case, 21.3 inches long, weighing 5.28 pounds. Some steel case armor-piercing-capped rounds are on hand.

e. PROPELLENT POWDER. Formerly designated "NH" or "FNH," according to the composition, 76-mm gun propelling charges now are designated "smokeless," flashless," or flashless-smokeless," in accordance with characteristics displayed by the charge when fired under average conditions. (See also paragraph 9c.) The firing characteristics are indicated on each round by marking on the base of the cartridge case, and on all packing thereof. A reduced propelling charge is used in certain high-explosive rounds to give a lower muzzle velocity for practice and for high-angle service fire. Such rounds are indicated by marking on the rounds and packing thereof (figs. 11 and 92).

f. PRIMERS. Two types of percussion primer are used with 76-mm ammunition—the 300-grain M28A2 and the 270-grain M40A1. The M40A1 primer, a 19-inch long front-burning type, is intended for use with 76-mm ammunition, except HVAP-T (service) and the HVTP-T (practice) rounds, loaded for a muzzle velocity in excess of 2,500 fps. The M28A2 primer (fig. 192), a 10-inch long assembly, is standard for these exceptions. An alternative for the M28A2 primer is the 300-grain M28A2B2. See section III, chapter 3.

119. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL R-1, R-5, and R-6.

120. Projectile, Fixed, APC-T, M62A1, Flashless-Smokeless, for 76-mm Guns (fig. 89)

a. GENERAL. This projectile is intended for use against armored targets. The projectile is the armor-piercing-capped type

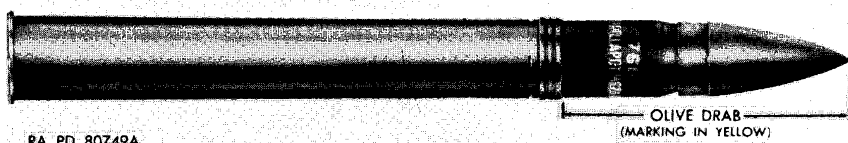


Figure 89. Projectile, fixed, APC-T, M62A1, flashless-smokeless, for 76-mm guns.

which relies on striking power for penetration, and is loaded and fuzed for blast effect behind the plate. The body of the projectile is solid except for a relatively small cavity at the rear which holds the high-explosive charge consisting of 0.144 pound explosive D. The nose of the body is fitted with an armor-piercing cap, increasing the effectiveness of the projectile against face-hardened armor. The windshield permanently fixed to the armor-piercing cap is a hollow thin-walled steel ogival cap which gives an improved ballistic shape to the round. The base is square, and the cavity is threaded for the base detonating fuze M66A1. This fuze functions with delay action; that is, for penetration before detonation of the explosive filler. The boat-tailed rear portion of the fuze housing holds a tracer which operates independently of the fuze mechanism. After its ignition by the propelling charge when the round is fired, the tracer composition burns for a minimum of 3 seconds, giving a visible trace for observation purposes. Due to the greater muzzle velocity, the round is effective at greater ranges than the corresponding round for 75-mm guns. New assemblies are fitted with the M40A1 primer which, in conjunction with the 3.75-pound propelling charge of new composition (M6), provides flashless and smokeless performance when the round is fired under average conditions. Earlier assemblies were fitted with the M28A2B2 and will have flashless or smokeless characteristics during firing, dependent upon the composition of the propellant.

b. DATA.

Weight of complete round.....	25.15 lb*
Weight of projectile, as fired.....	15.44 lb
Length of complete round.....	33.80 in
Length of fuzed projectile.....	13.78 in
Length of cartridge case.....	21.30 in
Width of rotating band.....	1.02 in

* With M40A1 primer; weight with M28A2B2 primer is 24.80 pounds.

Type of base.....	Square
Radius of ogive (false ogive).....	7.05 cal.
Muzzle velocity.....	2,600 fps
Maximum range.....	17,000 yd
Penetration (at 0° obliquity of face-hardened plate at 1,000 yd).....	4.6 in
Penetration (at 0° obliquity of homogeneous plate at 1,000 yd).....	4.4 in

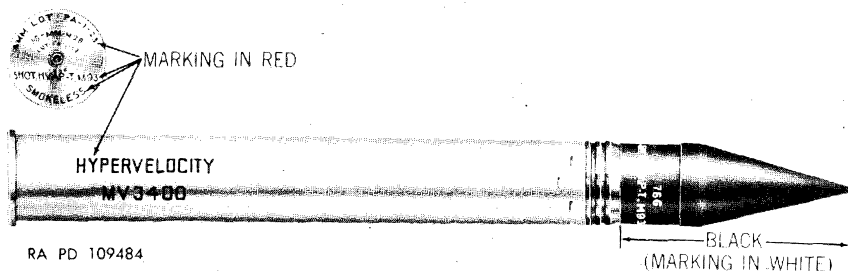


Figure 90. Shot, fixed, HVAP-T, M93, smokeless, for 76-mm guns.

121. Shot, Fixed, HVAP-T, M93, Smokeless, for 76-mm Guns

a. GENERAL. The details of this shot are illustrated in figures 2, 12, and 90. It is a special hypervelocity armor-piercing round for use against heavily armored targets. The shot is an unfuzed lightweight projectile made up of a 3.95-pound tungsten carbide core, an aluminum body and windshield, and a steel base with integral steel rotating band. A steel ring seated on the front end of the body serves as the bourrelet. A small well in the base contains a tracer which, after initiation by the propelling charge upon firing, provides a bright trace for observation purposes over a range of about 4,500 yards. With an initial velocity of 3,400 fps, the projectile has a striking velocity of 1,573 fps at 3,500 yards. Penetration effectiveness is about 40 percent greater than that of the M62 APC-T projectile up to 2,000 yards. Other components of this round are the M26 cartridge case, a 3.90-pound charge of loosely loaded M2 propellant, and an M28A2 percussion primer. The round gives muzzle flash but is smokeless when fired under average conditions.

b. DATA.

Weight of complete round.....	18.91 lb
Length of complete round.....	31.10 in
Length of projectile.....	11.00 in
Length of cartridge case.....	21.30 in

Width of rotating band.....	1.02 in
Type of base.....	Square
Type of nose.....	Conical
Degree of nose taper.....	14° 21'
Muzzle velocity	3,400 fps
Range (at 1° 20').....	3,500 yd
Maximum range	13,100 yd
Penetration (homogeneous plate at 30° obliquity, at 1,000 yd).....	5.3 in

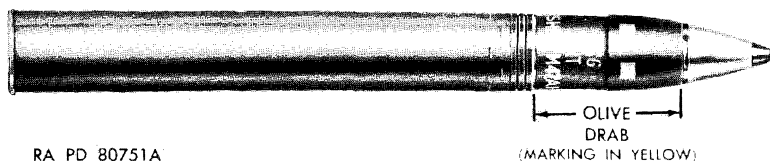


Figure 91. Shell, fixed, HE, M42A1, smokeless, w/ fuze, PD, M51A5, 0.05-sec delay, for 76-mm guns.

122. Shell, Fixed, HE, M42A1, Smokeless, w/Fuze, PD, M51A5, 0.05-Sec Delay, for 76-mm Guns (fig. 91)

a. GENERAL. This shell provides for fragmentation and blast effect at the target for use against personnel and light matériel. The complete assembly consists of the standard cartridge case, an M40A1 primer, a 3.75-pound propelling charge of M6 powder, and a fuzed high-explosive shell. The shell body is a relatively thin-walled forged steel casing having an explosive charge cavity extending almost the full length of the body. As shipped, the shell is fitted with the M51A5 fuze, a selective type providing alternative superquick action for surface burst on impact, or 0.05-second delay action. The round gives smokeless performance when fired under average conditions. Some rounds on hand are assembled with the M51A4 or the M48A2 fuze, with 0.05- or 0.15-second delay, and with flashless or flashless-smokeless propelling charges. Otherwise, the rounds are the same and the same data apply.

b. DATA.

Weight of complete round.....	22.57 lb
Weight of the projectile, as fired.....	12.66 lb
Length of complete round.....	32.32 in
Length of fuzed projectile.....	12.26 in
Length of cartridge case.....	21.30 in
Width of rotating band.....	1.02 in
Type of base.....	Square

Radius of ogive-----	7.04 cal.
Muzzle velocity -----	2,700 fps
Maximum range -----	14.360 yd

123. Shell, Fixed, HE, M42A1, Smokeless, w/Fuze, MTSQ, M500, for 76-mm Guns

This round is identical with that described in paragraph 122 except for the 75-second mechanical time and superquick fuze assembled thereto. Data in paragraph 122 are applicable to this round. Some rounds on hand are assembled with the 25-second time and superquick fuze M55A3 and with flashless-smokeless propelling charge.

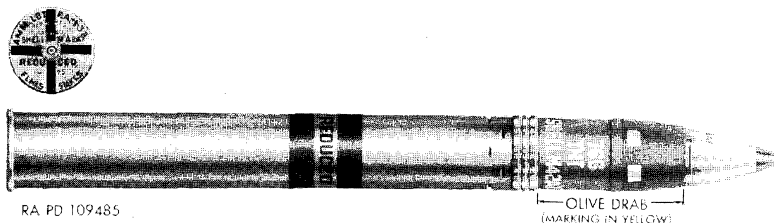


Figure 92. Shell, fixed, HE, M42A1, reduced charge, smokeless, w/fuze, PD, M51A5, 0.05-sec delay, for 76-mm guns.

124. Shell, Fixed, HE, M42A1, Reduced Charge, Smokeless, w/Fuze, PD, M51A5, 0.05-Sec Delay, for 76-mm Guns (fig. 92)

This round is similar to that described in paragraph 122 except that it has a reduced charge of propellant composed of M1 powder. This round is fitted with the M28A2 primer which, with the reduced charge, gives smokeless performance under average conditions. Weight of complete round is 19.01 pounds, muzzle velocity is 1,500 fps, and maximum range is 8,805 yards. Some rounds on hand are fitted with the M48A2 or the M51A4 fuze and have a flashless-smokeless propelling charge. Otherwise, data in paragraph 122 are applicable.

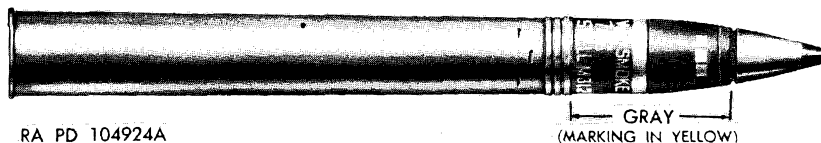


Figure 93. Shell, fixed, smoke, WP, M312, smokeless, w/fuze, PD, M48A3, 0.05-sec delay, for 76-mm guns.

125. Shell, Fixed, Smoke, WP, M312, Smokeless, w/Fuze, PD, M48A3, 0.05-Sec Delay, for 76-mm Guns (fig. 93)

a. GENERAL. This shell is provided for 76-mm guns for screening and spotting purposes. It also has very limited incendiary and antipersonnel effects. The body of the M312 shell is similar to that of the M42A1 high-explosive shell, except that the former has thinner side walls forward of the rotating band. Its nose is cut off to seat an adapter which is brazed onto the shell body. The adapter, in addition to serving as a nose for the shell and a seat for the fuze, provides a tight seal for the 0.78-pound filler of white phosphorus and a means of seating the front end of the burster casing M12. The M23 burster charge, which is held in the burster casing, consists of 524 grains of tetrytol. It extends approximately the full length of the shell cavity. Other components of the round are the standard cartridge case, the M40A1 primer, and a 3.75-pound propelling charge. Rounds fitted with the M40A1 primer will give smokeless performance under average firing conditions. The M48A3 fuze provides superquick action on impact, giving surface burst and effective dissemination of the burning phosphorus filler. Ballistically, the shell is the same as the M42A1 high-explosive shell. Some rounds on hand are fitted with the single-action fuze M57 and with smokeless or smokeless-flashless propelling charges. Otherwise, the same data apply.

b. DATA.

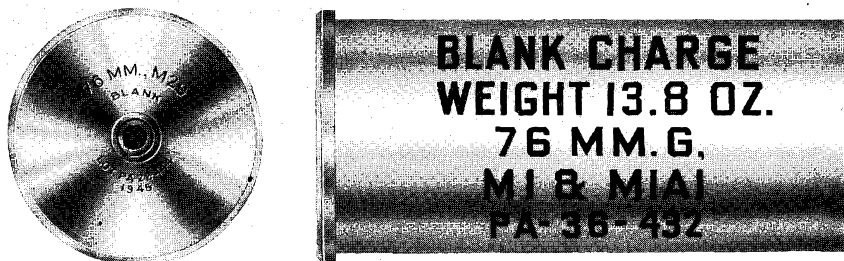
Weight of complete round.....	22.66 lb
Length of complete round.....	32.38 in
Length of fuze'd projectile.....	12.26 in
Length of cartridge case.....	21.30 in
Width of rotating band.....	1.02 in
Type of base.....	Square
Radius of ogive.....	7.05 cal.
Muzzle velocity	2,700 fps
Maximum range	14,360 yd



Figure 94. Shot, fixed, HVTP-T, M315A1, smokeless, for 76-mm guns.

**126. Shot, Fixed, HVTP-T, M315A1, Smokeless, for 76-mm Guns
(fig. 94)**

This shot is a target practice round matching the ballistics of SHOT, fixed, HVAP-T, M93, smokeless, for 76-mm guns. The shot is composed of a mild steel body with copper alloy rotating band and an aluminum windshield. Tracer, M4, is a plug which screws into the base of the shot. Loading components are the same as for the M93 round.



RA PD 104926

Figure 95. Ammunition, blank, for 76-mm guns.

**127. Ammunition, Blank, for 76-mm Guns
(fig. 95)**

This ammunition is similar in design to the double pellet blank ammunition provided for 75-mm guns and howitzers (par. 92 and fig. 78). The complete assembly is made up of an M29 cartridge case, which is essentially a service cartridge case cut down to suitable length, two 6.90-ounce black powder pellets, and an M1B1A2 primer. The assembly is sealed at the front end by a closing cup assembly consisting of a pulpboard cup backed on the inner face with a $\frac{3}{8}$ -inch thick hard hair felt wad. Weight is 3.88 pounds; length is 7.28 inches.

**128. Cartridge, Drill, M20, w/Fuze, Dummy, M59, for 76-mm
Guns**

The M20 drill cartridge (fig. 96), made of bronze, simulates the high-explosive round M42A1 assembled with an M48 series or an M51 series fuze, and the armor-piercing-capped projectile M62A1. The alternative drill round M20B1 is made of malleable iron. A copper-base center pin, fitted in the center of the base, simulates the primer. FUZE, dummy, M59 simulates the M48 and the M51 series. The weight of the drill cartridge is 24.80 pounds; length is 33.80 inches.

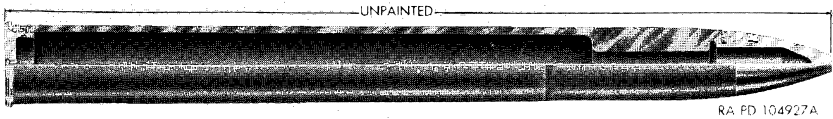


Figure 96. Cartridge, drill, M20, w/fuze, dummy, M59, for 76-mm guns.

Section XI. AMMUNITION FOR 81-mm MORTARS

129. General

a. GENERAL DISCUSSION. The 81-mm mortar M1 or M21 is a refinement of the 3-inch trench mortar, which no longer is used or manufactured. Like the 60-mm, the 81-mm is a smooth-bore, muzzle-loading weapon primarily for infantry support. The M21 mortar is a portable weapon separable into four lightweight sections. The tube is divided into two sections, and may be fired with either the short (22½ in.) section only to obtain ranges up to approximately 1,690 yards, or with a 23-inch section assembled to the short section to obtain ranges up to 3,290 yards. With the shorter tube, the mortar can perform all missions now performed by the 60-mm mortar; with the long tube, it can perform all functions of the previous standard 81-mm mortar M1. Ammunition for both mortars is the same and consists of light and heavy types of explosive rounds, together with several chemical rounds for screening purposes, and suitable practice and training ammunition. A round for illumination of targets and target areas is in stock, but the round is limited standard and no further manufacture is contemplated. The 81-mm rounds are considered to be "semifixed," that is, the propelling charges are adjustable and the round is loaded into the weapon in one operation. All service and practice ammunition is issued and shipped in the form of fuze complete rounds.

b. IDENTIFICATION. The use of a fin to give stability of flight to the projectile in place of rotational forces gives a characteristic appearance to the round which serves to distinguish mortar rounds (except 4.2-inch mortar ammunition (sec. XIV, this ch.)) from other artillery types. Complete identification is provided for by painting and marking in accordance with the basic scheme prescribed in TM 9-1900.

c. FUZES. Service and practice 81-mm shell are fuze with point fuzes. The fuzes in use are: FUZE, PD, M52 series and M53A1; FUZE, TSQ, M77; and FUZE, time, M84. The M52 series and M53A1 fuzes are single-action types, the M52 series providing for

superquick action and the M53A1 having a 0.1-second delay element. The M77 is a combination time and superquick fuze for use with M56 and M57 shell. The M84 is used with the 81-mm illuminating shell, and is a 25-second time fuze without impact element. Plastic body fuzes are not to be assembled in chemical shell. See section I, chapter 3, for further details of fuzes.

d. PROPELLING CHARGES. Propellant increments M1A1 and M2A1 are provided for 81-mm mortar ammunition. The M1A1 charge is similar to the M3A1 charge for the 60-mm mortar rounds and assembled in the same manner to the fin assembly. The M1A1 increments are contained in individual cellophane bags for protection against moisture. Standard full charge consists of six increments for HE and TP rounds M43A1. Four increments comprise the standard full charge. Four M2A1 increments, individually cellophane-wrapped and held around the fin shaft by the M3 holder, comprise the standard full charge for all other 81-mm mortar rounds. All increments of all types of charges are removable as required for zone firing. For firing charge 0, the ignition cartridge serves solely as the propellant. For heavy HE rounds M56 and chemical rounds M57, the minimum charge used is charge 1, that is, ignition cartridge plus one increment. In normal service use, the maximum charge is the standard full charge noted above. However, for limited emergency firing in combat, two additional increments (charges 7 and 8) may be used with M43A1 shell to obtain ranges up to 4,035 yards.

e. PRIMER AND IGNITION CARTRIDGES. For all current manufacture, PRIMER, percussion, M34, is used in conjunction with CARTRIDGE, ignition, M6 or M8, to ignite the propellant increments. The M6 and M8 ignition cartridges differ only with respect to the length of the cartridge, the M8 being 0.20 inch shorter. The M6 and M8 cartridges and M34 primers have replaced the M3 cartridge, which included the primer, except for the training projectile M68 (sec. III, ch. 3).

130. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL R-4.

131. Shell, HE, M43A1, w/Fuze, PD, M52A1, for 81-mm Mortars (fig. 97)

a. GENERAL. This shell is a lightweight round provided for fragmentation and blast effect. Standard rounds are made up of the M43A1 shell fuzeed with an M52A1 superquick fuze, and a stabilizing fin M3 which also seats an M1A1 propelling charge, an M8 ignition cartridge, and an M34 percussion primer. However,

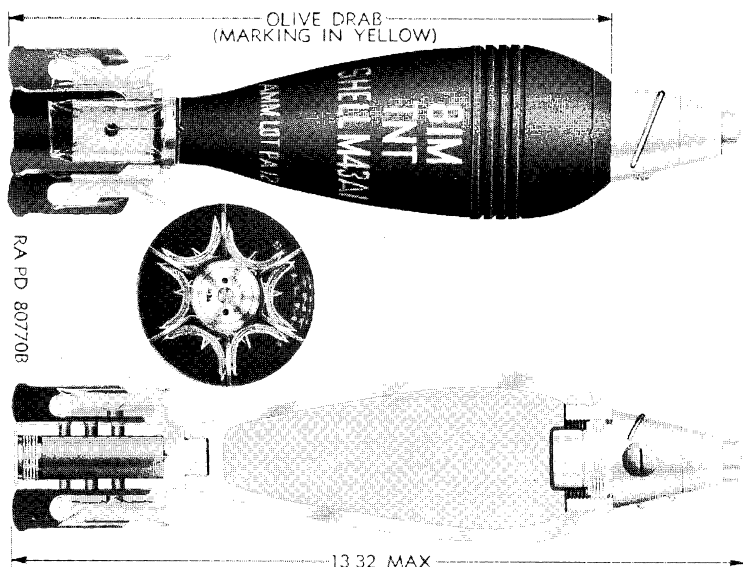


Figure 97. Shell, HE, M43A1, w/fuze, PD, M52A1, for 81-mm mortars.

rounds may be assembled with the following alternatives: the M43A1B1 shell, a manufacturing alternative of the M43A1 which eliminates the need for a nose adapter; and fuze M52A1B1 or M52A1. Earlier rounds may be encountered which are assembled with M52, M52B1, M52B2, or M52B4 fuzes. The M43A1 and M43A1B1 shell consist of a thin-walled egg-shaped steel casing holding a 1.23-pound high-explosive charge. The M43A1B1 has a nose opening drilled and threaded to seat the M52 series fuzes. In the M43A1, the shell casing is cut and threaded at the nose end to fit an adapter into which the fuze with its booster is screwed after the shell is loaded, the bursting charge being shaped at the free end to provide a suitable well for the booster. The base of the shell is drilled and threaded to hold the fin assembly. The fin assembly consists of three double-bladed fins welded to a cylindrical shaft. The shaft is drilled and threaded internally at the rear to hold the igniter cartridge and the primer, the latter holding the cartridge in position. The shaft is threaded at the front end to screw into the base of the shell. Vents in the shaft provide for transmission of the cartridge flash to the propellant increments. The propellant increments are pushed into the spaces within the

fin blades and held there by a spring clip arrangement which permits easy removal as desired. With the M52-series fuze, the shell functions with superquick action and before any appreciable penetration of the target.

b. DATA.

Weight of complete round----- 7.28 lb*
 Length of complete round----- 13.32 in
 Muzzle velocity ----- 700 fps**
 Maximum range ----- 3,290 yd**

* With M52A1 fuze; weight with M52A1B1 fuze is 7.15 pounds; with M52 or M52B2 fuze, 7.05 pounds; with M52B1 fuze, 6.86 pounds.

** For six increments (full charge). Corresponding data for other charges are—

	Muzzle velocity (fps)	Maximum range (yd)
Charge 0 (ignition cartridge only)-----	235	541
Charge 1 (ignition cartridge plus 1 increment)---	332	1,020
Charge 2 (ignition cartridge plus 2 increments)--	419	1,502
Charge 3 (ignition cartridge plus 3 increments)--	499	2,042
Charge 4 (ignition cartridge plus 4 increments)--	572	2,517
Charge 5 (ignition cartridge plus 5 increments)--	638	2,963

132. Shell, HE, M56, w/Fuze, TSQ, M77, for 81-mm Mortars (fig. 98)

a. GENERAL. This shell is the heavy type of the two current standard rounds for fragmentation and blast effect. The standard round consists of six components: the M56 shell or an alternative (M56B1, M56B2, or M56B3), an M77 TSQ fuze, an M4 fin assembly, an M2A1 propelling charge, an M6 ignition cartridge, and an M34 percussion primer. When the M77 fuze is not available, FUZE, PD, M52A1 will be issued when SQ action is needed. The projectile is made up of a 4.3-pound high-explosive charge (TNT) held in a thin-walled shell made of steel tubing. The shell casing is formed to a long cylindrical shape with a long tapered (boat-tailed) base and a short ogival nose. In M56 and M56B2 shell, the nose is threaded to hold an adapter into which the fuze is assembled after the shell is loaded. The M77 fuze is not staked to shell M56B1, and M56B3 shells have nose openings to suit the fuze eliminating the need for an adapter. The tapered base is drilled and threaded to hold the fin assembly, except in the case of the M56B3 shell which is fitted with a threaded base plug. The fin assembly is an aluminum alloy die casting with 12 blades seated on a hollow cylindrical shaft. The shaft acts as a sleeve for a steel liner which is threaded at the front end to screw into the shell base. The rear of the liner is hollow and holds the ignition cartridge and primer, the latter screwing in and holding the cartridge in position. The shaft is vented to permit transmission of

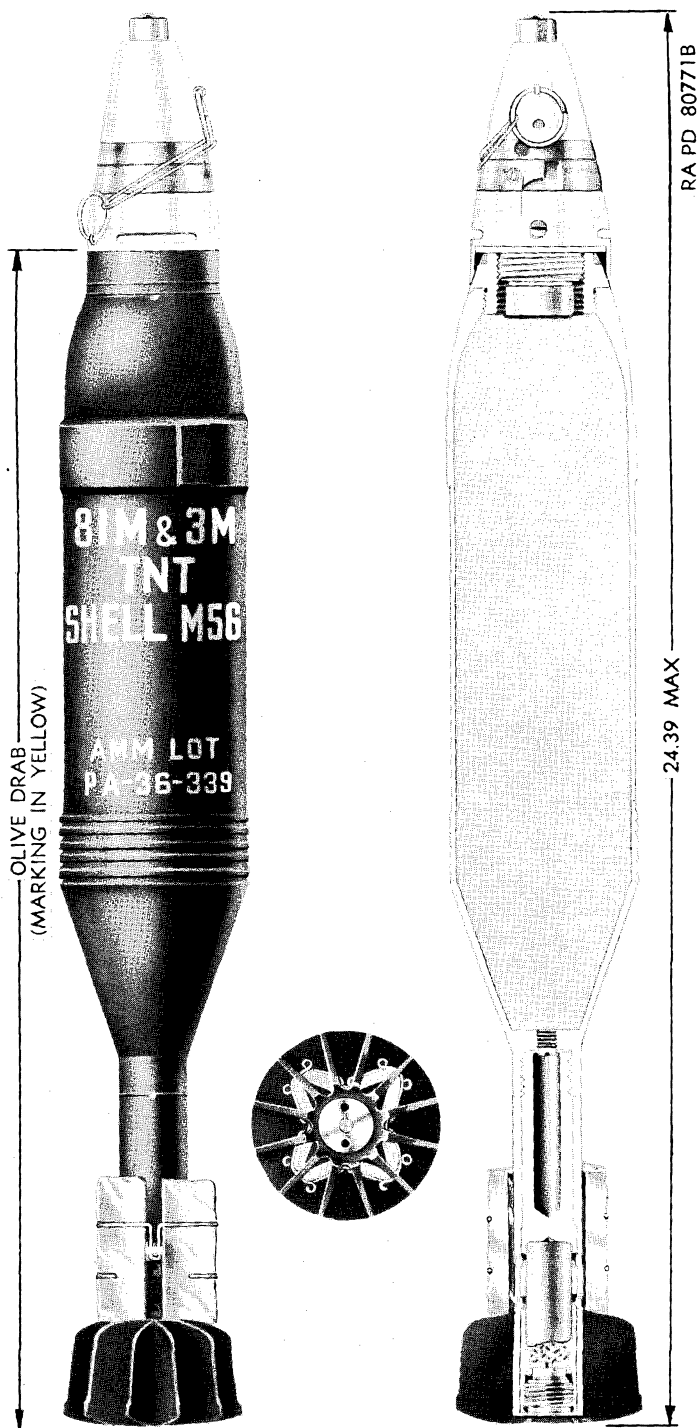


Figure 98. Shell, HE, M56, w/fuze, TSQ, M77, for 81-mm mortars.

the flash of the ignition cartridge to the propellant increments. The M2A1 propelling charge comprises four increments or bundles of propelling powder in the form of square flakes or sheets. The M2A1 increments (cellophane-wrapped) are held on the fin shaft by means of the HOLDER, M3.

b. DATA.

Weight of complete round-----	11.86 lb
Length of complete round-----	24.45 in
Muzzle velocity -----	557 fps*
Maximum range -----	2,450 yd*

* For four increments (full charge). Corresponding data for other charges are—

	<i>Muzzle velocity</i> (fps)	<i>Maximum range</i> (yd)
Charge 1 (ignition cartridge plus 1 increment)---	291	800
Charge 2 (ignition cartridge plus 2 increments)--	390	1,425
Charge 3 (ignition cartridge plus 3 increments)--	472	1,950

133. Shell, HE, M56, w/Fuze, PD, M52A1, for 81-mm Mortars

This shell has the same components as the round described in paragraph 132 except for the fuze. With the M52A1 or M52A1B1 fuze, or earlier modifications M52, M52B1, M52B2, and M52B4, which may be found on some assemblies, the round functions with superquick action on impact. Differences in the various fuzes of the M52 series are in the materials used in the assemblies, and in the resultant variations in weight. Maximum range with charge 4 (cartridge and 4 increments) is approximately 2,560 yards. Maximum ranges with other charges are: charge 3, 3,000 yards (at $49\frac{3}{4}^{\circ}$); charge 2, 1,400 yards (at $68\frac{1}{4}^{\circ}$); charge 1, 800 yards ($56\frac{1}{2}^{\circ}$). Weight of complete round is 10.97 pounds and length is 22.91 inches.

134. Shell, HE, M56, w/Fuze, PD, M53A1 for 81-mm Mortars

This shell differs from the rounds described in paragraphs 132 and 133 only in the fuze. The M53A1 provides 0.1-second delay functioning on impact. With the M53A1 fuze, the round weighs 11.48 pounds. The round, with all fuzes, is 22.91 inches long. Range data given in paragraph 133 are applicable to this round. Maximum range is 2,600 yards.

135. Shell, Smoke, WP, M57, w/Fuze, TSQ, M77, for 81-mm Mortars (fig. 99)

a. GENERAL. This shell is assembled from the same components as are used with the M56 high-explosive round described in para-

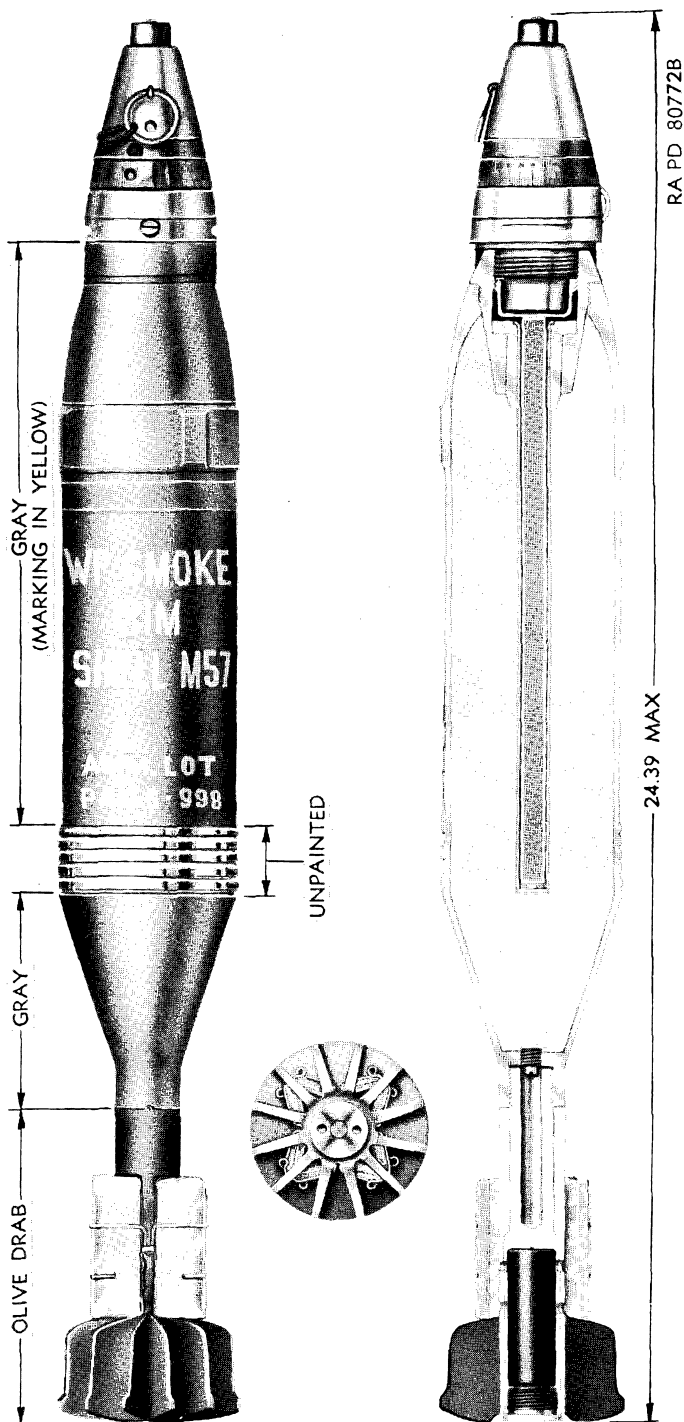


Figure 99. Shell, smoke, WP, M57, w/fuze, TSQ, M77, for 81-mm mortars.

graph 132, but is loaded with a phosphorus filler for screening purposes. To adapt the M57 shell for this filler, the nose of the shell casing is fitted with a special adapter. This serves to provide the tight seal necessary with chemical loading and also acts as the seat for the burster assembly. The burster charge M1 consists of a thin-walled tube filled with a small charge of tetryl. It is held in the burster casing M2 which is press-fitted into the shell adapter. This assembly extends from the nose longitudinally through the chemical filler for about three-quarters of the length of the cavity. Its function is to burst the shell casing and scatter the chemical contents. The time and superquick type of fuze is fitted to the shell to provide for air burst and for burst before penetration. White phosphorus burns with a dense smoke, and has a slight incendiary effect.

b. DATA.

Weight of complete round-----	12.76 lb
Length of complete round-----	24.39 in
Muzzle velocity -----	535 fps*
Maximum range -----	2,330 yd*

* For four increments (full charge). Corresponding data for other charges are—

	<i>Muzzle velocity</i> (fps)	<i>Maximum range</i> (yd)
Charge 1 (ignition cartridge plus 1 increment)---	—	775
Charge 2 (ignition cartridge plus 2 increments)--	—	1,300
Charge 3 (ignition cartridge plus 3 increments)--	—	1,825

136. Shell, Smoke, WP, M57, w/Fuze, PD, M52A1, for 81-mm Mortars

a. GENERAL. This shell differs from the WP smoke round described in paragraph 135 in that it is assembled with the super-quick fuze M52A1. Earlier rounds were fuzed with the M52 or alternatives M52B2 or M52B4. The M52A1B1 and other plastic body fuzes are not to be used with this round.

b. DATA.

Weight of complete round-----	11.83 lb*
Length of complete round-----	22.91 in
Muzzle velocity -----	560 fps**
Maximum range -----	2,470 yd**

* With M52A1 fuze; with M52 fuze, weight is 11.36 pounds.

** For four increments (full charge). Corresponding data for other charges are—

	Muzzle velocity (fps)		Maximum range (yd)	
	M52A1	M52	M52A1	M52
Charge 1 (ignition cartridge plus 1 increment) -----	291	297	808	833
Charge 2 (ignition cartridge plus 2 increments) -----	390	399	1,374	1,409
Charge 3 (ignition cartridge plus 3 increments) -----	472	484	1,916	1,952

137. Shell, Smoke, FS, M57, w/Fuze, PD, M52A1, for 81-mm Mortars

a. GENERAL. This shell is assembled from the same components as are used with the WP smoke round (par. 136) assembled with M52A1 or M52 fuze but is loaded with FS, a liquid smoke producer which functions very much like white phosphorus.

b. DATA.

Weight of complete round-----	12.33 lb*
Length of complete round-----	22.91 in
Muzzle velocity -----	544 fps**
Maximum range -----	2,431 yd**

* Weight with M52B2 fuze (plastic head) is 12.07 pounds (plastic is not recommended).

** For four increments (full charge). Corresponding data for other charges are—

	Muzzle velocity (fps)	Maximum range (yd)
Charge 1 (ignition cartridge plus 1 increment)---	291	808
Charge 2 (ignition cartridge plus 2 increments)--	390	1,374
Charge 3 (ignition cartridge plus 3 increments)--	472	1,916

138. Shell, Smoke, FS, M57, w/Fuze, TSQ, M77, for 81-mm Mortars

a. GENERAL. This round contains the same components as the FS smoke round described in paragraph 137, except that it is assembled with the TSQ fuze M77, and is the same as the WP smoke round described in paragraph 135, except for the muzzle filler.

b. DATA.

Weight of complete round-----	13.26 lb
Length of complete round-----	24.39 in
Muzzle velocity -----	560 fps*
Maximum range -----	2,431 yd*

* For four increments (full charge). Corresponding data for other charges are—

	Muzzle velocity (fps)	Maximum range (yd)
Charge 1 (ignition cartridge plus 1 increment)---	291	808
Charge 2 (ignition cartridge plus 2 increments)--	390	1,374
Charge 3 (ignition cartridge plus 3 increments)--	472	1,916

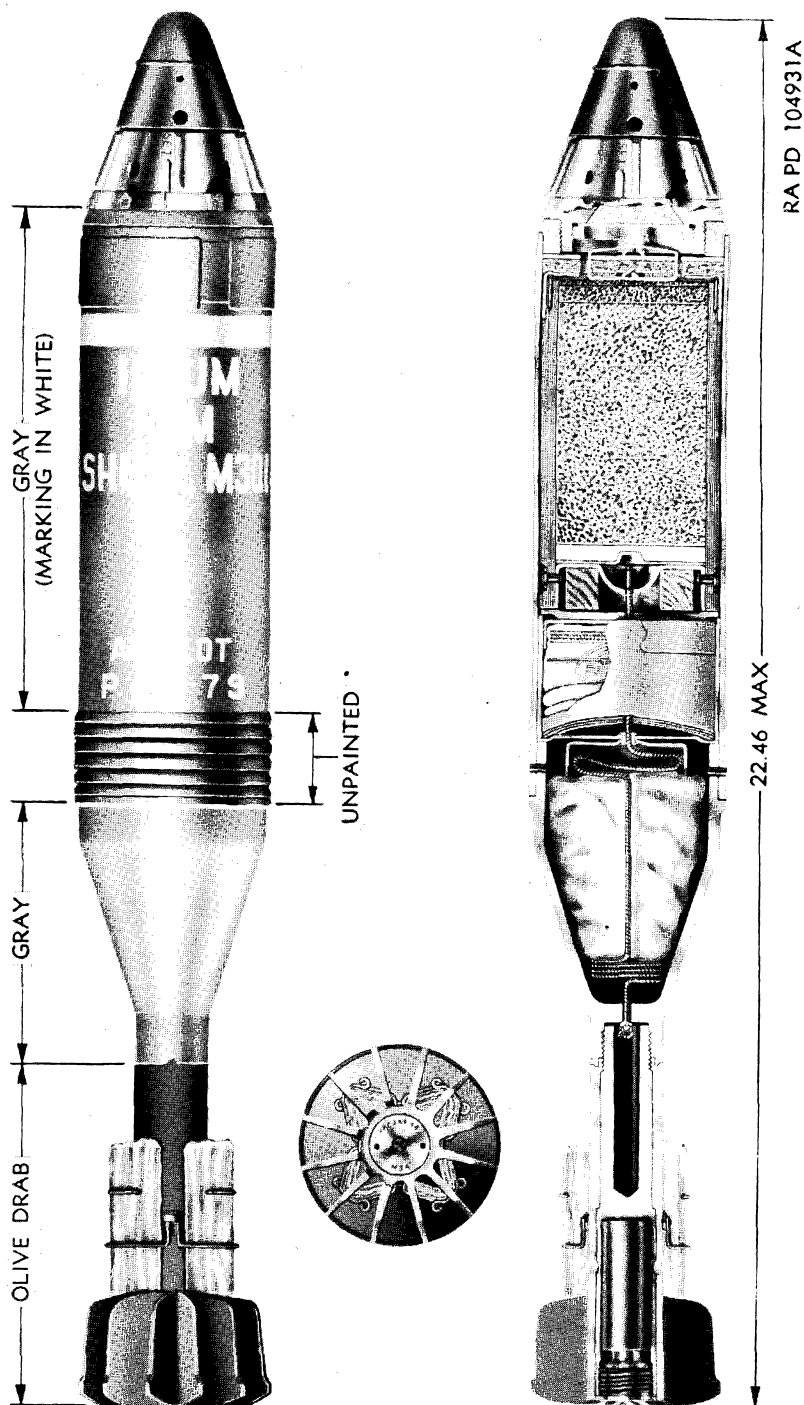


Figure 100. Shell, illuminating, M301, w/fuze, time, M84, for 81-mm mortars.

139. Shell, Illuminating, M301, w/Fuze, Time, M84, for 81-mm Mortars (fig. 100)

a. GENERAL. This shell is similar in design to the illuminating shell M83A1 for 60-mm mortars. The shell is made up of four major parts: a body tube assembly, illuminant assembly, a parachute assembly, and a tail assembly. The body is a thin-walled steel tubing at the front end of which is welded a steel adapter threaded internally to seat the fuze. The tail assembly is a light-weight cone inserted into the body tube and held in position by four equally spaced shear pins. The base end of the cone is fitted with an adapter which holds the M4 fin; the latter holds the ignition cartridge and percussion primer. The illuminant assembly consists of a quickmatch, a black powder priming charge, a first-fire composition, and the main charge of illuminant composition held in a boxboard casing. The casing is attached to the parachute by a suspension wire about 30 inches in length. In functioning, the fuze expelling charge ejects the parachute and illuminant assemblies from the base of the shell, at the same time igniting the quickmatch. The quickmatch in turn ignites the primary charge which lights the first fire composition and illuminant. The illuminant composition burns for at least 55 seconds, with a minimum of 250,000 candlepower. Rate of descent is approximately 12 fps. The shell is intended to be fired in zones 2, 3, and 4 only, with fuze settings to secure functioning at ranges from 100 to 2,200 yards. The M84 fuze provides for time setting up to 25 seconds, and has no impact element.

b. DATA.

Weight of complete round.....	10.71 lb
Length of complete round.....	22.48 in
Muzzle velocity	583 fps
Maximum range:	
Horizontal	2,300 yd*
Height of burst.....	450 yd

* For charge 4 (ignition cartridge and four increments). Data for other charges are—

	<i>Horizontal range (yd)</i>
Charge 2 (ignition cartridge plus 2 increments).....	1,000 (at 61° 45')
Charge 3 (ignition cartridge plus 3 increments).....	1,700 (at 50° 45')

140. Shell, TP, M43A1, w/Fuze, PD, M52A1, for 81-mm Mortars (fig. 101)

This is a practice round to simulate SHELL, HE, M43A1. It is an adaptation of the M43A1 service round (par. 131) for practice

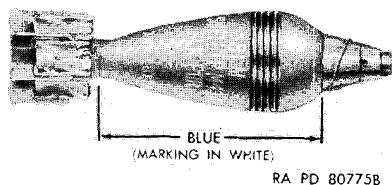
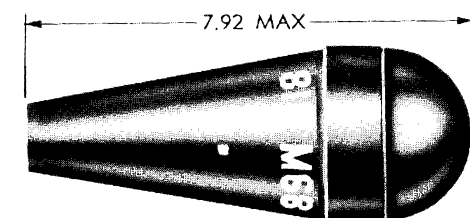
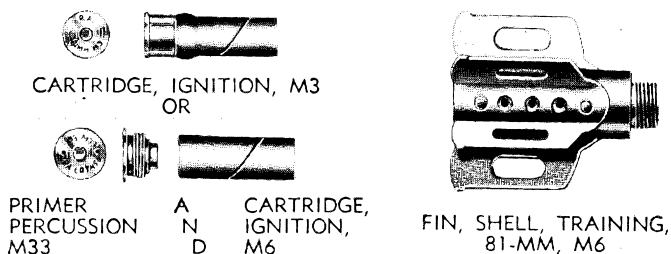


Figure 101. Shell, TP, M43A1, w/fuze, PD, M52A1, for 81-mm mortars.

purposes, accomplished by changing the shell filler. All other components are the same as for the service round, and construction and assembly of these in the round are the same. For practice purposes, the shell cavity is filled with an inert material (plaster of paris and stearic acid) except for a 0.05-pound black powder pellet. The black powder is loaded at the front end of the cavity, adjacent to the rear wall of the booster casing when the fuze is assembled to the shell. The fuze booster charge and black powder pellet provide a spotting charge for observation of fire. Ballistic properties are the same as for the M43A1 service round, and data given in paragraph 131 are applicable to the practice round.

141. Shell, Training, M68, w/o Fin Assembly, for 81-mm Mortars (fig. 102)

a. GENERAL. This shell is provided for drill in loading and firing the mortar. The projectile is completely inert and has no fuze. It consists of a cast-iron body shaped to a pear or tear drop contour, and is drilled at the narrow base to hold an M6 fin assembly similar to that on the M43A1 projectiles. No propellant increments are issued or used except the M3 ignition cartridge; if this is not available, the combination of percussion primer M33 and ignition cartridge M6 is issued for use in firing the projectile. The four components are issued separately to facilitate replacement of damaged or worn-out parts and the procurement of extra ignition cartridges. A training kit used in the field holds 10 training shell and accessories, including a ground hook used in the recovery of fired training shell. To overcome difficulties encountered in extracting fired ignition cartridges M3 after firing the round, modification of the fin assembly M3 (when this service type fin is used) is authorized for field operation. The modification consists of drilling a $\frac{3}{8}$ -inch diameter hole longitudinally through the front (threaded) end of the fin shaft. A steel rod or punch with a blunt point and diameter permitting a free fit then can be driven through the hole to eject the spent cartridge. This procedure is not effective when the M33 percussion primer and the



SHELL, TRAINING, M68, W/O FIN ASSEMBLY,
FOR 81-MM MORTARS

A—COMPONENTS



B—ASSEMBLED

RA PD 80777H

Figure 102. Shell, training, M68, w/o fin assembly, for 81-mm mortars.

ignition cartridge M6 are used in firing. The most satisfactory method in this case is use of long-nose pliers which are issued for the purpose. When using modified fins, the lead seals of ignition cartridges may lodge in the threaded recess in the base of the shell, resulting in progressive filling of the recess. Insecure seating of the fin and excessive vibration as a result may, under such conditions, cause the threaded portion at the base of the shell to break off or crack. The condition can be corrected by cleaning out the shell recess or prevented by inserting a thin steel disk ahead of the ignition cartridge. The M6 fin assembly does not require modification as it already contains a longitudinal hole.

b. DATA.

Weight of complete round.....	10.82 lb
Length of complete round.....	11.08 in
Weight of projectile.....	9.8 lb
Length of projectile.....	7.92 in
Muzzle velocity	172.8 fps
Maximum range	310 yd

Section XII. AMMUNITION FOR 90-mm GUNS

142. General

a. GENERAL DISCUSSION. Originally intended for antiaircraft defense, the 90-mm gun since has been adapted, by the use of various types of mounts, for use also against ground and water-borne targets. On the several models of 90-mm guns now in use, the M1, M1A1, M1A2, M2, M2A1, M3, M3A1, and T8, all have the same type of chamber and can fire the same ammunition. Ammunition for these guns is of the fixed type, that is, the rounds have propelling charges which are not adjustable and are loaded into the cannon in one operation. Armor-piercing, armor-piercing-capped, high-explosive, hypervelocity armor-piercing, smoke, target practice, hypervelocity target practice, blank, and drill rounds are provided. Rounds requiring fuzes are shipped with fuzes assembled to the shell, except deep-cavity HE rounds of early manufacture which were shipped without fuze and with or without supplementary charge. Once removed from packing materials, the rounds require only adjustment of the fuzes to be ready for firing.

b. IDENTIFICATION. Painting and marking for identification is in accordance with the basic color scheme prescribed in TM 9-1900.

c. FUZES. Shell for antiaircraft use are fitted with the M43 series mechanical time fuze which permits adjustment of setting to 30 seconds but has no impact element. Shell for ground fire or anti-motor-torpedo-boat defense are shipped fuzed with the M48 or M51 series fuzes. The fuzes differ in that the M51 models incorporate the booster whereas the M48 models are used with boosters which are manufacturing components of the shell or are used without boosters. These fuzes provide for selective super-quick or delay setting for surface burst, or for detonation after penetration, or upon ricochet, with either 0.05- or 0.15-second delay (0.15-sec delay is limited standard). The M51A4 (M48A2) has been manufactured with both delays. Some rounds are assembled with TSQ M55A3 fuzes which provide for selective ad-

justment of time to 25 seconds and includes an impact element. Smoke shell are assembled with the M48A3 fuze; some rounds on hand are assembled with the M57 fuze (limited standard). The M57 fuze, a single action superquick type, is similar in appearance to the M48 series fuzes except that it has no setting sleeve. The MTSQ M500 fuze is a mechanical time superquick fuze, which is standard type to replace the M55A3 and the M67A3 fuzes. This fuze gives selective time up to 75 seconds and also contains an impact element. The MTSQ M502 fuze is a mechanical time superquick fuze giving selective time up to 30 seconds. This fuze also contains an impact element which is designed to function on impact with thin aircraft surfaces that usually would not offer enough resistance to cause functioning of the ordinary type impact elements. VT fuzes have been used to a particularly large extent in the 90-mm guns. FUZE, VT, M92 (T74E6) is used for most antiaircraft applications; FUZE, VT, M93 (T152) is used for engagement of target aircraft at low quadrant elevations over friendly territory; and FUZE, VT, M97A1 is used to obtain proximity bursts with terrestrial fire. VT fuzes are assembled to deep-cavity shell in the field after removal of fuzes and/or supplementary charges shipped assembled to the shell. Loaded armor-piercing projectiles are fitted with FUZE, BD, M68, a base detonating fuze which functions with delay action. Practice and drill rounds are fitted with either dummy or inert service fuzes. The 75-second mechanical time fuze M67A3 is authorized for 90-mm HE ammunition and is issued separately for assembly to rounds in the field. The concrete-piercing fuze M78 with booster M25, issued separately, also is authorized for use with 90-mm HE rounds. For complete description of fuzes, see section I, chapter 3.

d. CARTRIDGE CASES. CASE, cartridge, 90-mm, M19, which is made of brass, is standard for all types of ammunition except blank. The case weighs 11 pounds. CASE, cartridge, M27 is used with 90-mm blank ammunition.

e. PROPELLING CHARGES. Flashless-smokeless rounds have been established as standard for all 90-mm ammunition except time-fuzed rounds, which for AA fire, will be flashless. Earlier impact-fuzed rounds which are flashless (but not smokeless) are to be reserved for target practice firing insofar as practicable. Time-fuzed, flashing, smokeless rounds will be used for daytime fire or for practice until supplies are exhausted and replaced by flashless rounds. See discussion of "flashless" and "smokeless" charges in paragraph 9c.

f. PRIMERS. PRIMER, percussion, M28A2 is standard for all AA (time-fuzed) ammunition for 90-mm guns. Alternative primer

is PRIMER, percussion, M28B2 (steel) or PRIMER, percussion, M28A1 or M28B1A2. The M49 primer is standard for use with impact-fuzed rounds and the M40A1 is used with the HVAP-T M304 and HVTP-T M317A1 rounds. PRIMER, percussion, M1B1A2, is used with blank ammunition. See section III, chapter 3.

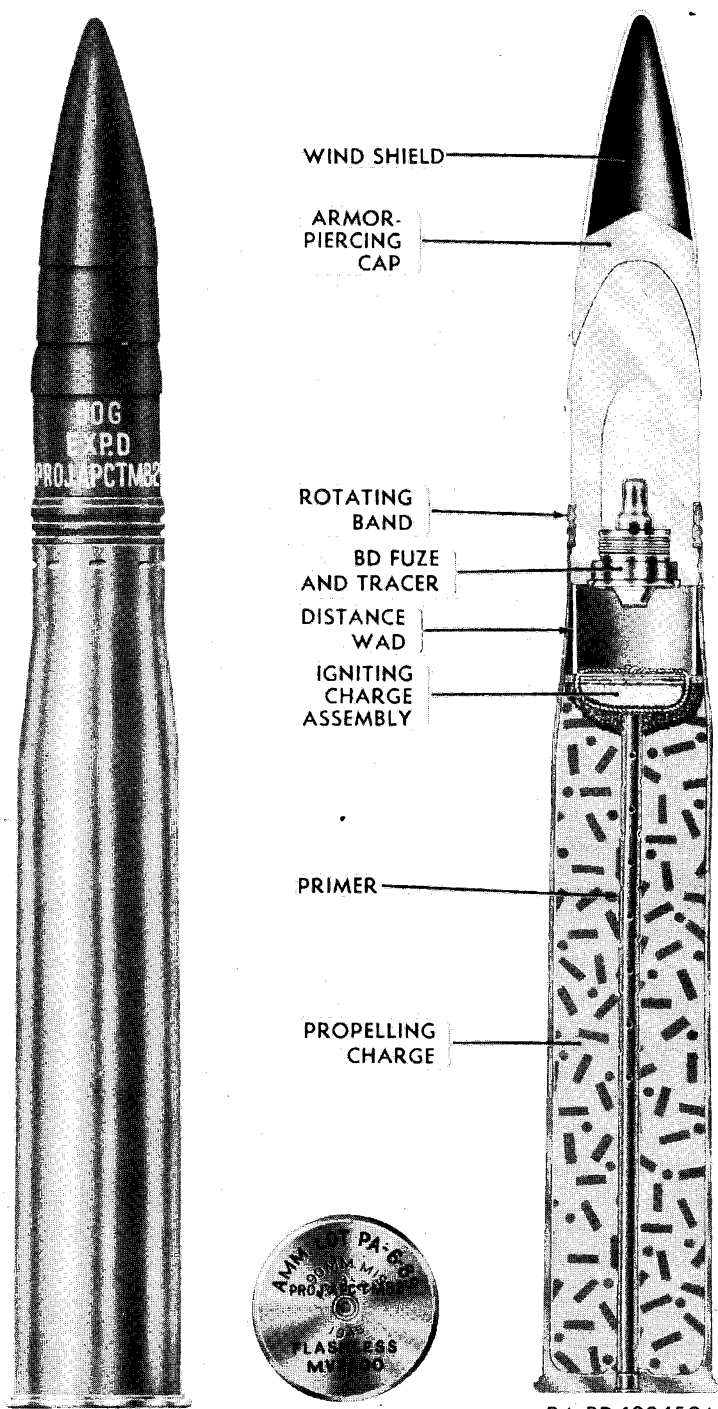
g. ADJUSTMENT OF RECOIL MECHANISMS. Because of high muzzle energy, use of the shot HVAP-T M304, shot HVTP-T M317A1, and projectile APC-T M82 necessitate adjustment of recoil mechanisms to prevent excessive recoil. The importance of these adjustments prior to the use of hypervelocity ammunition cannot be overstressed. If proper adjustments, as described in technical manuals on the weapon are *not* made, irreparable damage to the recoil mechanism may result. *Do not fire the M1, M1A1, M1A2, M2 or M2A1 90-mm guns at elevations above 800 mils when using the hypervelocity ammunition, as this may cause the gun to strike the top carriage during recoil.*

143. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL's P-5, P-7, and P-8.

144. Projectile, Fixed, APC-T, M82, MV 2,800, Flashless, w/Fuze, BD, M68, for 90-mm Guns M1, M1A1 M1A2, M2, M2A1, M3, M3A1, and T8 (fig. 103)

a. GENERAL. This projectile is provided for 90-mm guns for use against ground targets, particularly armored matériel. The projectile is similar to other standard types especially adapted for combating face-hardened armor. The body proper is made of hard steel, with a square base and a nose shaped to a relatively short ogive. A steel armor-piercing cap is soldered to the harder steel nose. A lightweight steel or aluminum windshield is screwed or crimped on the armor-piercing cap. The rear portion of the body contains a small cavity which, in the loaded projectile, holds a small charge of explosive D. The base hole is threaded to receive the M68 base detonating fuze. This fuze, a simple inertia type, functions with delay action. The rear housing of the fuze extends approximately three-quarters inch beyond the rear surface of the projectile base. This portion of the fuze contains a red tracer for observation purposes. Functioning independently of the fuze mechanism, the tracer composition is ignited by the propelling charge when the round is fired. It burns with a visible trace for a minimum of 3 seconds, equivalent to a minimum range



RA PD 109459A

Figure 103. Projectile, fixed, APC-T, M82, MV 2,800, flashless, w/fuze BD, M68, for 90-mm guns M1, M1A1, M1A2, M2, M2A1, M3, M3A1, and T8.

of about 2,400 yards. To obtain the muzzle velocity of 2,800 fps, a charge of M6 propellant (without flash-reducing salt), the long M49 primer, and an igniter charge at the top of the cartridge case are used. This results in flashless firing.

b. DATA.

Weight of complete round.....	43.87 lb
Length of complete round.....	38.24 in
Length of fuze projectile.....	16.19 in
Length of cartridge case.....	23.70 in
Width of rotating band.....	1.20 in
Type of base.....	Square
Radius of ogive (false ogive).....	9.05 cal.
Muzzle velocity	2,800 fps
Maximum range	21,400 yd
Penetration (at 0° obliquity of face-hardened plate at 1,000 yd).....	5.9 in
Penetration (at 0° obliquity of homogeneous plate at 1,000 yd).....	6.0 in

145. Projectile, Fixed, APC-T, M82, MV 2,800, Smokeless, w/Fuze, BD, M68, for 90-mm Guns M1, M1A1, M1A2, M2, M2A1, M3, M3A1, and T8

This round differs from the APC-T M82 described in paragraph 144 in that it is "smokeless," but gives large muzzle flash. This results from using a double-base propellant powder. Some lots on hand may be marked "SC," signifying "Supercharge." Markings on recent lots show muzzle velocity.

146. Projectile, Fixed, APC-T, M82, MV 2,600, Flashless, w/Fuze, BD, M68, for 90-mm Guns M1, M1A1, M1A2, M3, M3A1, and T8

This round differs from those having a 2,800 fps muzzle velocity by the smaller propelling charge, the shorter M28A2 primer, and the absence of an additional igniter charge. This round is flashless when fired. Weight of the complete round is 42.75 pounds; maximum range is 20,400 yards.

147. Projectile, Fixed, APC-T, M82, MV 2,600, Smokeless, w/Fuze, BD, M68, for 90-mm Guns M1, M1A1, M1A2, M2, M2A1, M3, M3A1, and T8

This round is similar to that described in paragraph 146 except that it is smokeless when fired.

148. Shot, Fixed, AP-T, M77, Flashless, for 90-mm Guns M1, M1A1, M1A2, M2, M2A1, M3, M3A1, and T8

a. GENERAL. This round has the same components, other than the projectile, as the M82 armor-piercing-capped round, and is used for the same purpose. The shot is a solid steel slug similar in contour to the body of the M82 projectile but lacking the armor-piercing cap and the windshield and without explosive charge and base fuze. The base is drilled to provide a small cavity for holding the red tracer. The tracer is similar to that in the M82 armor-piercing-capped round and burns for approximately 3 seconds.

b. DATA.

Weight of complete round.....	42.04 lb
Length of complete round.....	32.75 in
Length of projectile.....	10.00 in
Length of cartridge case.....	23.70 in
Width of rotating band.....	1.20 in
Type of base.....	Square
Radius of ogive.....	1.51 cal.
Muzzle velocity	2,700 fps
Maximum range	12,790 yd
Penetration (at 0° obliquity of face-hardened plate at 1,000 yd).....	4.5 in
Penetration (at 0° obliquity of homogeneous plate at 1,000 yd).....	5.5 in

149. Shot, Fixed, AP-T, M77, Smokeless, for 90-mm Guns M1, M1A1, M1A2, M2, M2A1, M3, M3A1, and T8

This round is similar to that described in paragraph 148 except that this round is smokeless when fired.

150. Shot, Fixed, HVAP-T, M304, Smokeless, for 90-mm Guns M1, M1A1, M1A2, M2, M2A1, M3, M3A1, and T8

a. GENERAL. This hypervelocity round (fig. 104) is provided for 90-mm guns for use against heavily armored targets. The shot is a lightweight hypervelocity projectile having a very hard armor-piercing core of tungsten carbide. Comprising the M304 HVAP-T shot are the 8-pound tungsten carbide core, a tracer-loaded base with integral steel rotating band, an aluminum body with pressed-on steel bourrelet, a nose plug, and an aluminum windshield. The tracer, which is ignited by the propelling charge when the round is fired, burns with a visible trace for a minimum of 4 seconds corresponding to approximately 4,000 yards of flight.

b. DATA.

Weight of complete round.....	37.13 lb
Length of complete round.....	35.92 in
Length of projectile.....	13.20 in
Length of cartridge case.....	23.70 in
Width of rotating band.....	1.20 in
Type of base.....	Skirted
Radius of ogive.....	Conical
Muzzle velocity.....	3,350 fps
Maximum range.....	15,700 yd
Penetration (at 30° obliquity of homogeneous plate at 1,000 yd).....	7.9 in

**151. Shot, Fixed, HVTP-T, M317A1, Smokeless, for 90-mm Guns
M1, M1A1, M1A2, M2, M2A1, M3, M3A1, and T8**

This target practice round is similar in appearance to the M304 HVAP-T shot (fig. 104) except that the bourrelet is integral with the body and the rotating band is made of gilding metal. In order to reduce gun wear caused by the integral steel rotating band of the earlier design, a gilding metal rotating band has been applied in its place.

152. High-Explosive Shell for 90-mm Guns

a. NORMAL-CAVITY HIGH-EXPLOSIVE SHELL.

- (1) The term "normal-cavity," as applied to high-explosive shell refers to the type of fuze cavity—in all other respects the loaded shell is similar to the deep-cavity type provided for these guns (*b* below). In the normal-cavity shell, the fuze cavity at the forward end of the bursting charge is only large enough (0.81 in long by 1.73 in diam) to accommodate the boosters used with point fuzes. The bursting charge cavity tapers conically over the lower half of the cavity and is hemispherical at the bottom. The shell bursting charge is TNT (some stocks are loaded with 50-50 amatol). With amatol loading, a "booster surround" of a small amount of TNT is used. The shell body consists of a hollowed steel casing with boat-tailed base. The nose is formed to a long ogive and is threaded to hold a standard point fuze. The fuze contour continues the long sweep of the shell nose, maintaining throughout, the streamlined effect which is characteristic of shell of modern design.
- (2) The normal-cavity shell have been assembled with the M19 cartridge case, fitted with the M28A2 or M49 primer



RA PD 109469



Figure 104. Shot, fixed, HVAP-T, 304, smokeless, for 90-mm guns M1, M1A1, M1A2, M2, M2A1, M3, M3A1, and T8.

C-1-ADD

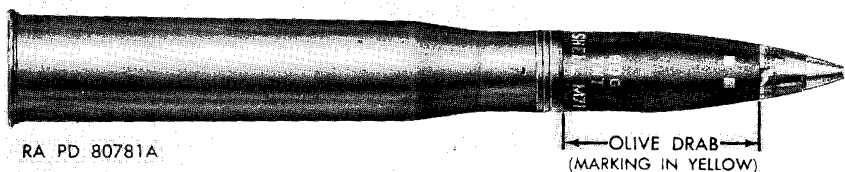


Figure 105. Shell, fixed, HE, M71, flashless, w/fuze, PD, M51A5, 0.05-sec delay, for 90-mm guns M1, M1A1, M1A2, M2, M2A1, M3, M3A1, and T8.

and a propelling charge of NH, M6, or M15 propellant, and various models of fuzes to make up the following complete rounds of flashless, flashless-smokeless, and smokeless ammunition.

(a) *Flashless rounds.*

SHELL, fixed, HE, M71, flashless, w/fuze, PD, M51A5, 0.05-sec delay (fig. 105).

SHELL, fixed, HE, M71, flashless, w/fuze, PD, M51A4, 0.15-sec delay.

SHELL, fixed, HE, M71, flashless, w/fuze, PD, M51A4 (M48A2), 0.05-sec delay.

SHELL, fixed, HE, M71, flashless, w/fuze, PD, M48A2, 0.05-sec delay.

SHELL, fixed, HE, M71, flashless, w/fuze, time, mechanical, M43A3-4.

(b) *Flashless-smokeless rounds.*

SHELL, fixed, HE, M71, flashless-smokeless, w/fuze, PD, M51A4 (M48A2), 0.05-sec delay.

SHELL, fixed, HE, M71, flashless-smokeless, w/fuze, PD, M51A4 (M48A2), 0.15-sec delay.

SHELL, fixed, HE, M71, flashless-smokeless, w/fuze, PD, M51A5, 0.05-sec delay.

SHELL, fixed, HE, M71, flashless-smokeless, w/fuze, TSQ, M55A3.

(c) *Smokeless rounds.*

SHELL, fixed, HE, M71, smokeless, w/fuze, MTSQ, M500.

SHELL, fixed, HE, M71, smokeless, w/fuze, PD, M51A5, 0.05-sec delay.

SHELL, fixed, HE, M71, smokeless, w/fuze, PD, M51A4, 0.15-sec delay.

SHELL, fixed, HE, M71, smokeless, w/fuze, PD, M51A4, 0.05-sec delay.

SHELL, fixed, HE, M71, smokeless, w/fuze, time, mechanical, M43A3-4.

SHELL, fixed, HE, M71, smokeless, w/fuze, TSQ, M55A3.

(d) *Data for above rounds.*

Weight of complete round.....	41.93 lb
Length of complete round.....	37.45 in
Length of fuze projectile.....	16.37 in
Length of cartridge case.....	23.70 in
Width of rotating band.....	1.20 in
Type of base.....	Boat-tailed
Degree of taper.....	6° 45'
Radius of ogive.....	8.96 cal.
Muzzle velocity	2,700 fps
Maximum range	19,560 yd*

* Effective maximum range limited by fuze time limits to around 13,000 yards. Range shown is horizontal range; maximum vertical range is 13,426 yards, but limited for effect by fuze time limit to 12,100 yards.

b. DEEP-CAVITY HIGH EXPLOSIVE SHELL.

(1) The deep-cavity shell is identical to the normal-cavity shell described in *a* above except for a deep fuze cavity which makes the shell adaptable for use with VT fuzes, or standard fuzes and boosters. For use with VT fuzes, a deep fuze cavity (3.59 in long by 1.73 in diam) is provided. The cavity is lined with a thin cardboard liner and bottom cap which serves as a partial support for the HE filler. This lining is not to be removed. Insertion of a supplementary charge into the fuze cavity (a supplementary charge consisting of a charge of TNT in a cylindrical boxboard body with felt cushion at the lower end and cap and lifting loop at the upper end) adapts the shell for standard point fuzes and boosters. When deep-cavity rounds are assembled with standard fuzes and boosters, the data are the same as for the normal-cavity shell described in *a* above. Originally, the shell were shipped unfuzed, in some cases with supplementary charge and in others, without it. Subsequently, all deep-cavity shell were assembled with supplementary charges and standard point fuzes and boosters.

(2) Deep-cavity shell have been assembled with various models of fuzes to make up the following complete rounds of flashless, flashless-smokeless, and smokeless ammunition.

(a) *Fuzed rounds as shipped.*

1. *Flashless rounds.*

SHELL, fixed, HE, M71, flashless, w/suppl chg, and fuze, MTSQ, M502.

SHELL, fixed, HE, M71, flashless, w/suppl chg, and fuze, PD, M51A4 (M48A2), 0.05-sec delay.

SHELL, fixed, HE, M71, flashless, w/suppl chg, and fuze, PD, M51A4 (M48A2), 0.15-sec delay.

SHELL, fixed, HE, M71, flashless, w/suppl chg, and fuze, PD, M51A5, 0.05-sec delay.

SHELL, fixed, HE, M71, flashless, w/suppl chg, and fuze, time, mechanical, M43A4.

2. *Flashless-smokeless rounds.*

SHELL, fixed, HE, M71, flashless-smokeless, w/suppl chg, and fuze, MTSQ, M500.

SHELL, fixed, HE, M71, flashless-smokeless, w/suppl chg, and fuze, MTSQ, M502.

SHELL, fixed, HE, M71, flashless-smokeless, w/suppl chg, and fuze, PD, M51A4 (M48A2), 0.05-sec delay.

SHELL, fixed, HE, M71, flashless-smokeless, w/suppl chg, and fuze, PD, M51A5, 0.05-sec delay.

3. *Smokeless rounds.*

SHELL, fixed, HE, M71, smokeless, w/suppl chg, and fuze, PD, M51A4 (M48A2), 0.05-sec delay.

SHELL, fixed, HE, M71, smokeless, w/suppl chg, and fuze, PD, M51A4 (M48A2), 0.15-sec delay.

(b) *Unfuzed rounds as shipped.*

1. These rounds are issued unfuzed with fuze holes protected by closing plugs. Rounds of earlier manufacture were assembled without supplementary charges; later manufacture had the charge and spacers inserted in the deep cavity:

*†SHELL, fixed HE, M71, flashless, w/o fuze, for VT fuze

†SHELL, fixed, HE, M71, flashless, w/suppl chg, w/o fuze

†SHELL, fixed, HE, M71, flashless-smokeless, w/suppl chg, w/o fuze

* With supplementary charge assembled to this round, standard point fuzes and boosters may be used.

† With supplementary charge in place, this round may be fuzed with the following standard point fuzes: CP, M78 or M78A1; MTSQ, M500 or M502; PD, M51A3, M51A4 (M48A2), or M51A5; time, mechanical, M43, M43A1, M43A2, M43A3, M43A4, or M67A3; TSQ, M55, M55A1, M55A2, or M55A3. Supplementary charge removed, round may be fitted with FUZE, VT, M92, M93, M97, or M97A1.

2. Data for above unfuzed rounds:

Weight of complete round.....	40.08 lb*
Length of unfuzed complete round.....	35.00 in
Length of VT fuzed projectile.....	16.44 in aprx
Length of cartridge case.....	23.70 in
Width of rotating band.....	1.20 in
Type of base.....	Boat-tailed
Degree of taper.....	6° 45'
Radius of ogive.....	8.96 cal.

* Unfuzed, with supplementary charge. When assembled with VT fuze, weight is 44.35 pounds (approximate).

153. Target-Practice Shell for 90-mm Guns

Shell provided for training in marksmanship in anti-motor-torpedo-boat firing are similar to the M71 service rounds except that the shell are loaded with inert material and are assembled with FUZE, dummy, M73, or M44A2 or FUZE, PD, M51A4 (M48A2), inert. Data for the target practice rounds listed below are the same as for the M71 rounds given in paragraph 152.

SHELL, fixed, TP, M71, flashless, w/fuze, dummy, M73

SHELL, fixed, TP, M71, smokeless, w/fuze, dummy, M73

154. Smoke Shell for 90-mm Guns

These rounds are assembled with the M313 WP smoke shell which resemble the high-explosive shell in outward appearance. The shell is boat-tailed and the ogival nose is threaded to receive an adapter. The adapter provides a tight seal for the chemical content of the shell and is threaded internally to receive a point fuze. It also provides a seat for the forward end of the M13 burster casing which is a thin-walled steel tube extending from the adapter to the rear of the shell cavity and contains the M24 burster charge and the M2 initiator-burster. The initiator-burster and the burster charge, when initiated by the fuze, ruptures the shell casing and disperses the chemical contents. White phosphorus is a smoke-producing chemical which also has a slight incendiary effect. The M313 WP shell has the same weight, range, and velocity as the M71 HE shell. Data given in paragraph 152 a (2) (d) are applicable to the following flashless-smokeless and smokeless rounds:

a. FLASHLESS-SMOKELESS ROUNDS.

SHELL, fixed, smoke, WP, M313, flashless-smokeless, w/fuze, PD, M48A3, 0.05-sec delay.

SHELL, fixed, smoke, WP, M313, flashless-smokeless, w/fuze, PD, M48A2, 0.05-sec delay.

SHELL, fixed, smoke, WP, M313, flashless-smokeless, w/ fuze, PD, M57.

b. SMOKELESS ROUNDS.

SHELL, fixed, smoke, WP, M313, smokeless, w/fuze, PD, M48A3, 0.05-sec delay (fig. 106).

SHELL, fixed, smoke, WP, M313, smokeless, w/fuze, PD, M48A2, 0.05-sec delay.

SHELL, fixed, smoke, WP, M313, smokeless, w/fuze, PD, M57.

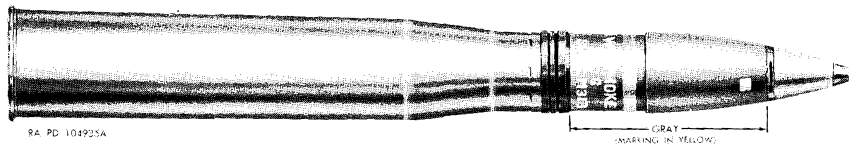
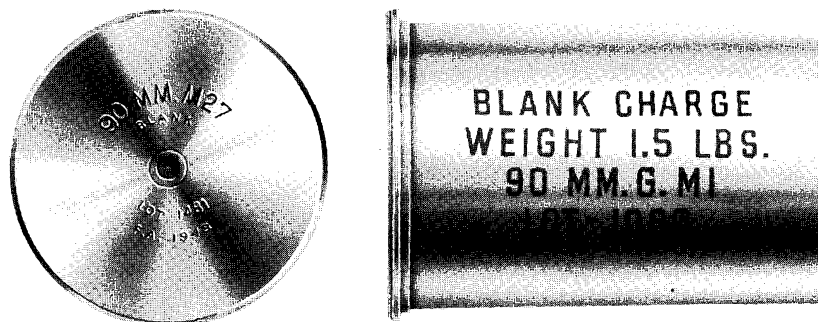


Figure 106. Shell, fixed, smoke, WP, M313, smokeless, w/fuze, PD, M48A3, 0.05-sec delay, for 90-mm guns M1, M1A1, M1A2, M2, M2A1, M3, M3A1, and T8.

155. Ammunition Blank, for 90-mm Guns M1, M1A1, M1A2, M2, M2A1, M3, M3A1, and T8 (fig. 107)

This ammunition consists of the M27 or M27B1 (steel) cartridge case similar to a service case M19 but shortened to 7.27 inches, a 100-grain M1B1A2 primer, and a 1.5-pound charge of black powder. The round is constructed like other standard types of blank ammunition, the blank charge being held in a cotton bag which is loaded into the cartridge case to surround the primer. The charge is held firmly in position at the base of the case by a



RA PD 80783

Figure 107. Ammunition, blank, for 90-mm guns M1, M1A1, M1A2, M2, M2A1, M3, M3A1, and T8.

closing cup or plug assembly. For 90-mm blank ammunition, the closing cup assembly consists of two pulpboard disks glued one to each surface of a felt disk, wad or palmetto plug. The assembly is inserted into the case and glued securely in position about 2.42 inches from the mouth of the case. Weight of complete round is 8.23 pounds and length is 7.27 inches.

156. Cartridge, Drill, M12B2, w/Fuze, Time, Mechanical, M43A2, Inert, for 90-mm Guns M1, M1A1, M1A2, M2, M2A1, M3, M3A1, and T8

The M12B2 drill cartridge, which is the standard type, consists of a body of manganese bronze, a steel base, and an inert M43A2 fuze. Weight of the complete round is 42.04 pounds. Earlier models designated M12 and M12B1 (M12B1 is made of malleable iron) were assembled with dummy fuze M44A2 and are usable except in guns with power rammer. *Malleable iron cartridges are not to be used under any circumstances in guns with automatic rammers.* Bronze cartridges may be used in all of the above weapons. When used in the M2 or M2A1 guns, the power rammer will be made inoperative and the cartridge will be rammed by hand.

Section XIII. AMMUNITION FOR 105-mm HOWITZERS

157. General

a. GENERAL DISCUSSION. Two models of 105-mm howitzer, the M2A1 and M4 now are in use. The M2A1 howitzer is used as a light field artillery weapon and also is used as armament for howitzer motor carriages. The M4 howitzer is mounted in mobile mounts such as medium tanks and tracked landing vehicles. Rounds provided for the 105-mm howitzers are alike. All rounds are classified as semifixed ammunition, and all have adjustable propelling charges for zone firing except the TP-T and the HE, AT-T rounds which are special types in that the charge is fixed, that is, not adjustable, the cartridge case and projectile not being crimped together because of the method of packing and shipment. Two types of HE shell are provided, a normal-cavity shell and a deep-cavity shell which permits interchangeable use of standard and VT fuzes. Except for a limited number issued unfuzed during early development of VT fuzes, all HE shell for these howitzers are issued assembled with standard fuzes and boosters; interchangeability is accomplished by replacement of fuzes in the field.

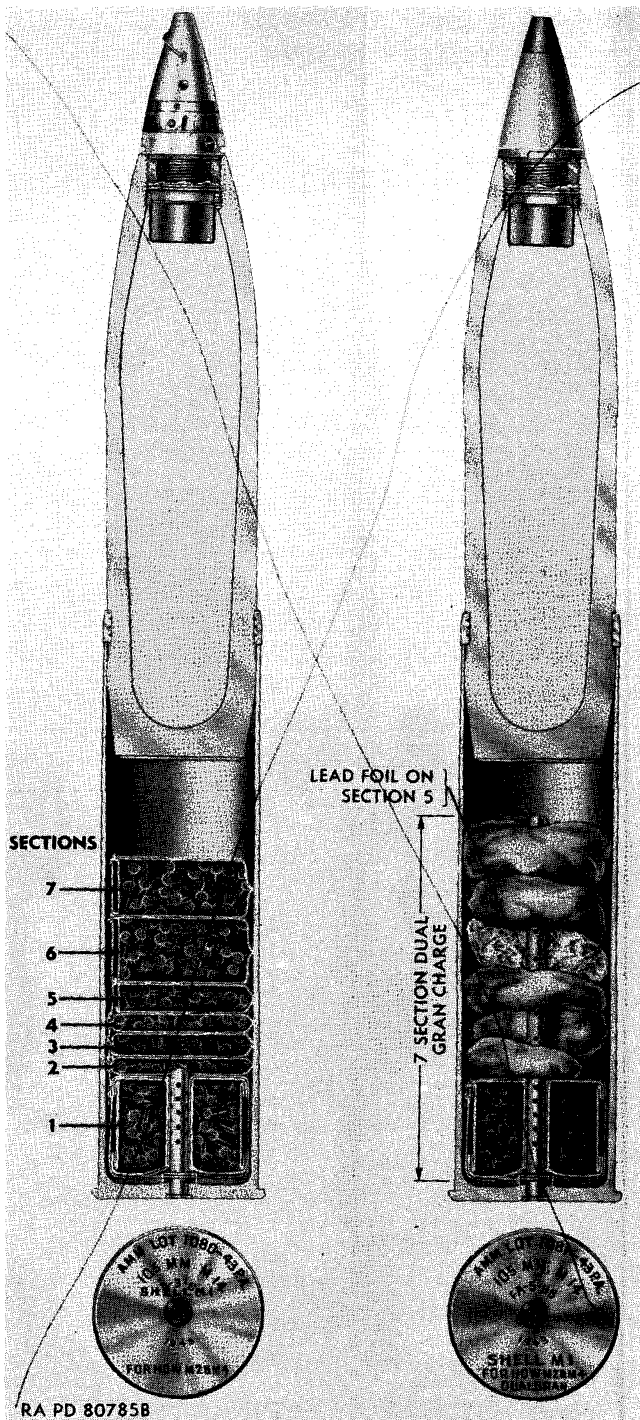


Figure 108. Comparison of semifixed rounds for M2A1 and M4 howitzers.

b. IDENTIFICATION. Painting and marking for identification are in accordance with the basic scheme prescribed in TM 9-1900, except that colored smoke shell are painted gray with a yellow band. Just below this band there is stencilled, in yellow letters, the color of the smoke produced. The designation of the cannon is marked on the containers and on the base of cartridge case of each round (fig. 108).

c. FUZES. BD fuze M62A1 (which has no tracer) is assembled in the base of the HE, AT shell M67; the BD fuze M91 (which has a tracer) in the HE, AT-T shell M67. These are boresafe base detonating fuzes which function with nondelay action. HE shell are shipped assembled with M48, M51, M54, or M55 series fuzes, and also without fuze. The M48 and M51 series are selective superquick-delay types which differ principally in that the M51 models incorporate the booster whereas the M48 models are used with boosters which are manufacturing components of the shell. The M54 and M55 series also are alike except that the M55 models incorporate the booster. They are a combination time and superquick type in which the superquick action always is operative. WP smoke shell M313, FS smoke shell M60, and H gas shell M60, are assembled with the M51A5 fuzes; some rounds on hand are assembled with the M57 fuzes (limited standard). The M57 fuze, which is a single action superquick type, is similar in appearance to the M48 series fuzes except that it has no setting sleeve. HC and colored smoke shell are assembled with the MTSQ M501 fuze; some rounds on hand are assembled with the M54 TSQ fuzes (limited standard). The MTSQ M500 fuze is a mechanical time superquick fuze, which is standard type to replace the M55A3 fuze. The MTSQ M501 is the same as the MTSQ M500 fuze but without booster. The VT fuze M97A1 (T80E9) which is provided for use with deep-cavity HE shell, is issued separately for assembly in the field after removal of the fuzes and/or supplementary charges shipped assembled to the shell. It is a special type fuze which provides, by its mechanism, for functioning of the fuze and shell at effective distances from the target without prior setting. The concrete-piercing fuze M78, issued separately, also is authorized for use with HE shell for use against appropriate targets. For a complete description of the fuzes, see section I, chapter 3.

d. CARTRIDGE CASES. CASE, cartridge, 105-mm, M14, made of brass, is standard for all 105-mm howitzer ammunition. The substitute standard M14B1 cartridge case is made of steel and weighs approximately 0.5 pound less than the standard brass case due to a thinner head and primer seat. Prior to the change in cartridge case for the HE, AT-T shell from a crimped case to the removable type, two types of cartridge case were made (type 1 and type 2).

Type 2 had a mouth with a slightly smaller diameter to adapt it for crimping to the HE, AT-T shell. However, all cases now used are type 1, that is, the free-fit or removable type. The type marking has been removed from cartridge cases.

e. PROPELLING CHARGES. Although assembled with removable cartridge case, the HE, AT-T and TP-T rounds have fixed (non-adjustable) single granulation propelling charges. Propelling charges of all other rounds are dual granulation charges and are divided into parts to permit adjusting for zone firing. For rounds to be fired from the M2A1 and M4 howitzers, the full (outer zone) charge consists of seven sections, a base charge and six increments, providing for seven zones of fire. The powder for each section is assembled in a cloth bag on which is marked the number of the charge. In rounds of earlier manufacture only, the base section (charge 1) (fig. 108) is fastened by a special clip around the primer. The first increment, or second section (charge 2), is tied to the base increment by a long twine. The other increments, in numerical order, are tied to each other with a short twine. This permits withdrawal of the increments, except the base charge, to the mouth of the cartridge case where those increments not required for the particular inner zone to be fired may be removed by cutting or breaking the twine. The increments to be used then are reassembled readily in the cartridge case in numerical order, the uppermost increment corresponding to the zone to be fired. All increments up to and including the number of the charge to be fired are required to fire the charge called for. Thus, to fire charge 3, the base charge (marked "1") and increments marked "2" and "3," in numerical order, must be used. The sections are of unequal weight and, hence, are not interchangeable. A flash reducer M4 (T4) is provided for 105-mm howitzer M2A1 and M4 for night firing. It consists of 438 grains of black powder in a square cotton cloth bag. It is not needed when firing dualgran charges.

Note. The zone 5 increment of dualgran charges contains a sheet of lead foil which serves as a decoppering agent (par. 288c).

f. PRIMER. PRIMER, percussion, M1B1A2 is used in all HE rounds containing a single powder granulation. The 300-grain M28A2 is used in all dualgran rounds for M2A1 and M4 howitzers. Alternative primer for the M28A2 is the 300-grain M28B2 (sec. III, ch. 3).

g. COLORED SMOKE CANISTERS. M2 colored smoke canisters are issued to replace the HC white smoke canisters in the M84 base-ejection smoke shell when conversion of these shell to colored smoke shell is desired. Green, red, and violet smoke canisters are available. These are to be issued until supply is exhausted.

158. Packing and Shipping Data

Packing and shipping data for the ammunition described in this section appear in Department of the Army Supply Catalog ORD 11 SNL's R-1, R-5, and R-6.

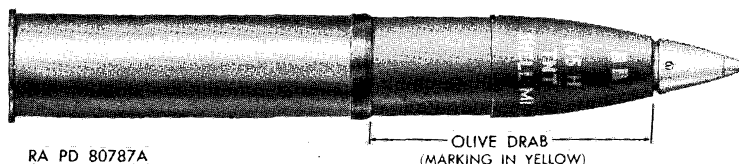


Figure 109. Shell, semifix, HE, M1, dualgran, w/ fuze, PD, M51A5, 0.05-sec delay, for 105-mm howitzers M2A1 and M4.

159. High-Explosive Shell for 105-mm Howitzers M2A1 and M4

a. NORMAL-CAVITY HIGH-EXPLOSIVE SHELL.

- (1) The term "normal-cavity" as applied to high-explosive shell refers to the type of fuze cavity—in all respects the loaded shell is similar to the deep-cavity type provided for these howitzers (*b* below). In the normal-cavity shell, the fuze cavity at the forward end of the bursting charge is only large enough (0.81 in. long by 1.73 in. diam.) to accommodate the boosters used with point fuzes. The bursting charge cavity tapers conically over the lower half of the cavity and is hemispherical at the bottom. The shell bursting charge is TNT although some shell have been loaded with 50-50 amatol. With amatol loading, a "booster surround" of a small amount of TNT is used. The shell body consists of a hollowed steel casing with boat-tailed base. The nose is formed to a long ogive and is threaded to hold a standard point fuze. The fuze contour continues the long sweep of the shell nose, maintaining throughout the streamlined effect which is characteristic of shell of modern design.
- (2) The normal-cavity shell have been assembled with M14 cartridge cases fitted with M28A2 primers and seven-section dualgran propelling charges and various models of fuzes to make up the following complete rounds for the M2A1 and M4 howitzers:

SHELL, semifix, HE, M1, dualgran, w/ fuze, MTSQ, M500.

SHELL, semifix, HE, M1, dualgran, w/ fuze, PD, M51A5, 0.05-sec delay (fig. 109).

SHELL, semifix, HE, M1, dualgran, w/ fuze, PD, M51A4, 0.05-sec delay.

SHELL, semifixed, HE, M1, dualgran, w/fuze, PD,
M51A4, 0.15-sec delay.

(3) Data are as follows:

Weight of complete round	42.00 lb*
Length of complete round	31.07 in
Length of fuzeed projectile	19.48 in
Length of cartridge case	14.64 in
Width of rotating band	0.81 in
Type of base	Boat-tailed
Degree of taper	8° 45'
Radius of ogive	6.18 cal.
Muzzle velocity	1,550 fps**
Maximum range	12,205 yd**

* Weight of round with single granulation charge is 40.48 pounds.

** With full charge (charge 7); corresponding data for other charges are—

	Muzzle velocity (fps)	Maximum range (yd)
Charge 1	650	3,825
Charge 2	710	4,475
Charge 3	780	5,280
Charge 4	875	6,430
Charge 5	1,020	8,295
Charge 6	1,235	10,150

b. DEEP-CAVITY HIGH-EXPLOSIVE SHELL.

- (1) The deep-cavity shell is identical to the normal-cavity shell described in *a* above, except for a deep fuze cavity which makes the shell adaptable for use with VT fuze or standard fuzes and boosters. For use with VT fuzes, a deep fuze cavity (3.59 in. long by 1.73 in. diam.) is provided. The cavity is lined with a thin cardboard liner and bottom cap which serves as a partial support for the HE filler. This lining is not to be removed. Insertion of a supplementary charge into the fuze cavity adapts the shell for standard point fuzes and boosters. The supplementary charge consists of TNT in a cylindrical box-board body with felt cushion at the lower end and cap and lifting loop at the upper end. When deep-cavity rounds are assembled with standard fuzes and boosters, the data are the same as for the normal-cavity shell described in *a* above. Originally, the shell were shipped unfuzed, in some cases with supplementary charge and, in others, without it. Subsequently, all deep-cavity shell were assembled with supplementary charges and standard point fuzes and boosters.

(2) Deep-cavity shell have been assembled with various models of fuzes to make up the following complete rounds for the M2A1 and M4 howitzers:

(a) *Fuzed rounds as shipped.*

SHELL, semifixed, HE, M1, dualgran, w/suppl chg, and fuze, MTSQ, M500.

SHELL, semifixed, HE, M1, dualgran, w/suppl chg, and fuze, PD, M51A5, 0.05-sec delay.

SHELL, semifixed, HE, M1, dualgran, w/suppl chg, fuze, PD, M51A4, 0.05-sec. delay.

SHELL, semifixed, HE, M1, dualgran, w/suppl chg, and fuze, PD, M51A4, 0.15-sec delay.

SHELL, semifixed, HE M1, dualgran, w/suppl chg, and fuze, TSQ, M55A3.

(b) *Unfuzed round as shipped.*

1. This round is assembled with fuze hole protected by a closing plug. Rounds of earlier manufacture were assembled without supplementary charges; rounds of later manufacture had the charge and spacers inserted in the deep cavity. The SHELL, semifixed, HE, M1, dualgran, w/suppl chg, w/o fuze, with supplementary charge in place, may be fuzed with the following standard point fuzes: CP, M78 or M78A1; MTSQ, M501; PD, M51A3, M51A4 (M48A2), or M51A5; TSQ, M55, M55A1, M55A2, or M55A3. With supplementary charge removed, round may be fitted with FUZE, VT, M97, or M97A1.

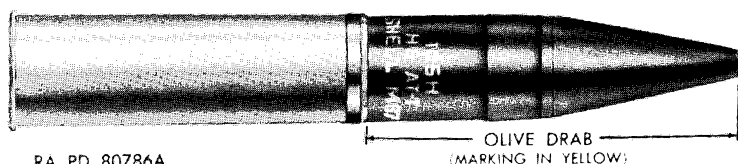
2. Data for above unfuzed round are as follows:

Weight of complete round	40.11 lb*
Length of complete round	28.60 in*
Length of VT fuzed projectile	19.45 in
Length of cartridge case	14.64 in
Width of rotating bands	0.81 in
Type of base	Boat-tailed
Degree of taper	8° 45'
Radius of ogive	6.18 cal.
Muzzle velocity	1,550 fps**
Maximum range	12,046 yd**

* Unfuzed. Weight fuzed with M97 or M97A1 fuze is 44.38 pounds; length when fuzed is 31.01 inches. For the round with single granulation charge, weight unfuzed is 39.76 pounds and weight with M97 and M97A1 is 42.07 pounds.

** With full charge (charge 7). This round will be fired only with charges 3, 4, 5, 6, or 7 when it is fuzed with fuze, VT, M97 or M97A1, Muzzle velocities and maximum ranges for charges 3, 4, 5, and 6 are—

	Muzzle velocity (fps)	Maximum range (yd)
Charge 3 -----	780	5,243
Charge 4 -----	875	6,394
Charge 5 -----	1,020	8,238
Charge 6 -----	1,235	10,057



RA PD 80786A

Figure 110. Shell, semifix, HE, AT-T, M67, w/fuze, BD, M91, for 105-mm howitzers M2A1 and M4.

160. Shell, Semifix, HE, AT-T, M67, w/Fuze, BD, M91, for 105-mm Howitzers M2A1 and M4 (fig. 110)

a. GENERAL. This shell is similar in all respects except size to the HE, AT round for the 75-mm howitzers. Like that round, it provides effective ammunition for the howitzers for use against tanks. The effect of the projectile is produced by the shaped charged high-explosive filler rather than by striking velocity. The construction of the shell differs materially from standard armor-piercing types. The shell body is a relatively thin-walled casing containing a shaped high-explosive filler and is closed off at the forward end and by a ballistic cap in the form of a steel cone. The ballistic cap is attached to an ogive and union assembly which provides sufficient "stand-off" from the target when impacting. The base is fitted with a base detonating fuze which functions with nondelay action. The M62A1 fuze, which has no tracer, is used with the HE, AT round while the M91 fuze, which has a tracer, is used with the HE, AT-T round. A standard cartridge case and the M28A2 300-grain primer is used with the projectile. However, the propelling charge consists of 1.54 pounds of flash-less powder (little more than half the full charge used with semi-fixed rounds) in a cloth bag, and is not intended to be adjusted, the cartridge case being a loose fit on the projectile, only for purposes of packing and shipping.

b. DATA.

Weight of complete round-----	37.06 lb
Length of complete round-----	31.05 in
Length of fuzed projectile-----	20.05 in
Length of cartridge case-----	14.64 in
Width of rotating band-----	0.81 in

Type of base.....	Boat-tailed
Degree of taper.....	8° 45'
Degree of nose taper.....	21° 30'
Muzzle velocity.....	1,250 fps
Maximum range.....	8,590 yd
Depth of penetration of homogeneous armor plate (at any range).....	4.0 in

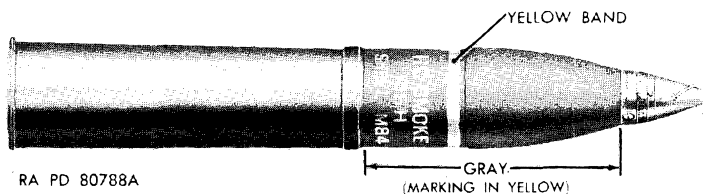


Figure 111. Shell, semifixed, smoke, HC, BE, M84, dualgran, w/fuze, TSQ, M54, for 105-mm howitzers M2A1 and M4.

161. Shell, Semifixed, Smoke, HC, BE, M84, Dualgran, w/Fuze, MTSQ, M501, for 105-mm Howitzers M2A1 and M4

a. GENERAL. This is one of several new types of smoke shell intended to overcome certain deficiencies of the bursting type smoke shell. Figure 111 illustrates this shell fuze with the TSQ M54 fuze. It is a base-ejection shell consisting essentially of a section of drawn steel tubing which contains three canisters of HC smoke mixture and a small black powder expelling charge at the nose end (fig. 3). The shell casing, like that of the M60 chemical shell, resembles the high-explosive shell in outward appearance, being boat-tailed and having the nose formed to the same long ogive. Internal construction differs in that the cavity is cylindrical in shape and extends the full length of the shell. Both ends are threaded, the rear to hold a base plug and the front to hold the M501 fuze. An expelling charge (0.14 lb) of black powder is loaded in the front end of the cavity. The remainder of the cavity holds three canisters of HC smoke mixture. A baffle plate separates the black powder charge and the smoke filler, but transmission of the flash and explosive action of the black powder is provided for by a flash tube which extends through the doughnut-shaped smoke canisters. In functioning, the black powder ignites the smoke filler and at the same time expels the canisters through the base end of the shell. Time of action is governed by the fuze, which provides for time setting up to 75 seconds or action on impact. Air burst does not alter materially the path of flight since the expelled canisters continue approximately along the original

trajectory. The smoke filler will burn for approximately 3 minutes emitting white smoke. Maximum emission of smoke from the canisters occurs in about 2 minutes although an effective smoke develops in about 1 minute. The M84 shell is fired with the standard semifixed propelling charge for the howitzers M2A1 and M4.

b. DATA.

Weight of complete round	42.72 lb*
Length of complete round	30.49 in
Length of fuzeed projectile	18.84 in
Length of cartridge case	14.64 in
Width of rotating band	0.81 in
Type of base	Boat-tailed
Degree of taper	8° 45'
Radius of ogive	6.18 cal.
Muzzle velocity	1,550 fps**
Maximum range	12,205 yd**

* For round with dualgran charge. For round with single granulation charge, weight is 41.94 pounds.

** When fired with full charge (charge 7). Ranges and muzzle velocities for other charges are the same as for the high-explosive shell (par. 159).

162. Shell, Semifixed, Smoke, Green, BE, M84, Dualgran, w/Fuze, MTSQ, M501, for 105-mm Howitzers M2A1 and M4 (see note)

This shell, in addition to the HC smoke shell (par. 161), has been standardized for use in the 105-mm howitzers for target and battery identification purposes. Some rounds on hand are assembled with the TSQ M54 fuze (limited standard). Characteristics are similar to those for the HC smoke shell with the exception of the filler and some slight variations in weight due to different densities of the fillers.

Note. Similar rounds, differing in color of smoke—RED, VIOLET, and YELLOW—also are provided for the target and battery identification purposes.

Like the HC smoke shell, the colored smoke projectiles are intended for firing with the standard propelling charge and other

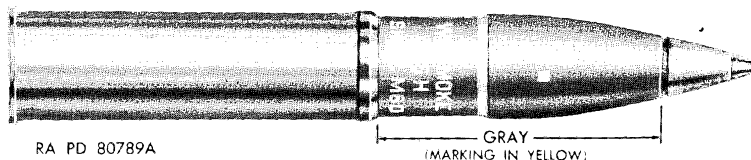


Figure 112. Shell, semifixed, smoke, WP, M60, dualgran w/fuze, PD, M51A5, 0.05-sec delay, for 105-mm howitzers M2A1 and M4.

components for the weapons. Complete round weights for dualgran charge rounds are: green or violet, 40.35 pounds; red, 40.55 pounds; yellow, 40.15 pounds. Ranges and muzzle velocities are the same as for the HC smoke shell (par. 161).

163. Shell, Semifixed, Smoke, WP, M60, Dualgran, w/Fuze, PD, M51A5, 0.05-Sec Delay, for 105-mm Howitzers M2A1 and M4
(fig. 112)

a. GENERAL. This round is assembled with the M60 smoke shell which resembles the high-explosive shell in outward appearance. The shell is boat-tailed and the nose is ogival and threaded to take an adapter. The adapter, which provides a tight seal for the chemical contents of the shell, holds the fuze and booster, and provides a seat for the forward end of burster casing M5. This casing is a thin-walled steel tube extending from the adapter to the rear of the shell cavity. It contains the burster charge M5 which ruptures the shell casing and disperses the chemical contents. FUZE, PD, M51A5 is used with the projectile to provide for superquick or delay action. White phosphorus is a smoke-producing chemical which also has a slight incendiary effect. The shell is used for spotting and screening purposes. Stocks of rounds on hand assembled with FUZE, PD, M51A4, and M57 (limited standard) will be issued until exhausted.

b. DATA.

Weight of complete round.....	44.20 lb*
Length of complete round.....	31.08 in
Length of fuzed projectile.....	19.46 in
Length of cartridge case.....	14.64 in
Width of rotating band.....	0.81 in
Type of base.....	Boat-tailed
Degree of taper.....	8° 45'
Radius of ogive.....	6.18 cal.
Muzzle velocity.....	1,550 fps**
Maximum range.....	12,205 yd**

* For round with dualgran charge. For round with single granulation charge, weight is 43.42 pounds.

** Full charge (charge 7).

164. Shell, Semifixed, Smoke, FS, M60, Dualgran, w/Fuze, PD, M51A5, 0.05-Sec Delay, for 105-mm Howitzers M2A1 and M4

This shell contains the chemical filler FS, a liquid smoke producer which produces a cloud similar to that of white phosphorus.

When filled with FS, the complete round weighs approximately 44.71 pounds. In other respects, it is similar to the round described in paragraph 163. Data, given therein, apply equally to this round. Stocks of rounds on hand, assembled with FUZE, PD, M51A4, and M57 will be issued until exhausted.

165. Shell, Semifixed, Gas, Persistent, H, M60, Dualgran, w/Fuze, PD, M51A5, 0.05-Sec Delay, for 105-mm Howitzers M2A1 and M4

This shell is similar to the WP- and FS-filled shell rounds, but the filler consists of mustard gas, a persistent liquid vesicant casualty producing agent. The complete round weighs 43.27 pounds. Other data given in paragraph 163 also apply to this round. Stocks of rounds on hand assembled with FUZE, PD, M51A4, and M57 (limited standard) will be issued until exhausted.

166. Shell Semifixed, Illuminating, M314, Dualgran, w/Fuze, MTSQ, M501, for 105-mm Howitzers M2A1 and M4

a. GENERAL. This shell is similar in appearance, construction, and functioning to the base-ejection smoke shell described in paragraph 161. The shell contains a black powder expelling charge adjacent to the fuze MTSQ M501, the M316 illuminating canister, and the M8 parachute unit. When the fuze functions, the expelling charge ignites the illuminating canister and expels the canister and parachute unit. The illuminant, suspended by the parachute, burns for approximately 43 seconds lighting up the target area. Some rounds are fuzed with TSQ M54 fuze (limited standard).

b. DATA.

Weight of complete round.....	46.43 lb*
Length of complete round.....	32.24 in
Length of fuzed projectile.....	19.31 in
Length of cartridge case.....	14.64 in
Width of rotating band.....	0.81 in
Type of base.....	Square

* For round with dualgran charge. For round with single granulation charge, weight is 45.65 pounds.

167. Shell, Semifixed, TP-T, M67, for 105-mm Howitzers M2A1 and M4

This round is provided for target practice to simulate firings with the M67 HE, AT-T round. It has an inert M67 HE, AT-T shell loaded to weight with a mixture of barium carbonate and stearic acid, or more recently with plaster of paris. A base plug, containing the tracer element, is used instead

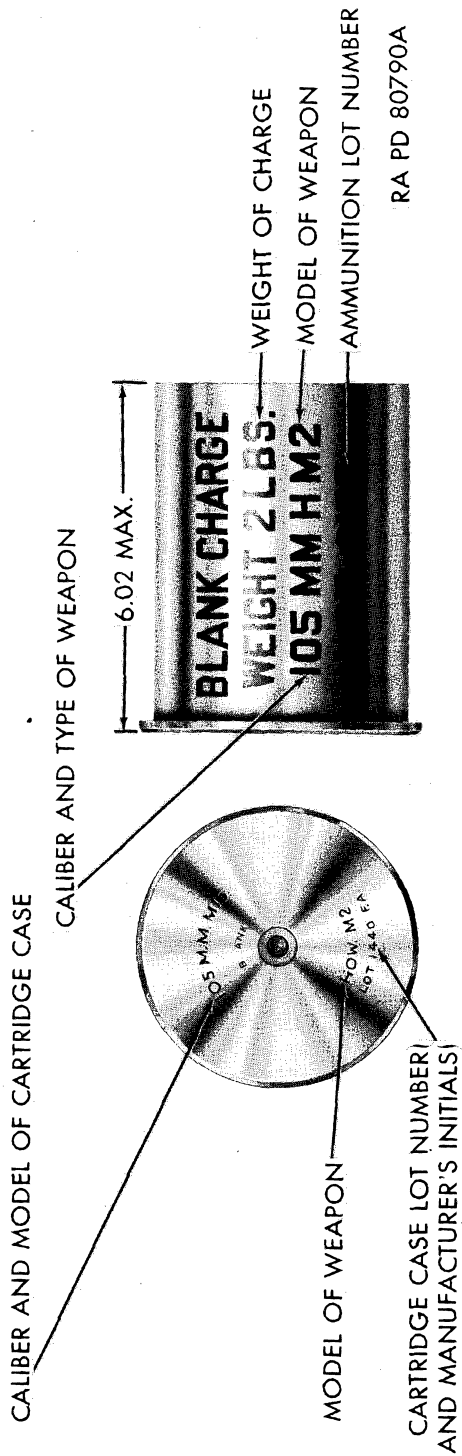


Figure 113. Ammunition, blank, for 105-mm howitzers.

of the standard BD fuze. The trace in flight has an average visibility of 8 seconds at night and 5 seconds by day. The shell has the same ballistics as the M67 HE, AT-T shell. The data in paragraph 160 are applicable to this round, except that it has no shaped charge penetration effect, and length of projectile is 19.46 inches.

168. Ammunition, Blank, for 105-mm Howitzers M2A1 and M4 (fig. 113)

This ammunition is provided for the 105-mm howitzers for salutes and simulated fire and consists of the M15 cartridge case, which is essentially the service case M14 cut down to a 6-inch length, a M1B1A2 primer, and a black powder charge. Construction is similar to other standard blank rounds. The powder charge is loaded in a cotton bag wrapped about the primer and held in position by a closing cup assembly. Standard powder is sodium nitrate composition but potassium nitrate may be used as an alternative. When sodium nitrate is used, the charge weighs 2 pounds and the closing cup assembly includes a felt wad cemented to the inner surface of a pulpboard disk. The assembly is inserted and cemented in position about 0.5 inch from the cartridge case mouth. When potassium nitrate is used, the charge weighs 1.5 pounds. The felt wad is omitted from the closing cup, which is inserted about 1 inch in the cartridge case, and cemented in position at that point. Weight of complete round with 1.5-pound charge is 5.74 pounds and with 2.0-pound charge is 6.24 pounds; length is 6.02 inches.

169. Cartridge, Drill, M14, w/Fuze, Dummy, M59, for 105-mm Howitzers (fig. 114)

This drill cartridge is a completely inert assembly designed to permit simulation of all adjustments required in the semifixed

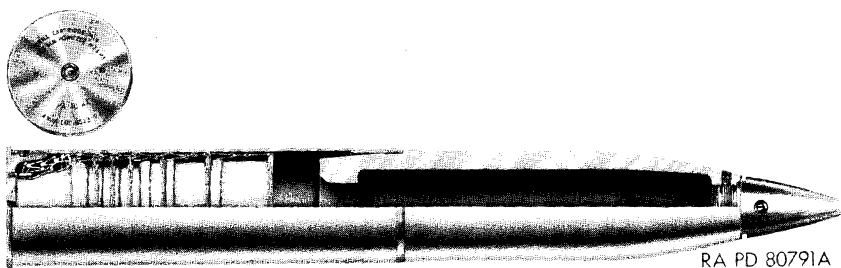


Figure 114. Cartridge, drill, M14, w/fuze, dummy, M59, for 105-mm howitzers.

service rounds. The round consists of a dummy projectile fitted with an inert fuze, loosely seated in a cartridge case containing an inert service primer and inert propelling charge. The cartridge case is a cadmium-plated steel tubing threaded at the rear to hold a bronze base and fitted at the front end with a bronze collar which serves as a sleeve for the projectile when the round is assembled. The inert propelling charge consists of seven sections constructed to resemble the service charge. The base or first section is secured to the inner face of the cartridge case base; the second section is attached to the base section by a 16-inch sash chain or, more recently, by twine. Each additional section is attached to the one preceding by snaps, if the chain is used, or by twine. The arrangement permits withdrawal of all sections, except the base, to the mouth of the case where adjustments of the charge can be made. As shipped with the 7-section charge, the round simulates the service ammunition for the M2A1 and M4 howitzers. The dummy projectile is a hollow malleable iron or bronze casting with an open base to facilitate extraction from the howitzer. As fitted with dummy fuze M59, the round provides for drill in setting the M48-type fuzes since this dummy fuze has a setting sleeve arrangement like that of the M48 or M51 type fuzes. Weight of complete round is 42.06 pounds; length is 31.07 inches.

170. Cartridge, Drill, M14, w/Fuze, TSQ, M54, Inert, for 105-mm Howitzers

This cartridge is the same as the drill cartridge described in paragraph 169 except that the fuze is an inert M54 fuze made up of a burned out service fuze or of rejected parts. This fuze provides for drill in time setting.

Section XIV. AMMUNITION FOR 4.2-INCH MORTARS

171. General

a. GENERAL DISCUSSION. The MORTAR, 4.2-inch, M2 (formerly designated MORTAR, chemical, 4.2-in, M2), is a rifled-bore, muzzle-loading, high-angle-of-fire weapon. The ammunition fired in this mortar is stabilized in flight by rotation rather than fins as in the case of the 60-mm and 81-mm mortars. This is accomplished by a "rotating disk" on the base of the shell. This disk expands on firing to engage the rifling of the mortar, thereby imparting rotation to projectile. On the base of all shell is a threaded stud to which the cartridge container is secured. This cartridge container is a steel tube threaded on the inside to screw

to the stud. It also is threaded externally and has a wire propellant holder and a striker nut to hold the propellant over the radial ventholes in cartridge container. Two basic types of shell are provided, the M2 and M2 alternative for chemical fillers (gas or smoke) and the M3 and M3 alternative for high-explosive fillers, the principal difference being that the M2 and M2 alternative shell have a perforated vane welded inside the shell. This vane aids in stabilizing flight by forcing the liquid filler to rotate with the shell. The perforations in the vane facilitate distribution of the liquid in the shell. The M2 and M3 shell are produced from forgings; the M2 alternative and M3 alternative are produced from steel tubing. The ammunition, issued as fuze complete rounds, falls within the classification of semifixed ammunition since the propelling charge is adjustable and the round is loaded into the weapon in one operation. The rounds need no preparation for firing other than a check of the fuze (*c* below) and adjustment of the propelling charge, as described in *d* below. (See figs. 115-119.)

b. IDENTIFICATION. Unlike 60-mm and 81-mm mortar ammunition, the 4.2-inch mortar ammunition is stabilized in flight by rotation of the projectile and, hence, does not have a fin. The rounds appear somewhat similar to spin stabilized rockets but are distinguished by the propelling charge on the base of the shell. Complete identification is provided by painting and marking in accordance with basic scheme prescribed in TM 9-1900.

Note. Some rounds may be marked to indicate use in the 4.2-inch "chemical" mortar M2, which was the former designation of the MORTAR, 4.2-in, M2.

c. FUZES. All 4.2-inch mortar ammunition is issued with point fuzes: FUZE, PD, M9 on the high-explosive shell; FUZE, PD, M8 on the gas and smoke shell. The FUZE, TSQ, M5, a modified M54 time and superquick fuze, with an adapter and booster or burster is issued separately for assembly in the field when "time" firing is required. High-explosive rounds fitted with the improved M3 fuze, and gas and smoke shell fitted with the improved M2 fuze are restricted for issue and used for reserve and emergency only. See section I, chapter 3, for further details of fuzes.

d. PROPELLING CHARGE.

- (1) *CHARGE, propelling, M6, for 4.2-inch mortar.* This charge consists of an ignition cartridge and a number of rings of nonhygroscopic sheet powder. A ring is the basic unit of the charge. It consists of two sheets sewn together. The powder consists of $25\frac{1}{2}$ rings assembled in the form of four 5-ring bundles, five single rings, and a one-half ring. The full propelling charge is assembled

to the shell (figs. 115, 116, 117) as issued. Maximum range is obtained with the full charge; lesser ranges with fewer rings as required in accordance with firing tables. After removing undesired rings, the propellant holder is pushed against the remaining rings in order to hold them tightly between the holder and the striker nut.

Caution: The propellant must be fastened firmly between the striker nut and the propellant holder; tighten the striker nut against the propellant and then the propellant holder against the propellant.

Note. Propelling charges of rounds prepared for firing should be protected by slipping one end of a shell shipping container over the base of the round until ready to fire the round.

- (2) *Propellant powder used in charge M6* is practically non-hygroscopic and smokeless, but not flashless. The sheets of powder are $2\frac{3}{4}$ inches square and about 0.026 inch thick. A circular hole 1.35 inches in diameter is cut in the center of each square. The sheets weigh approximately 60 grains each. Each square is slit radially from the circular hole to one of the edges. The size of units may be identified by their thickness.

e. **IGNITION CARTRIDGE.** The ignition cartridge (figs. 115 and 116) used with the M6 propelling charge is designated CARTRIDGE, ignition, M2. It is similar in exterior appearance to a commercial 12-gage shotgun shell.

172. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Catalog ORD 11 SNL R-4.

173. Gas Shell for the 4.2-Inch Mortar (fig. 115)

a. **GENERAL.** Several different kinds of gas shell are provided for the 4.2-inch mortar. They are used for irritating (harrassing)

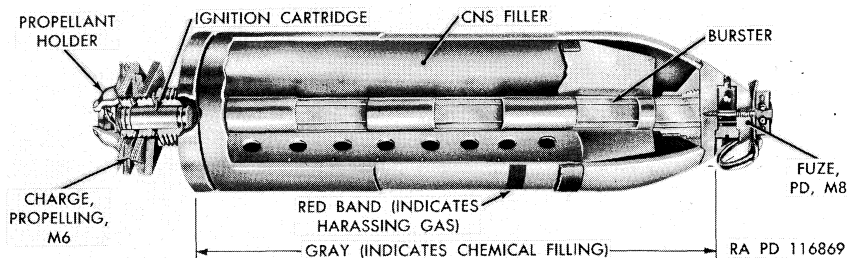


Figure 115. Shell, gas, irritant, CNS, M2, w/fuze, PD, M8, for 4.2-inch mortars.

or for casualty effect, depending upon the filler. The rounds are similar except for the kind of filler and, hence, slight differences in weight. They have the same shell body, propelling charge (M6), fuze (M8), and ignition cartridge (M2). The shell is 4.19 inches in diameter and 20.4 inches long. The complete round weighs 23.5 to 25 pounds, depending upon the filler. The weight of the propellant powder used in the full charge (25½ rings) is 0.51 pound. All chemical shell have a maximum muzzle velocity of approximately 820 fps and a maximum range of approximately 4,300 yards. Velocities and ranges corresponding to propelling charges using different numbers of rings are given in appropriate firing tables. Some rounds on hand are fuze with the M2 improved fuze but such rounds are for reserve and emergency use only. Designations of gas shell with corresponding kind of filler and weight are as follows:

b. DATA.

<i>Nomenclature</i>	<i>Kind of filler</i>	<i>Weight of complete round</i>
SHELL, gas, irritant, CNB, M2, w/fuze, PD, M2 improved for 4.2-inch mortar.	Chloracetophenone, benzol, and carbon tetrachloride solution.	23.5
SHELL, gas, irritant, CNS, M2, w/fuze, PD, M2 improved for 4.2-inch mortar.	Chloracetophenone in chlorpicrin-chloroform solution.	25.0
SHELL, gas, irritant, CNB, M2, w/fuze, PD, M8, for 4.2-inch mortar.	Chloracetophenone, benzol, and carbon tetrachloride solution.	23.5
SHELL, gas, irritant, CNS, M2, w/fuze, PD, M8, for 4.2-inch mortar.	Chloracetophenone in chlorpicrin-chloroform solution.	25.0
SHELL, gas, nonpersistent, CG, M2, w/fuze, PD, M8, for 4.2-inch mortar.	Phosgene gas -----	24.25
SHELL, gas, nonpersistent, CK, M2, w/fuze, PD, M8, for 4.2-inch mortar.	Cyanogen chloride gas-----	23.0
SHELL, gas, persistent, H, M2, w/fuze, PD, M8, for 4.2-inch mortar.	Mustard -----	23.7
SHELL, gas, persistent, HD, M2, w/fuze, PD, M8, for 4.2-inch mortar.	Mustard, distilled -----	24.2

<i>Nomenclature</i>	<i>Kind of filler</i>	<i>Weight of complete round</i>
SHELL, gas, persistent, HT, M2, w/fuze, PD, M2 improved, for 4.2-inch mortar.	Mustard-T mixture -----	23.3
SHELL, gas, persistent, HT, M2, w/fuze, PD, M8, for 4.2-inch mortar.	Mustard-T mixture -----	23.3

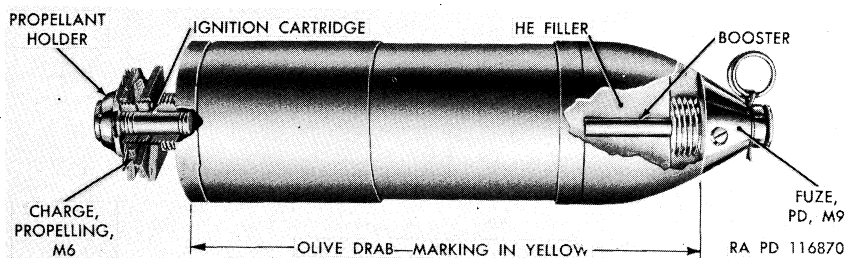


Figure 116. Shell, HE, M3, w/fuze, PD, M9, for 4.2-inch mortars.

174. Shell, HE, M3, w/Fuze, PD, M9, for 4.2-Inch Mortar

a. GENERAL. This shell (fig. 116) is used for fragmentation and mining effect. It is shipped fitted with fuze M9 and is used with this fuze for impact fire. If it is desired to use the high-explosive shell with time fire, the fuze M9 is to be replaced by the time and superquick fuze M5, which is issued separately for assembly in the field. The HE round uses the same propelling charge (M6) and the same ignition cartridge (M2) as the gas shell and the smoke shell. Some rounds on hand are fuzed with fuze M3 improved but these are for reserve and emergency use only.

b. DATA.

Weight of complete round-----	24.5 lb
Length of complete round-----	20.4 in*
Muzzle velocity (max)-----	841.0 fps
Range (max)-----	4,400 yd

* Length with fuze M5 is 22 inches.

175. Smoke Shell for the 4.2-Inch Mortar (fig. 117)

Several different kinds of smoke shell are provided for the 4.2-inch mortar. They are used for producing smoke screens. All chemical (gas and smoke) shell use the same fuze (M8), the same

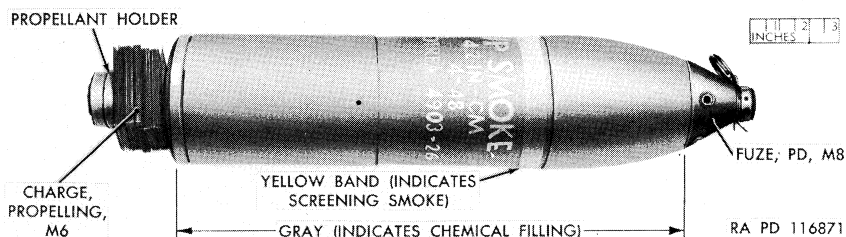


Figure 117. Shell, smoke, WP, M2, w/ fuze, PD, M8, for 4.2-inch mortars.

propelling charge (M6), and the same ignition cartridge (M2). Some rounds on hand are fuzed with the fuze M2 improved but such rounds are for reserve and emergency use only. All chemical (gas and smoke) shell have a maximum muzzle velocity of approximately 820 fps and a maximum range of approximately 4,300 yards. These smoke shell differ from each other only in the kind of filler and the consequent slight difference in weight.

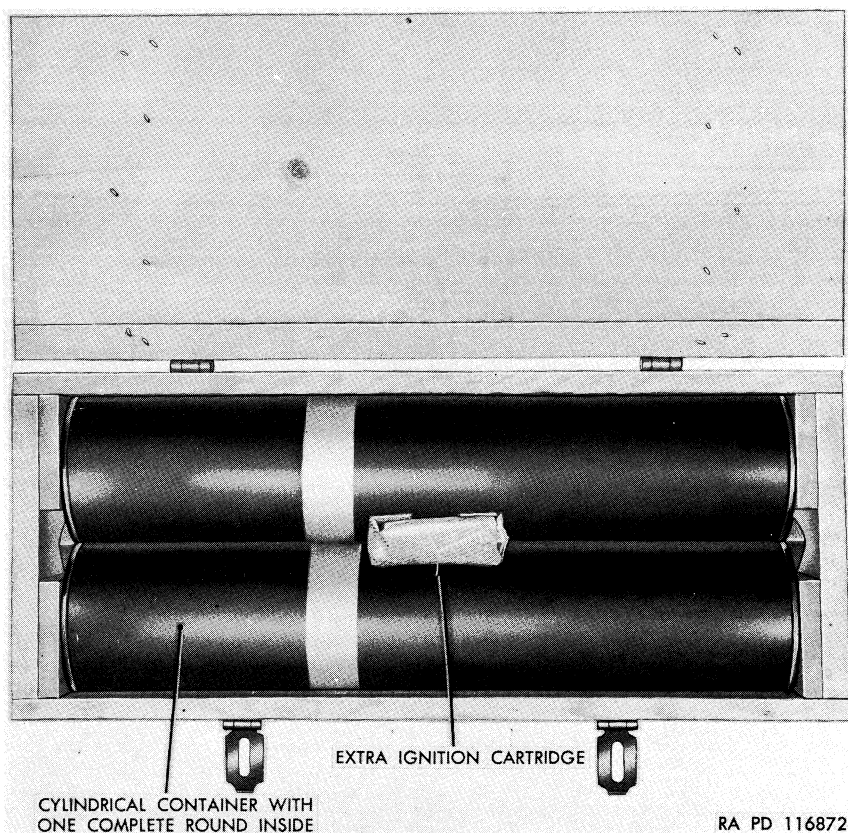


Figure 118. Packing containers and packing box for 4.2-inch mortar ammunition.

Designations of smoke shell with corresponding kind of filler and weight are as follows:

<i>Nomenclature</i>	<i>Kind of filler</i>	<i>Weight of complete round (lb)</i>
SHELL, smoke, WP, M2, w/fuze, PD, M8, for 4.2-inch mortar.	White phosphorus -----	25.5
SHELL, smoke, PWP, M2, w/fuze, PD, M8, for 4.2-inch mortar.	Plasticized white phosphorus	23.8
SHELL, smoke, FS, M2, w/fuze, PD, M8, for 4.2-inch mortar.	Sulfur trioxide-chlorosulfonic acid solution.	25.5
SHELL, smoke, FM, M2, w/fuze, PD, M8, for 4.2-inch mortar.	Titanium tetrachloride.	

Section XV. AMMUNITION FOR 120-mm GUNS

176. General

a. GENERAL DISCUSSION. The 120-mm gun M1 is an antiaircraft weapon intended for protection of large areas against aircraft at altitudes up to 30,000 feet. The complete round for this gun is considered "separated" ammunition. The projectile and the propelling charge assembly are packed, shipped, and issued separately. In separated ammunition, unlike separate-loading ammunition, a cartridge case protects the nonadjustable propelling charge against moisture and foreign matter and prevents the loss of powder. In firing, the projectile and the propelling charge are



Figure 119. Packing containers for propelling charge for 4.2-inch mortar ammunition.

placed on a tray and then loaded into the gun by a power rammer.

b. IDENTIFICATION. The 120-mm complete round is identified by means of the painting and marking as illustrated in figure 120 and in accordance with basic color scheme as prescribed in TM 9-1900.

c. FUZES. The mechanical time fuzes M61 and M61A1 and the VT fuze T75E6 are used with this ammunition. See section I, chapter 3. The high-explosive shell are assembled with mechanical time fuze of the M61 series as shipped. This fuze permits selective time settings up to 30 seconds but has no impact element. The VT fuze T75E6 is provided for use with deep-cavity HE shell. This fuze is issued separately for assembly in the field. It is a proximity fuze which, without prior setting, functions and explodes the shell at effective distances from the target.

d. CARTRIDGE CASE, AND PROPELLING CHARGE. The M15 propelling charge is illustrated in figure 120. The brass cartridge case M24 is of the conventional type but is sealed by PLUG, closing, M2 (palmetto pulp) or PLUG, cork, M1, which is pressed in the mouth and permanently cemented thereto. A protruding portion provides protection for the cartridge case mouth. To insure complete burning of the propelling charge, an igniter of black powder is attached to the M1B1A2 primer. A dummy propelling charge M13 simulates the service charge. For descriptions of these charges, see section II, chapter 3.

e. PRIMER. PRIMER, percussion, M1B1A2 is used. See section III, chapter 3.

177. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL's P-5 and P-8.

178. Normal-Cavity High-Explosive Shell

a. GENERAL. The term "normal-cavity" as applied to high-explosive shell refers to the type of fuze cavity—in other respects the loaded shell is similar to the deep cavity type provided for these guns. In the normal cavity shell, the fuze cavity at the forward end of the bursting charge is only large enough (0.81 in long by 1.73 in diam) to accommodate the boosters used with point fuzes. The shell body consists of a steel forging with boat-tailed base. The bursting charge cavity tapers conically over its lower half and is hemispherical at the bottom. The nose is formed to a long ogive and is threaded for a standard point fuze. The fuze contour continues the long sweep of the shell nose, maintaining, throughout, the streamlined effect which is character-



X-AIC SYMBOL
"P5UAA" APPEARS
ON REVERSE SIDE

120MM

RA PD 104908A

Figure 120. Ammunition for 120-mm gun.

istic of shell of modern design. The normal-cavity shell described in *b* below has been assembled with mechanical time fuze M61A1. Some rounds on hand have been assembled with the M61 fuze.

b. SHELL, HE, M73, W/FUZE, TIME, MECHANICAL, M61A1, FOR 120-MM GUN (fig. 120). This shell has two bourrelets, one (front bourrelet) approximately at the center of the projectile and the other (rear bourrelet) just to the rear of the rotating band. The rotating band, made of gilding metal, has two cannelures or grooves. The fuze is of the mechanical clockwork type designed for use with anti-aircraft ammunition. The projectile is fitted with a base cover which prevents the hot gases generated by the burning propelling charge from coming in contact with the bursting charge through possible flaws in the base.

c. DATA.

Weight of loaded projectile.....	49.74 lb
Weight of loaded charge and cartridge case.....	49.71 lb
Length of fuzed projectile.....	24.06 in
Length of cartridge case.....	32.80 in
Width of rotating case.....	2.25 in
Type of base.....	Boat-tailed
Degree of taper.....	7° 30'
Radius of ogive (conical end).....	5.73 cal.
Muzzle velocity.....	3,100 fps
Maximum range:	
Horizontal	28,275 yd*
Vertical	20,100 yd**

* When not limited by fuze.
 ** Limited by 30-second fuze.

179. Deep-Cavity High-Explosive Shell

a. The deep-cavity shell is identical to the normal-cavity shell described in paragraph 178 except for a deep fuze cavity which makes the shell adaptable for use with either the VT fuze or standard fuzes and boosters. For use with the VT fuze, a deep fuze cavity (3.59 in. long by 1.73 in. diam.) is provided. The cavity is lined with a thin cardboard liner and bottom cap which serves as a partial support for the HE filler. This lining is not to be removed. Insertion of a supplementary charge into the fuze cavity adapts the shell for standard point fuzes and boosters. The supplementary charge consists of a charge of TNT in a cylindrical boxboard body with felt cushion at the lower end and cap and lifting loop at the upper end. When deep-cavity rounds are assembled with standard fuzes and boosters, the data are the same as for the normal-cavity shell described in paragraph 178. Origi-

nally, the shell were shipped unfuzed, in some cases with supplementary charge and, in others, without it. Subsequently, all deep-cavity shell were assembled with supplementary charges and standard point fuzes and boosters.

b. Deep-cavity rounds which have been shipped fuzed or unfuzed, with or without supplementary charges, are as follows:

(1) *Fuzed rounds as shipped.*

SHELL, HE, M73, w/suppl chg and fuze, time, mechanical, M61A1.

SHELL, HE, M73, w/suppl chg and fuze, time, mechanical, M61.

(2) *Unfuzed rounds as shipped.* This round is issued unfuzed with fuze hole protected by a closing plug:

SHELL, HE, M73, w/suppl chg, w/o fuze.



Figure 121. Projectile, dummy, M15, w/fuze dummy, M79, for 120-mm gun.

180. Projectile, Dummy, M15, w/Fuze, Dummy, M79, for 120-mm Guns
(fig. 121)

This dummy projectile consists of an inert loaded M73 shell body, the rotating band of which has been machined flush with the rear bourrelet. The dummy fuze M79 is screwed into the shell body. The weight of the projectile is 49.53 pounds; length is 24.12 inches.

Section XVI. AMMUNITION FOR 155-mm GUNS

181. General

a. SHELL CHARACTERISTICS. Projectiles used in the 155-mm gun M2 are the same size and shape as those fired from 155-mm howitzers. They differ in the marking and the width of the rotating band. The gun projectile has a rotating band which is 2 inches wide, as compared with 1.02 inches for the howitzer projectile.

b. IDENTIFICATION. Ammunition and ammunition components are identified by the painting and marking in accordance with the basic color scheme prescribed in TM 9-1900.

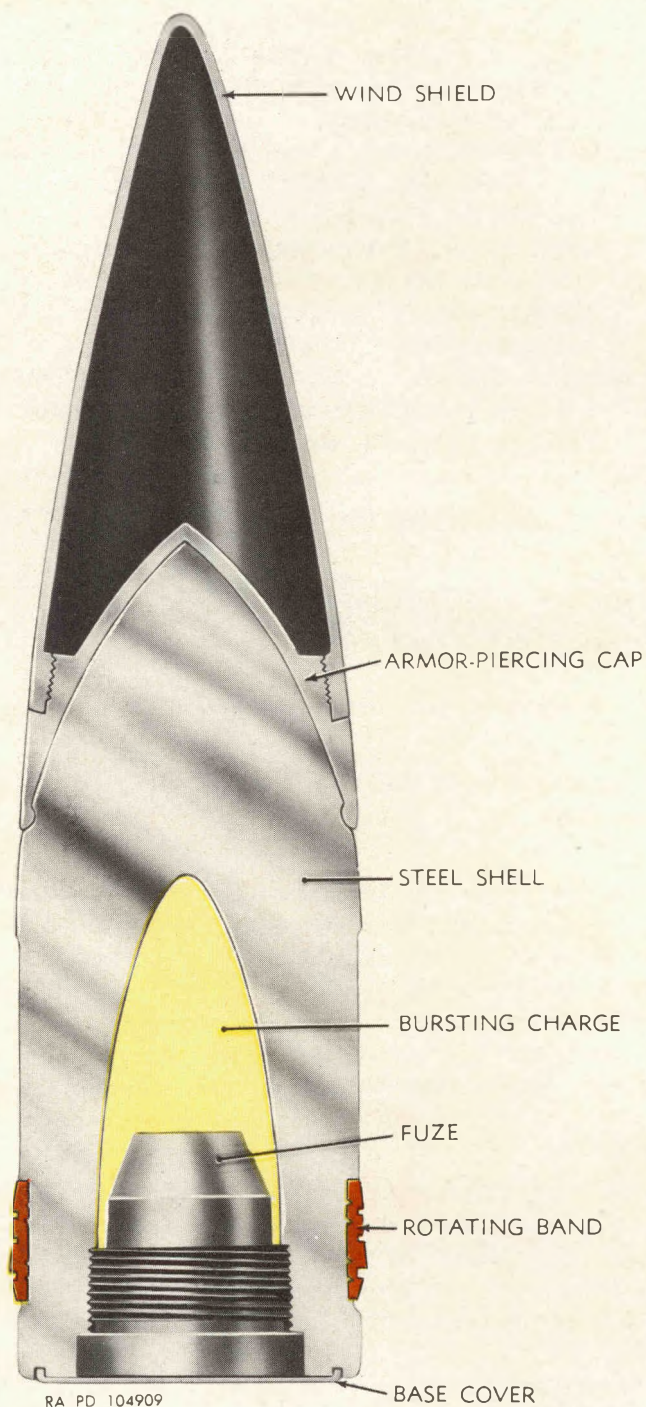


Figure 122. Projectile, AP, M112, for 155-mm guns.

c. FUZES. The base detonating fuze M60, which functions with delay action, is assembled with AP projectile M112. All other rounds for this weapon are shipped unfuzed. The HE shell are fuzed in the field with fuzes of the M51 series and the M500 series. Smoke and gas shell are fuzed with the M51 series fuzes. The M501 fuze is used with M118 illuminating shell.

d. PROPELLING CHARGE. The propelling charge M19 used with all service rounds in the 155-mm gun M2 is of the base and increment type and is approximately 37½ inches long by 6½ inches in diameter. The flash reducer M1 is used with this propelling charge. Its use greatly reduces the flash and is intended primarily for use in night firing. See section II, chapter 3.

e. PRIMER. The Mk 2A4 percussion primer is used in this weapon. See section II, chapter 3.

182. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL's P-1, P-2, and P-8.

183. Projectile, AP, M112, for 155-mm Guns (fig. 122)

a. GENERAL. This projectile is intended for use against armored targets, concrete emplacements, and similar targets. It consists of a hardened steel body which contains a cavity in the base filled with explosive D and a base detonating fuze M60 which functions with delay action. A comparatively thin adapter cap which is soldered and staked to the ogive provides the means of attaching the steel windshield. A base cover is fitted over the fuze in the base of the projectile. Manufacturing alternative is AP M112B2.

b. DATA.

Weight of projectile, as fired.....	100 lb
Length of projectile.....	23.62 in
Width of rotating band.....	2.02 in
Type of base.....	Square
Radius of ogive.....	10.67 cal.
Muzzle velocity (supercharge).....	2,745 fps
Maximum range (supercharge).....	24,075 yd
Penetration (at 0° obliquity of homogenous plate at 1,000 yd).....	4 in
Penetration (of reinforced concrete at 1,000 yd).....	60 in

184. Shell, HE, M101, for 155-mm Guns (fig. 123)

a. GENERAL. This shell has a single 2-inch wide rotating band. The rear of the rotating band is located approximately 3.5 inches

forward of the base. The shell is adapted for either the M51 series PD fuze, the mechanical time superquick fuze M500, the M67 series time and superquick fuze, or the M78 series concrete-piercing fuze.

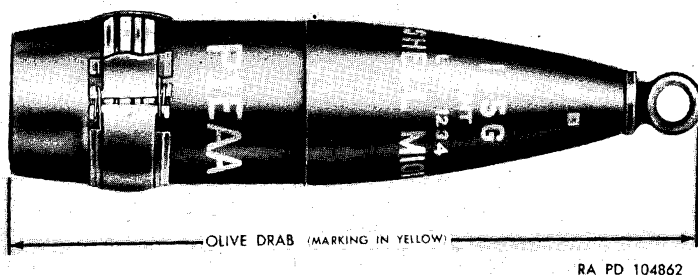


Figure 123. Shell, HE, M101, for 155-mm guns.

b. DATA.

Weight of projectile, as fired	95.59 lb
Length of projectile*	26.88 in
Width of rotating band	2.02 in
Type of base	Boat-tailed
Degree of taper	8.0°
Radius of ogive	10.75 cal.
Muzzle velocity:	
Maximum charge	2,800 fps
Maximum range	25,715 yd

* With eyebolt-lifting plug.

185. Shell, Illuminating, M118, for 155-mm Guns or Howitzers (fig. 124)

a. GENERAL. This shell is standard for use in the 155-mm gun M2, as well as the howitzer M1. It consists of an illuminating candle attached to a parachute unit and an ejection charge, all encased in a steel shell. The base of the projectile is closed by a steel base plug which, in the functioning of the shell is blown out. The shell is adapted for the MTSQ M501 fuze. Some rounds on hand are assembled with TSQ M54 fuze. This fuze ignites the ejection charge which ejects the burning candle suspended from the parachute and illuminates the target area. The average burning time of the candle is about 60 seconds with limits of 50 and 70. Rate of fall of the parachute supported candle is 35 to 40 fps. The maximum benefit of lighting (minimum candlepower is 400,000) is obtained from a height of burst of 2,500 feet. This

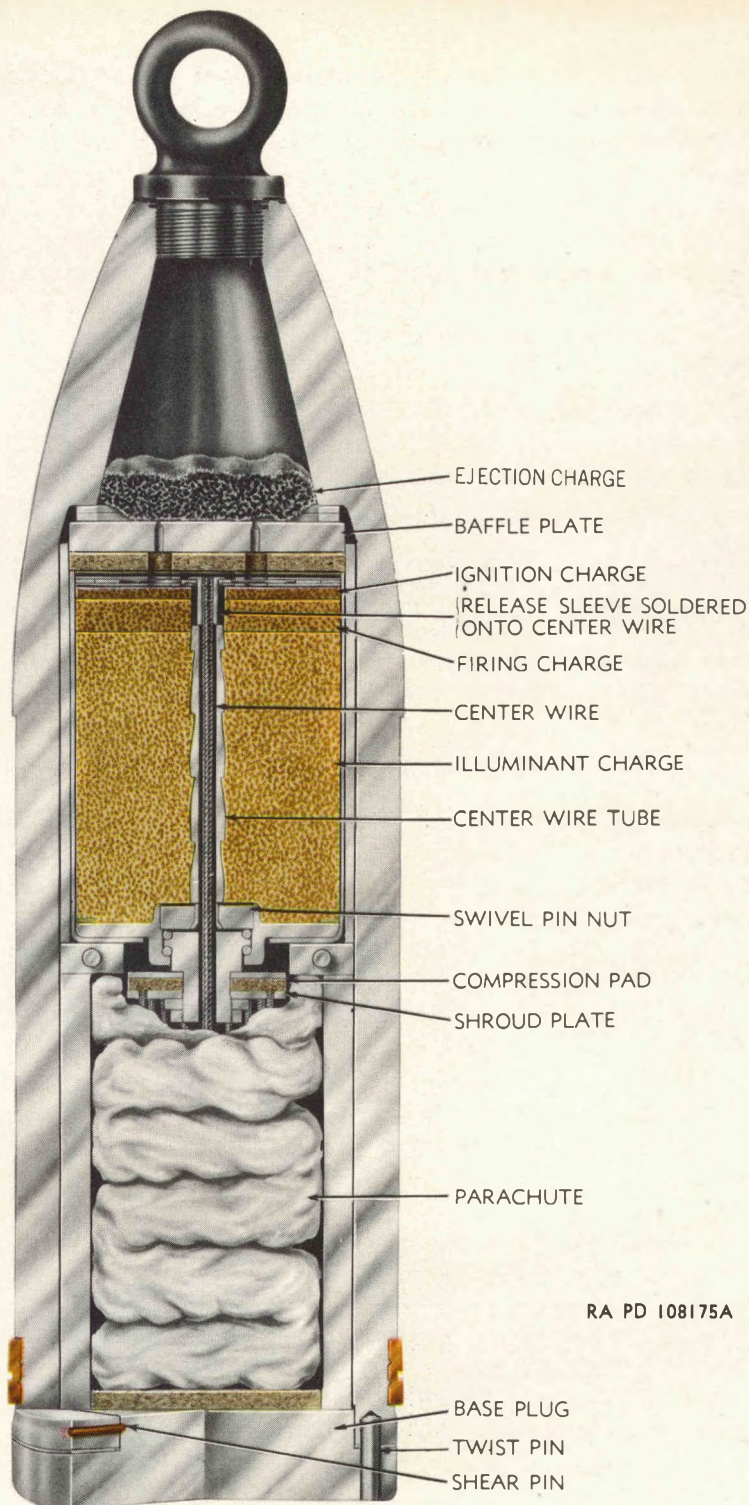


Figure 124. Shell, illuminating, M118, for 155-mm guns or howitzers.

height of burst allows the illuminant to burn out from 300 to 150 feet above the ground. The shell should be fired so that the height of burst is a minimum of 2,100 feet so that the illuminant is practically burned out before striking the ground. The optimum balance of light intensity and area coverage occurs at the height of about 1,050 feet. At this height, the area of illumination is a circle whose approximate diameter is 400 yards. A manufacturing alternative is SHELL, illuminating, M118B1. This shell is used only with the base section of the propelling charge.

b. DATA.

Weight of projectile, as fired.....	103.06 lb
Length of projectile*.....	23.20 in
Width of rotating band.....	1.02 in
Type of base.....	Square
Radius of ogive.....	3.28 cal.
Muzzle velocity.....	2,000 fps
Maximum range.....	15,400 yd**

* With eyebolt-lifting plug.

** Range shown is maximum to ground impact if the time element of the fuze does not function.

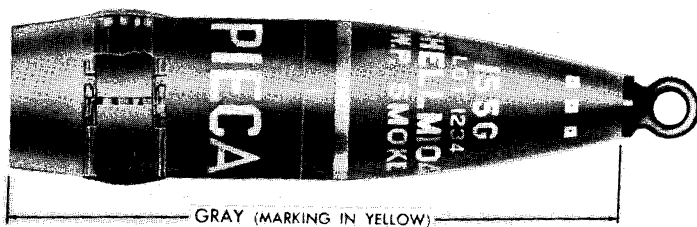
186. Shell, Gas or Smoke, M104, for 155-mm Guns

a. GENERAL. This shell has the same contour as the HE M101 shell described in paragraph 184. The M104 WP smoke shell is shown in figure 125. The M6 burster charge which is contained in thin aluminum or steel tube is held in place in the casing by the fuze well cup. The top of the burster casing is pressed into an adapter in the nose cavity. The shell is adapted for the PD fuze M51 series. The various types of gas and smoke shell using the M104 body and a burster are—

SHELL, gas, persistent, H, M104, for 155-mm guns.

SHELL, smoke, FS, M104, for 155-mm guns.

SHELL, smoke, WP, M104, for 155-mm guns.



RA PD 80817A

Figure 125. Shell, smoke, WP, M104, for 155-mm guns.

b. DATA.

Weight of projectile, as fired-----	94.81 lb (H)
	100.01 (FS)
	98.71 (WP)
Length of projectile*-----	26.78 in
Width of rotating band-----	2.00 in
Type of base-----	Boat-tailed
Degree of taper-----	8.5°
Radius of ogive-----	10.75 cal.
Muzzle velocity, maximum charge-----	2,800 fps
Maximum range, supercharge-----	25,715 yd

* With eyebolt-lifting plug.

187. Shell, Empty, M101, for 155-mm Guns

This target practice shell consists of an M101 shell body, which is shipped empty and is sand-loaded to weight at point of use. An inert fuze and booster is used. These shell may be issued as long as stocks last; no more are being assembled. For data, see paragraph 184.

188. Projectile, Dummy, M7, for 155-mm Guns or Howitzers (fig. 126)

This dummy projectile is intended for training in the service of the 155-mm gun or howitzer. Projectiles of earlier manufacture are for use in the 155-mm gun only because of the greater diameter of the rear band (6.3 in.). It is of the type having a fully inclosed spring-operated plunger, which kicks the projectile loose from the forcing cone of the gun on the rebound upon ramming. It has a bronze cap, steel body, bronze front band, steel base, and bronze rear band. The bronze front band simulates the bourrelet of a service projectile. The bronze rear band simulates the rotating band of a service projectile. The several parts of this dummy projectile are replaceable. The projectile is 27.56 inches long and weighs 95 pounds. Some projectiles, marked M7B1,

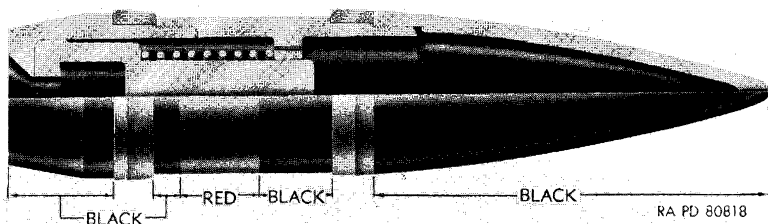


Figure 126. Projectile, dummy, M7, for 155-mm guns or howitzers.

differ from the M7 only in the cap which in the M7B1 is made of malleable iron.

Section XVII. AMMUNITION FOR 155-mm HOWITZERS

189. General

a. GENERAL DISCUSSION. Projectiles used on the 155-mm howitzer M1 are the same size and shape as those used in the 155-mm gun. They differ in the marking and in the width of the rotating band. The rotating band of the howitzer projectile is 1.02 inches as compared with 2 inches for the gun projectile, and there is a groove immediately to the rear of it.

b. IDENTIFICATION. Ammunition and ammunition components are identified by the painting and marking in accordance with the basic color scheme prescribed in TM 9-1900.

c. FUZES. The normal-cavity HE shell M102 and HE shell M107 are issued unfuzed and are adapted for assembly with the superquick and delay (PD) fuze M51A5 or the mechanical time superquick (MTSQ) fuze M500. Gas and smoke shell also are issued unfuzed for assembly of fuze PD M51A5 in the field. The following fuzes on hand also may be used with HE, gas, and smoke shell: PD M51A4; mechanical time M67A3; and time and superquick (TSQ) M55A3. The concrete-piercing (CP) M78 or M78A1 fuze is authorized for assembly to HE shell in the field. Deep-cavity shell may be fuzed with the VT M96 (T76E6) fuze after removal of the supplementary charge shipped assembled in the cavity. Some deep-cavity shell were issued without supplementary charges. With supplementary charge assembled in the cavity of these shell, they may be fuzed with any of the following fuzes: CP M78 or M78A1; MTSQ M500; PD M51A4 or M51A5; time, mechanical, M67A3; or TSQ M55A3. The BE (base ejection) smoke shell M116 and the illuminating shell M118 are adapted for use with MTSQ fuze M501; some TSQ fuzes M54 are on hand for use with these shell. See section I, chapter 3.

d. PROPELLING CHARGES. Base and increment charges, both green bag for inner zones and white bag for outer zones of fire, are used. In addition, flash reducer M2 (T2) is provided for night firing with white bag charges. See section II, chapter 3.

e. PRIMER. The Mk 2A4 percussion primer is used. See section III, chapter 3.

f. INTERCHANGEABILITY.

- (1) The following shell may be used with the M3 green bag or M4A1 white bag charges *for training purposes only*

in the 155-mm howitzer M1 but use of the M4A1 white bag charge is *not* recommended:

SHELL, HE, M102.

SHELL, smoke, FS or WP, M105.

- (2) In addition to the above, the following shell are authorized *for both service and target practice use* with the M3 green bag or M4A1 white bag charges in the 155-mm howitzer M1:

SHELL, HE, M107.

SHELL, gas or smoke, M110.

SHELL, smoke, HC or colored, BE, M116.

SHELL, illuminating, M118 (with M3 charge only).

190. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL's R-2 and R-6.

191. Shell, HE, M107, w/Suppl Chg, for 155-mm Howitzers (fig. 127)

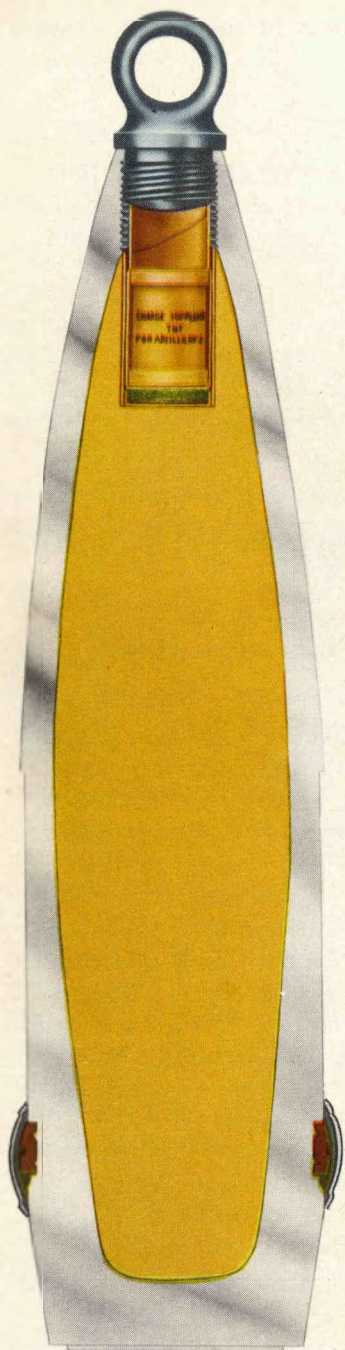
a. GENERAL. This shell is similar to other standard high-explosive shell of modern design. The body is a relatively thin-walled steel shell with a nose formed to a long ogive and threaded to hold a point fuze. This shell has a deep fuze cavity in its bursting charge and a supplementary charge of TNT to shorten the cavity for use with MTSQ, superquick and delay, mechanical time, TSQ, or CP fuzes, each type with its booster. Without the supplementary charge, VT fuze M96 (T76E6) may be used with this shell. The projectile has a single rotating band located about 3.5 inches in front of the base. A steel base plate welded to the base end of the projectile prevents hot gases from the propelling charge from reaching the bursting charge of the projectile through possible flaws in the base.

b. DATA.

Weight of projectile, as fired.....	94.52 lb*
Length of projectile**.....	26.81 in
Width of rotating band.....	1.02 in
Type of base.....	Boat-tailed
Degree of taper.....	8.0°
Radius of ogive.....	10.75 cal.

* With eyebolt-lifting plug.

** With fuze PD M51A5.



RA PD 104896A

Figure 127. Shell, HE, M107, w/suppl chg, for 155-mm howitzers.

Muzzle velocity:

M3 charge ----- 1,220 fps

M4A1 charge ----- 1,850 fps

Maximum range:

M3 charge ----- 10,780 yd

M4A1 charge ----- 16,355 yd

192. Shell, HE, M107, Adapted for Fuze, VT, M96 (T76E6), for 155-mm Howitzers

This shell does not contain a supplementary charge in its deep fuze cavity and, hence, is adapted for use with a VT fuze M96 (T76E6). When fired with the VT fuze, only charges 5, 6, and 7 are used. Data in paragraph 191 are applicable to this projectile, except for weight, as fired, of 94.87 pounds for this round.

193. Shell, HE, M107, for 155-mm Howitzers

This shell does not contain a deep fuze cavity, but its normal fuze cavity accommodates an MTSQ, superquick and delay, mechanical time, TSQ, or CP fuze, each type with its booster. The bursting charge is TNT or amatol. When the shell is loaded with amatol, the charge has a booster surround consisting of 0.2 pound of cast TNT. Data in paragraph 191 are applicable to this shell, except for weight, as fired, of 94.75 pounds for this round.

194. Shell, HE, M102, for 155-mm Howitzers (fig. 128)

a. GENERAL. This shell is similar to the M107 shell described in paragraph 193, differing chiefly in that it has the narrow (0.60-in wide) rotating band.

b. DATA.

Weight of projectile, as fired ----- 95.08 lb

Length of projectile* ----- 26.82 in

Width of rotating band ----- 0.60 in

* With eyebolt-lifting plug.

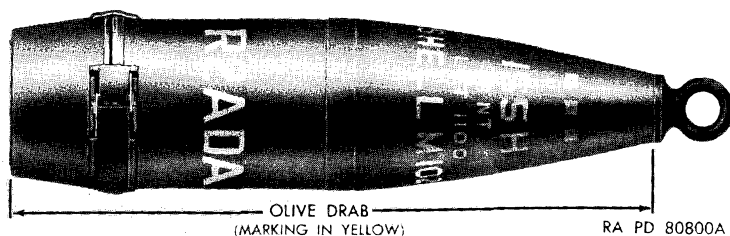


Figure 128. Shell, HE, M102, for 155-mm howitzers.

Type of base.....	Boat-tailed
Degree of taper.....	8.0°
Radius of ogive.....	10.75 cal.
Muzzle velocity:	
M3 charge	1,222 fps
Maximum range:	
M3 charge	10,604 yd

195. Shell, Gas or Smoke, M110, for 155-mm Howitzers (fig. 129)

This shell has the same ballistic shape and external dimensions as the shell M107 described in paragraph 191. The explosive charge of the burster, which is contained in a thin aluminum or steel tube, is held in place in the burster casing by the fuze well cup. The



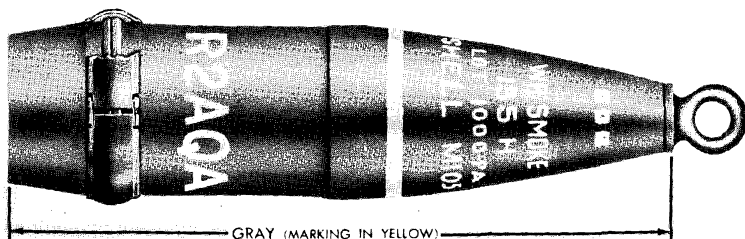
Figure 129. Shell, gas, persistent, H, M110, for 155-mm howitzers.

upper end of the burster casing is fastened to the adapter in the nose of the shell. The adapter which is assembled to the nose of the shell is threaded to receive the PD M51 series fuzes. The various types of gas and smoke shell using the M110 shell body and bursters are—

	<i>Weight, as fired</i>
SHELL, gas CNS, M110, for 155-mm howitzers	97.31 lb
SHELL, gas, persistent H, M110, for 155-mm howitzers	94.49 lb
SHELL, smoke, FS, M110, for 155-mm howitzers	99.70 lb
SHELL, smoke WP, M110, for 155-mm howitzers	98.40 lb

196. Shell, Smoke, WP, M105 for 155-mm Howitzers (fig. 130)

a. GENERAL. This shell is similar to the M110 gas and smoke shell described in paragraph 195 but has the narrow (0.60-inch) rotating band. The adapter which is assembled to the nose of the shell is threaded to receive the PD M51 series fuzes. The M105 FS smoke shell is similar to the M105 WP smoke shell.



RA PD 80808A

Figure 130. Shell, smoke, WP, M105, for 155-mm howitzers.

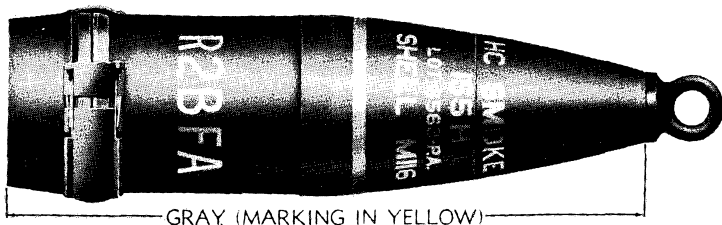
b. DATA.

Weight of projectile, as fired	98.21 lb (WP)
	99.51 lb (FS)
Length of projectile*	26.78 in
Width of rotating band	0.60 in
Type of base	Boat-tailed
Degree of taper	8.0°
Radius of ogive	10.75 cal.
Muzzle velocity:	
M3 charge	1,222 fps
Maximum range:	
M3 charge	10,530 fps

* With eyebolt-lifting plug.

197. Shell, Smoke, HC, BE, M116, for 155-mm Howitzers (fig. 131)

a. GENERAL. This shell is a base-ejection type of smoke shell, in which the nose, body, and base, are manufactured as separate parts and assembled by screwing together. An expelling charge of black powder backed up by a baffle plate is located in the front end of the shell cavity. The remainder of the cavity holds four canisters of smoke mixture, one behind the other, and the for-



RA PD 104868

Figure 131. Shell, smoke, HC, BE, M116, for 155-mm howitzers.

ward canister is conical to conform with the taper of the cavity. A hole passes through the baffle plate and the longitudinal axis of each canister, thus forming a flash tube. The base of the projectile is closed by a base plug which, in the functioning of the shell, is blown out, as are the four smoke canisters. Maximum emission of smoke occurs in about 1 minute although an effective smoke develops in 30 seconds. The smoke cloud emitted from each canister is approximately two or three times greater in volume than that from a canister of 105-mm BE smoke. A manufacturing alternative is SHELL, smoke, HC, BE, M116B1 in which the body section and nose section are integral. The MTSQ fuze M501 or the TSQ fuze M54 may be used with this shell. Propelling charge M3 (green bag) or M4A1 (white bag) is used with this shell.

b. DATA.

Weight of projectile, as fired	95.10 lb
Length of projectile*	26.41 in
Width of rotating band	1.02 in
Type of base	Boat-tailed
Degree of taper	8.0°
Radius of ogive	10.75 cal.
Muzzle velocity:	
M3 charge	1,222 fps
M4A1 charge	1,850 fps
Maximum range**	16,700 yd
Burning time	4 min

* With eyebolt-lifting plug.

** Shell range shown is maximum to ground impact unless prior functioned by fuze.

198. Shell, Smoke, Colored, BE, M116, for 155-mm Howitzers

a. GENERAL. This shell is similar to the HC smoke (white) BE shell M116 described in paragraph 197 except for the red, yellow, green, or violet smoke filler. The colored smoke mixture burns for a minimum of 30 seconds. Nomenclature for these shell are—

SHELL, smoke, red, BE, M116, for 155-mm howitzers
 SHELL, smoke, yellow, BE, M116, for 155-mm howitzers
 SHELL, smoke, green, BE, M116, for 155-mm howitzers
 SHELL, smoke, violet, BE, M116, for 155-mm howitzers

b. DATA.

Weight of projectile, as fired	86.43 lb
Length of projectile*	26.41 in
Width of rotating band	1.02 in
Type of base	Boat-tailed

Degree of taper-----	8.0°
Radius of ogive-----	10.75 cal.
Muzzle velocity:	
M3 charge -----	1,220 fps
M4A1 charge -----	1,902 fps
Maximum range** -----	16,300 yd
Burning time -----	4 min

* With eyebolt-lifting plug.

** Shell range shown is maximum to ground impact unless prior functioned by fuze.

199. Shell, Illuminating, M118, for 155-mm Guns or Howitzers

For description and data, see paragraph 185 and figure 124. This shell is used only with the green bag charge M3 when fired in the M1 howitzer; otherwise, the rated maximum pressure might be exceeded. Muzzle velocity with zone charge 5 of green bag charge M3 in the M1 howitzer is 1,160 fps, and maximum range is 9,000 yards to ground impact unless prior functioned by fuze.

200. Projectile, Dummy, M7, for 155-mm Guns or Howitzers

For description and data, see paragraph 188 and figure 126.

Section XVIII. AMMUNITION FOR 8-INCH GUNS

201. General

a. GENERAL DISCUSSION. One model of high-explosive shell, one model of armor-piercing projectile, and one model of dummy projectiles are authorized for use in the 8-inch gun M1.

b. IDENTIFICATION. The ammunition and ammunition components are identified by means of the painting and marking in accordance with the basic color scheme prescribed in TM 9-1900.

c. FUZES. The PD fuze M51A5 Mod 3 is used with the HE shell and the BD fuze Mk 11 or Mk 11 Mod 8 is used with the AP projectile. See section I, chapter 3.

d. PROPELLING CHARGES. The charge M13 is used with the HE and AP shell. The dummy charge M7 is used with the dummy projectile. See section II, chapter 3.

e. PRIMERS. The Mk 2A4 percussion primer is used. See section III, chapter 3.

202. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL's P-1, P-2, and P-8.

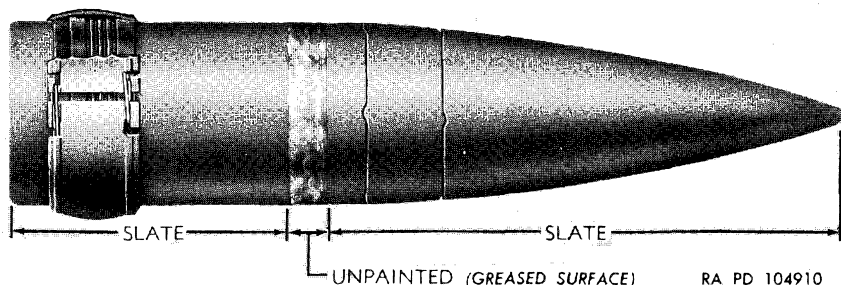


Figure 132. Projectile, common, Mk 14 and 17 (all mods), for 8-inch guns.

203. Projectile, Common, Mk 14 and 17 (all Mods), for 8-Inch Guns (fig. 132)

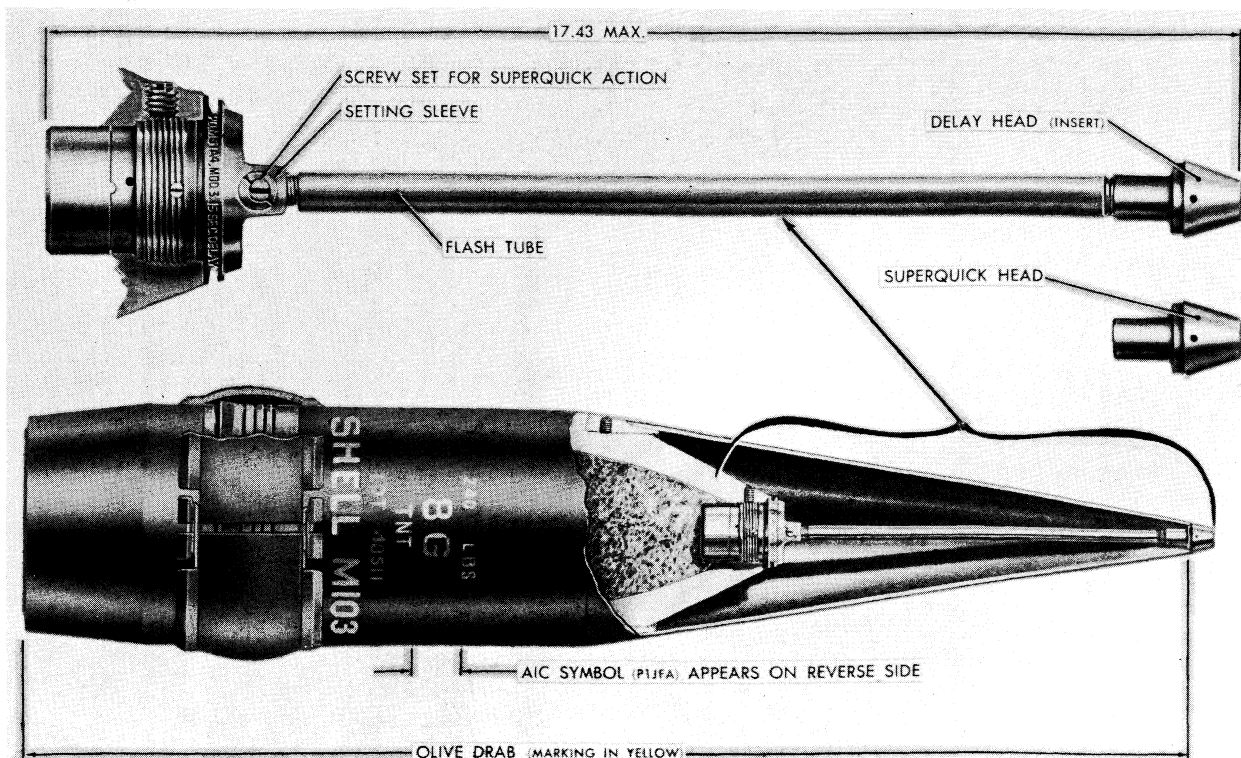
a. GENERAL. This projectile is of Navy design and is limited standard for use in the M1 gun. The shell, fitted with a base fuze, Mk 11 or Mk 11 Mod 8, has one bourrelet of 7.98 inches diameter. The rotating band is located 2 inches forward of the base. The projectiles Mk 14 and Mk 17 are identical except for slight differences in the base plug, explosive cavity, and method of attaching the windshield.

b. DATA.

Weight of projectile, as fired.....	260 lb
Length of projectile.....	36.0 in
Width of rotating band.....	3.30 in
Type of base.....	Square
Muzzle velocity (supercharge).....	2,750 fps
Maximum range (supercharge)	32,500 yd

204. Shell, HE, M103, w/Fuze, PD, M51A5 Mod 3, 0.05-Sec Delay, for 8-Inch Gun M1

a. GENERAL. As shipped, the shell (fig. 133) is fitted with the PD fuze M51A5 (or M51A4) mod 3, 0.05-second delay, and inert head. A superquick fuze head is packed in the box with the shell as shipped. This fuze may be replaced by the mechanical time fuze M67A3, the concrete-piercing fuze M78 or M78A1 or MTSQ fuze M500. If the M51A5 Mod 3 is replaced by the M67A3, the M78 or M78A1, or the M500, remove the windshield, discard the flash tube, install fuze, and restore windshield (par. 251). It has two bourrelets of 7.990 inches diameter; one (front bourrelet) just to the rear of the windshield; the other (rear bourrelet) is at the rear of the projectile body. The rotating band is located ap-



RA PD 104870

Figure 133. Shell, HE, M103, w/fuze, PD, M51A5, Mod 3, 0.05-sec delay, for 8-inch gun M1.

proximately 6 inches forward of the base and within the rear bourrelet.

b. DATA.

Weight of projectile, as fired.....	240.37 lb
Length of projectile.....	40.95 in
Width of rotating band.....	3.33 in
Type of base.....	Boat-tailed
Degree of taper.....	6°
Radius of ogive.....	2.78 cal.
Muzzle velocity (supercharge).....	2,850 fps
Maximum range	35,490 yd

205. Projectile, Dummy, M13, for 8-Inch Gun M1

This projectile (fig. 134) simulates the HE shell M103, described in paragraph 204, and is intended for training in service of the piece. It is 35.90 inches long and is of the type having a fully enclosed spring-operated plunger, which loosens the projectile in the forcing cone of the gun on rebound resulting from ramming. It has a bronze cap, steel body, bronze front band, steel base, and

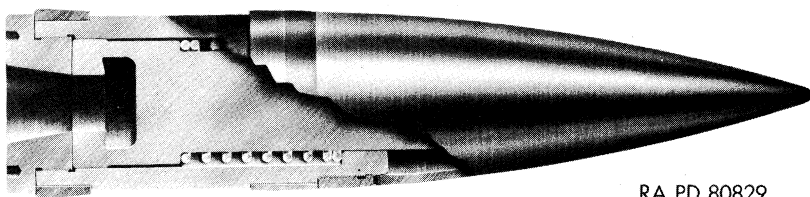


Figure 134. Projectile, dummy, M13, for 8-inch gun M1.

bronze rear band. The bronze cap is ogival in shape and is attached to the forward end of the body. The bronze front band simulates the bourrelet of a service projectile. The bronze rear band simulates the rotating band of the service projectile. The several parts are replaceable. Weight is 260 pounds. Dummy projectile M13B1 is identical to the M13 with the exception that the cap is made of malleable iron.

Section XIX. AMMUNITION FOR 8-INCH HOWITZERS

206. General

a. GENERAL DISCUSSION. One model of high-explosive shell and one model of dummy projectiles are authorized for use in the 8-inch howitzer M2.

b. IDENTIFICATION. The ammunition and ammunition components are identified by means of the painting and marking in accordance with the basic color scheme prescribed in TM 9-1900.

c. FUZES. The MTSQ fuze M500, PD fuze M51A5, mechanical time fuze M67A3, CP fuze M78 or M78A1, VT fuze M96, and modifications of these fuzes are used with HE shell for the 8-inch howitzer. See section I, chapter 3.

d. PROPELLING CHARGES. Two types of charge are provided, the green bag M1 and white bag M2. A flash reducer M3 (T3) is provided for optional use with the M2 charge. See section II, chapter 3.

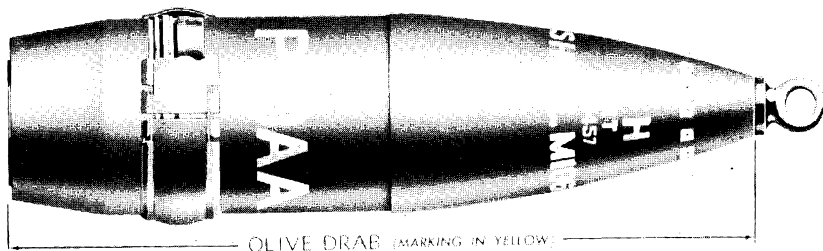
e. PRIMERS. The Mk 2A4 percussion primer is used. See section III, chapter 3.

207. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL's P-1, P-2, and P-8.

208. Shell, HE, M106, for 8-Inch Howitzers

a. GENERAL. This shell (fig. 135) has a normal cavity in which an aluminum fuze well cup is assembled. The rotating band, made of copper or gilding metal, is located 6.06 inches from the base end and has two cannellures or grooves. The shell is adapted to receive the following fuzes: CP M78 or M78A1; MTSQ M500; M51A5 or PD M51A4; or mechanical time M67A3. The projectile is fitted with a base cover which may consist either of a steel cup assembly, secured to the base by means of a lead calking strip, or of a steel plate which is welded to the base. This base cover prevents the hot gases from the propelling charge from reaching the bursting charge of the projectile through possible defects or flaws in the base. The bursting charge consists of 36.75 pounds of TNT.



RA PD 104864

Figure 135. Shell, HE, M106, for 8-inch howitzers.

b. DATA.

Weight of projectile, as fired	200 lb
Length of projectile*	34.35 in
Width of rotating band	2.02 in
Type of base	Boat-tailed
Degree of taper	9.0°
Radius of ogive	8.0 cal.
Muzzle velocity (charge 7)	1,950 fps
Maximum range (charge 7)	18,510 yd

* With eyebolt-lifting plug.

209. Shell, HE, M106, w/Suppl Chg, for 8-Inch Howitzers

This shell is similar to the shell M106 described in paragraph 208, except that it has a deep fuze cavity so that it can be used with VT fuzes. The shell, as issued with a supplementary bursting charge is adapted for use with standard, mechanical time superquick, time and superquick, impact, or concrete-piercing fuzes.

210. Projectile, Dummy, M14, for 8-Inch Howitzers

This projectile (fig. 136) simulates the HE shell M106. It is of the conventional type having a fully enclosed spring-operated plunger, which kicks the projectile loose from the forcing cone of the gun on the rebound upon ramming. It has an ogival bronze cap, a steel body, and a steel base, each screwing into the next neighboring part when assembled. Some projectiles have steel caps. The rotating band and bourrelet of the service shell are simulated by bronze bands. The several parts are replaceable. Projectile is 34.40 inches long and weighs 200 pounds.

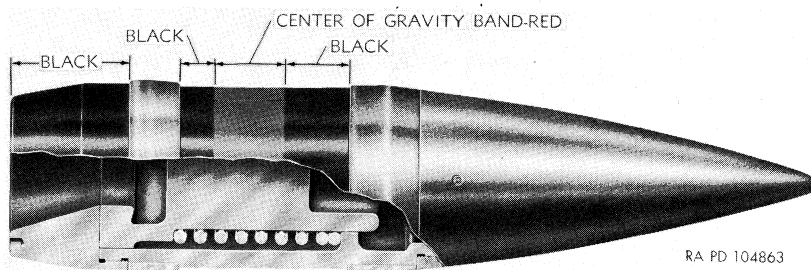


Figure 136. Projectile, dummy, M14, for 8-inch howitzers.

211. Projectile, Dummy, MK I A1, for 8-Inch Howitzers

This projectile is provided for training in the service of the 8-inch gun as well as the howitzer. Its principal parts are a bronze cap, a steel body, bronze front band, steel base, and a steel rear ring with bronze rear band. The bronze cap is ogival in shape and is attached to the forward end of the body. The bronze front band simulates the bourrelet of a service projectile. The steel rear ring is mounted on the cylindrical portion of the base and can slide freely upon it. The bronze rear band mounted on the rear ring simulates the rotating band of the service projectiles. The several parts are replaceable. The projectile is 29 inches long and weighs 200 pounds.

Section XX. AMMUNITION FOR 240-mm HOWITZERS

212. General

a. GENERAL DISCUSSION. The projectiles used in this howitzer are shipped unfuzed. They comprise one model of the high-explosive type and one model of the dummy type.

b. IDENTIFICATION. The ammunition and ammunition components are identified by the painting and marking in accordance with the basic color scheme prescribed in TM 9-1900.

c. FUZES. The high-explosive shell is adapted for use with the PD M51A5, the MTSQ M500, or the VT M96 fuze. See section I, chapter 3.

d. PROPELLING CHARGES. CHARGE, propelling, M23 is used with the HE shell, and CHARGE, propelling, dummy, M12 is used with the dummy projectile M12. See section II, chapter 3.

e. PRIMERS. The Mk 2A4 percussion primer is used. See section III, chapter 3.

213. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL's P-1, P-2, and P-8.

214. Shell, HE, M114, for 240-mm Howitzers

a. GENERAL. This shell (fig. 137) has a normal cavity. It is shipped unfuzed with eyebolt-lifting plug. The shell is adapted to receive the following fuzes: CP M78 or M78A1; MTSQ M500; PD M51A4 or M51A5; or mechanical time M67A3. The bursting charge consists of 54.06 pounds of TNT.

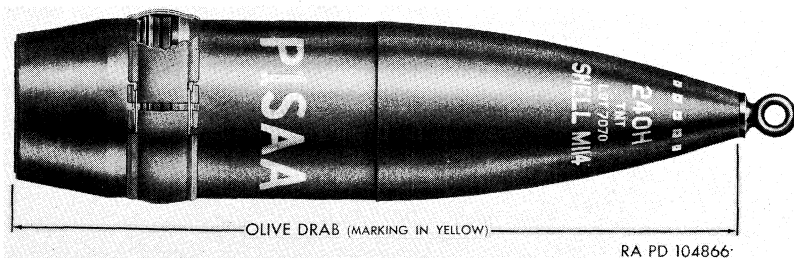


Figure 137. Shell, HE, M114, for 240-mm howitzers.

b. DATA.

Weight of projectile, as fired	360 lb
Length of projectile*	41.06 in
Width of rotating band	2.5 in
Type of base	Boat-tailed
Degree of taper	8.0°
Radius of ogive	8 cal.
Muzzle velocity (maximum charge)	2,300 fps
Maximum range (maximum charge)	25,255 yd

* With eyebolt-lifting plug.

215. Shell, HE, M114, w/Suppl Chg, for 240-mm Howitzers

This shell is similar to the HE shell M114 described in paragraph 214 except that it has a deep fuze cavity, so that it can be used with VT fuze M96, after removal of the supplementary charge which is in the shell as issued. When using the fuzes mentioned in paragraph 214 for which this shell is adapted, the supplementary charge also is used in the deep fuze cavity.

216. Projectile, Dummy, M12, for 240-mm Howitzers

This projectile (fig. 138) is intended for training in service of the piece. It is 40.45 inches long and is of the type having a fully

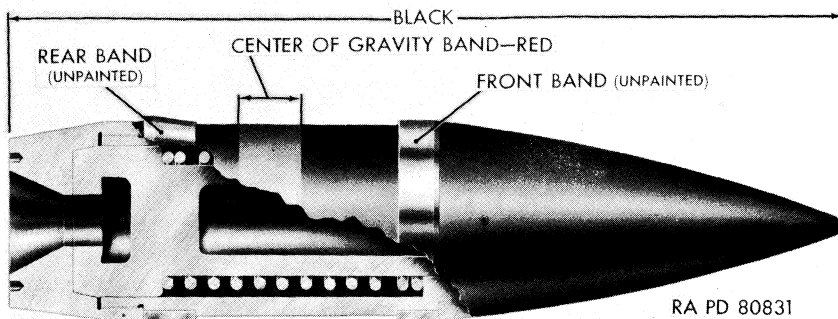


Figure 138. Projectile, dummy, M12, for 240-mm howitzers.

enclosed spring-operated plunger, which loosens the projectile in the forcing cone of the gun on rebound of the plunger due to ramming. It has a malleable iron cap, a steel body, bronze front band, steel base, and bronze rear band. The iron cap is ogival in shape and is attached to the forward end of the body. The bronze front band simulates the bourrelet of a service projectile. The bronze rear band simulates the rotating band of the service projectile. The several parts are replaceable. The projectile weighs 360 pounds.

Section XXI. AMMUNITION FOR SUBCALIBER EQUIPMENT

217. General

a. GENERAL DISCUSSION. Subcaliber ammunition is intended for use in subcaliber equipment for training personnel in target practice. For small-caliber weapons, interior-type (in bore) subcaliber equipment is provided which fire small-arms ammunition, such as caliber .22 and caliber .30 cartridges. Caliber .50 cartridges are used in machine guns on exterior subcaliber mounts on medium caliber antitank and antiaircraft weapons. For the remaining medium caliber weapons, the 37-mm subcaliber guns are used on appropriate subcaliber mounts. Caliber, 22-.30 rifle adapter (M17) is used with 37-mm subcaliber guns when small-arms cartridges are used. The 4.2-inch mortar is provided with 3-inch subcaliber equipment and ammunition. Weapons of 155-mm caliber and larger use 37-mm or 75-mm subcaliber guns. See table II for a list of weapons and their subcaliber weapons and ammunition. Also described in this section is the field artillery trainer M3, which, although not subcaliber equipment, simulates field artillery firings. See TM 9-1990 for more detailed descriptions of small-arms cartridges and field artillery trainer ammunition.

b. IDENTIFICATION. The subcaliber rounds, except small-arms cartridges, are identified by means of painting and marking in accordance with the basic color scheme in TM 9-1900.

c. FUZES. The 37-mm shell M92 uses a point fuze M74, and the 37-mm shell M63 Mod 1 uses a practice base fuze M58. Other subcaliber rounds do not have a fuze or are assembled with inert or dummy fuzes. See section I, chapter 3.

d. CARTRIDGE CASES. The standard 37-mm cartridge case for ammunition used in 37-mm subcaliber guns is the brass case Mk 1A2. The Mk 1A2B1 case is a steel case alternate and is 0.02 pound lighter. The 75-mm subcaliber rounds use the 75-mm service cartridge case (sec. VII of this ch.). For description of small-arms cartridge cases, caliber .22, caliber .30, and caliber .50, see TM 9-1990.

Table II. Subcaliber Matériel and Ammunition

Weapon subcalibered	Subcaliber weapon	Subcaliber ammunition
37-mm gun M6-----	RIFLE, subcaliber, cal. .22, M5. ¹	CARTRIDGE, ball, cal. .22, long rifle.
57-mm gun M1 and M1A1.	RIFLE, subcaliber, cal. .22, M2A1. ¹ or RIFLE, subcaliber, cal. .30, M1903A2. ¹	CARTRIDGE, ball, cal. .22, long rifle. CARTRIDGE, ball, cal. .30, M2.
76-mm gun M1A1C and M1A2.	GUN, machine, cal. .50, Browning, M2, HB (flexible), on subcaliber mount. ²	CARTRIDGE, ball, cal. .50, M2.
90-mm gun M3.	GUN, 37-mm, M1916, on subcaliber mounts. ²	SHELL, fixed, TP, M92, w/fuze, PD, M74, for 37-mm subcaliber guns. or SHELL, fixed, TP, M63 Mod 1, for 37-mm subcaliber guns.
75-mm howitzer M1A1.		
155-mm gun M2 (other than sea-coast).		
155-mm howitzer M1.		
8-inch howitzer M2.		
75-mm howitzer M1A1 and M3.	GUN, subcaliber, 37-mm, M12. ¹	
105-mm howitzer M2A1 and M4.	GUN, subcaliber, 37-mm, M13. ¹	
76-mm gun M1A1C and M1A2.	GUN, subcaliber, 37-mm, M15. ¹	
90-mm gun M3-----	GUN, subcaliber, 37-mm, M14. ¹	
90-mm gun M1 and M1A1 (on mount M3 (anti-motor-torpedo-boat)).	GUN, subcaliber, 37-mm, M14. ¹	SHELL, fixed, TP, M63 Mod 1, for 37-mm subcaliber guns.
4.2-inch mortar M2--	MORTAR, subcaliber, 3-inch, M3. ¹	SHELL, training, M5, for 3-inch subcaliber mortar M3.
155-mm gun M2 (seacoast).	GUN, subcaliber, 75-mm, M25. ¹	SHELL, fixed, TP, M48, w/fuze, PD, M48 ³ , inert, for 75-mm subcaliber guns M25. ¹ SHELL, fixed, HE, M48, normal charge, w/fuze, PD, M51A5 ⁵ , 0.05-sec delay, for 75-mm guns M3, M1, and M17. SHELL, fixed, TP, M48, w/fuze, PD, M48 ³ , inert, for 75-mm gun M25. ⁴

Table II. Subcaliber Matériel and Ammunition—Continued

Weapon subcalibered	Subcaliber weapon	Subcaliber ammunition
8-in gun M1----- 240-mm howitzer M1.	HOWITZER, 75-mm, M1A1.	SHELL, semifixed, HE, M48, w/suppl chg and fuze, PD, M51A5 ⁵ , 0.05-sec delay, for 75- mm howitzers. SHELL, semifixed, HE, M48, w/suppl chg and fuze, MTSQ, M500 ⁷ , for 75-mm howitzers. SHELL, smoke, WP, M64, w/fuze, PD, M48A3 ⁶ , for 75-mm howitzers.

¹ Interior mount.

² Exterior mount.

³ With booster body. Dummy fuze M73 may also be used.

⁴ Assembled with igniting primer M48.

⁵ Some rounds on hand assembled with M51A4, M51A3, or M48A2 fuzes.

⁶ Assembled with percussion primer M22A3.

⁷ Some rounds on hand assembled with M55A3 fuze.

⁸ Some rounds on hand assembled with M48A2 fuze.

e. PRIMERS. The 37-mm round M92 uses percussion primer M38A1 (par. 315) and the M63 Mod 1 round uses the percussion primer M23A2 (par. 309). The 75-mm TP shell M48 used in the 75-mm subcaliber gun M25 is fitted with the igniting primer M48. The presence of an igniting primer is indicated by one red diametral stripe on the base of the cartridge case. See section III, chapter 3.

218. Packing and Shipping Data

Packing and shipping data for 37-mm and 75-mm subcaliber rounds appear in Department of Army Supply Catalog ORD 11 SNL R-1; for 3-inch subcaliber mortar rounds, in ORD 11 SNL R-4; for small-arms cartridges, in ORD 11 SNL's T-1 and T-2.

219. Cartridge, Ball, Cal. .22, Long Rifle

The muzzle velocity of the 40-grain lead bullet is 1,130 fps and the maximum range is 1,500 yards.

220. Cartridge, Ball, Cal. .30, M2

The muzzle velocity of the 150-grain bullet is 2,800 fps and maximum range is 3,500 yards.

221. Cartridge, Ball, Cal. .50, M2

This cartridge is for use with the Browning machine gun, cal. .50, M2 HB (flexible) or subcaliber mounts on medium caliber



RA PD 108174A

Figure 139. Shell, fixed, TP, M63 mod 1, for 37-mm subcaliber guns.



RA PD 80888B

Figure 140. Shell, fixed, TP, M92, w/fuze, PD, M74, for 37-mm subcaliber guns.

antitank guns and 40-mm AA gun. Muzzle velocity of 698-grain bullet is 2,930 fps in a 45-inch barrel, and maximum range is 7,400 yards.

222. Shell, Fixed, TP, M63 Mod 1, for 37-mm Subcaliber Guns

a. GENERAL. This round (fig. 139) is for use in 37-mm subcaliber guns M1916, M12, M13, and M15. It is the only round used in subcaliber gun M14 when this gun is used to subcaliber the 90-mm guns M1 and M1A1 in anti-motor-torpedo-boat (AMTB) mount M3. Other M1 and M1A1 guns are not equipped with subcaliber guns. The shell M63 Mod 1 is used in the subcaliber gun M14 when used to subcaliber the 90-mm gun M3. The projectile of the M63 Mod 1 round is the same as the M63 described in paragraph 36 except the M63 Mod 1 has a charge of 0.086 pound of black powder, the base practice fuze M58, and a rotating band diameter of 1.491 inches.

b. DATA.

Weight of complete round.....	2.01 lb
Length of complete round.....	8.98 in
Weight of projectile, as fired.....	1.63 lb
Length of fuze projectile.....	6.15 in
Length of cartridge case.....	3.64 in
Width of rotating band.....	0.74 in
Radius of ogive.....	8.95 cal.
Muzzle velocity	1,100 fps
Maximum range	4,980 yd

223. Shell, Fixed, TP, M92, w/Fuze, PD, M74, for 37-mm Subcaliber Guns

a. GENERAL. This round (fig. 140) is used in subcaliber guns M12, M13, M14, M15, and M1916. However, it should not be fired in the 37-mm subcaliber gun M14 when used on the 90-mm gun M1 or M1A1 on anti-motor-torpedo-boat mount M3 because of the type of the fire control equipment on the M3 mount. The explosive charge consists of 0.086 pound of pressed black powder.

b. DATA.

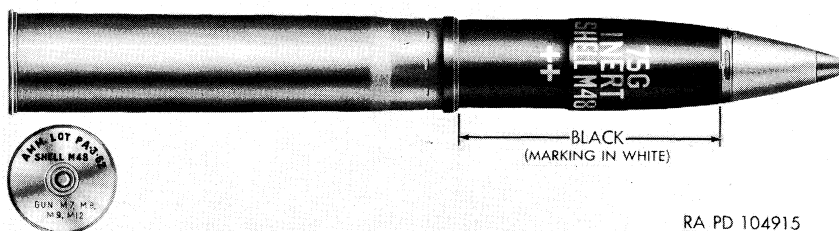
Weight of complete round.....	1.64 lb
Length of complete round.....	7.21 in
Weight of projectile, as fired.....	1.20 lb
Length of fuze projectile.....	4.14 in
Length of cartridge case.....	3.64 in
Width of rotating band.....	0.74 in
Radius of ogive.....	2.24 cal.
Muzzle velocity	1,276 fps
Maximum range	5,165 yd

224. Shell, Fixed, HE, M48, Normal Charge, w/Fuze, PD, M51A5, 0.05-Sec Delay, for 75-mm Guns M3, M6, and M17

This round has a high-explosive charge of 1.49 pounds of TNT and a propelling charge weighing 1.05 pounds (normal charge). It is fitted with the M22A3 percussion primer. It is authorized for use with the 75-mm subcaliber gun M25 with the 155-mm gun M2 on seacoast mount. Some rounds on hand are fitted with the M51A3, M51A4, or the M48A2 fuze in lieu of the M51A5.

225. Shell, Fixed, TP, M48, w/Fuze, PD, M48, Inert, for 75-mm Subcaliber Gun M25 (fig. 141)

This round has a sand-loaded projectile, an inert fuze M48, and the igniting primer M48. It is used in subcaliber gun M25 with the 155-mm gun M2 on seacoast mount. The round is issued



RA PD 104915

Figure 141. Shell, fixed, TP, M48, w/fuze, PD, M48, inert, for 75-mm subcaliber gun M25.

fuzed; it may be assembled with dummy fuze M73 in lieu of the M48 inert. The complete round weighs 19.04 pounds; otherwise, the data given in paragraph 84 apply to this round.

226. Shell, Fixed, TP, M48, w/fuze, PD, M48 Inert, for 75-mm Subcaliber Gun M1916

This round is similar to the practice round (par. 225) except that it has a percussion primer M22A3 instead of the igniting primer M48, and is authorized for use in the 75-mm subcaliber gun M25.

227. Shell, Semifixed, HE, M48, w/Suppl Chg and Fuze, PD, M51A5, 0.05-Sec Delay, for 75-mm Howitzer M1A1

This round is similar to service HE round described in paragraph 98(b) except that it has propelling charge of 0.93 pound instead of 1.06 pounds used in the service round. It is used in the

75-mm howitzer M1A1 when it is used to subcaliber the 8-inch gun M1 or the 240-mm howitzer M1. Some rounds on hand are assembled with the fuze M51A4.

Note. This round is available also with the mechanical time superquick fuze M500 but some of these rounds on hand are assembled with time and superquick fuze M55A3.

228. Shell, Smoke, WP, M64, w/Fuze, PD, M48A3, 0.05-Sec Delay, for 75-mm Howitzer M1A1

This round is similar to the service smoke WP round except that it has a propelling charge of 0.93 pound instead of 1.06 pounds used in the service round. It is used in the 75-mm howitzer M1A1 when it is used to subcaliber the 8-inch gun M1 or the 240-mm howitzer M1. Some rounds on hand are fitted with the PD fuze M48A2.

229. Subcaliber Ammunition for 3-Inch Subcaliber Equipment for the 4.2-Inch Mortar

a. SHELL, TRAINING, M5, FOR 3-INCH SUBCALIBER MORTAR M3 (fig. 142). This shell is used in the 3-inch subcaliber mortar which is used in connection with the 4.2-inch mortar M2 (sec. XIV, this ch.). This shell is 12-9/16 inches long and weighs 6 pounds. It

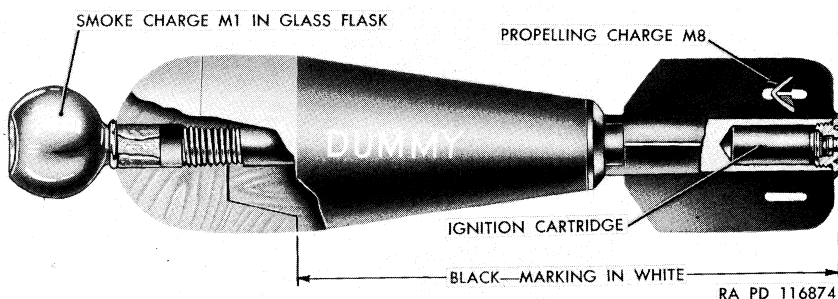


Figure 142. Shell, training, M5, for 3-inch subcaliber mortar M3.

has a cast iron nose, steel backbone shaft, hardwood body, and steel tail vanes. The nose and lower ends of the vanes are turned to a 3.017-inch and 2.035-inch caliber, respectively. A $\frac{3}{4}$ -inch diameter well is drilled 1-3/16 inches into the nose to receive the smoke charge. The vanes are slotted to accommodate the powder rings. The shell are retrievable.

b. CARTRIDGE, IGNITION, M5A1, FOR 3-INCH TRAINING SHELL M5. This cartridge is used as the basic propelling force, fitting into a container inside the tail vane assembly. This is the same

cartridge used with the 60-mm mortar shell. An M32 percussion primer is screwed into place behind it.

c. CHARGE, PROPELLING, M8, FOR 3-INCH TRAINING SHELL M5. The charge consists of sheets 1 inch square, assembled five sheets to a ring (fig. 142).

d. CHARGE, SMOKE, M1, FOR 3-INCH TRAINING SHELL M5. The charge is a 50-cubic centimeter resistant glass boiling flask filled with FM (titanium tetrachloride). The flask has an 11/16-inch lipless neck and takes a rubber stopper which is dipped in sodium silicate solution before insertion. The neck then is dipped in sealing wax, and a laminated protective sleeve is fitted over it (fig. 142).

e. ACCESSORIES. Among the accessories in the regular shipping chest is a primer wrench used to tighten and loosen the M32 percussion primer cap, and a hook to remove spent cartridges from retrieved shell.

230. Field Artillery Trainer M3

This trainer is a compressed air unit comprising a miniature gun mounted on a miniature carriage. Four units mounted on a firing platform make up a field artillery trainer battery. The M3 trainer is a modification of, and has replaced, the M2 and M2A1 trainers, which use a caliber .22 short blank cartridge as propellant. The projectile is a 1-inch commercial steel ball weighing approximately 1,024 grains. The maximum range is 85 yards at 45° (800 mils) elevation and 80 psi air pressure (charge 5).

CHAPTER 3

FUZES, PROPELLING CHARGES, PRIMERS, AND OTHER COMPONENTS

Section I. FUZES

231. General

a. DEFINITION. A fuze is a device used with an explosive item of ammunition to explode it at the same time and under the circumstances desired. The arrangement of description of fuze types is as follows: VT, base detonating, point detonating, and dummy. Treatment of individual models is arranged numerically within these groups. It will be noted that there is a distinction between *fuze*, as defined above, and *fuse*, a burning device for igniting a blasting cap, firecracker, or similar items.

b. CLASSIFICATION. Artillery fuzes are classified according to their location on the projectile as *base* detonating (used primarily with armor-piercing shell) or *point* detonating (used for most other purposes). They also are classified, according to the method of functioning, as *time*, *impact*, or *proximity* (VT), or may be a combination of these. *Time fuzes* usually contain a graduated time element in the form of a compressed black powder train or a mechanism with a gear train like a clock, which may be set to a predetermined time prior to firing. *Impact fuzes* are classified according to the quickness of action after impact as *superquick*, *nondelay*, or *delay*. See figure 16 for action of ammunition at the target according to the quickness of action. Superquick fuzes produce a burst immediately upon impact before any penetration occurs, thus giving maximum surface effect. Nondelay fuzes are inertia-operative and burst the projectile on a hard surface before complete penetration or ricochet. Delay fuzes allow penetration of material targets before bursting or allow air bursts in ricochet fire. It will be noted that the time of action for impact fuzes is measured from the instant of its *impact* on a target, whereas the time of action of time fuzes is measured from the instant of *firing* the weapon. An impact fuze which is intended to function on impact with a very light material target, such as an airplane wing, is called *supersensitive*. *Proximity fuzes* function on approach to a target.

c. DESCRIPTION. In general, modern fuzes consist of a connected series (train) of small explosive charges together with a striker or firing-pin device for initiating the action of the first

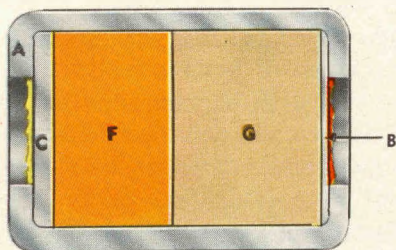
charge in the train. The mechanism and explosive elements are held in a body or housing. In the case of modern point detonating (PD) fuzes, the housing (that is, the fuze contour visible above the shell) is shaped for best ballistics. In impact fuzes now in use, the explosive train usually consists of a small but highly sensitive explosive charge of primer mixture followed by a larger and less sensitive explosive charge such as lead azide, in turn followed by a still larger and still less sensitive explosive charge such as tetryl. Such charges function by successive *detonation*—hence the prevalent term *detonating fuzes*. When delay action is desired by the use of a black powder pellet, the initial charge is a primer mixture which passes a flame to the black powder, and, in turn, to a detonator. Black powder is used exclusively in the time train of powder-train time fuzes, and for the magazine charge of both powder-train and mechanical types of time fuze. Black powder, being a low explosive, differs in manner of functioning from high-explosive charges used in fuzes in that it produces its effect by *ignition*. Black powder that has been compressed to great density burns slowly, the rate of combustion decreasing as the density increases. In the functioning of a fuze, each charge by its action initiates that of the next charge in the train, the final charge in the fuze causing the detonation of the booster which, in turn, detonates the bursting charge of the shell (fig. 8).

d. BORESAFETY. To prevent accidental arming during handling and shipping, safety devices, such as a safety wire or a cotter pin, are used when required. In certain types of fuzes, the mechanisms are arranged so that the fuzes are said to be “boresafe” (detonator-safe). A boresafe fuze is one in which the explosive train is interrupted so that, while the projectile still is in the bore of the weapon, premature action of the bursting charge is prevented if any of the more sensitive elements (primer or detonator) function.

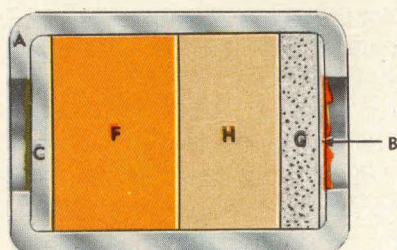
e. METHODS OF ARMING.

- (1) A fuze is said to be armed when it is ready to detonate the shell, that is, when all parts are in, or are free to move to, their proper positions so that the fuze may operate in its intended manner. The principal forces used in arming fuzes are *inertia* and *centrifugal force*. In some fuzes, both these forces are used to activate safety devices; in others, only one is used.
- (2) Inertia may be exhibited in several ways, each of which may be used to advantage, or each of which must be guarded against. *Setback* occurs when the shell accelerates on being fired. It may be used to unlock safety de-

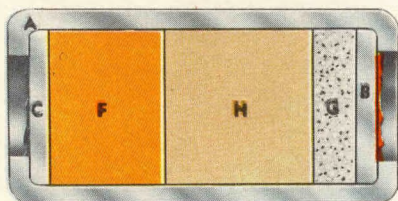
- | | |
|-----------------------------------|--------------------------------|
| A – DETONATOR CUP | E – RETAINER WASHER |
| B – DETONATOR DISC | F – LOWER CHARGE |
| C – DETONATOR CLOSING DISC | G – UPPER CHARGE |
| D – RETAINER | H – INTERMEDIATE CHARGE |



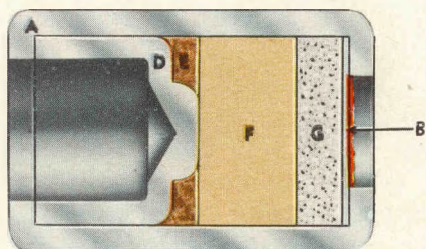
DETONATOR, M17



DETONATOR, M18



DETONATOR, M23



DETONATOR, M24

RA PD 108176A

Figure 143. Typical denotators used in artillery fuzes and boosters.

vices, or lock them in place until the proper time for unlocking. *Creep* occurs as the projectile body decelerates in flight. Precautions must be taken to prevent this phenomenon from causing a malfunction. *Set-forward* occurs at impact or sudden deceleration. This effect may be used to drive firing pins into primers or to drive primers against stationary firing pins.

- (3) Centrifugal force occurs in spinning projectiles. This force may be utilized to actuate gear trains, and to move safety devices into their proper positions in fuzes and boosters. Such fuzes and boosters are designed to operate in the rotational velocity range of the missile-weapon combination in which they are used. Rotational speed is dependent upon the twist of the rifling and the muzzle velocity. For example, the rotational velocity of a 37-mm shell fired in the M1A2 gun is approximately 66,000 rpm; the rotational velocity of a shell fired in the 105-mm howitzer is 13,500 rpm. Fuzes for missiles fired in these weapons, then, would have different arming characteristics based on rate of rotation. Fuzes utilizing centrifugal force also must be fashioned so that they will not become unarmed as the rotational velocity decreases during flight.

f. DETONATORS.

- (1) *General.* A detonator is used in the explosive train to create or transmit a detonation wave to the booster charge, booster lead, or burster. Three types of detonators are employed. One contains a primer mixture as the upper layer, for initiation by stab action of a firing pin. Another contains lead azide as the upper layer, for initiation either by flame action from a separate primer, delay pellet, time-train ring, or by detonation of a separate detonator. The third type contains a fine wire or other high resistance electric circuit in contact with a heat-sensitive primer mixture. Passage of an electric current through the resistance circuit generates heat, which initiates detonation in the primer mixture. Most detonator cups and disks are made of aluminum. Table III lists the various detonators used in fuzes and boosters indicating their use, dimensions, and color identification. Figure 143 illustrates typical detonators.
- (2) *Identification.* Detonators make use of colors to indicate the insensitive end. Yellow is used on detonators which do not contain primer mixture or igniting mixture; green on detonators containing primer mixture; and black on

detonators having a heavy disk (0.02 inch instead of 0.002 inch) on the primer mixture end. Detonators usually are not colored externally at the sensitive end. However, due to the method of sealing the disk in place and the red color specified for the sealing lacquer, a color identification is provided for the sensitive end. Coating of the end of the detonator and the entire detonator disk with the red sealing lacquer is optional, depending on the detonator manufacture. The color scheme described above applies to latest detonator construction; discrepancies may be found on detonators of older manufacture.

Table III. Detonators

Model	Used in—	Dimensions in inches		Color Identification*	
		Length	Diameter	Sensitive end	Insensitive end
M17	FUZE, BD, M66A1, M72, M68; BOOSTER, M21A4, M25; FUZE, PD, M53A1.	0.342	0.241	None	Yellow
M18	FUZE, PD, M52A1, M82; FUZE, BD, M58.	0.342	0.241	Red	Green
M21	FUZE, BD, M60-----	0.395	0.192	None	Yellow
M22	FUZE, BD, M62A1, M91; FUZE, MTSQ, M500, M501.	0.395	0.192	Red	Green
M23	FUZE, PD, M56, M85; FUZE, MTSQ, M502.	0.395	0.192	Red	Black
M24	FUZE, PD, M48A3, M48A2, M51A5, M51A4, M51A5—Mod 3, M51A4—Mod 3, M57; FUZE, TSQ, M54, M55A3.	0.370	0.241	Red	(Cavity)
M29	FUZE, PD, M74, M77, M89.	0.390	0.145	Red	Green
M30	BOOSTER, M24; FUZE, PI, M90.	0.390	0.145	None	Yellow
M37	FUZE, PD, M86-----	0.446	0.239	Red	Green
M42	FUZE, PD, M503-----	0.436	0.241	Red	Green

* Significance of colors:

- Yellow — Detonator does not contain primer mixture or igniting mixture.
- Green — Detonator contains primer mixture (stab type detonator).
- Black — Detonator contains heavy disk on primer mixture end (0.02 in instead of 0.002 in).
- Red — Used for sealing purposes only (when present indicates sensitive end of detonator).

g. FUZE INTERCHANGEABILITY.

- (1) *Boosters.* Standard boosters are secured firmly to standard fuzes in fixed and semifixed rounds. Rounds of older manufacture may have boosters secured by a set screw to the shell. The M51 series, the M55 series, the M500, and M67A3 assemblies for separate-loading shell consist of fuze with the M21A4 booster attached. The CP M78 fuze has a separated booster M25 which is packed one booster with each fuze. The M24 booster is a substitute for the M21A4 booster. The securing of boosters to fuzes in all cases facilitates removal of the fuze with booster assembly from shell.
- (2) *Need for changing fuzes.*
 - (a) Tactical situations and available supplies frequently necessitate changing fuzes, for example, from a time or VT fuze for AA use to a PD fuze for ground targets, or vice versa, etc.
 - (b) To replace or remove unsafe fuzes.
 - (c) In renovation activities, when the original fuze or booster, or both, becomes unservicable due to corrosion, rust, general deterioration, or obsolescence.
- (3) *Authority and responsibility.* Assembly to and disassembly from separate-loading shell of point fuzes is a normal operation in the field. This also is true of deep-cavity shell, fuzed or unfuzed, with or without supplementary charge. Details for fuzing with, and care and handling of, VT fuzes are given in paragraph 14e, as well as in this chapter. Such projectiles as well as fixed and semifixed shell may be fuzed, defuzed, and refuzed by qualified artillery personnel. Fuzing or unfuzing of rounds in which the booster is fastened to the projectile by a *staked* setscrew must be performed by ordnance personnel or under the direct supervision of ordnance personnel. The CP fuze M78 is assembled to shell as described in this chapter. It is pointed out that the 75-second mechanical time fuze M67 is authorized for the 90-mm fixed HE shell M71. In the Fuze Interchangeability Chart, authorized fuzes for shell from 20-mm through 240-mm are indicated as well as those fuzes which physically can be fitted to the shell, as for emergency use in combat, but whose use is not authorized specifically by the Chief of Ordnance. In assembling fuzes to or disassembling fuzes from shell, only authorized fuze wrenches should be used.

FUZE INTERCHANGEABILITY CHART—RESTRICTED									
CODE:									
■ Authorized Fuzes ■ Authorized Fuzes—Supplementary charge present in shell. For fuzes without boosters, boosters must be assembled to the fuzes. ■ Authorized Fuzes—Supplementary charge not present in shell. ■ Fuzes for battle emergency only, without additional modifications. For deep-cavity shell, supplementary charge must be in shell. ■ Fuzes for battle emergency only, after addition of M20, M21, or M24 type booster. For deep-cavity shell, supplementary charge must be in shell. ■ Fuzes for battle emergency only, after removal of M20 type booster from shell or of M21 or M24 type from fuze with booster assembly.									
NOTES: 1. Latest models of fuzes shown in this chart. 2. Chart is based on physical interchangeability.									
WEAPONS			PROJECTILES						
20-mm guns			M57, HEI						
37-mm guns			M54, HET (SD)						
40-mm guns			M63, HE						
57-mm guns			Mx 2, HET (SD)						
57-mm rifles			M86, APC-T						
60-mm mortars			M303, HET						
			M306A1, HF or TP						
			M307A1, HE, AT						
			M308A1, smoke						
			M49X2, HF						
			M63A1, illum						
			M302, smoke						
			M50A2, TP						
75-mm guns			M50A1, APC-T						
			M64, smoke						
			M48, HE, normal chg						
			M48, HE, reduced chg						
			M48, HE, superchg						
75-mm howitzers			M66, HE, AT-T; HE, AT						
			M64, smoke						
			M48, HE						
			M48, HE, w/suppl chg						
			M48, HE, deep-cavity						
1			2						

Table IV. Fuze Setters

Fuze setter models	Fuzes for which authorized	Ammunition with which used	Type of fuze setter	Type of operation		Range of scale (s)
				Adjusting	Setting	
M13	FUZE, time, mechanical, M43 series. FUZE, dummy, M44A2-----	SHELL, fixed, HE, M71, 90-mm gun. CARTRIDGE, drill, M12, 90-mm gun. Projectiles of various calibers.	Electrical indicating Hand (wrench type)	Electrical	Manual	0-30 sec.
M14	FUZE, TSQ, M54-----			None	Manual	No graduations or calibrations (fuze scale is used).
M27 (T40)	FUZE, TSQ, M55 series FUZE, time, mechanical, M67 series. FUZE, TSQ, M77 FUZE, MTSQ, M500 FUZE, MTSQ, M501 FUZE, time, mechanical, M61 series. FUZE, time, mechanical, M61 series.			Electrical	Manual	0-30 sec.
M18		SHELL, HE, M73, 120-mm gun M1.	Electrical indicating Automatic electric	Electrical	Manual	
M19		SHELL, HE, M73, 120-mm gun M1.		Electrical	Electrical	None, preset by signals fed from remote control director.
M20	FUZE, time, mechanical, M43 series. FUZE, time, mechanical, M502.	SHELL, fixed, HE, M71, 90-mm gun.	Combination setter and rammer Hand	Electrical	Electrical	None, preset by signals fed from remote control director.
M22	FUZE, TSQ, M54----- FUZE, TSQ, M55 series	Projectiles of various calibers.		Manual	Manual	0-25 sec.

M23	FUZE, time, mechanical, M67 series. FUZE, MTSQ, M500 FUZE, MTSQ, M501 FUZE, time, mechanical, M43 series. FUZE, time, mechanical, M502.	Projectiles of various calibers.	Hand	Manual	Manual	0-75 sec.
M24 Orientation		SHELL, fixed, HE, M71, 90-mm gun.	Hand	None	Manual	No graduation or calibrations required. Used for setting "SAFE" accurately.
M25	FUZE, time, M84-----	SHELL, illuminating, M301, 81-mm.	Hand (wrench type)	None	Manual	No graduations or calibrations.
M26 (T41)	FUZE, TSQ, M54----- FUZE, TSQ, M55 series FUZE, time, mechanical, M67 series. FUZE, TSQ, M77 FUZE, MTSQ, M500 FUZE, MTSQ, M501	Projectiles of various calibers.	Hand	Manual	Manual	0-25 sec scale—1 sec intervals 0-75 sec scale—0.2 sec intervals

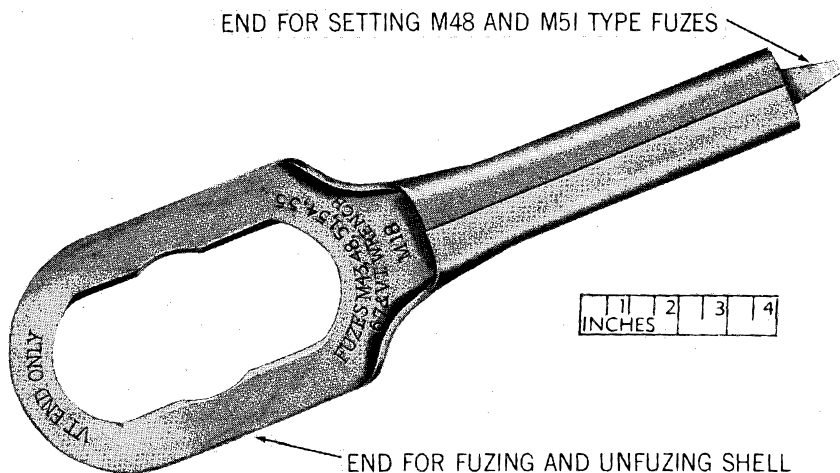
h. PRECAUTIONS IN FIRING THE M48, M51, M54, M55, AND M57 SERIES IN THE RAIN.

- (1) Recent tests have shown that if PD fuzes of the M48, M57, and M51 series and the time and superquick fuzes of the M54 and M55 series are fired during extremely heavy rainfall, premature functioning of the superquick element may occur which will result in an air burst. The exact position of such bursts is not predictable. Actual firings with 90-mm ammunition under such conditions have resulted in bursts anywhere from 100 to 11,000 yards from the gun position. The occurrence of such bursts is more likely to occur with higher velocity weapons such as the 90-mm or 155-mm guns than with lower velocity weapons such as the 105-mm and 155-mm howitzer. In the latter, these air bursts will occur only rarely. The rainfall necessary to cause such malfunctioning is difficult to define in practical terms but may be described as similar to the exceedingly heavy downpours commonly occurring during summer thunderstorms in the United States.
- (2) If necessary to continue firing under such conditions, this occurrence may be prevented with the M48 and M51 series of fuzes by setting the fuzes for delay action, in which case the superquick element is inoperative. However, the M54, M55, and M57 series cannot be remedied because the superquick element is always operative after firing.
- (3) The apparent deficiency in these fuzes is of such a nature that it cannot be eliminated by redesigning the fuzes without changing their military characteristics insofar as sensitivity to functioning on impact is concerned. Since the occurrence of such air bursts will be very infrequent and it is desired to retain the existing degree of sensitivity in these fuzes, no change in design is contemplated.

i. PACKING AND SHIPPING DATA. Packing and shipping data for separately issued fuzes appear in Department of the Army Supply Catalog ORD 11 SNL's P-7 and R-3; dummy fuze data appear in ORD 11 SNL's R-6 and P-8.

232. Fuze Wrenches

a. Separate-loading shell are shipped unfuzed with eyebolt-lifting plugs; they are fuzed in the field. With the advent of CP fuzes and VT fuzes, fixed and semifixed shell need to be defuzed and refuzed in the field. In addition, replacement or renovation



RA PD 109522

Figure 144. Fuze wrench M18 (T12E1) for artillery fuzes.

activities require the use of fuze wrenches. Therefore, fuze wrenches are required for screwing fuzes to or unscrewing fuzes from shell.

b. Fuze wrench M18 (T12E1) (7230148) (fig. 144) is standard for use with the M43, M48, M51, M54, M55, M67, M77, M81, M500, M501, M502, and VT type fuzes for 75-mm through 240-mm HE shell, with the exception of 120-mm HE shell M73. The screw driver end of this wrench is used for setting the M48, M51, and M81 selective setting sleeve from SQ to DELAY, or vice versa. The M18 wrench supersedes fuze wrenches M7, M7A1, and T2. The M7A1 will be issued until the M18 is available.

c. Fuze wrench M16 (T5) (fig. 145), which is for use with the CP fuze M78, is packed in the same box. The fuze end of wrench is used for screwing or unscrewing the CP M78 fuze. The booster end of the wrench is used for the M20 series type boosters, if they are not secured to the fuze, and the M25 booster.

d. Fuze wrench T15 is used with the PD, MT, and VT fuzes for the 120-mm HE shell M73.

233. Fuze Setters

For accurate and rapid setting, time fuzes require a fuze setter graduated to suit the fuze. A number of models of fuze setters have been standardized, ranging from simple hand types to full automatic types operating in conjunction with a power rammer. Most fuze setters are constructed for a particular fuze or type of fuze, but certain models are adapted for several fuzes.

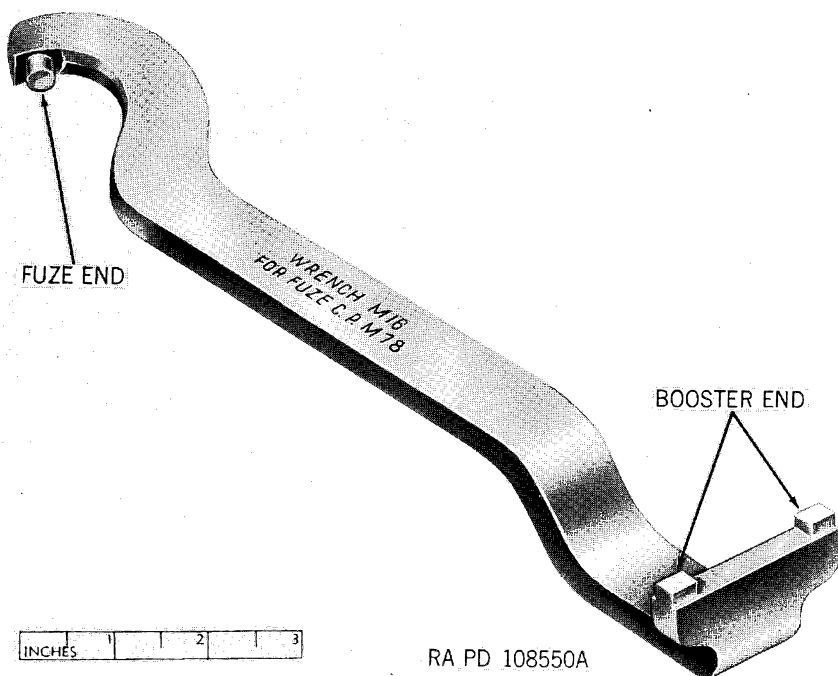


Figure 145. Fuze wrench M16 (T5).

Models of fuze setters now in use are listed in table IV, together with the fuzes and ammunition for which intended and additional pertinent data. An example of the hand type of fuze setter, the M14, is illustrated in figure 146. For further information on fuze setters, see TM 9-2300.

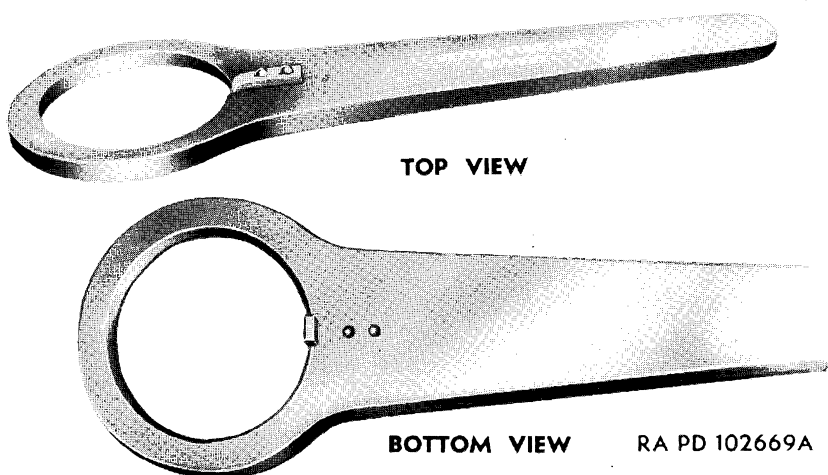


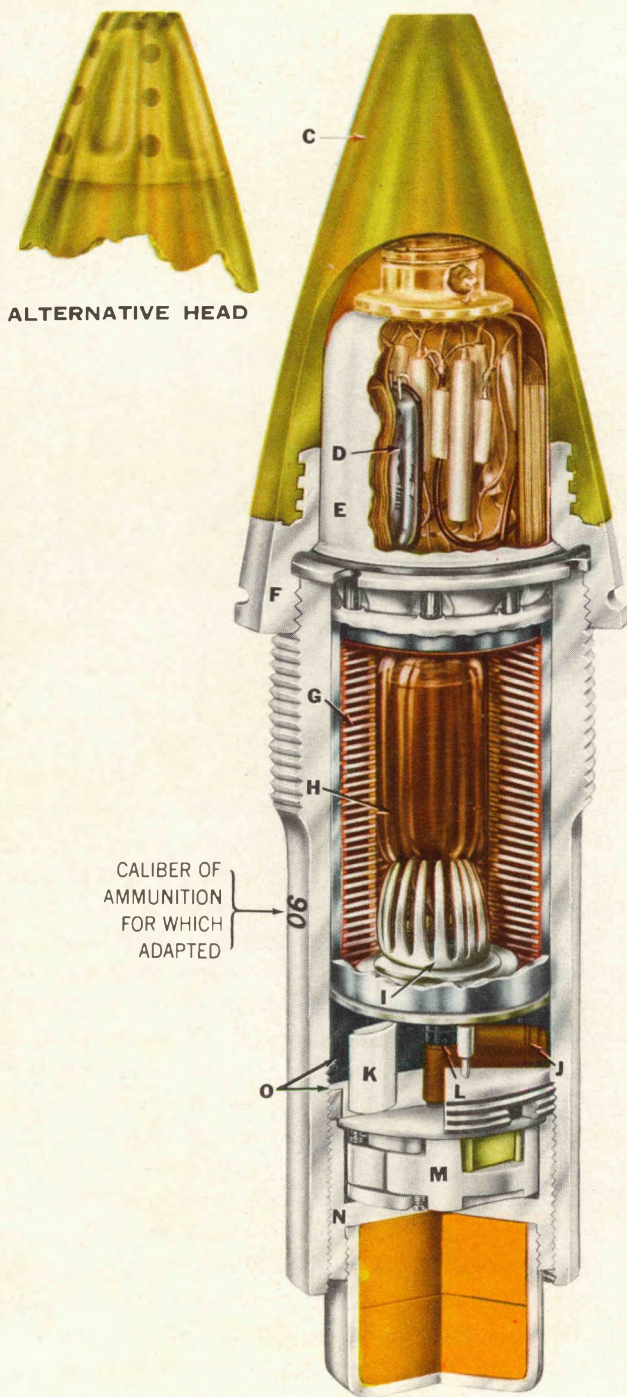
Figure 146. Fuze setter M14.

234. VT Fuzes

a. GENERAL. The fuzes, designated as VT, also have been termed "Pozit," "Proximity," "Buck Rogers," "Special," "Influence," and "Bonzo." In effect, VT fuzes are automatic time fuzes. Without "setting" or adjustment, they detonate the missiles that carry them on approach to the target at the most effective point on their trajectories. Artillery VT fuzes are essentially combination self-powered radio transmitting and receiving units. In flight, the armed fuze broadcasts radio waves. Unlike radar devices, the radio waves are sent continuously and are nondirectional. Those radio wave fronts which are reflected back from airplane, ground, or water to the moving missile, interact with the transmitted wave. When this interaction of transmitted and reflected waves, resulting in ripples or beats, reaches a predetermined intensity, it trips an electronic switch, which then permits an electric charge stored in the firing capacitor (condenser) to flow through an electric firing squib. The VT fuzes can be used only in deep-cavity shell (booster cavity is 2.75 inches deeper than for PD, MT, and TSQ fuze booster cavities) without the supplementary bursting charge. For description of deep-cavity artillery shell and method of fuzing shell with VT fuzes, see paragraph 14e and figure 4.

b. DATA. Length, visible, 3.74 inches; over-all, 8.6 inches; weight, 2.7 pounds; thread size, 2-12NS-1.

c. DESCRIPTION AND FUNCTIONING. Although the several models of VT fuzes differ from each other in details, the following is a general description of artillery VT fuzes. The VT fuze (fig 147) consists of a plastic nose (C) molded to a steel base (F). A perforated nose cap may or may not be molded inside the nose tip. A special booster (N) containing a boresafe element (M), extends below the base of the fuze. Some lots of the fuzes are protected by a heavy outside coating of wax which must not be removed at any time. In flight, the wax covering on the fuze normally spins off, occasionally producing a visible trail. This trail disappears after 3 or 4 seconds time of flight. If present, paper or cellophane caps protecting the tip of the nose of the fuze must be removed by the using unit prior to firing. A radio transmitter and receiver (E) is housed within the plastic nose of the fuze. A wet battery of the reserve type is used to supply electric current. It consists of a number of cells (G) and a glass vial (H) containing the electrolyte. A supporting device (I) prevents the vial from moving to the rear until a setback force of some duration acting upon the glass vial forces the leaves of the device to open. The vial drops inside the supporting device and is broken.



RA PD 108191A

Figure 147. VT fuze.

The electrolyte is released and is forced by centrifugal action into the plates of the battery. Current is generated, the radio tubes (D) light up, and the transmitter broadcasts a continuous wave. To provide delayed arming, the firing capacitor (condenser) is charged by the battery through a high resistance circuit. The high resistance in the circuit prevents a charge of sufficient energy to fire the electric squib from collecting on the capacitor (condenser) for a half second or so after the battery is activated. This mercury switch or "unshorter" (J) consists of an electrical contact chamber, a porous metal cup, and a sump. This mercury switch shorts out the electric squib until the projectile has rotated at a high rate for a predetermined length of time. Centrifugal action forces the mercury out of the electrical contact chamber through the porous cup into the sump. In this way, the "short" between the central contact and the outside shell is removed, enabling the charge in the firing capacitor (condenser) to be discharged through the squib when the fuze is "triggered" by a target, instead of harmlessly being shunted past the squib through the mercury. The time of unshorting is determined by the porosity of the metal cup and the centrifugal force developed. VT fuzes incorporate either a self-destruction switch (K) for AA firing or a centrifugal switch for terrestrial firing. These consist of a flexible metal reed in a plastic plug, inserted in an insulated metal cylinder, and are assembled off the axis of the fuze. They keep the firing capacitor (condenser) shorted when the projectile is at rest so that the firing capacitor (condenser) cannot accumulate a charge. Centrifugal force bends the reed spring, opening the switch, when the projectile is spinning at a rate higher than a preset value. Used as a self-destruction switch, the setting is adjusted so that spring action closes the switch, completing a circuit between the firing capacitor (condenser) and electric squib (L), when the rate of spin of the projectile decreases to the preset value. An impact element is contained in the rear fitting device of some VT fuzes for howitzer shell. The Mk 6 rear fitting safety device (O) does not contain an impact element, but the Mk 10 (not shown) does contain one.

d. CHARACTERISTICS. Arming is delayed by the series of safety devices for at least 2 seconds after firing for the T76E6 and T80E6 models of fuzes, for at least 0.5 second for the M92 and M93 fuzes, and for at least 5 seconds for all other models of the T76 and T80 fuzes, including the M96 and M97. The exact time of arming depends upon the caliber and propelling charge used, and also may vary from lot to lot. The VT fuzes are completely boresafe and muzzle safe. Height of burst above the terrain of terrestrial VT fuzes varies with large changes in angle of fall,

becoming lower as the angle of fall becomes steeper. These fuzes are designed to give optimum burst over average soil; however, the average height of burst is slightly higher over moist soil than over dry soil and 50 percent higher over marshy or very wet terrain than over dry land. The height of burst over a body of water may be approximately two to four times the height of burst over land. Light tree foliage and vegetation do not affect the height of burst materially, but dense tree foliage and thick vegetation will increase the height of burst above ground. This effect is decreased at a steep angle of fall, in which case most shell will burst below treetop level. The dispersion in height of burst *decreases* as the time of flight is increased. At the present state of development, approximately 70 percent (AA type) to 90 percent (FA type) of these fuzes are expected to function correctly.

e. MODIFICATIONS. Several modifications of each standard type of VT fuze have been made to incorporate various improvements in the electrical portion of the fuze. Although many of these improvements have little significance in over-all fuze performance, they have been designated by letters or numerals for identification purposes. Significant information pertaining to modifications to the T76 and T80 type fuzes are—

- T76} -E6 —Nominal arming delay, 2 seconds; Mk 6 rear
T80} fitting safety device.
- T76} -E7 —Improved circuit; nominal arming delay, 5
T80} seconds; Mk 6 rear fitting safety device.
- T76} -E8 — -E6 type circuit; nominal arming delay, 5
T80} seconds; Mk 6 rear fitting safety device.
- T76} -E9 —Improved -E7 circuit; nominal arming delay
T80} 5 seconds; Mk 6 rear fitting safety device.
- T76} -E10 — -E9 circuit; nominal arming delay, 5 sec-
T80} onds; Mk 10 rear fitting safety device.
- T76} -E11 —Improved -E9 circuit; nominal arming delay,
T80} 5 seconds; Mk 6 rear fitting safety device.
- T76} -E12 — -E11 circuit; nominal arming delay, 5 sec-
T80} onds; Mk 10 rear fitting safety device.

f. IDENTIFICATION.

- (1) The model of the fuze is stamped in the steel base of the nose. The letters (A, B, C, etc.) following the "T" designation of VT artillery fuzes (T80E9 A, T76E9 A, etc.) and the numbers (/1, /2, /3, etc.) following the "M" designation (M97/1, M96/2, etc.) are called "classification letters" or "classification numbers" and may be

disregarded for most practical purposes. However, it is desirable to fire fuzes of different classification groups from the several weapons in a battery, insofar as practicable.

- (2) The caliber of shell for which the VT fuze is intended is stenciled on the cylindrical body. It should be noted that some (T80E()) series fuzes may not have "90" stenciled thereon; nevertheless, they may be used for terrestrial fire in 90-mm guns.

g. USE. The VT fuzes may be used as indicated in table V.

Table V. Authorized Use of VT Fuzes

Fuze	Weapon	Shell	Propelling charge	Minimum usable range (yd)
M97 (T80E9)	75-mm how M1, M1A1, M2, M3	M48	1, 2, 3, 4	2,200
	105-mm how M2A1, M4	M1	4, 5, 6, 7	2,700
M96 (T76E9)	155-mm how M1	M107	5, 6, 7	4,000
	8-in how M1	M106	6, 7	6,000
	240-mm how M1	M114	3, 4	9,000
M92 (T74E6)	90-mm guns M1, M1A1, M2	M71	For AA fire only. Minimum quadrant elevation 400 mils. Minimum slant range 1,000 yards.	
M93 (T152)	90-mm guns M1, M1A1, M2	M71	For AA fire only. Minimum quadrant elevation 200 mils. Minimum slant range 1,000 yards.	
M97A1 (T80E9)	90-mm guns M1, M1A1, M2, M3	M71	For terrestrial fire only. Minimum range for normal charge is 6,000 yards.	

h. CARE, HANDLING, AND PRESERVATION.

- (1) *Temperature.* The fuzes function properly at temperatures between 0°F. and 120°F. and should not be used outside these temperature limits. As long as the fuzes are between these limits at the time of firing, they will operate properly, even though the atmospheric temperature is outside these limits. Temporary exposure outside of the prescribed temperature limits will not permanently injure the fuzes. If the fuze projectile is loaded into the chamber of a hot gun but not fired before 30 seconds have elapsed, the fuze may cause either a random burst after arming or a dud, but safety characteristics will not be impaired.

- (2) *Weather conditions.* Darkness has no effect on the functioning of VT fuzes. Heavy rain, or clouds containing rain, ice, hail, or snow may materially increase the malfunction rate of AA, and early types of field artillery VT fuzes by causing early bursts. Field artillery VT fuzes of “-E9” or later design types, are not affected by rain or clouds. Occurrence of malfunctioning due to clouds may be anticipated when clouds having sufficient reflectivity to be apparent on S-band type radar target indicators are encountered. In cases where malfunctioning due to clouds or rain is so frequent it is objectionable, temporary substitution of mechanical time fuzes for VT fuzes may be necessary.
- (3) *Moisture.* Although VT fuzes are nearly waterproof, exposure to damp climates may increase the number of duds. In all but Tropical climates, fuzes can be used safely after 2 months’ storage outside their original packing containers. In Tropical climates, the storage time of unpacked fuzes should be kept to a minimum. Contact with rain or immersion in water will hasten deterioration. The fuzes will not be affected by dampness if stored in their original sealed metal containers, provided the container is not damaged in such manner as to permit air to enter.
- (4) *Storage.* The precautions given to other packed ammunition also should be given to VT fuzes. In addition, the storage temperature limits should be between -20°F . and $+130^{\circ}\text{F}$. Storage outside these limits for any length of time may result in permanent damage. The direct rays of the sun on VT fuze containers or on poorly ventilated paulins may cause the temperature inside individual containers to exceed 130°F . Localized overheating from these causes will result in permanent damage to the fuzes and should be avoided.
- (5) *Resistance to shock.* VT fuzes will withstand normal handling without danger of detonation or damage when in their original packing containers or when assembled to projectiles. However, care should be taken not to strike or drop the fuzes or fuzed rounds and projectiles as these actions may increase the number of duds. Excessive rough handling may increase the number of duds, but will not decrease fuze safety. A drop of 4 feet in certain positions may cause the electrolyte vial in the reserve type battery to break, resulting in a dud when the fuze is fired.

- (6) *Recovery of duds.* Should it become necessary to recover duds, the fuze may be considered safe for handling 24 hours after the firing of the projectile. The fuzes should be handled with care since they still contain sensitive explosive components.

- (7) *Wax coating on VT fuzes.* See paragraph 12m.

i. FUZE, VT, M92 (T74E6). This fuze is for use with antiaircraft 90-mm HE shell. It will detonate the shell when it passes within 60 feet (maximum influence radius) of aircraft, earth, or water. About 90 percent of the fuzes become armed at 1,000 yards from the gun. If the fuze malfunctions and does not arm, the shell drops as a dud. VT fused duds, like other dud shells, may detonate upon impact with such hard surfaces as rock, concrete, or metal. The fuze contains a self-destruction switch which causes an armed fuze to detonate when the spin of the shell drops to a preset value. "P" and "G" self-destruction switches are adjusted to close after approximately 25 seconds time of flight at 22.5° gun elevation, approximately 55 seconds at 60° elevation, and from 60 to 80 seconds at 80° elevation. This self-destruction feature will function in approximately 95 percent of the fuzes; the remaining 5 percent will be duds. The self-destruction feature in the fuze is intended to detonate the round sufficiently high on the descending branch of the trajectory when fired at a quadrant elevation greater than 300 mils (17°), to prevent injury and damage to friendly troops, but in addition a safety factor of 100 mils must be considered. *Therefore, shells fused with the M92 (T74E6) fuze will NOT be fired over friendly troops and installations at quadrant elevations of less than 400 mils (22.5°).* If the fire is not over friendly troops and installations, the minimum quadrant elevation is 100 mils. Approximately 70 percent of these fuzes will operate correctly upon approach to the target. The remaining 30 percent may be either duds (about 5 percent) or may cause the shell to detonate somewhere between a point 500 yards from the gun and the point of impact of the trajectory (about 25 percent).

j. FUZE, VT, M93 (T152). This fuze is intended only for use in the 90-mm AA gun, for engagement of low flying targets over friendly terrain. It is a modification of the M92 (T74E6) which provides for self-destruction after 14 seconds time of flight at 22.5° elevation, instead of the 25 seconds in the M92 fuze. This modification consists of substituting a "Q" type self-destruction switch for the "P" and "G" types used in the M92 fuze. The "Q" switch is adjusted to close after approximately 10 seconds time of flight at 18° elevation and 13 seconds time of flight at 60° elevation. The self-destruction feature operates at quadrant ele-

vation of 170 mils and above, but 200 mils ($11^{\circ} 15'$) is the minimum quadrant elevation in firing over friendly troops and installations. If the fire is not over friendly troops, the minimum quadrant elevation is 100 mils. See *i* above for further details.

k. FUZE, VT, M96 (T76E9). This fuze is intended for terrestrial fire from the 155-mm, 8-inch, and 240-mm howitzers. In place of the self-destruction switch, a centrifugal safety switch is used. The M96 (T76E9) and T76E11 models do not contain an impact element but the T76E10 and T76E12 models do have one. Close approach to any terrain feature will cause an armed fuze to function. Passing within 10 yards of aircraft will cause the armed fuze to detonate the shell; a clearance of 100 yards is considered safe. When firing over crests, clearances should be at least 70 yards to prevent the fuze from functioning on the crest. Approximately 90 percent of the fuzes will operate correctly; the remaining 10 percent may be either duds (about 5 percent) or may function at random at any point beyond the minimum arming range (about 5 percent).

l. FUZE, VT, M97 (T80 series). This fuze is intended for terrestrial fire from 75-mm and 105-mm howitzers and 90-mm guns. A centrifugal safety switch is used in place of the self-destruction switch of the M92 and M93 fuzes. The T80 series through T80E11 have no impact element; but the T80 series above T80E11 have an impact element. Close approach to any terrain feature will cause an armed fuze to function. Passing within 10 yards of aircraft will cause the armed fuze to detonate the shell; a clearance of 100 yards is considered safe. When firing over crests, clearances should be at least 70 yards to prevent fuzes from functioning on the crest. Approximately 90 percent of the fuzes will operate correctly; the remaining 10 percent may be either duds (about 5 percent) or may function at random at any point beyond the minimum arming range (about 5 percent). At the higher velocities of the 90-mm gun, approximately 75 percent of the fuzes may be expected to function normally.

235. Fuze, BD, M58

a. GENERAL. This fuze (fig. 148) is used with the HE shell M63 for 37-mm guns M3A1 and M6.

b. DATA. Over-all length, 2.02 inches; weight, 0.30 pound; thread size, 1.02-18NS-3 LH.

c. DESCRIPTION. The fuze consists of a brass or steel body (I) containing the firing pin (F) and sleeve (G) assembly; a brass detonator holder (C) which holds the detonator (D); and a brass

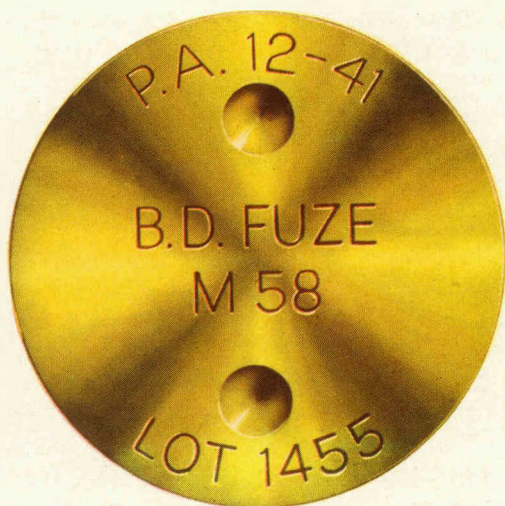
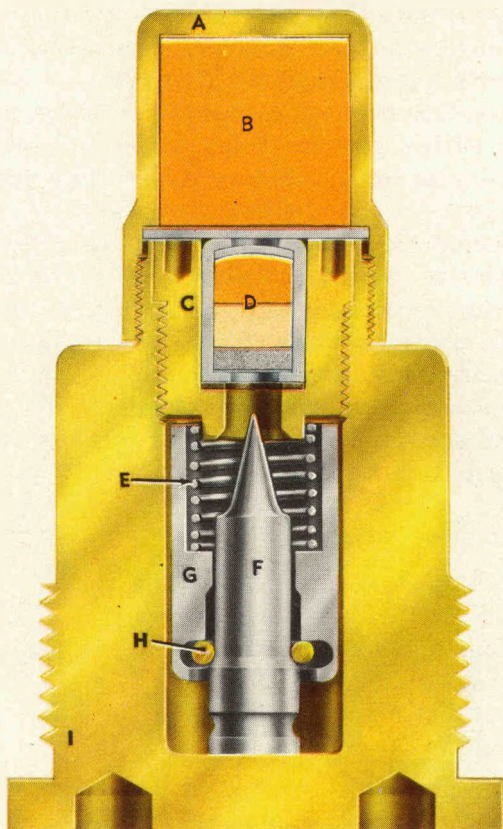


Figure 148. Fuze, BD, M58.

RA PD 80839A

or steel closing cup (A). The closing cup holds the booster pellet (B), the final charge in the fuze explosive train. These components are assembled as illustrated. There are no boresafety arrangements or external safety devices, the striker being held in the unarmed position prior to firing by a resistance ring (H) which holds the firing pin at the rear of the sleeve and away from the detonator.

d. **FUNCTIONING.** Upon firing, set-back forces the ring back over the shoulder of the firing pin and into the groove near the back of the firing pin, locking the pin in a more forward position in the sleeve. During the flight of the projectile, the combined pin and sleeve assembly is held to the rear by its spring. Upon impact, the pin and sleeve assembly moves forward against the restraint of the spring and the firing pin strikes the detonator, initiating the explosive train.

236. Fuze, Base, Practice, M58

a. **DESCRIPTION AND FUNCTIONING.** The practice fuze M58 is the service fuze M58 with the booster omitted. Except for this difference, it functions like the service model. The practice fuze is used with practice shell M36 Mod 1 for 37-mm subcaliber guns. A booster is unnecessary with this shell, since detonation of the detonator is sufficient to ignite the black powder shell filler.

b. **DATA.** Over all length, 1.6 inches; weight, 0.29 pound; thread size, 1.02-18NS-3 LH.

237. Fuze, BD, M60

a. **GENERAL.** The M60 (fig. 149) is a base detonating fuze which functions with delay action. It is used in the 155-mm gun M2.

b. **DATA.** Over-all length, 4.28 inches; weight, 9.22 pounds; thread size, 3.6-6NS-2 LH.

c. **DESCRIPTION.** It is made up of a steel body (C) which holds a (rotor-type) firing pin (M) and plunger assembly (L), a delay-charge holder (I), and a rotor assembly (G). The delay-charge holder contains the primer (J) and a black powder delay pellet (H). The rotor assembly contains a detonator. The front end of the fuze body is drilled to hold the tetryl booster pellet (B). After loading, the fuze is closed at the base end by a steel plug (O), and at the front end by a closing screw (A) which seals the booster cavity. The components are assembled in the fuze as illustrated in figure 149. Boresafety is provided for by the arrangement of the rotor assembly, which keeps the detonator out of alinement with the primer and delay element until sufficient

centrifugal force is exerted on the rotor to turn it approximately 90°.

d. FUNCTIONING. Prior to firing, the rotor is held in out-of-alinement in the unarmed position by two spring-held pins (D). After firing, under the action of centrifugal force, these pins move outward against the resistance of their springs, allowing the rotor to swing into the armed position. A stop pin (E) halts the rotation of the rotor when it reaches the alined or armed position, whereupon a rotor lock pin located in a recess in the rotor becomes alined with a hole (F) provided in the fuze body and partly engages therein. This locks the rotor in the armed position. Prior to firing, the firing pin also is held in an unarmed position in the plunger by two spring-held pins (N). These move outward in the same manner as the rotor pins upon sufficient centrifugal force, permitting the firing pin to swing into the armed position by its own weight. Both the rotor and the firing pin arm when the fuze revolves at the rate of 1,450 or more rpm but must not arm at 1,150 rpm. The plunger spring (K) holds the firing pin to the rear and away from the primer during flight of the projectile. Upon impact, the plunger overcomes the resistance of the spring, carrying the firing pin forward against the primer. The action of the primer ignites the delay pellet, which burns for a prescribed time (approximately 0.04 to 0.06 second) and then initiates the action of the detonating elements of the explosive train. The final charge (the booster pellet) in turn causes the detonation of the shell bursting charge.

238. Fuze, BD, M62A1 and Fuze, BD, M62

a. DESCRIPTION. FUZE, BD, M62A1 is a nondelay base detonating fuze formerly provided for use with 75-mm and 105-mm HE, AT projectiles. It is superseded in use by the BD fuze M91. (par. 242) which is essentially the same as the M62A1 except for a tracer in its conical base end. The M62A1 differs from the earlier M62 fuze in the firing pin plunger assembly. In the M62, the steel plunger housing is omitted and two small springs held in light brass housings are used to restrain the plunger and firing pin assembly during the flight prior to impact. In the M62A1, one large spring is used as in the M91. See figure 152.

b. DATA. Over-all length, 3.46 inches; weight, 1.27 pounds; thread size, 1.5-12NS-1 LH.

239. Fuze, BD, M66A1

a. GENERAL. The M66A1 (fig. 150) is a delay-action base detonating fuze which is provided for use with the M61 and M61A1

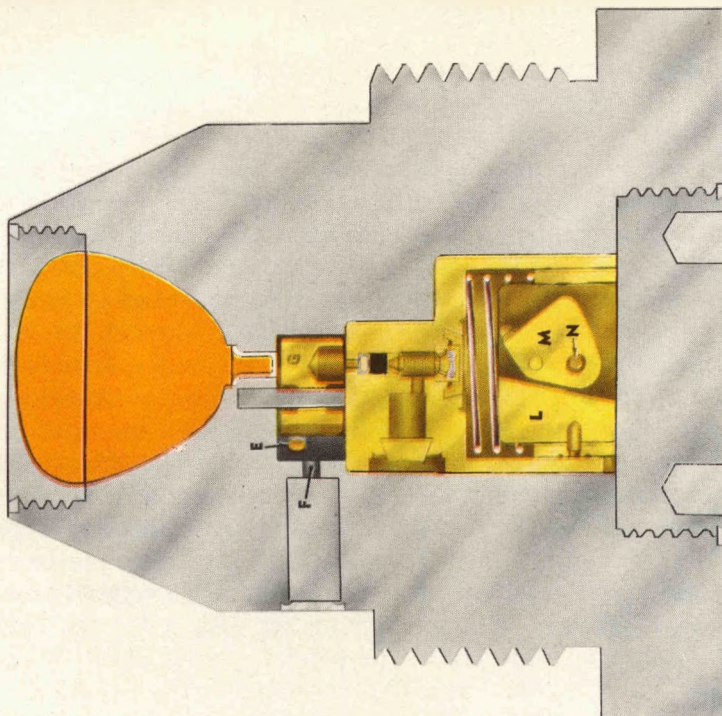
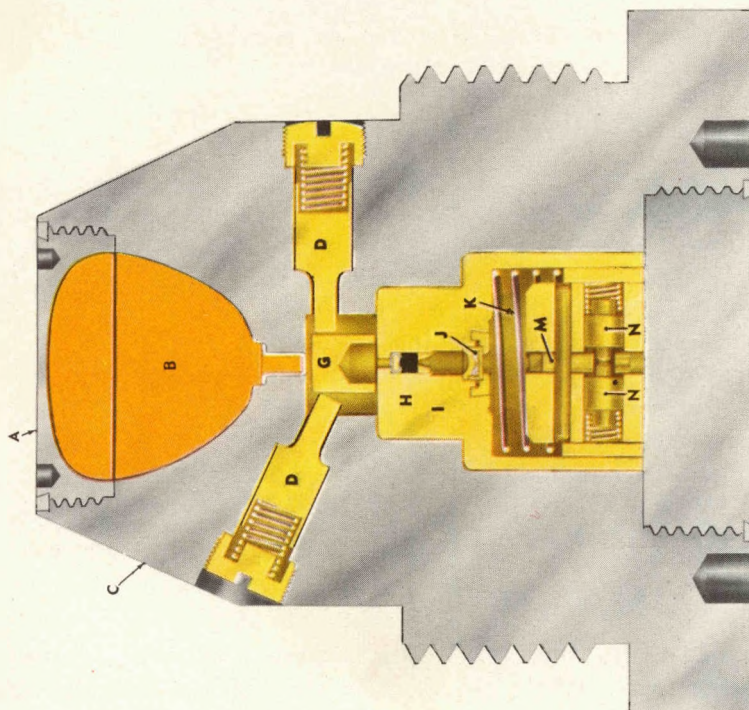
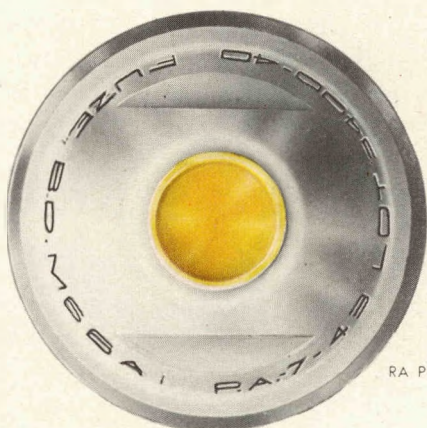
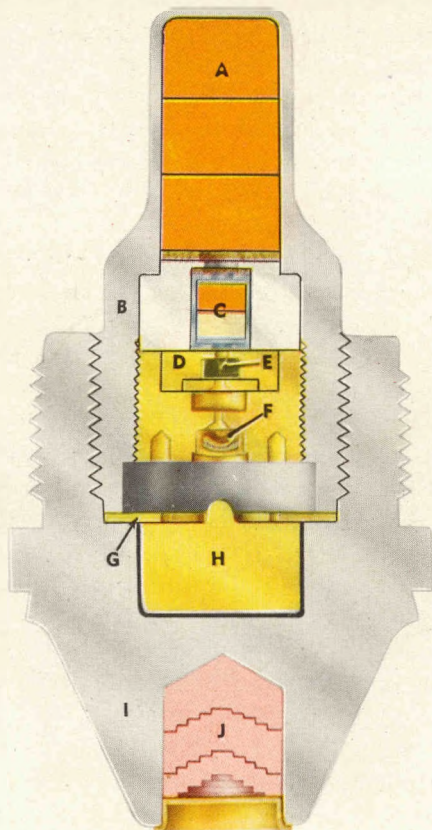


Figure 149. Fuze, BD, M60.



RA PD 80842A

Figure 150. Fuze, BD, M66A1.

(75-mm) and M62 and M62A1 (76-mm) armor-piercing-capped projectiles. It is a simple inertia-type fuze, without boresafety provision, in which the firing pin (H) is held at rest by a soft steel washer (G) prior to impact at the target. Upon impact, the weight of the firing pin forces it past the washer.

b. DATA. Over-all length, 3.458 inches; weight, 1 pound; thread size, 1.65-10NS-1 LH.

c. DESCRIPTION. The fuze is made up of three parts: a body assembly (I), a detonator-booster assembly (B), and a primer holder assembly (D). The body assembly contains the firing pin and, in a cavity in the boat-tailed rear portion, a red tracer composition (J) which operates independent of the fuze mechanism. The detonator-booster assembly holds a tetryl booster pellet (A) and a detonator (C). The primer holder assembly contains PRIMER, No. 26 (F) and a black powder delay pellet (E).

d. FUNCTIONING. The tracer composition is ignited by the flash of the propelling charge, and burns thereafter for a prescribed time (a minimum of 3 seconds), providing a visible trace. The firing pin remains at rest upon firing and during the flight of the projectile. Upon impact, the forward force of the firing pin breaks the soft steel washer, and the point of the pin strikes the primer. Action of the primer ignites the delay pellet. After burning a prescribed time (0.01 second), the black powder pellet initiates denotation of the detonating elements in the explosive train. The final charge (the booster pellet) in turn causes the filler of the projectile to explode.

240. Fuze, BD, M68

a. DESCRIPTION. Except that the diameter of the body is larger, the construction and functioning of the M68 are identical with those of the M66A1 (par. 239 and fig. 150). The M68 is 2 inches in diameter across the threaded part of the body, whereas the diameter of the M66A1 is 1.65 inches, the increased thread diameter being necessary to adapt it for the larger 90-mm projectile.

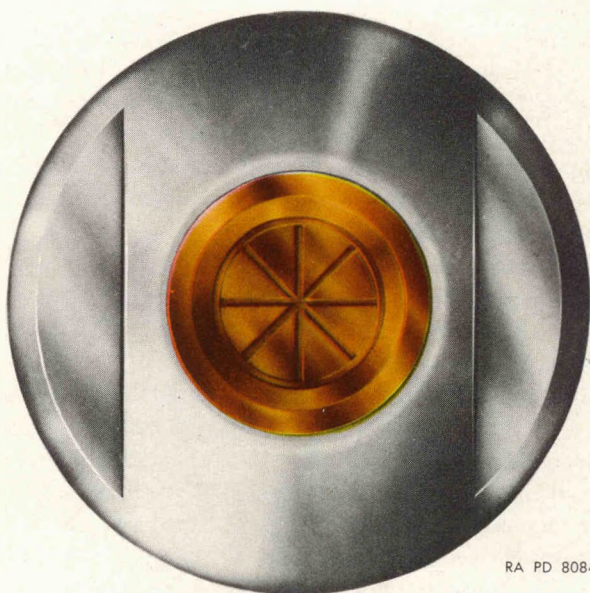
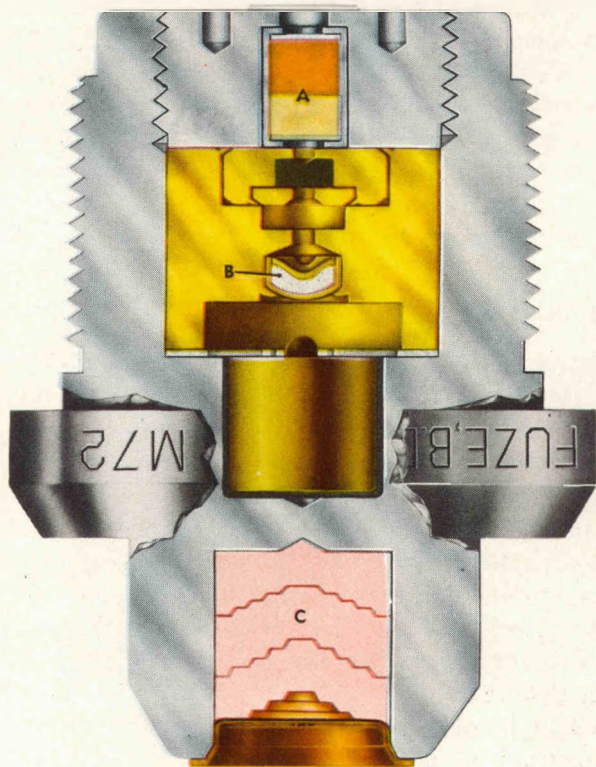
b. DATA. Over-all length, 3.458 inches; weight, 1.56 pounds; thread size, 2.00-10NS-1 LH.

241. Fuze, BD, M72

a. GENERAL. The M72 fuze (fig. M51) is a delay-action, base detonating fuze provided for the 57-mm armor-piercing-capped projectile M86.

b. DATA. Over-all length, 2.167 inches; weight, 0.86 pound; thread size, 1.375-10NS-2 LH.

c. DESCRIPTION. The fuze is based on the same principles as the



RA PD 80844A

Figure 151. Fuze, BD, M72.

M66A1 and M68, and has a similar firing mechanism as well as the same tracer (C), primer (B), and detonator (A) assemblies. However, the diameter of the body is smaller and the booster pellet is omitted; instead of a booster for the fuze, the shell loading includes a tetryl pellet at the base end of the main charge.

d. FUNCTIONING. Aside from this shift from booster in the fuze to a pellet in the shell loading, functioning of the M72 is the same as that described for the M66A1 in paragraph 239.

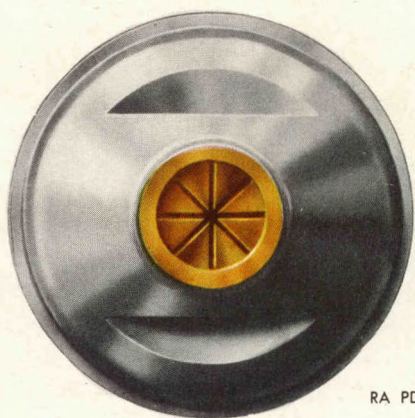
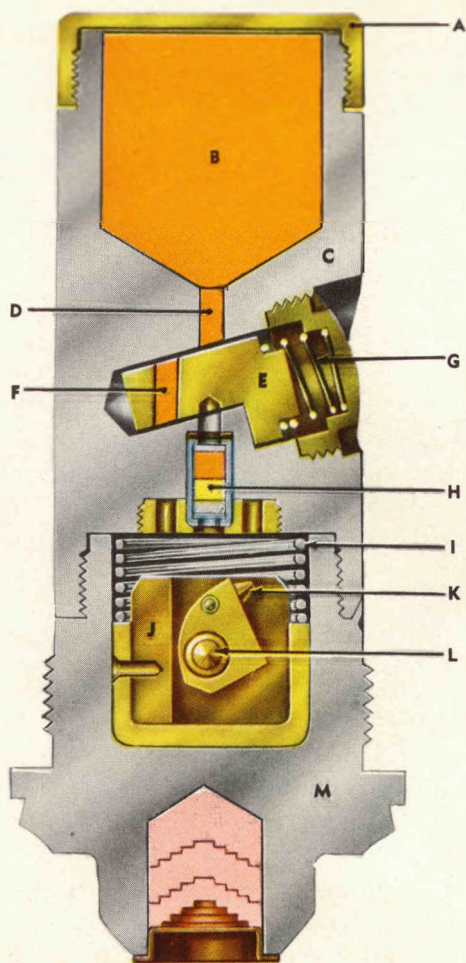
242. Fuze, BD, M91

a. GENERAL. FUZE, BD, M91 (fig. 152) is a nondelay base detonating fuze provided for use with 75-mm and 105-mm HE, AT-T projectiles. It differs from the BD fuze M62A1 (par. 238) only in having a tracer element in its conical base end. The tracer has an average burning time of 7.5 seconds.

b. DATA. Over-all length, 4.09 inches; weight, 1.41 pounds; thread size, 1.5-12NS-1 LH.

c. DESCRIPTION. The fuze consists of three parts: a steel head (M), a steel body (C), and a brass booster cup (A). The head holds a rotor-firing pin (K) and inertia plunger (J). The body contains a detonator (H), a slider assembly (E) with a slider charge (F), a booster pellet (B), and a booster lead (D). The booster cup, made of brass, seals the booster pellet in its cavity in the fuze body when screwed to the body. Boresafety is provided for by the slider assembly.

d. FUNCTIONING. The rotor-firing pin (K) is held in the unarmed position in the plunger by spring-held safety pins (L) which release the rotor-firing pin under the action of centrifugal force. The plunger assembly will not arm at 1,700 rpm or less. The slider assembly normally is positioned under spring pressure in its recess in the fuze body so that the slider charge of the slider is out of alinement with the other explosive elements. When sufficient centrifugal force has been set up, the slider overcomes the resistance of the spring and moves outward, bringing the slider charge into alinement. The slider will not arm when the fuze revolves at 2,400 rpm or less, but must arm at 3,600 rpm. Upon firing and after sufficient rotational force has been created, the firing pin and slider move into the armed position. However, the plunger assembly is held to the rear during the flight of the projectile by the restraining spring (I). Upon impact, the plunger overcomes the resistance of the spring and carries the firing pin forward against the detonator, initiating the action of the explosive train. The booster pellet, in its turn, causes detonation of the shell bursting charge.



RA PD 109523A

Figure 152. Fuze, BD, M91.

243. Fuze, PD, M2 Improved

This fuze, which is designed for use with gas and smoke ammunition in the 4.2-inch mortar, is an impact fuze of the point detonating type. It is similar to the PD fuze M8 described in paragraph 246. The M2 improved has improved safety features over the original M2 model, but the M2 improved will be used for reserve and emergency only. For data, see paragraph 246.

244. Fuze, PD, M3 Improved

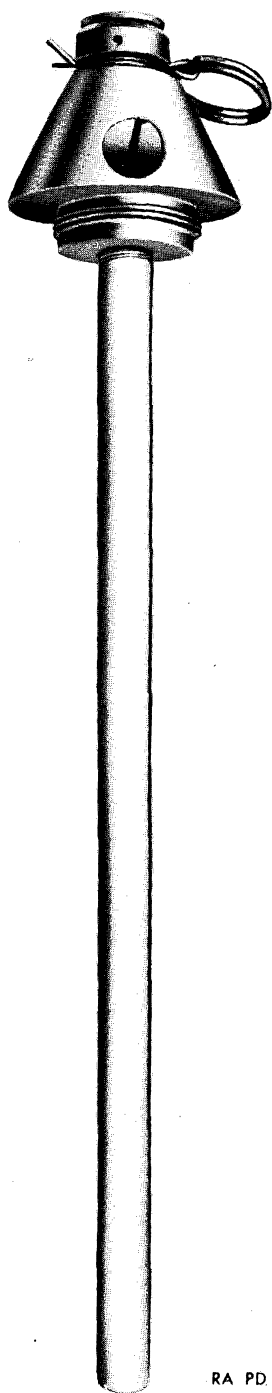
This fuze, which is designed for use with high-explosive ammunition in the 4.2-inch mortar, is an impact fuze of the point detonating type. It is similar to the PD fuze M9 described in paragraph 247. The M3 improved has improved safety features over the original M3 model, but the M3 improved will be used for reserve and emergency only. For data, see paragraph 246.

245. Fuze, TSQ, M5

This time and superquick powder train time fuze consists of an M54 fuze (par. 254) to which has been added an adapter and booster. This permits assembling the fuze to 4.2-inch mortar high-explosive shell. The fuze is issued separately for assembly in the field and is used to obtain an air burst of the shell.

246. Fuze, PD, M8

a. GENERAL. This fuze, which is used with chemical ammunition in the 4.2-inch mortar M2, is a superquick impact fuze of the point detonating type, weighing about 1½ pounds. The complete assembly consists of the fuze proper with an aluminum body, its various components, and a seamless steel burster tube. The bursting charge consists of about 65 grams of tetryl pellets in the burster tube and the lead cup. FUZE, PD, M9 (for 4.2-inch high-explosive ammunition) is an impact fuze of the point detonating type, used with the high-explosive shell M3. *The M8 and the M9 fuzes are identical, except that the M8 fuze has a burster tube, while the M9 fuze has a booster.* The burster tube of the M8 fuze (fig. 153) is about three times the length of the seamless steel booster tube of the M9 fuze (fig. 154). This difference is necessary because the M8 burster must contain a sufficient amount of tetryl to rupture the shell body, while the function of the booster in the M9 is to transmit the shock action to the high explosive (TNT) filler which in turn bursts the shell. The M9 fuze has the same safety features as the M8 and functions in exactly the same manner. The M8 and M9 supersede and, except for certain refinements



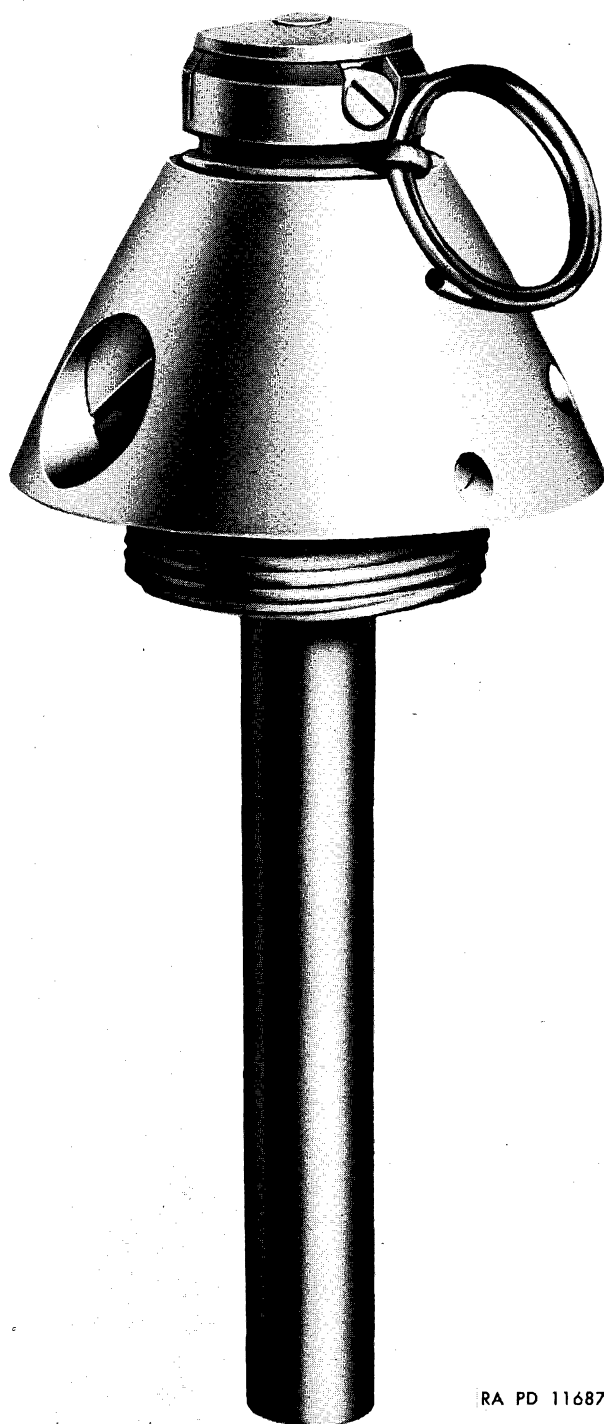
RA PD 116876

Figure 153. Fuze, PD, M8.

in design for functional improvement and safety, are identical with the formerly used M2 and M3, respectively; the M2 improved and the M3 improved may be used (in place of the M8 and the M9, respectively) for combat emergency only. The time and superquick fuze M5, which is provided with an adapter-booster for use with the 4.2-inch high-explosive mortar shell, may be used when air burst action to the shell is desired.

b. SAFETY FEATURES. The M8 and M9 fuzes have four safety features:

- (1) The *safety pin* is a cotter pin passing through (off center) the body of the fuze and the retainer. The pin secures the retainer firmly to the body of the fuze and prevents its movement. Its function is to act as a reinforcement for the shear wire. Just before firing, the safety pin is pulled from the fuze by means of the ring attached to the pin.
- (2) The *shear wire* passes through the retainer and the fuze body. This prevents any movement of the retainer, even after the safety pin has been withdrawn, as long as the shear wire itself remains unbroken. The ends of the shear wire are bent into the annular groove around the outer surface of the retainer. This prevents accidental damage to the shear wire from external sources and enables the fuze to arm itself by cutting the shear wire inside the retainer only.
- (3) The *retainer* is a brass ring which holds two steel balls in cylindrical holes 180° apart in the upper part of the fuze body. When the striker is in the unarmed position, two hemispherical recesses, 180° apart in the stem are located opposite the two holes in the fuze body. The diameter of the holes is slightly larger than the diameter of the balls but their depth is less. When the retainer is held in the unarmed position by the shear wire, its inner surface covers the outer openings of the holes so that approximately one-third of each ball fits into the corresponding hemispherical recess in the striker stem. The other two-thirds remains in the cylindrical hole in the body of the fuze. The balls prevent movement of the striker. Immediately below the retainer is a well in the fuze body into which the retainer drops when the shear wire is cut. The retainer has either two slots or two holes through which the two steel balls can be seen. For safety, every fuze must contain the two steel balls.
- (4) The *slider* is a cylindrical brass piece. Holes are cut in the slider to take the primer detonator, the striker point,



RA PD 116875

Figure 154. Fuze, PD, M9.

and the lock pin, and there is a groove for the guide screw. In the unarmed position, the primer detonator is out of line with the bursting charge and the striker. The point on the end of the striker fits into a hole in the slider, locking it in place as long as the retainer is held in position by the shear wire.

- (5) The *setback pin assembly* consists of setback pin, socket, and spring. In the unarmed position, the slider is held safe by the setback pin which is held in place by force of the spring. This serves as an additional safety feature in preventing alinement of the primer detonator with bursting charge before firing.

c. FUNCTIONING.

- (1) The safety pin is pulled out of the fuze just before the shell is inserted in the barrel. After striking the striker pin at the base of the barrel and igniting the propellant, the shell is forced up the barrel by the pressure of the powder gases. The retainer, being a movable part, moves down into the well below it, cutting the shear wire. The inside of the retainer is recessed at the top so that when the retainer drops into the well below it, the recessed portion comes opposite the holes in the fuze body containing the steel balls. The balls are forced out into the additional space in the recessed portion of the retainer by a combination of two factors: centrifugal force set up by the rotating shell, and pressure against the balls by the striker which is forced by the striker spring. The striker thus is shoved up into the armed position, with the striker head projecting 0.25 inch above the fuze body. The entire fuze is armed when the shell has traveled approximately 5 feet from the muzzle of the barrel.
- (2) The striker is prevented from being forced entirely out of the fuze by a setscrew passing through the upper part of the body at the same level as the steel balls and 90° from each ball. A vertical slot is cut in the striker from the bottom of the striker head to the safety pin hole. The point of the setscrew extends into this slot and thus controls the movement of the striker. A U-shaped slot in the wall of the retainer, at the point where the head of the setscrew projects from the fuze body, permits the retainer to fit around the head of the setscrew without interference with the downward movement of the retainer.
- (3) When the striker is free to move, the spring lifts the point of the striker, and the setback forces the setback

pin to the rear and the centrifugal force, caused by the rotating shell, moves the slider outward until its shoulder meets a shoulder in the fuze body. At the same time, the setback pin is locked in place. On completion of this movement, the slider is held fast in the armed position by the lock pin, which also functions by centrifugal force and prevents backward movement of the slider. The guide screw in the fuze body fits into a groove in the slider and prevents rotation of the slider about its own axis until the lock pin functions, thus insuring vertical alinement of the detonator when coming into the armed position. During flight of the shell, tension of the striker spring holds the striker up in the armed position. Upon impact, the spring is compressed and the pin of the striker is driven into the detonator, thereby setting off the primer detonator. This, in turn, detonates the bursting charge of the shell.

d. SAFETY PRECAUTIONS. Observe the following precautions:

- (1) Exercise extreme care in handling and assembling fuzes to shell. All fuzes should be treated as delicate mechanisms because forces that arm a fuze when a round is fired can be introduced also by rolling or dropping the fuzes. Arming may result from improper handling, and functioning may occur from impact of a blow or by dropping, if fuze is armed.
- (2) Do not remove plugs or fuzes from shell except when a new fuze is to be inserted immediately.
- (3) Inspect body, threads of fuze and adapter, and cavity of shell for burs or foreign material, if necessary to assemble a fuze to a shell. Assemble with proper seating.
- (4) Do not attempt to alter or disassemble fuzes in the field.
- (5) Protect fuzes against shock, heat, and fire. Take special care to avoid blows on the fuze.
- (6) Leave safety pin in fuze until ready to fire. Replace immediately if round is not fired.

e. PREPARATION FOR FIRING.

- (1) After any necessary cleaning and removal of burs (d above), pull safety pin and examine fuze to see that the shear wire is in place and bent over at both ends, and that the two steel balls are present.
- (2) Replace safety pin. Ends of safety pin in fuze may be straightened with pliers to facilitate rapid removal by mortar squad when ready to fire.
- (3) Adjust propelling charge if required (par. 171d).
- (4) Remove safety pin just before ready to fire.

f. DATA. Length, visible, 2.04 inches; over-all (M8), 16.15 inches; over-all (M9), 6.76 inches; thread size 1.7-14NS-2.

247. Fuze, PD, M9

This fuze, which is used with high-explosive ammunition in the 4.2-inch mortar M2, is identical with the M8 except that it is assembled to a booster instead of a burster as in the case of the M8. The M9 with its booster is used in the high-explosive shell M3. For further information, see paragraph 246.

248. Fuze, Time, Mechanical, M43 (All Modifications)

a. GENERAL. The M43 fuze (figs. 155 and 156) is a mechanical time type. All modifications have the contour which is characteristic of modern design fuzes, provide for time setting to 30 seconds, and are without impact element. The fuze originally was adopted for antiaircraft use with medium caliber shell fitted with a suitable booster (the M20 type) but now is assembled with the M21 type booster as a fixed component. A number of models have been manufactured, all based on the same principles but incorporating improvements and refinements since the original design. Differences in the various models are described in *g* below; basic features are described in *b* through *g* below.

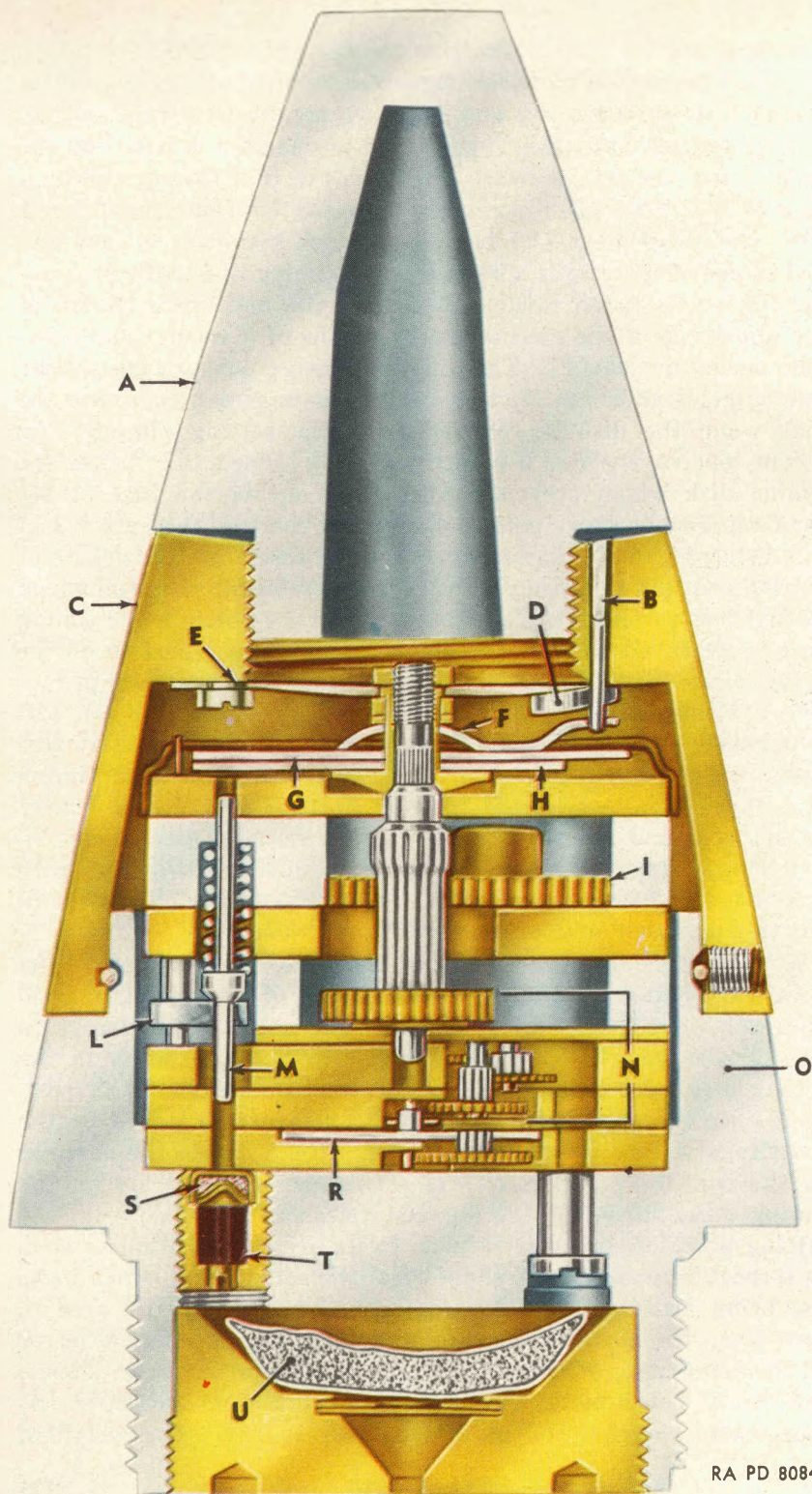
b. DATA. Length, visible, 3.70 inches; over-all, 4.51 inches; weight, 1.41 pounds; thread size, 1.7-14NS-1.

c. EXTERNAL DETAILS. The fuze body for the M43 to M43A4 fuzes is in three parts: an upper cap, a movable lower cap, and a fixed base (O). The lower cap holds the setting pin (B) and a hammer (D) device which releases the timing disk (G) upon firing. The lower cap and base house the other mechanical parts and explosive elements. The upper cap is staked to the lower cap and turns as a unit with it during fuze setting. The base is engraved circumferentially with 0.2-second graduations up to 30 seconds, full seconds being numbered. A safety line with "S" below it, also is stamped on the base, and indicates a point in the setting at which the fuze cannot function. As shipped, the fuze is set "safe," that is with "S" line alined with the register line of the lower cap. Timing is regulated by the angular distance which the timing disk must turn before the firing arm is released for functioning. This distance is increased by turning the lower cap clockwise as viewed from the point of fuze and reduced by turning in a counterclockwise direction. The desired time has been set when the register line on the lower cap is alined with the appropriate graduation on the base. The lower cap may be turned in either direction and through the zero and safety graduations.

For accuracy in time of functioning, the time setting should always be approached from the same direction. Two setting grooves, one each in the lower cap and base, are provided for fuze setting.

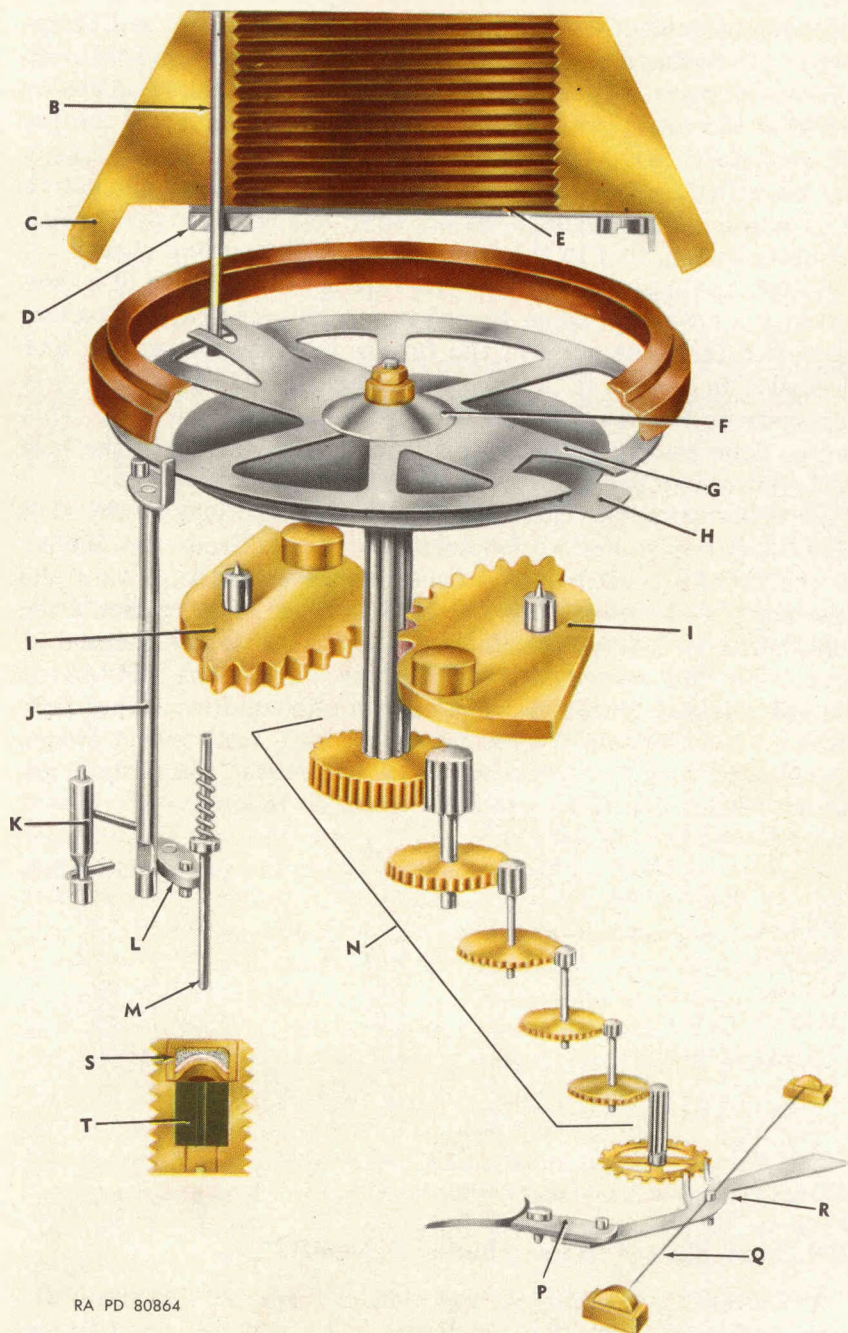
d. INTERNAL DETAILS. The driving mechanism is based on the same principles as clockwork but differs in that it is driven by a pair of weighted gear segments actuated by centrifugal force. Also, the escapement (R) beats at a much higher frequency and makes use of a straight spring (Q). A timing disk with protruding lug and a notch is connected with the main gear pinion at the upper end of the mechanism by means of a washer and belle-ville spring device (F). This allows slippage during fuze setting but provides sufficient friction for the main pinion to rotate the disk when the disk is released from the setting pin (B). In recent models, there is a safety leaf (H) immediately below the timing disk which prevents functioning should the fuze be set for dangerously short periods; in earlier models, the safety leaf was attached to the hammer. A striker assembly, consisting of a firing arm (J) and firing pin (M), is assembled in the mechanism so that it is released for functioning when the notch in the timing disk becomes alined with the finger on the upper portion of the firing arm. Explosive elements comprise a percussion primer (S), a black powder pellet (T) (omitted in earlier models), and a magazine charge (U) of black powder. Three main safety features make for boresafety: hammer (D) which acts on timing disk on setback, setback pin (K) which releases striker assembly on setback, and safety lock (P) which releases escapement on centrifugal action. Earliest models were fitted with a pull wire to prevent accidental rotation of the lower cap during shipment, but this has been omitted on more recent models.

e. FUNCTIONING. When setting the fuze, the turning of the lower cap rotates the timing disk by means of the setting pin and upraised lug on the timing disk, causing the desired change in angular distance between the firing arm and the notch in the timing disk. All other parts of the mechanism remain in position, since the gear train (N) and escapement are locked by the centrifugal safety device. Upon firing, setback causes the hammer on the cantilever spring (E) to strike the upraised lug on the timing disk, flattening the lug and releasing the disk from the setting pin. The hammer returns to its original position as soon as setback ceases. At the same time, the setback pin which locks the firing arm moves backward, leaving the firing arm free to turn when the notch in the timing disk comes opposite the finger on the firing arm. When sufficient centrifugal force has developed, the safety lock holding the escapement rotates and releases the escapement, leaving the movement free to run. The weighted



RA PD 80848

Figure 155. Fuze, time, mechanical, M43A4.



RA PD 80864

Figure 156. Mechanism of fuze, time, mechanical, M43A4.

gear segments (I) in mesh with the main driving pinion then drive the movement, the rate of rotation of the pinion, and therefore of the timing disk, being governed by the escapement through a series of gears. When the notch in the timing disk reaches the finger of the firing arm, the firing arm turns, permitting the firing pin safety plate (L) to swing from under the firing pin flange, and allowing the firing pin to strike the primer under the action of its spring. This initiates the action of the powder train, which action is transmitted to the booster and shell bursting charge.

f. PREPARATION FOR FIRING. The fuze is set by means of a fuze setter, the lower cap being turned in a counterclockwise direction as viewed from the point of the fuze to increase the setting, and clockwise to reduce it. In the case of early M43A1 fuzes, it is necessary to remove the pull wire before setting the fuze. This can be done readily by pulling the end of the wire from the hole in the lower cap and sliding the wire off the end of the fuze.

g. MODIFICATIONS. There are several modifications of the M43 fuze, and these differ as follows: The change from the M43A1 to the M43A2 consisted of a bevel in the shoulder so that the fuze could be screwed into the M23 booster. The change from the M43A2 to M43A3 resulted from a change in the method of regulating the movements. The change from the M43A3 to M43A4 resulted from the decrease in minimum functioning time from 1.67 seconds to 0.6 second. Since safe setting and torque required to turn the lower cap may be critical, these data are presented for the various modifications, as follows:

<i>Modification</i>	<i>Minimum functioning time (sec)¹</i>	<i>Torque required to turn lower cap (lb-in)</i>
² M43A4 -----	0.6	80 to 100
M43A3 -----	1.67	80 to 100
M43A2 -----	1.67	60 to 80
³ M43A1 (late) -----	1.67	60 to 80
⁴ M43A1 (early) -----	1.4	40 to 60

¹ Fuze will not function if set below this figure.

² Upper cap painted red.

³ Fuzes of late manufacture without pull wire.

⁴ Fuzes of earlier manufacture with pull wire.

249. Fuze, PD, M48A3 and Fuze, PD, M48A2

a. GENERAL. The M48A3 and M48A2 fuzes are essentially the same as the M51A5 and M51A4 fuzes (par. 250 and fig. 157) except that the M48 series does not include the booster. Like the M51 series, the M48 series fuzes are selective superquick-delay types. Either action can be obtained, prior to firing, by turning

a setting sleeve in the side of the fuze. The M48A2 fuze has two variations, one having a delay of 0.05 second, the other a delay of 0.15 second; the time of delay is stamped on the fuze body. The M48A3 fuze, however, is made with only one delay of 0.05 second. The M48 fuze with 0.05-second delay is used with INITIATOR, burster, M1 in 75-mm chemical shell. The M48A3 has the new delay plunger assembly M1 (0.05-sec delay) which also is used in the M51A5 (par. 250) and is standard for all ammunition employing fuzes of the M48 series.

b. DATA. Length, visible, 3.74 inches; over-all, 4.55 inches; weight, 1.41 pounds; thread size, 1.7-14NS-1.

c. DESCRIPTION. For detailed explanation of operation, setting, safety devices, and preparation for firing, see paragraph 250.

250. Fuze, PD, M51A5 and Fuze, PD, M51A4

a. GENERAL. The M51A5 fuze (fig. 157—booster not shown) is essentially the M43A3 (par. 249) with the booster M21A4 attached and replaces earlier modifications of the M51 series. The M51A5 fuze has a 0.05-second delay and recently has been designated as standard for all ammunition employing fuzes of the M51 series. The M51A4 and M51A5 fuze and booster assemblies have the firing pin of the delay plunger assembly housing secured against movement prior to impact, and the booster has an additional lockpin. The M51A4 was manufactured in lots having either 0.05-second or 0.15-second delay, the length of delay being indicated by marking on the fuze. The M51A5 uses the improved delay plunger assembly M1 (0.05-sec. delay) which is more sensitive than the delay plunger assembly used in the M51A4 fuze. The delay plunger assembly M1 includes a new delay element consisting of a primer, delay charge and relay. This element shows a marked improvement in sensitivity, uniformity of burning time, and surveillance, over the element used in earlier models of the M51 series. This element can be loaded, tested, and stored as a unit, similar to the current practice with detonators and primers. A minor dimensional change has been made in delay plunger body and the rigidly fixed firing pin has been given a sharper point.

b. DATA. Length, visible, 3.74 inches; over-all, 5.93 inches (including booster); weight, 2.15 pounds (including booster); thread size, of fuze, 1.7-14NS-1, of booster, 2-12NS-1.

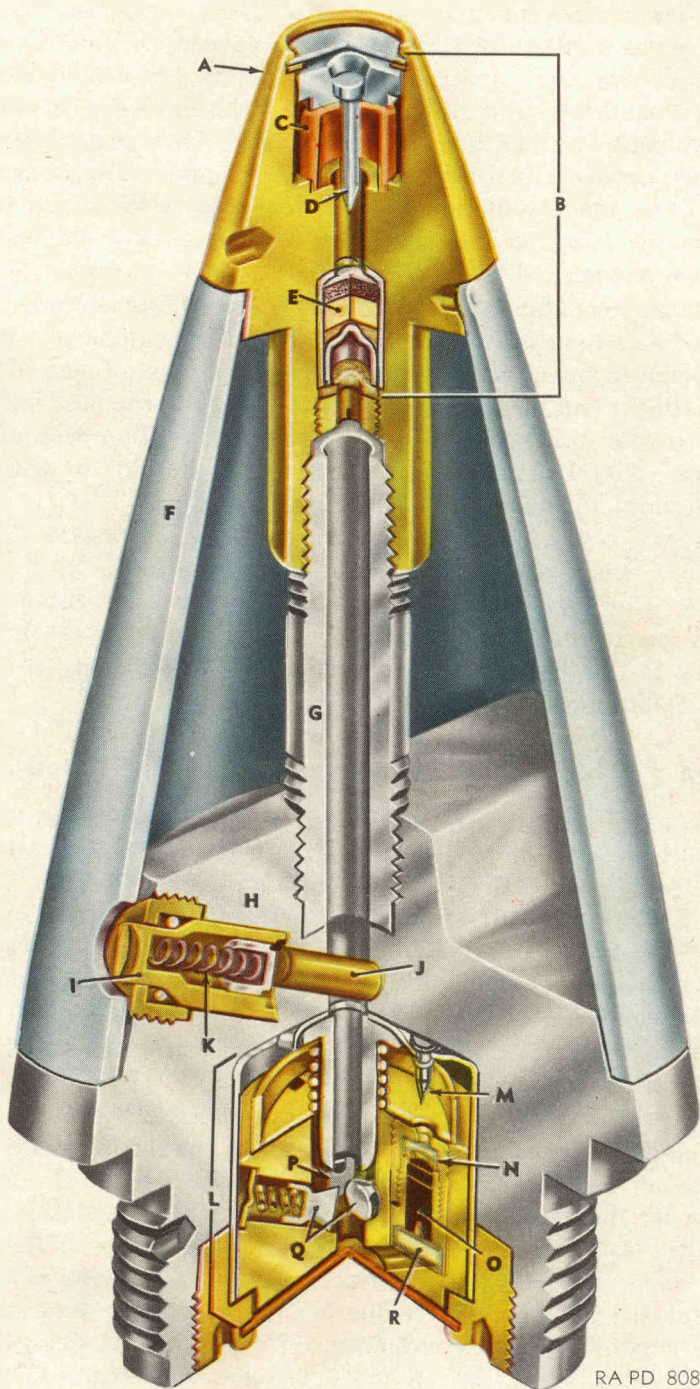
c. DESCRIPTION. With reference to figure 157, which depicts essentially either the M51A5 or the M51A4 with the exception of the delay plunger assembly and the shape of the delay firing pin, the fuze consists of a head (A) which holds a superquick element (B), a body (H) which holds a delay plunger assembly and its

housing (L), and a selective setting device. These main assemblies are connected by a flash tube (G) which holds the parts firmly in position, and are supported further by a thin-walled ogive (F). The superquick element comprises a firing pin (D) supported by a gilding metal cup (C), and a detonator (E). The firing pin support is strong enough to withstand ordinary blows on the firing pin as well as setback forces upon firing, but collapses under the force of impact at the target. The delay assembly is an inertia plunger type and includes a firing pin (M), the point of which is less sharp in the M51A4 than in the M51A5, primer (N), black powder delay pellet (O), and a relay charge (R).

d. **SETTING.** The setting device is an eccentrically positioned plunger (J) and plunger spring (K), the functioning of which is regulated by a setting sleeve (I). The head of the sleeve is slotted to facilitate turning when adjusting the setting. To enable exact alinement, two register lines and the marking "SQ" and "DELAY" are stamped on the ogive of the fuze. When the slot in the sleeve head is alined with the "SQ" line (parallel to the fuze axis), or within 15° thereto, the sleeve, which is thicker on one side than on the other, is turned so that it does not interfere with movement of the plunger. The plunger is free, therefore, to move outward under centrifugal force, and thereby opens the passage for superquick action. When the slot is alined with the "DELAY" line (at right angles to the fuze axis) or within 15° thereto, a section on the setting sleeve rests against the plunger, securing it in the lower extremity of the recess, across the superquick passage.

e. **SAFETY DEVICES.** Boresafe superquick action is provided by the plunger (J). Boresafe delay action is provided by arrangement of mechanism within the booster.

f. **FUNCTIONING.** (Functioning described herein refers to the fuze; for booster functioning, see par. 324.) No action takes place in the fuze upon firing until sufficient rotational speed has been established to overcome the resistance of springs and setback force on the several safety devices. When set for superquick action, after the projectile leaves the muzzle of the weapon, centrifugal force causes the plunger (J) to move outward opening the passage. At the same time, the plunger pins (Q) locking the delay assembly in unarmed position also move outward, releasing that assembly in preparation for impact. The plunger pin lock (P) then swings on its pivot under centrifugal force, placing an arm against the inner end of each plunger pin and thereby preventing the return of the pins to the unarmed position. Upon impact, the firing pin of the superquick action is driven against the detonator, initiating the superquick action. Inertia causes the delay action plunger to move forward, driving the primer against



RA PD 80852 B

Figure 157. Fuze, PD, M51A5—booster not shown.

the delay action firing pin and initiating the delay action. In normal functioning with superquick action, the delay action has no effect since the superquick train will have caused the shell to explode before the delay train can burn for its prescribed time. However, should the superquick action fail, the shell will function with delay action rather than become a dud. When set for delay action, the plunger which interrupts the superquick passage is restrained from moving. Upon impact, the superquick firing pin and detonator function but the effect is prevented from being transmitted to the shell.

g. PREPARATION FOR FIRING. The fuze need be adjusted only for the desired action, as described above. The setting can be adjusted at will, prior to firing, with a screw driver or fuze wrench M18. The adjustment can be made in the dark by noting the position of the slot, parallel to the fuze axis (or within 15° either side) for superquick ("SQ") action and at right angles thereto (or within 15° either side) for delay ("DELAY") action.

h. LIMITATIONS AND PRECAUTIONS (EARLIER MODELS). The M51A4 fuze, when set "SQ," generally functions under all firing conditions. However, when set "DELAY," a small percentage of duds may result when fired in zone 1 of 155-mm and 8-inch howitzers, due to the low striking velocity obtained especially at low angles of fall or on soft ground.

251. Fuze, PD, M51A5 Mod 3 and Fuze, PD, M51A4 Mod 3

a. GENERAL. The M51A5 Mod 3 and M51A4 Mod 3 (fig. 133) are modifications of the M51A5 and M51A4 respectively, to adapt this fuze for use with the M103 8-inch high-explosive shell. The M51A5 Mod 3 and M51A4 Mod 3 are fitted with the M21A4 booster. The ogive is omitted from the "MOD" fuzes and the flash tube is replaced by a longer tube so that the fuze can be assembled within the windshield of the M103 shell.

b. DATA. Weight, 2.47 pounds; thread size, 1.7-14NS-1 (fuze), 2-12NS-1 (booster).

c. DESCRIPTION. Since the fuze cannot be reset by means of the setting sleeve when assembled to the shell, the setting sleeve in the fuze body (not visible when the fuze is assembled to the shell) always is set for superquick action, so that the superquick interrupter always is free to arm under centrifugal force. Selective delay of superquick action is provided for by use of one of two heads provided with the fuze. One head is inert; the other contains the superquick action consisting of a striker and firing pin assembly, and a detonator. When delay action is required, the inert head is used. When superquick action is required, the inert

head is unscrewed from the shell and replaced by the superquick action head. As shipped assembled to the 8-inch M103 high-explosive shell, the fuze is fitted with the inert head (for delay action). The two heads are distinguished by differences in the end—the inert head is solid brass, whereas the superquick head is closed by an aluminum disk, crimped in place. For shipment separately from the shell, the flash tube hole in the body is closed by a body closing plug which is removed when the flash tube is to be assembled to the fuze. The appearance of the fuze when assembled to the shell is shown in figure 133; the mechanism in the body of the fuze is the same as that shown in the illustration of the M51A5 fuze (fig. 157).

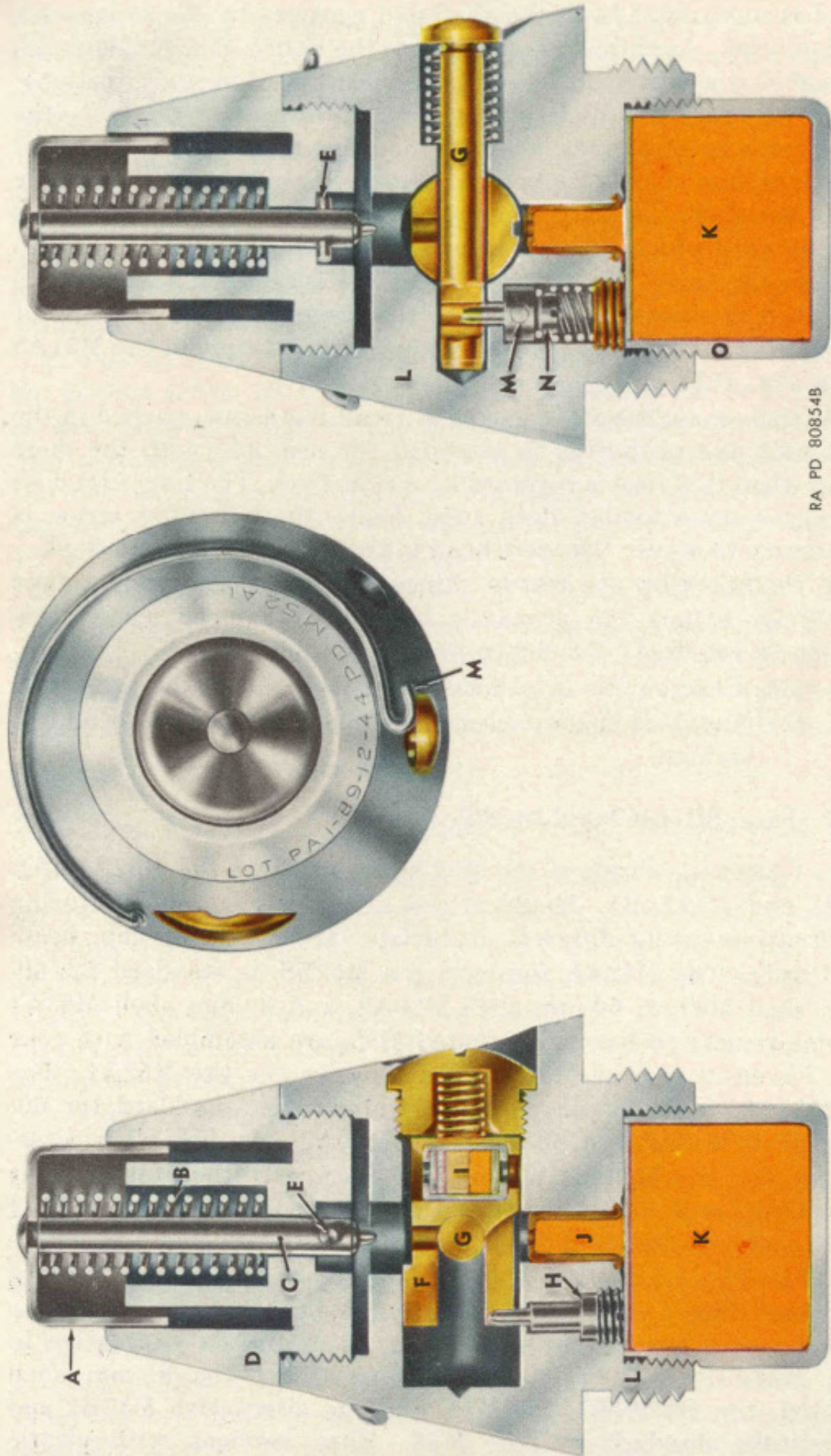
d. USE OF ALTERNATIVE FUZE. A retaining screw, packed in the box with the projectile, is intended for use only with the inert head when this fuze is replaced by a time fuze. The time fuze does not have an extended flash tube, hence the retaining screw is necessary to secure the inert head to the windshield of the shell.

e. PREPARATION FOR FIRING. Since the fuze is shipped arranged for delay action, the projectile is fired as shipped when delay action is required. To obtain superquick action—

- (1) Unscrew the inert head from the point of the projectile.
- (2) Assemble superquick head in place of the inert head and tighten.

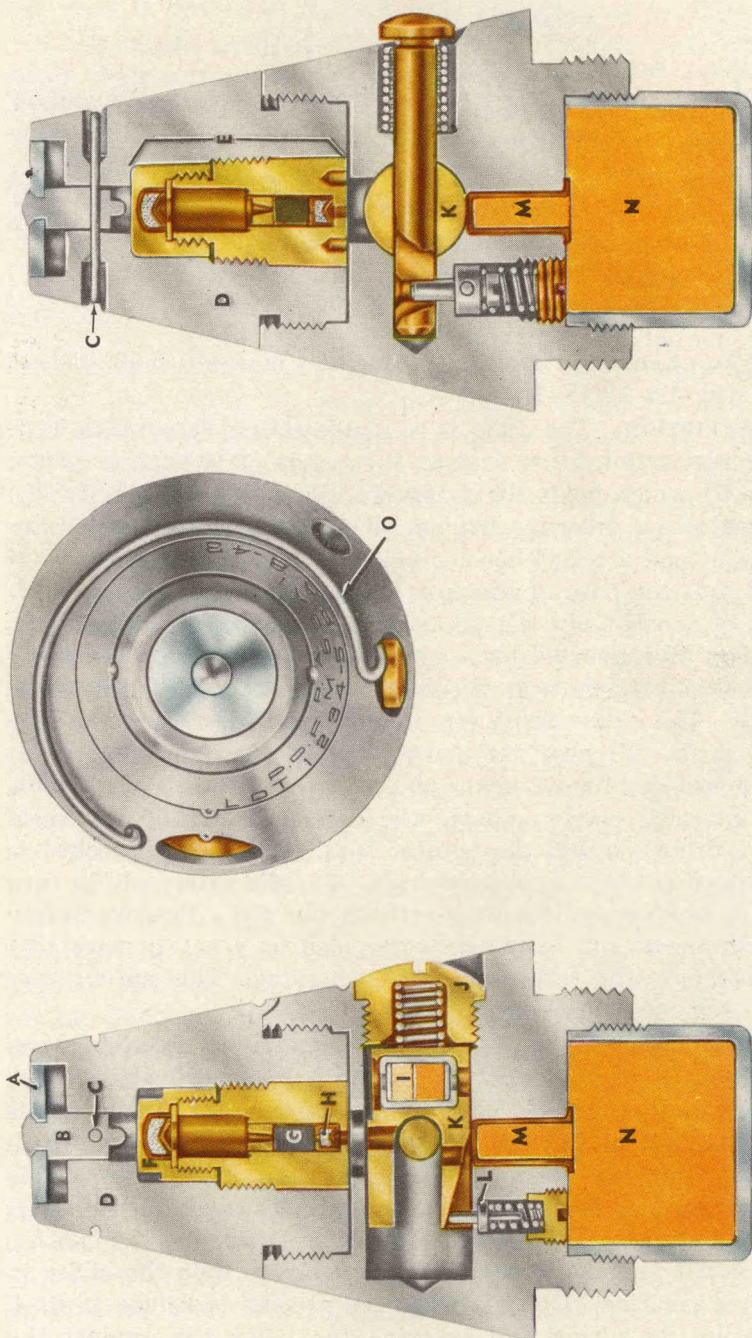
252. Fuze, PD, M52 and Modifications

a. GENERAL. Fuzes of the M52 series used are the M52A1 (fig. 158) and M52A1B1. Modifications are generally manufacturing alternatives using different materials in the booster cup, head, and body. The M52A1, formerly the M52B8, is standard for 60-mm shell M49A2, 60-mm shell M50A2, and 60-mm shell M83A1 (some rounds on hand, designated M83, are assembled with four M4 increments); the M52B9 is alternative for the M52A1. The M52A1B1, formerly the M52B6, is alternative standard for 60-mm shell M49A2 and 60-mm shell M50A2; the M52B7 is alternative for the M52A1B1. The M82, formerly the M52B1E5, is standard for 60-mm smoke shell M302. The M52B2 and M52B4 are substitute standard for the 81-mm shell M57 and alternative M57B1. The M52A1B1, formerly M52B6, is alternative standard for the M43A1 and the alternative M43A1B1, and substitute standard for the 81-mm shell M56; the M52B7 is alternative to the M52A1B1. The M52A1 is standard for the 81-mm shell M43A1, the M43A1B1, the M57, and the alternative M57B1 and substitute standard for the M56. Fuze versions with plastic bodies and booster cups are not used with chemical shell. Char-



RA PD 80854B

Figure 158. Fuze, PD, M52A1.



RA PD 80855A

Figure 159. Fuze, PD, M53A1.

acteristics and weights of the various fuzes and the shell for which they are applicable are as follows:

<i>Fuze</i>	<i>Material used</i>			<i>Weight of fuze</i>	<i>Applicable shell</i>
	<i>Body</i>	<i>Head</i>	<i>Booster cup</i>		
M52A1	Al alloy	Zinc*	Al alloy**	0.56 lb	60-mm HE and TP 81-mm HE, chemical, and TP
M52A1B1	Plastic	Zinc*	Plastic	0.43 lb	60-mm HE and TP 81-mm HE and TP

* Brass head alternative.

** Aluminum base alloy die casting.

b. DATA. Length, visible, 2.40 inches; over-all, 3.52 inches; thread size, 1.5-12NF-1.

c. DESCRIPTION. The fuze is a single-action superquick type with a direct-action firing device. It consists of two major parts: a head (D) which holds the firing pin assembly; and a body (L) which contains a slider mechanism (F), a detonator (I), a booster lead-in (J), and a tetryl booster pellet (K) in a booster cup (O) screwed into the base of the fuze body. The firing pin assembly consists of a firing pin (C) secured to a cup-shaped striker (A). The striker is supported by a spring (B) which holds the firing pin at a safe distance from the detonator during the flight of the projectile. The entire firing pin assembly is held within the fuze head by a pin (E) near the pointed end of the firing pin. Bore-safety is provided for by means of a slider type interrupter which, in the unarmed position, holds the detonator out of alinement with the firing pin and the booster lead. The slider is locked in the unarmed position by a safety pin (G); the safety pin in turn is held in locking position by a setback pin (N). Positive safety during shipment and handling is provided by a safety wire (M) which prevents the setback pin from moving. This safety wire must be removed before firing.

d. FUNCTIONING. Upon firing, after removing the safety wire, setback causes the setback pin to move backward against the resistance of the spring. This releases the safety pin, which is held in the fuze by the inner wall of the mortar tube but which is ejected from the shell as it emerges from the muzzle. This releases the slider (F) which then, guided by the guide pin (H), moves into armed position. In modifications preceding the M52A1, the guide pin (H) also served as a lock pin to hold the slider in the armed position. Upon impact, the striker is driven inward, compressing its spring and carrying the firing pin against the detonator. Action of the detonator is transmitted through the

booster lead to the tetryl booster pellet and, thereby, to the bursting charge of the shell.

e. PREPARATION FOR FIRING. The fuze requires no preparation for firing other than removing the safety wire. This should be done just before firing and at no other time.

253. Fuze, PD, M53 and Modifications

a. GENERAL. The M53A1 fuze (fig. 159) is provided for use with 81-mm high-explosive ammunition when delayed functioning is desired. The M53A1 and M53B1 are standard for 81-mm shell M56 and alternatives M56B1, M56B2, and M56B3. The M53A1 has a steel head and body.

b. DATA. Length, visible, 2.35 inches; over-all, 3.47 inches; weight 1.06 pounds; thread size, 1.5-12NF-1.

c. DESCRIPTION. The fuze is a single-action type with a direct-action firing device. The body mechanism therein is identical with that of the M52A1 mortar fuze (fig. 158), except that the guide pin (L) in the M53A1 fuze serves as both a lock pin and guide pin. The head (D) is fitted with a delay assembly (E), and a short plug type firing pin (B) with a nipple at one end and riveted at the other end to a thin aluminum-alloy disk (A) which forms the striker. Normally, the firing pin is held at rest by a shear wire (C). This wire is sufficiently strong to withstand ordinary blows and the setback created upon firing, but is sheared or bent upon impact at the target, allowing the nipple of the firing pin to come into contact with a primer (F) in the delay assembly. The delay assembly consists of the primer, a black powder delay pellet (G) which is loaded to cause the fuze to function with 0.1-second delay, and a relay charge (H) of lead azide.

d. FUNCTIONING. Upon impact the firing pin is driven against the primer. Action of the latter ignites the black powder. After burning for the prescribed time, action of the lead azide relay is initiated. When the detonator (I) in the slider (K) has been brought into alinement in the same manner as in the M52 series fuzes (par. 252) and locked in the armed position by the lockpin (L), action of the relay charge is transmitted to the detonator and, thereby, to the booster lead (M) and booster charge (N). The booster charge, in turn, causes the shell to explode.

e. PREPARATION FOR FIRING. There is no preparation other than removing the safety wire (O). This should be done just before firing, and at no other time.

254. Fuze, TSQ, M54

a. GENERAL. The M54 (fig. 160) is a combination time and superquick fuze with settings for time action (to 25 seconds)

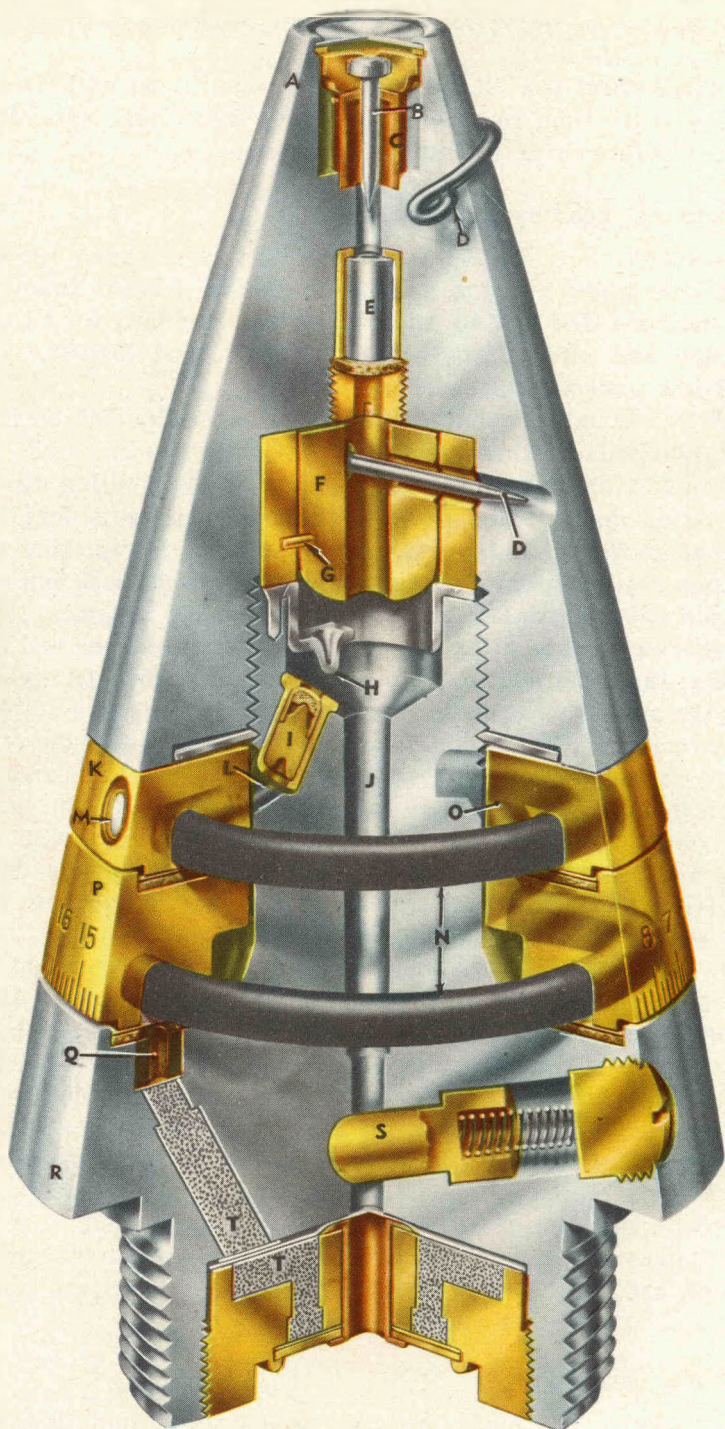


Figure 160. Fuze, TSQ, M54.

and for superquick action. The fuze is used with fixed, semifixed, and separate-loading base-ejection smoke and illuminating shell. The M54 is of the same size, shape, and weight as the M48A2 (par. 249). It is identical with the M55 series fuzes except that the M55 models have a booster assembled to the fuze.

b. DATA. Length, visible, 3.78 inches; over-all, 4.59 inches; weight, 1.42 pounds; thread size, 1.7-14NS-1.

c. DESCRIPTION. The fuze consists of three major parts: a closing cap or head (A) containing the superquick impact element (B, C, E) and the time-action plunger (F); two time-train rings, one fixed (K) to the body and the other movable (P); and a body (R) containing a time-action striker (H) and primer (I), a magazine charge (T), and an interrupter (S). The superquick action is identical in construction and functioning with that in the M48A2 fuze except that the interrupter incorporated in the body of the fuze has no setting sleeve, being automatic and always operative regardless of fuze setting. Hence, the fuze will function on impact unless prior functioning has been caused by the time action. The time action is typical of powder-train types and is initiated upon firing by the time-action plunger under setback. The fixed upper and movable lower time rings have a tunnel-shaped slot or groove in their lower surfaces which is filled with compressed black powder (N). One end of the lower ring powder train is connected by a black powder pellet (O) with the upper ring train; one end of the upper train is connected by a pellet (L) with the primer. Movement of the lower ring in relation to the fixed upper ring and a pellet (Q) in the body determines the time of functioning. Counterclockwise turning of the lower ring (viewed from the point of the fuze) lengthens the time by increasing the amount of powder which must burn in the upper and lower rings before the flame reaches the pellet in the body and is transmitted thereby to the body and magazine charges. For setting purposes, the lower ring is graduated to 25 seconds, with 0.2-second graduations, and a register line is engraved on the body.

d. SAFETY DEVICES. When used with the M20 or M21 series booster, boresafety is provided by the arrangement of the booster mechanism. Provision is made also for boresafe superquick action by the interrupter, which shuts off the superquick flash hole (J) until sufficient rotational speed has been established. A metal cup-shaped support (C), which is sufficiently strong to withstand initial setback, holds the superquick element firing pin (B) away from the detonator (E) until impact at the target. When the fuze is set safe ("S"), the time-train rings are positioned so that either or both may burn without causing func-



RA PD 80857B

Figure 161. Fuze, TSQ, M55A3.

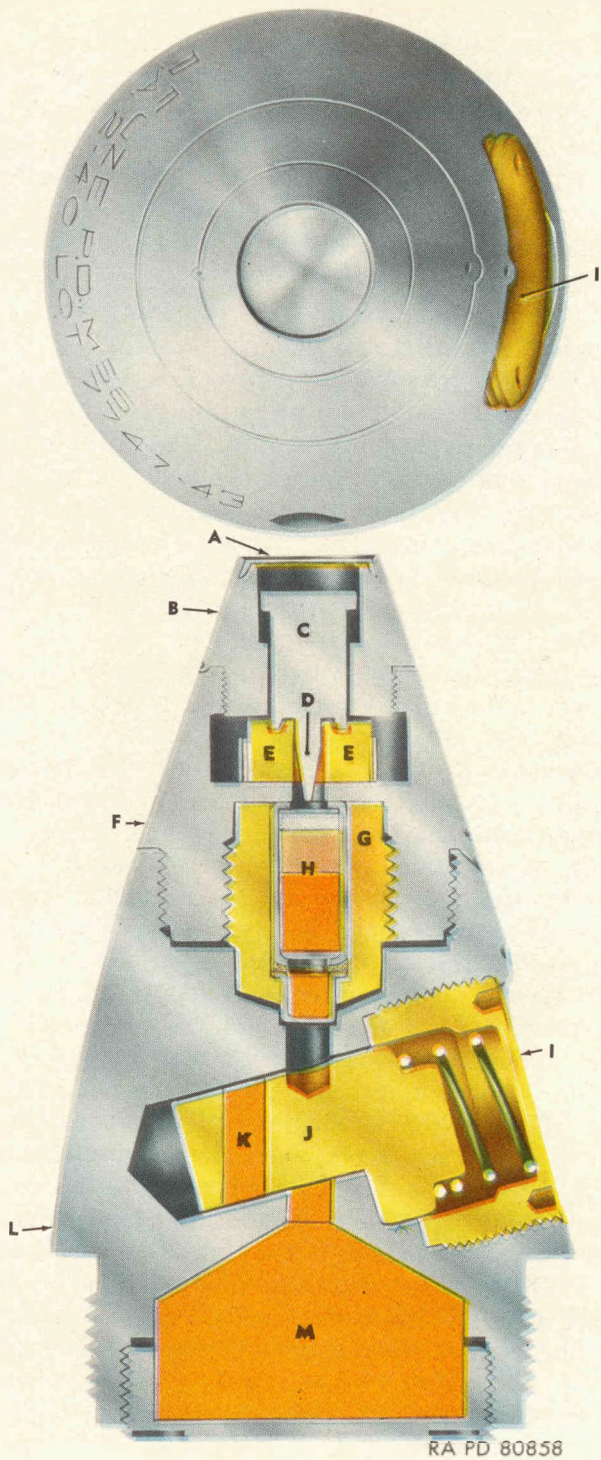


Figure 162. Fuze, PD, Mbo.

tioning of the succeeding elements in the time train. To prevent functioning within dangerously short time limits, a safety disk incorporated in the lower time ring covers the body pellet and prevents its ignition when the fuze is set at less than 0.4 second. A pull (safety) wire (D) and a shear pin (G) are fitted in the time-action plunger to prevent accidental functioning of the plunger prior to firing. The safety pull wire must be removed before firing.

e. **FUNCTIONING.** Upon firing, with the safety wire removed, setback causes the time-action plunger to shear the shear wire and force the striker against the primer. The primer flash ignites the black powder pellet and the train in the upper time ring, which then burns at a relatively uniform rate. The burning progresses until the flame contacts and ignites the pellet of the graduated (lower) time ring, unless the fuze is set at safe ("S"). In this event, flame of the upper train cannot contact the graduated time-ring pellet since the lower-ring pellet is covered by the solid part of the upper ring, and time action stops at this point. Upon ignition, the pellet in the lower ring transmits the flame to the graduated time-ring powder train, which burns in manner similar to that of the upper ring. After burning for a time determined by the fuze setting, the flame contacts and ignites the black powder pellet in the fuze body unless the setting is less than 0.4 second. In this event, the flame is interrupted before making contact with the body pellet, and time action is stopped at this point. When ignited, the body pellet transmits the flame to the body charge and, thereby, to the magazine charge. This charge initiates action of the booster unless prior functioning has been caused by the superquick action on impact. The superquick action becomes armed when sufficient rotational speed has been established to force the slider of the interrupter outward against the resistance of its spring and thereafter remains operative until impact unless the time action has completed its functioning during flight. Upon impact, the firing pin support collapses and the firing pin strikes the superquick detonator. Action of the detonator is transmitted directly to the shell booster through the uninterrupted flash hole. The fuze will function on impact, therefore, with superquick action, when the time setting is set for a time greater than the time of flight or otherwise fails to complete its functioning. The gases formed by the burning of the powder train escape through vents in both time rings (M).

f. **PREPARATION FOR FIRING.** Prior to firing, with either superquick or time setting, the safety pull wire must be removed from the fuze (pull free end of wire off fuze and out of hole).

If superquick action is required, the graduated time ring can be left as shipped set at safe ("S") or be set for a time greater than the time of flight. If time action is required, the graduated time ring is set for the required time burning by means of a fuze setter.

255. Fuze, TSQ, M55 and Modifications

a. DESCRIPTION. The M55A3, M55A2, M55A1, and M55 fuzes (fig. 161), which are employed with HE shell primarily for high burst ranging, are identical in every respect with M54 fuze (par. 254) except that BOOSTER, M21A4, M21A2, M21A1, or M21, respectively, is a manufacturing component of the fuze. The only difference between the M55A3, M55A2, M55A1, and M55 fuzes is in the booster with which each is assembled. See section IV of this chapter for a description of the boosters.

b. DATA. Length, visible, 3.78 inches; over-all, 5.99 inches (including booster); weight 2.16 pounds (including booster); thread size of fuze, 1.7-14NS-1; of booster, 2-12NS-1.

c. PREPARATION FOR FIRING. The fuzes are shipped separately from the shell with which they are used, for assembling to the projectile in the field. This is done by—

- (1) Removing the shipping plug from the projectile.
- (2) Examining all threads to insure that no foreign matter is present which may interfere with proper assembly.
- (3) Removing safety pin (C) from the booster.
- (4) Screwing the fuze with booster into the fuze hole by hand, then tightening with fuze wrench M18.
- (5) When thus assembled to the projectile, the fuze is set for the required action as described in paragraph 254 for the M54 fuze.

256. Fuze, PD, M56

a. GENERAL. The M56 fuze (fig. 162) is a supersensitive type used with 37-mm high-explosive shell.

b. DATA. Length, visible, 1.74 inches; over-all, 2.21 inches; weight, 0.17 pound; thread size, 1.125-20NS-1.

c. DESCRIPTION. The fuze consists of two main parts: a head assembly; and a body (L) containing a booster charge (M) and an interrupter (I) which holds a part of the explosive train connecting the booster with the detonator (H). The head assembly is made in three parts: the head proper (F); the detonator assembly (G), which screws into the base of the head proper; and a nose (B). The nose holds the firing pin (C), and screws into the upper end of the head in such a manner as to leave

a recess below the firing pin. Half-blocks (E) and a coiled spring (D) are positioned in the recess to hold the firing pin in an unarmed position prior to firing. The front end of the nose is closed by a thin aluminum disk (A) for protection against foreign matter or air resistance. Safety in handling and bore-safety are provided for by half-blocks and interrupter devices which hold the fuze in an unarmed condition until sufficient rotational force overcomes resistance of springs, setback, and friction.

d. **FUNCTIONING.** When sufficient rotational speed has been established to offset the resistances of springs, setback, and friction, the slider (J) of the interrupter moves outward, bringing the slider charge (K) into alinement with the detonator and booster. While in the bore, setback causes the firing pin to seat firmly in the half-blocks, preventing them from flying outward. Upon leaving the bore, the firing pin "creeps" forward and the half-blocks holding the firing pin in the unarmed position then move outward under centrifugal force, leaving the firing pin in a "floating" position with an unobstructed passage to the detonator. In this position, the fuze is fully armed. Upon impact, the thin closing disk is perforated, or the head is crushed, depending on the force of impact. In either case, the firing pin is driven against the detonator. Action of the detonator is transmitted through the slider charge to the booster, which then causes the shell to explode.

e. **PREPARATION FOR FIRING.** There are no preparations.

Caution: Fuzes with perforated or imperfect closing disks will not be fired.

257. Fuze, PD, M57

a. **GENERAL.** The M57 fuze (fig. 163) is a single-action superquick type of the same size, shape, and weight as the M48A2, or M51A4 without booster. It is essentially the same as the M48A2 without a delay element. The M57 is used primarily with 75-mm chemical shell, and in conjunction with the M22 booster in 105-mm howitzer chemical shell. The M57 has been superseded for such use by the M48A2 fuze with 0.05-second delay in 75-mm chemical shell M64 and M311 and by the M51A4 fuze with 0.05-second delay in 105-mm howitzer chemical shell.

b. **DATA.** Length, visible, 3.74 inches; over-all, 5.93 inches (including booster); weight, 2.14 pounds; thread size of fuze, 1.7-14NS-1, of booster, 2-12NS-1.

c. **DESCRIPTION.** The superquick element (A) is identical in construction and functioning to the M48A2, or M51A4 without

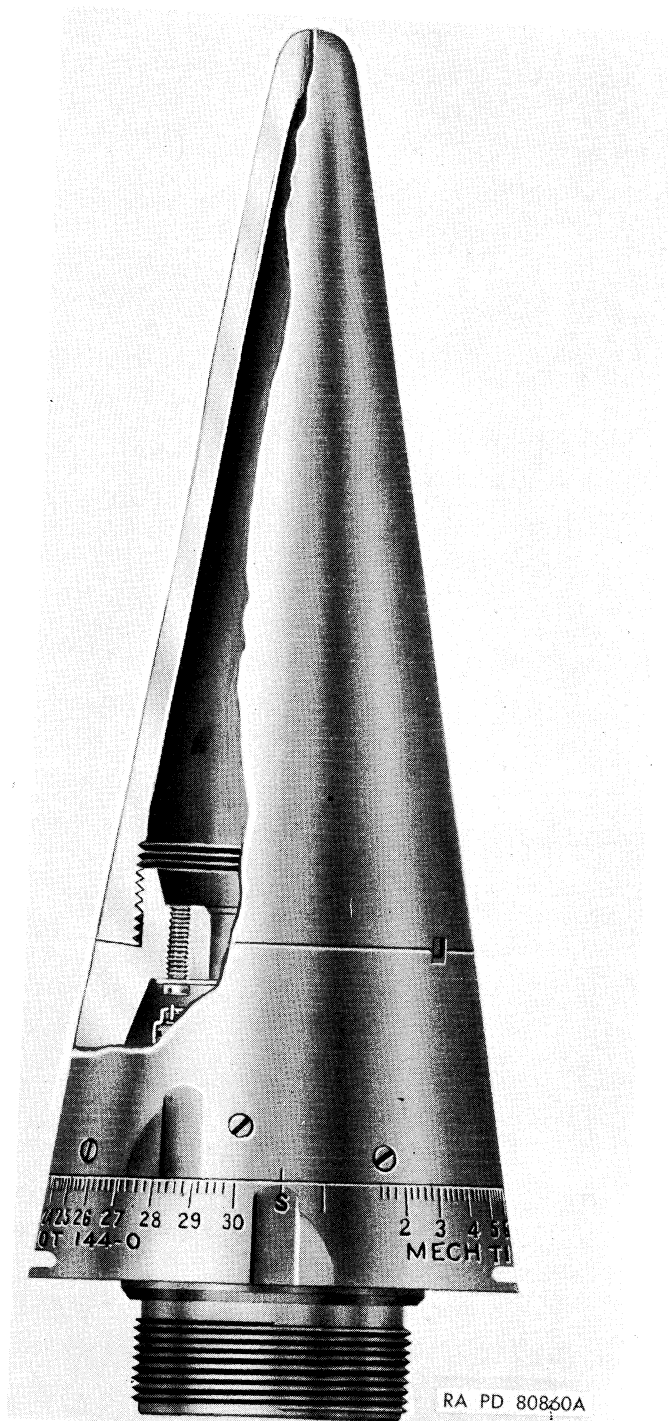


Figure 164. Fuze, time, mechanical, M61A1.

booster (pars. 249 and 250), except that there is no setting sleeve on the centrifugal interrupter (B) and there is no delay assembly.

d. FUNCTIONING. For details on functioning, see paragraph 250.

e. PREPARATION FOR FIRING. There are no preparations.

258. Fuze, Time, Mechanical, M61A1 and Fuze, Time, Mechanical, M61

a. DESCRIPTION. The M61A1 (fig. 164) is essentially the M43A4 fuze with an extended conical nose. The long-pointed shape is required to adapt the fuze to the ogive of the 120-mm anti-aircraft shell M73, for which the fuze is provided. Aside from the difference in contour, the M61A1 and M43A4 are alike in construction and, in functioning (see par. 248 for details of arrangement and functioning), including safety devices and the minimum safe setting time of 0.6 second, as well as the torque required to turn the movable cap. Similarly, the M61 is the same as the M43A3 except for the difference in shape and weight.

b. DATA. Length, visible, 6.867 inches; over-all, 7.677 inches; weight, 1.62 pounds; thread size, 1.7-14NS-1.

c. PREPARATION FOR FIRING. The fuze is prepared for firing in the same manner as described for the M43 fuzes in paragraph 248.

259. Fuze, Time (Fixed), M65A1

a. GENERAL. The M65A1 fuze (fig. 165) is a fixed time fuze used with the 60-mm illuminating shell M83A1, to obtain the delay in functioning required for the most effective illumination. It differs from the adjustable powder-train types in that the burning time is fixed at approximately 15 seconds, and therefore does not have a movable time ring or require adjustment. This delay permits the round to be at its optimum range and height before the illuminant begins to burn. The M65A1 differs from the earlier model M65, used with the M83 illuminating shell, in the following respects: the striker is longer; the body is recessed beneath the time-train ring to protect the felt pads which separate the body and ring; the fuze wrench holes in the body are replaced with two fuze wrench slots cut into the lower flange on the body; the time-train ring is slightly heavier, and the quickmatch is replaced by a black powder pellet (F).

b. DATA. Length, visible, 2.06 inches; over-all, 2.54 inches; weight, 0.74 pound (M65 weighs 0.77 pound); thread size, 2-20NS-1.

c. DESCRIPTION. The time train is a powder-train type consist-

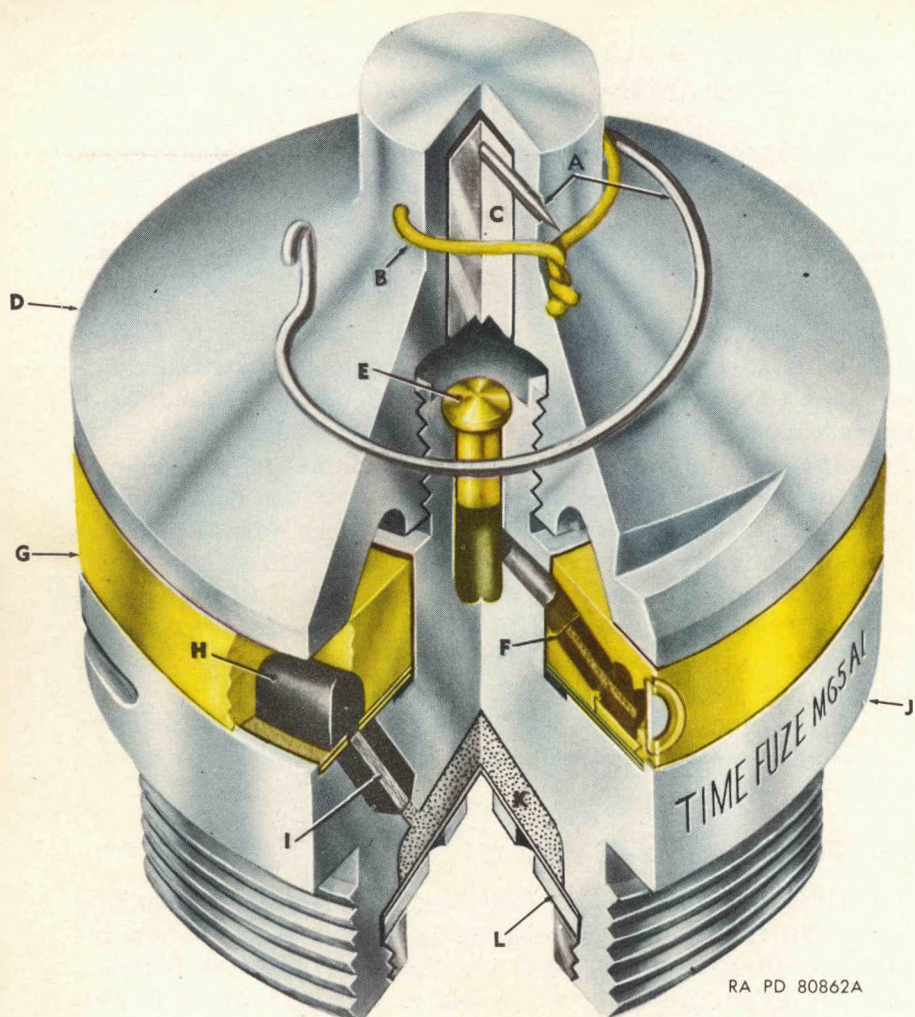


Figure 165. Fuze, time (fixed), M65A1.

ing of a primer (E), black powder pellet (F), a time-ring charge (H) loaded for a prescribed time of burning, a body pellet (I), and an expelling charge (K). Powder elements other than the black powder pellet (F) and time-ring charge are held in a die-cast body. The black powder pellet and time-ring charge are assembled in the time ring (G), which is essentially a large washer grooved and drilled to hold the charges. A head (D) seating the striker (C) screws on to a threaded neck on the body (J), holding the time ring securely in a fixed position. A safety (cotter) pin (A) and a shear wire (B) pass through the head and the striker. The cotter pin provides positive safety during handling prior to firing. The shear wire holds the striker at rest until broken or bent by setback forces on firing.

d. FUNCTIONING. Upon firing, setback causes the striker to move rearward with sufficient force to shear the shear wire and strike the primer. The flame from the primer ignites the black powder pellet, which, in turn, ignites the time-ring charge. After the flame of the time-ring charge has completed its circle about the time ring, it ignites the body pellet. The body pellet then ignites the expelling charge. Flame from the latter passes

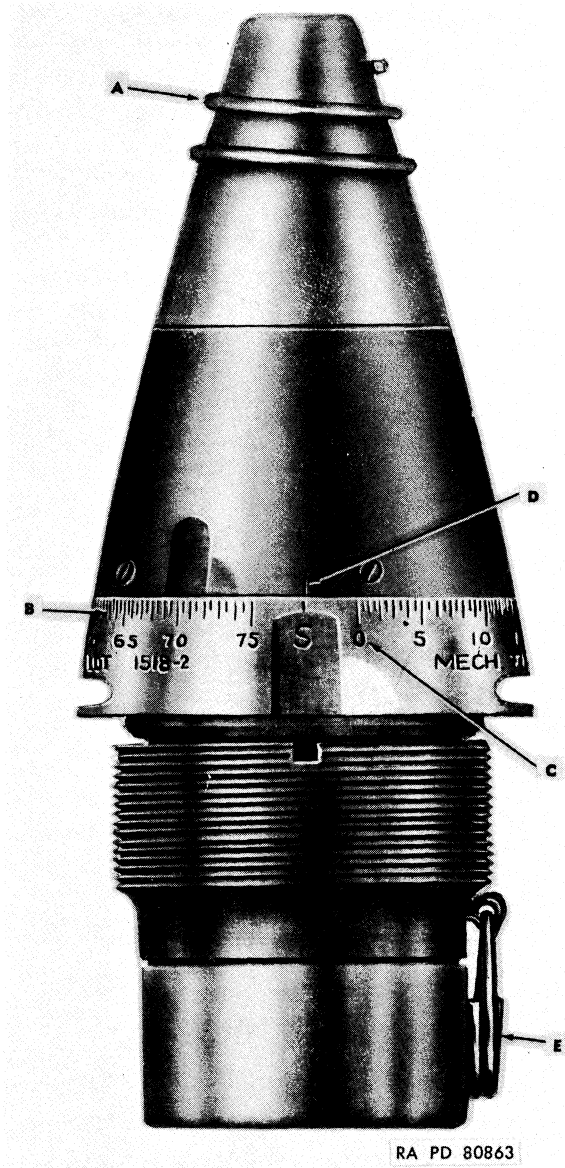


Figure 166. Fuze, time, mechanical, M67A3.

through the apertures in the expelling charge retainer disk (L), igniting the illuminant of the shell.

e. PREPARATION FOR FIRING. There is no preparation except the removal of the safety (cotter) pin, just prior to firing.

260. Fuze, Time, Mechanical, M67A3

a. GENERAL. The M67A3 fuze (fig. 166) is a mechanical time fuze used with high-explosive shell in calibers from 155-mm to 240-mm (field weapons only) and with 90-mm high-explosive shell M71. Due to its longer time range, the fuze also has replaced the M55, M55A1, M55A2, and M55A3 fuzes for use for high-burst ranging with these calibers.

b. DATA. Length, visible, 3.74 inches; over-all, 5.93 inches (including booster); weight, 2.14 pounds (including booster); thread size, 2-12NS-1.

c. DESCRIPTION. The M67A3 fuze without booster has the same size, weight, and shape as the M43A4 and, like it, has no impact element. The time action is based on the same clockwork principle. It has "kick off" springs and a 30-tooth gear meshing with the escapement and functions similarly to the M43A4 except that the escapement and gears of the M67A3 are set to give a functioning time up to 75 seconds, and the safety leaf prevents functioning when the fuze is set for less than 1.5 seconds. The setting register is engraved with 0.5-second graduations up to 75 seconds, a zero line, and a safety (S) line. The fuze is set safe as shipped. A safety wire (A) extends through the fuze body and the movement firing pin, providing positive safety during the handling prior to firing. This wire must be removed when preparing the fuze for firing.

d. PREPARATION FOR FIRING. To assemble the fuze and booster assembly to the projectile—

- (1) Remove the shipping plug from the projectile.
- (2) Inspect the fuze hole threads to make certain that no foreign matter is present which may interfere with proper assembly.
- (3) Remove safety (cotter) pin (E) from booster.
- (4) Screw the fuze and booster assembly into the projectile by hand and tighten with the fuze wrench M18.
- (5) When the fuze is assembled to the projectile, it is necessary only to remove the safety wire (A) (pull end of wire from hole and slip the wire off the head) and then set the fuze for the desired time of action by means of the fuze setter, to complete the preparation for firing.

261. Fuze, PD, M74

a. GENERAL. The M74 (fig. 167) is a point fuze containing a direct-action firing pin and a cylindrical rotor. The fuze is provided for use with the M92 practice shell in 37-mm subcaliber guns. It is used to ignite the black powder spotting charge of the shell and does not have or require a booster.

b. DATA. Length, visible, 0.965 inch; over-all, 1.43 inches; weight, 0.21 pound; thread size 1.125-20NS-1.

c. DESCRIPTION. The fuze consists of a zinc-alloy body (B) recessed at the forward end to hold the firing pin (A) and recessed again at about the middle of the fuze to hold a rotor housing (C)

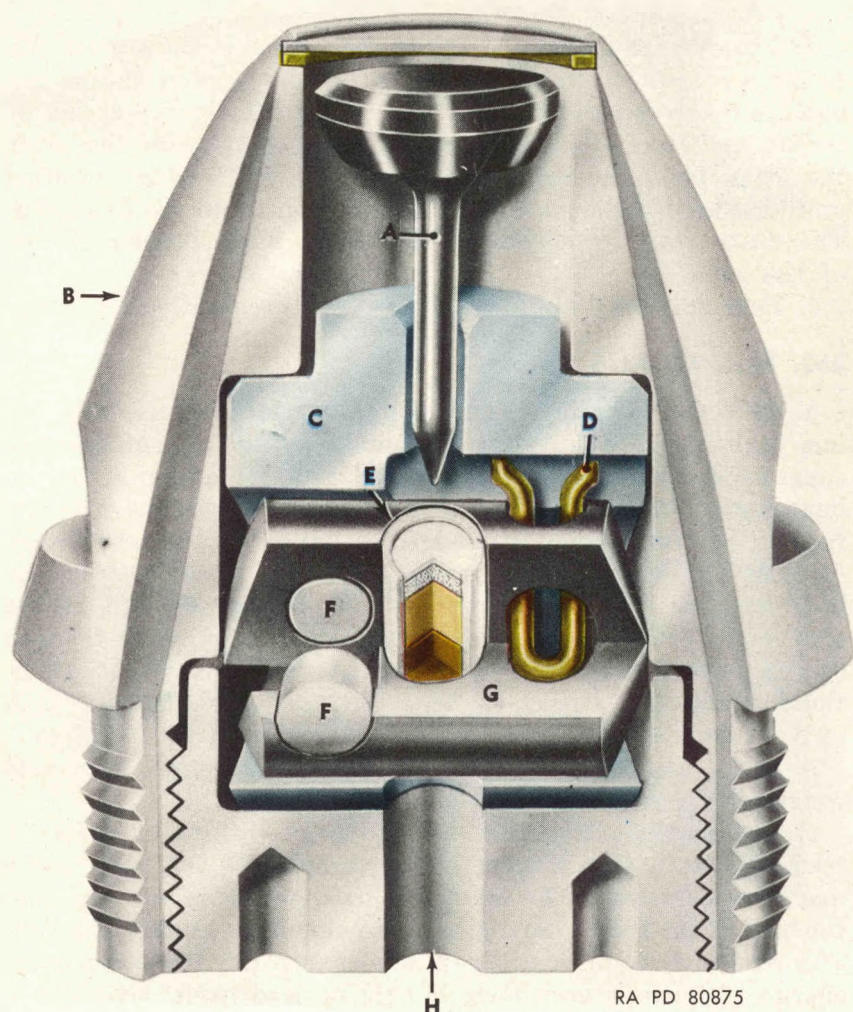


Figure 167. Fuze, PD, M74.

and rotor assembly. The base is closed by a zinc-alloy plug (H) which screws into the body, serving both to close the base of the fuze and to hold the rotor housing assembly firmly in position in its recess. The rotor housing is drilled through, at right angles to the vertical axis of the fuze, to provide a recess for the rotor (G). The rotor is a cylindrical steel assembly slotted and weighted with two lead plugs (F) at one end and drilled in two places, one to hold the detonator (E), the only explosive assembly in the fuze, and the other to provide a recess for a U-shaped setback pin (D). In the unarmed or interrupted position, the rotor holds the detonator diagonally across the vertical fuze axis and away from the firing pin, providing for safety in handling and during firing. The rotor is locked in the unarmed position by the setback pin.

d. FUNCTIONING. Upon firing, setback causes the setback pin to move rearward into its recess. After the friction due to setback is overcome, the rotor is free to turn under the action of centrifugal force, thereby bringing the detonator in line with the firing pin. The firing pin remains in a "floating" position until impact, whereupon it is driven rearward into the detonator. The flash from the detonator ignites the black powder charge of the shell.

e. PREPARATION FOR FIRING. There is no preparation for firing.

262. Fuze, PD, M75

a. GENERAL. The M75 (fig. 168) is provided for use with 20-mm high-explosive-incendiary ammunition. It is a single-action superquick type intended to function with percussion action on impact with aircraft targets. Its design differs from the ordinary fuze in that functioning is initiated on impact by the set-forward force of the detonator charge (C), by pieces of metal from the body striking the detonator charge, or by compression of the air column (with the accompanying formation of heat) forward of the detonator charge, or by a combination of any or all of these. Hence, the striker or firing pin mechanisms usually found in point detonating fuzes is omitted in this design.

b. DATA. Length, visible, 0.84 inch; over-all length, 1.20 inches; weight, 348.0 grains; thread size, 0.5625-32NS-1.

c. DESCRIPTION. The fuze is made up of two major parts: a body (D) with an air space in the forepart of the fuze, and a magazine containing the explosive train which is screwed into the base of the body to seat against an aluminum impact disk (B). The explosive train consists of a mercury fulminate detonator charge (C), an intermediary charge of lead azide (E), and a tetryl base charge (booster) (F). Since there are no interrupter



RA PD 65131B

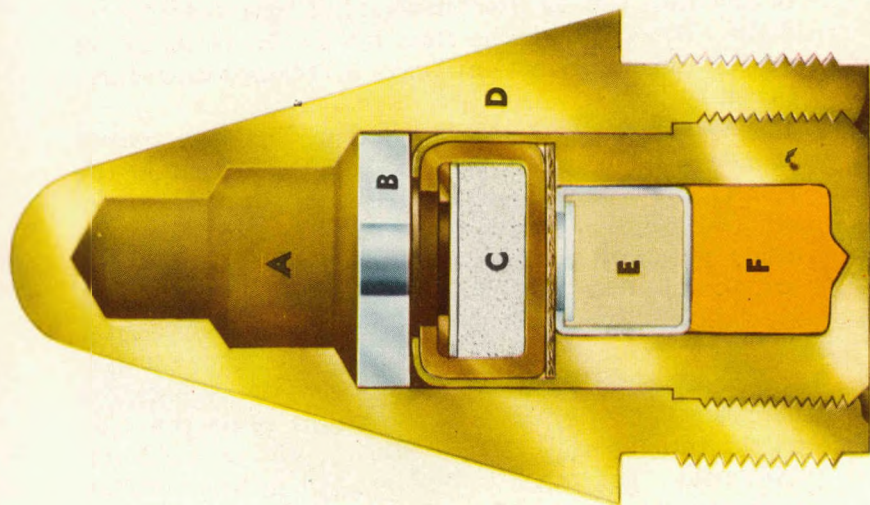


Figure 168. Fuze, PD, M75.

or other safety devices, the fuze is not considered a boresafe type.

d. FUNCTIONING. Upon firing, no action takes place until impact. Upon impact with sufficiently resistant targets, the head is crushed and the detonator charge (C) functions. Action of the detonator charge in turn initiates functioning of the lead azide intermediary charge, which causes the base charge (booster) to detonate. The booster action causes the shell to explode.

e. PREPARATION FOR FIRING. There is no preparation for firing.

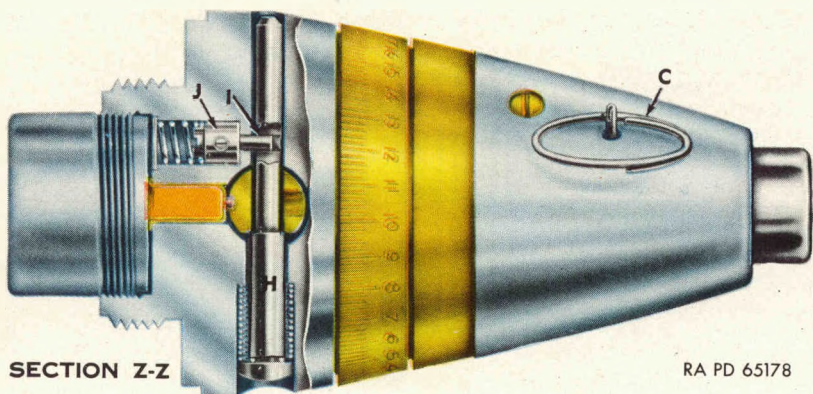
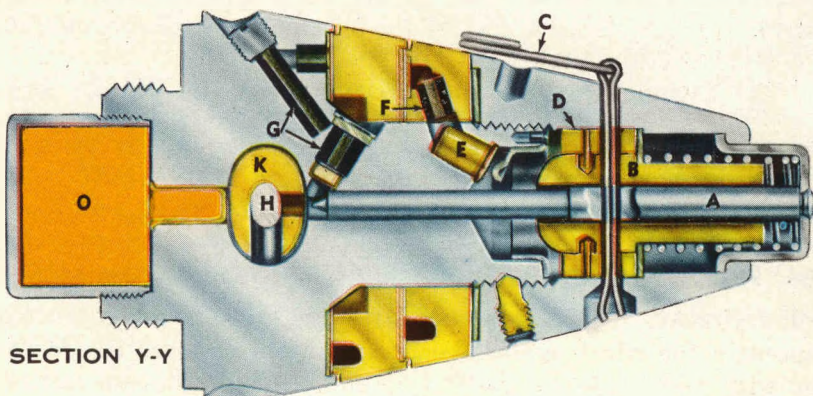
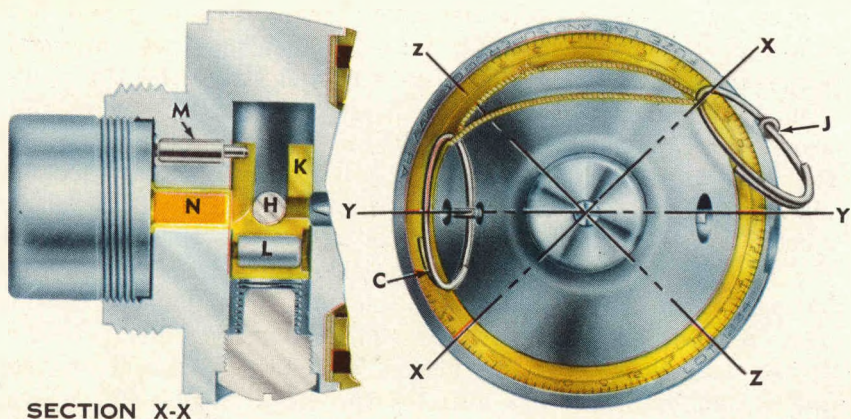
263. Fuze, TSQ, M77

a. GENERAL. This fuze (fig. 169) is a combination time and superquick fuze which provides either impact action or time functioning for air bursts. It is standard for the 81-mm mortar shell M56 and for the alternatives M56B1, M56B2, and M56B3. It also is standard for shell M57 and alternative M57B1.

b. DATA. Length, visible, 3.77 inches; over-all, 5.00 inches; thread size, 1.5-12NF-1.

c. DESCRIPTION.

- (1) The time element of this fuze consists of the powder-train time rings used in FUZE, TSQ, M54 (fig. 160 and par. 254), the lower ring of which is graduated from 0 to 25 seconds, numbered every second, and calibrated every 0.2 second. A safe marking "S" and a zero marking also appears on the lower ring. A slot in this graduated time ring and another in the body of the fuze are provided for setting the fuze by means of a fuze setter.
- (2) Impact action is obtained by setting the fuze to "S" or to any time setting greater than the expected time of flight. When issued, the fuze will be found to be set to "S." Superquick action always is obtained when functioned by impact.
- (3) The safety elements incorporated in this fuze consist of a bore-riding safety pin (H) similar to that in the M52A1 and M53A1 point detonating fuzes and a shear pin (D) which supports the time-action plunger. Two cotter pins with pull rings, secured together by a cord, are assembled to the fuze. The bore-riding pin passes through a slider assembly (K) carrying the detonator (L) which normally is out of line with the firing pin (A) and booster lead (N). A setback pin (I) secures the bore-riding pin in place and one of the cotter pins (J) passes through this setback pin, preventing accidental movement. The other cotter pin (C) passes through both the time-action plunger assembly (B) and firing pin, preventing premature movement of these assemblies. In addition, a spring supports the firing pin.



RA PD 65178

Figure 169. Fuze, TSQ, M77.

d. **FUNCTIONING.** Prior to firing, both cotter pins and pull rings must be removed. When fired, setback causes the time-action plunger to break the shear wire and strike the time-train primer (E) and ignite the time train, through the pellet (F), provided a time setting of 0.8 second or more has been made. At the same time, setback retracts the bore-riding setback locking pin (I) which releases the bore-riding pin (H). This pin is ejected by its spring from the fuze as soon as the shell leaves the mortar tube. The slider assembly then is moved by its spring so that the detonator is in line with firing pin and booster lead. A guide pin (M) keeps the slider assembly alined properly. If the fuze is set for time action, the powder train burns for the designated time and initiates the relay pellets (G) which, in turn, initiate the detonator. This detonates the booster (O) and the explosive charge. Upon impact, the firing pin is depressed against its spring and strikes the detonator in the slider assembly, which, in turn, sets off the booster and explosive charge.

e. **PREPARATION FOR FIRING.**

- (1) Examine fuze for the bore-riding pin (H). If not present, dispose of the rounds in accordance with regulations for disposal of unsafe ammunition.
- (2) Remove both cotter pins (C) and (J).
- (3) Set fuze for impact or time action, as desired.

264. Fuze, CP, M78, and Fuze, CP, M78A1, and Booster M25

a. **GENERAL.** The M78 series fuzes (fig. 170) are constructed especially for effect against concrete targets and are issued for use with high-explosive shell of 75-mm through 240-mm caliber. In 75-mm guns, the use of these fuzes is restricted to guns M3,

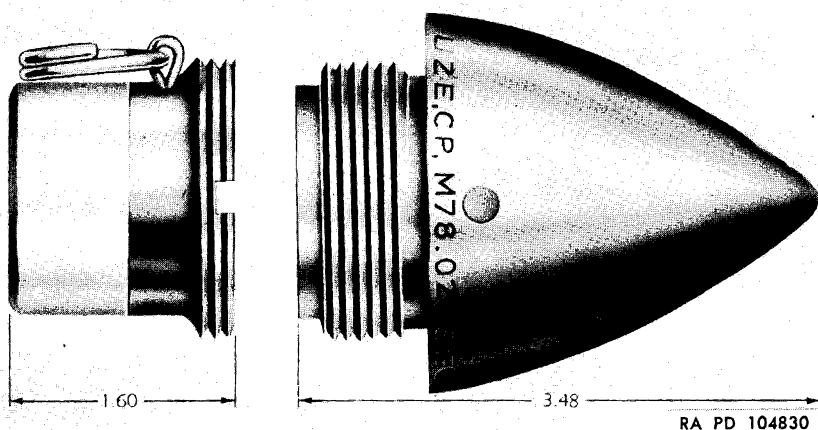


Figure 170. Fuze, CP, M78, 0.025-sec delay, and booster M25.

M6, and M17, and, on these guns, to HE shell M48 supercharge only. In 76-mm guns, these fuzes may be used in guns M1A1C and M1A2 but with shell HE M42A1 normal charge only. The fuzes M78A1 are of two types: a nondelay type using delay plunger assembly M1 (nondelay), primarily for spotting purposes, and a delay type using delay plunger assembly M1 (0.025-second delay), for fire for effect. The nondelay fuze has its nose painted white about 1 inch wide from the tip. Booster M25 is a separate assembly, but is packed and shipped with the fuze for assembly to the shell at the time the shell is to be fuzed. This booster is designed especially for use with the M78 series and cannot be used with any other fuze.

b. DATA. Length, visible, 2.68 inches; over-all (fuze alone), 3.48 inches; weight (fuze alone), 2.09 pounds; thread size, 2-12NS-1.

c. DESCRIPTION. The fuze consists of a solid, hardened steel body with ogival nose, with a cylindrical well in the base end which holds an inertia firing mechanism. The firing mechanism used in the M78 is similar to the delay plunger mechanism in the M51A4 fuze and the mechanism used in the M78A1 is similar except in delay time to that of the M51A5 (par. 250) (fig. 157). Safety devices consist of two plunger pins which hold the firing assembly in the unarmed position until acted upon by rotational forces, and arrangements within the booster M25 which prevent arming until setback and centrifugal forces operate. For a complete description of booster M25, see paragraph 327.

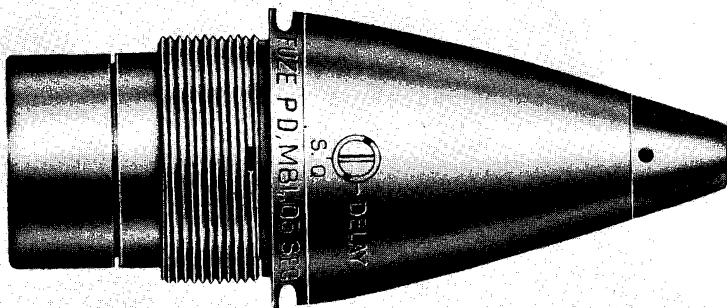
d. PREPARATION FOR FIRING.

- (1) When assembled to the shell, no further preparation or adjustment is necessary.
- (2) The fuze and booster are assembled to the shell as described below. When a staked setscrew is used to retain the original fuze and booster in the shell, the disassembly and assembly operations must be performed by or under supervision of ordnance personnel; when no setscrew is present, defuzing and refuzing may be done by qualified artillery personnel.
 - (a) Examine fuze threads in the shell and the threads on the booster M25 and fuze M78 to insure that they are in good condition. Do not use components with damaged threads.
 - (b) Remove the safety pin from the booster M25, and screw the booster into the booster cavity of the shell. Tighten the booster firmly with booster end of fuze wrench M16. Boosters which are issued without safety pins should not be used.

- (c) Screw the fuze M78 into the fuze cavity and tighten it securely with the fuze end of fuze wrench M16. Make sure the fuze shoulder seats firmly against the nose of the shell. There should be no space between the fuze shoulder and the shell. Do not stake the fuze to the shell.
- (d) Some shell have a booster set screw, but this plays no part in the use of fuze M78 and booster M25. If a setscrew is present in a shell fuzed and boosted with fuze M78 and booster M25, the setscrew should be screwed tightly into the shell so that no part of it protrudes outside of the ogival surface of the shell.

265. Fuze, PD, M81A1 and Fuze, PD, M81

a. GENERAL. The M81 (fig. 171) is a superquick and 0.05-second delay fuze. Some M81 fuze are loaded for 0.15-second delay. Contour, appearance, and mechanism (except the booster mechanism) are identical with those of the M51A4 fuze described in paragraph 250. Functioning also is like that of the M51A5. The

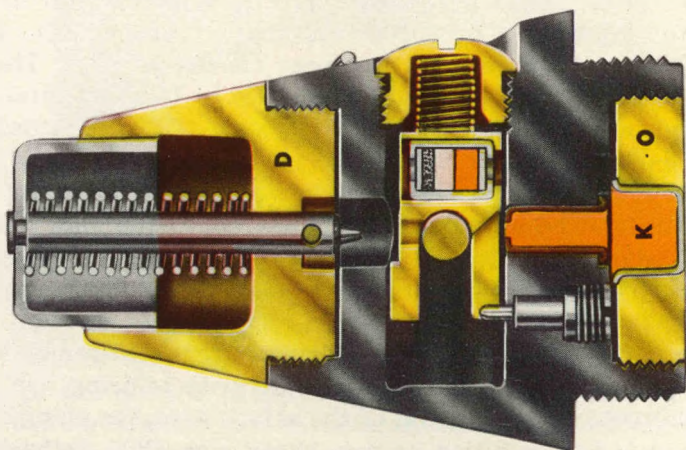
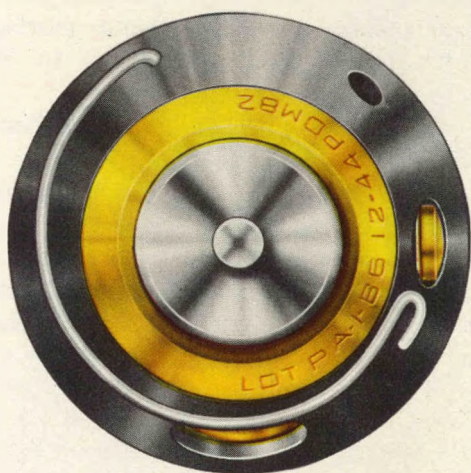
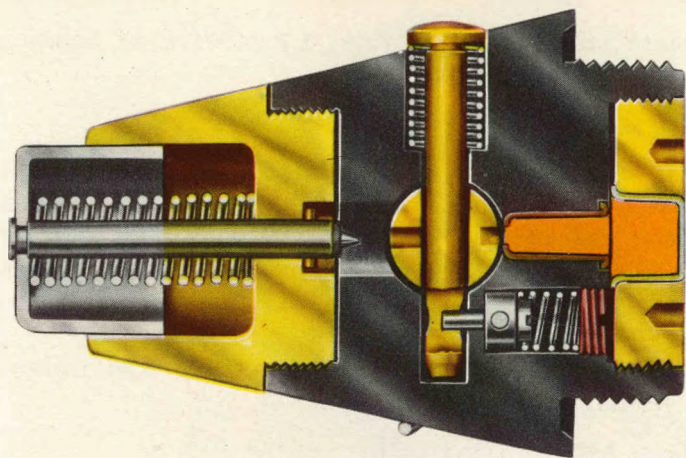


RA PD 104831

Figure 171. Fuze, PD, M81, 0.05-sec delay.

M81 is essentially the M51A4 except that it has the booster M24 instead of the M21A4. It is used with the 4.5-inch spin-type rocket because it can arm with the relatively low setback characteristic of rockets, but it can be used in case of emergency wherever the M51A4 is used. (See fuze interchangeability chart, table VI). For a description of the M24 booster, see paragraph 326. The M81A1 uses the delay plunger assembly M1 (0.05-sec delay) which also is used in the M48A3 and the M51A5 (pars. 249 and 250).

b. DATA. Length, visible, 3.74 inches; over-all, 5.93 inches (in-



RA PD 108179A

Figure 172. Fuze, PD, M82.

cluding booster); thread size of fuze, 1.7-14NS-1, of booster, 2-12NS-1; weight, 2.14 pounds.

266. Fuze, PD, M82

a. GENERAL. The M82 fuze (fig. 172) is a modification of the M52A1B1 fuze described in paragraph 252 to provide a small 10-grain booster charge (K) with brass securing plug (O) for use with the M19 burster in the M302 smoke shell for 60-mm mortars. A brass head (D) is employed. Functioning is the same as with the M52 series fuzes.

b. DATA. Length, visible, 2.36 inches; over-all, 2.86 inches; weight, 0.47 pound; thread size, 1.5-12NF-1.

267. Fuze, Time, M84

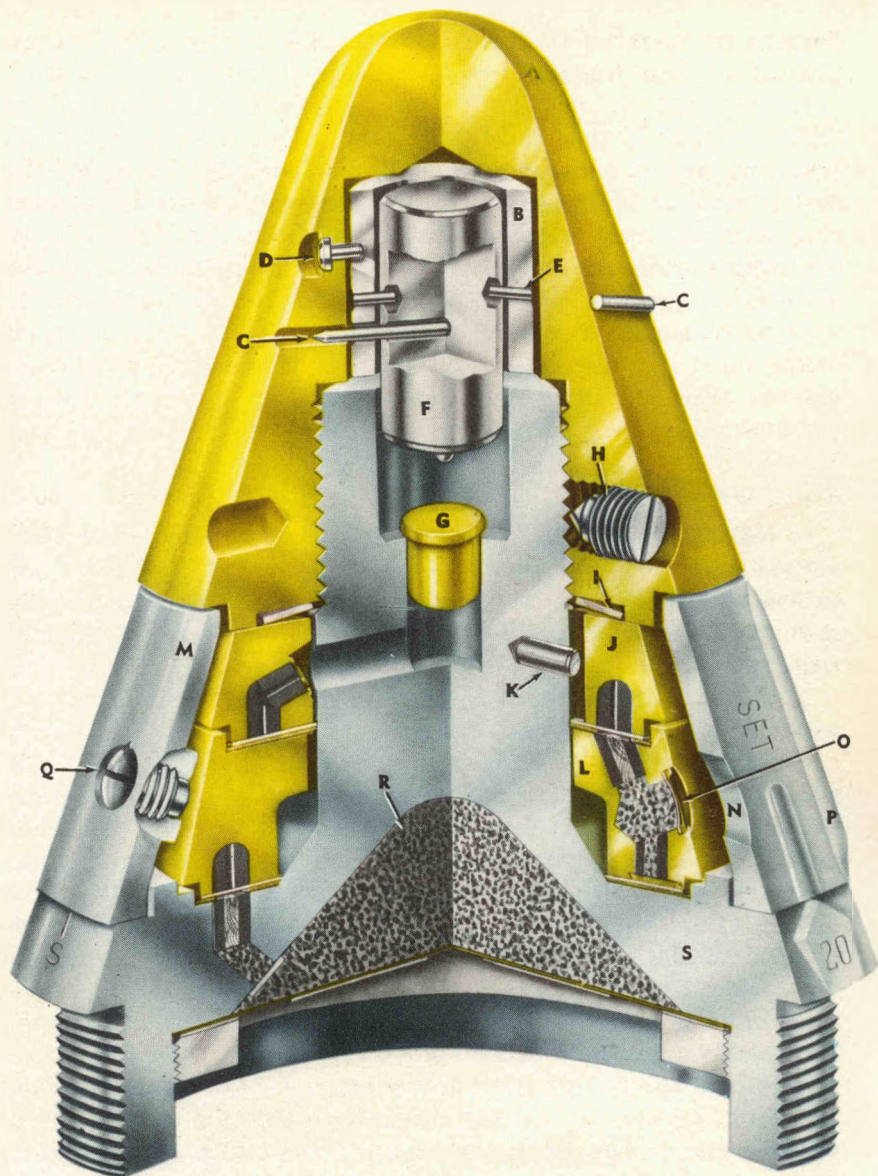
a. GENERAL. The M84 fuze (fig. 173) is a single-purpose powder-train type fuze and is standard for firing the 81-mm mortar illuminating shell M301 which has a time setting up to 25 seconds.

b. DATA. Length, visible, 3.25 inches; over-all, 3.85 inches; weight, 1.82 pounds; thread size, 2.4-18NS-1.

c. DESCRIPTION. The fuze incorporates time-train rings similar to those of the M54 fuze (par. 254) but omits the impact element. The assembly consists of a brass head (A) which holds a time-action plunger (F), and a body assembly (S) which holds the Mk 5 percussion primer (G) and expelling charge (R), the two inner time-train rings and an outer adjustment ring (M) with six equally spaced vent holes (N). The head assembly screws onto the body and is further secured in the assembled position by a setscrew (H). The upper time-train ring (J) is secured in a fixed position by a lock pin (K). The lower time-ring (L) is fixed to the outer adjustment ring by a lock screw (Q) so that the two rings move in unison. A tension washer (I) is positioned between the head and the upper time-train ring. The fuze body is graduated from 0 to 25 seconds in 1-second intervals; 5-second intervals are indicated by bosses. The "0"-second boss is of greater width and different shape than the other body bosses; "SAFE" setting position is indicated by the letter "S" on the fuze body. The adjustment ring has six raised ribs (P) for use in conjunction with the fuze setter M25, and a setting indicator rib (marked "SET") of approximately half the height and width of the other six ribs.

d. SAFETY DEVICES. Safety prior to firing is provided for by a safety wire (C) which must be removed just prior to firing.

e. FUNCTIONING. After removal of the safety wire, the plunger (F) is held in a fixed position by two shear pins (E). Setback



RA PD 108180

Figure 173. Fuze, time, M84—schematic view.

force upon firing causes the plunger to shear these restraining pins (E) and to move to the rear along the plunger guide (B) until it strikes the primer, initiating burning of the powder-train of the time-train rings. A positioning pin (D) is provided for the plunger guide. After burning through a total length of powder train which is determined by the setting of the lower time-train ring as made by means of the adjustment ring, the

burning train ignites the black powder pellet and expelling charge. The latter then produces the desired functioning of the shell.

f. PREPARATION FOR FIRING. As shipped, the fuze is set "SAFE," that is, the raised setting indicator on the movable adjustment ring is alined with the "S" on the body. To obtain the desired time of functioning, it is necessary to turn the adjustment ring with the fuze wrench M25 provided for the purpose until the setting indicator on the adjustment ring is alined with the appropriate graduation or boss on the fuze body. Counterclockwise movement of the adjustment ring (viewed from the point of the fuze) increases the fuze time. The raised setting indicator and the fuze body bosses provide a means of setting the fuze in the dark. Just prior to firing, the safety wire must be removed.

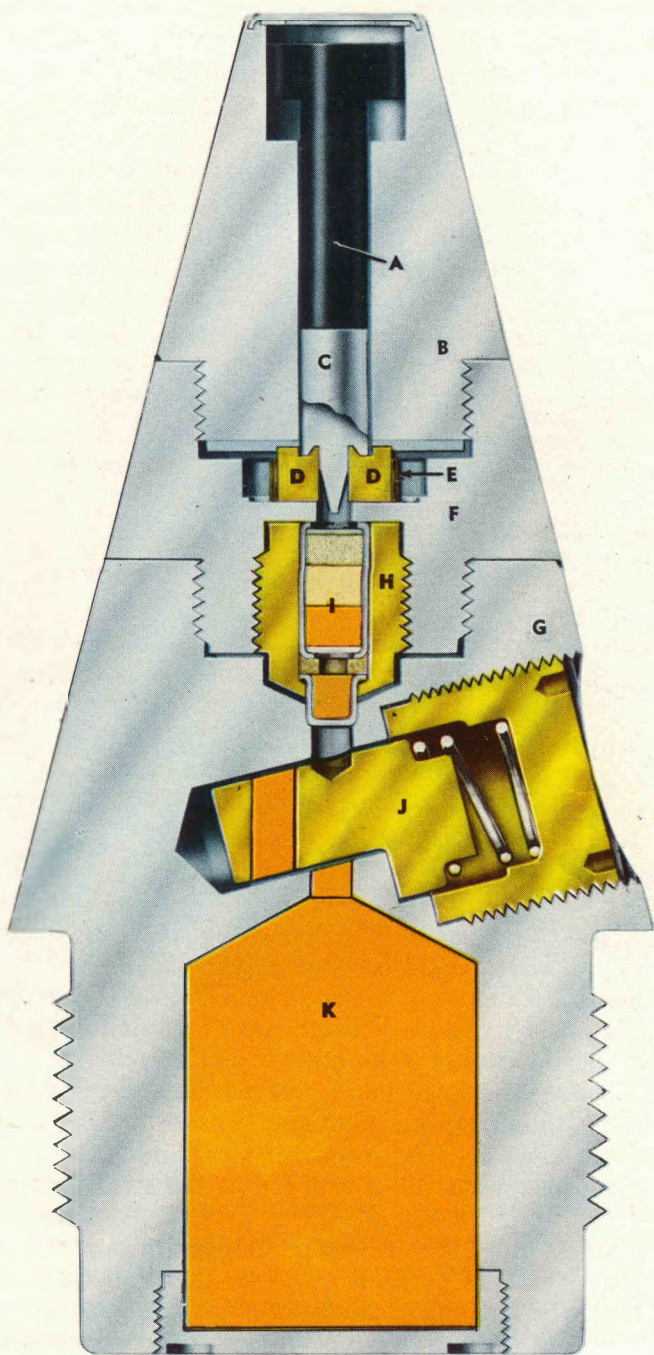
268. Fuze, PD, M85

a. GENERAL. The M85 fuze (fig. 174) embodies the same characteristics as the M56 supersensitive fuze used with 37-mm high-explosive shell M54 but is modified as to length and weight of the assembly to suit 57-mm high-explosive shell and to match the M86 fuze (par. 269).

b. DATA. Length, visible, 2.61 inches; over-all, 3.72 inches; weight, 0.42 pound; thread size, 1.50-12NF-1.

c. DESCRIPTION. Like the M56 fuze (par. 256), the M85 consists of two main parts; a head assembly; and a body (G) containing a booster charge (K) and an interrupter (J), which holds a part of the explosive train connecting the booster with the detonator (I). The head assembly is made in three parts: the head proper (F); the detonator assembly (H), which screws into the base of the head; and a nose (B). The nose holds the firing pin (C) and its striker (A), and screws into the upper end of the head in such a manner as to leave a recess below the firing pin. Half-blocks (D) and a coiled spring (E) are positioned in the recess to hold the firing pin in an unarmed position prior to firing. The front end of the nose is closed by a thin aluminum disk to prevent interference with the proper functioning due to foreign matter or air resistance. Safety in handling prior to firing and during travel through the bore of the gun after firing is provided for by the half-blocks and interrupter devices. These hold the fuze in an unarmed condition until sufficient rotational force has been set up to overcome the resistance of springs, setback, and frictional forces.

d. FUNCTIONING. The mechanism does not move immediately after firing, due to the resistance of springs, setback, and frictional forces. When sufficient rotational speed has been established to offset the resistances, the slider of the interrupter moves



RA PD-108181

Figure 174. Fuze, PD, M85.

outward, bringing the slider charge into alinement with the detonator and booster. While in the bore, setback causes the firing pin to seat firmly in the half-blocks, preventing them from flying outward. Upon leaving the bore, the firing pin "creeps" forward, and the half-blocks holding the firing pin in unarmed position now can move outward under centrifugal force, leaving the firing pin in a "floating" position with an unobstructed passage to the detonator. In this position, the fuze, is fully armed. Upon impact, the thin closing disk is perforated, or the head is crushed, depending on the force of impact. In either case, the firing pin is driven against the detonator. Action of the detonator is transmitted through the slider charge to the booster, which then causes the shell to explode.

e. PREPARATION FOR FIRING. There are no preparations.

Caution: Fuzes with perforated or imperfect closing disks will not be fired.

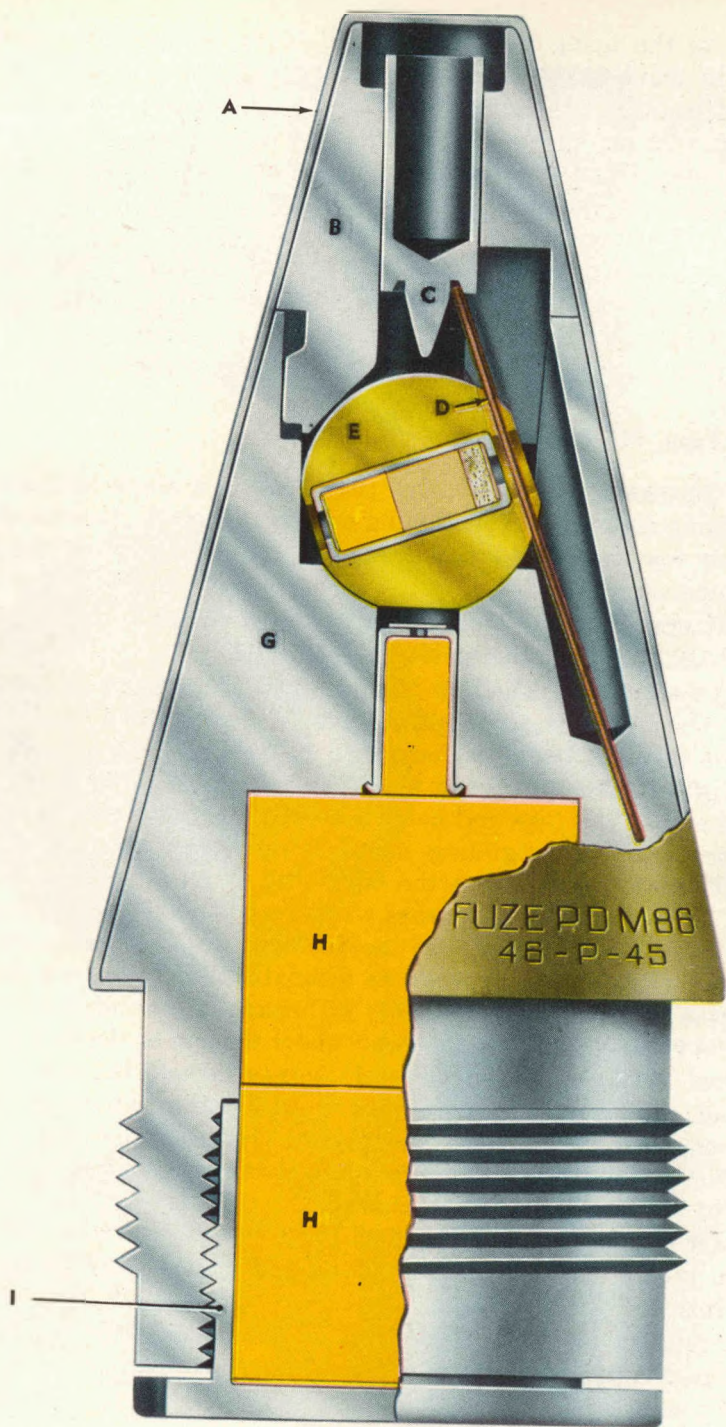
269. Fuze, PD, M86

a. GENERAL. Fuze M86 (fig. 175), like the M85 (par. 268), is provided for use with 57-mm high-explosive shell to give super-quick functioning on impact. The M86 resembles the M85 as to contour. However, the fuze mechanisms differ in that the M86 incorporates a spherical rotor-type interrupter which operates in conjunction with a safety spring to provide boresafety, instead of having a slider-type interrupter and safety blocks.

b. DATA. Length, visible, 2.58 inches; over-all, 3.69 inches; weight, 0.34 pound; thread size, 1.50-12NF-1.

c. DESCRIPTION. The fuze consists of four major parts: an aluminum head (B) which seats the direct-action firing pin (C); a body (G) which seats the rotor-type interrupter, holds the spring lock wire (D), and houses a lead charge and approximately half of the booster charge; the ball-shaped rotor (E) which houses the detonator (F); and a booster cup (I) holding about half of the total booster charge. The booster cup screws into the base of the fuze body. The head has a key which slides into a keyway in the body, thus properly alining the head and body. The fuze body and the head are held in proper position by a thin aluminum cover which also closes the front end of the striker cavity of the head.

d. FUNCTIONING. Upon firing, no immediate action of the mechanism occurs due to setback. The firing pin sets back on the spring lock wire holding it firmly in place; the lock wire, in turn, prevents the rotor from turning. As setback ceases and the speed of travel of the projectile begins to decrease, the firing pin creeps forward in its passage. This releases the spring lock wire from the



RA PD 108182

Figure 175. Fuze, PD, M86.

notch in the firing pin. Centrifugal force then causes the lock wire to move outward and the ball-shaped rotor to turn to the armed position. In the armed position, the rotor also holds the spring wire out of position so that it will not interfere with the firing pin. Upon impact, the forward end of the fuze cover is perforated or the head is crushed, dependent upon the force of impact. The firing pin, in either event, is driven against the detonator, initiating superquick action in the fuze explosive train which culminates when the booster charge causes functioning of the shell bursting charge.

e. PREPARATION FOR FIRING. There are no preparations.

270. Fuze, PD, M89

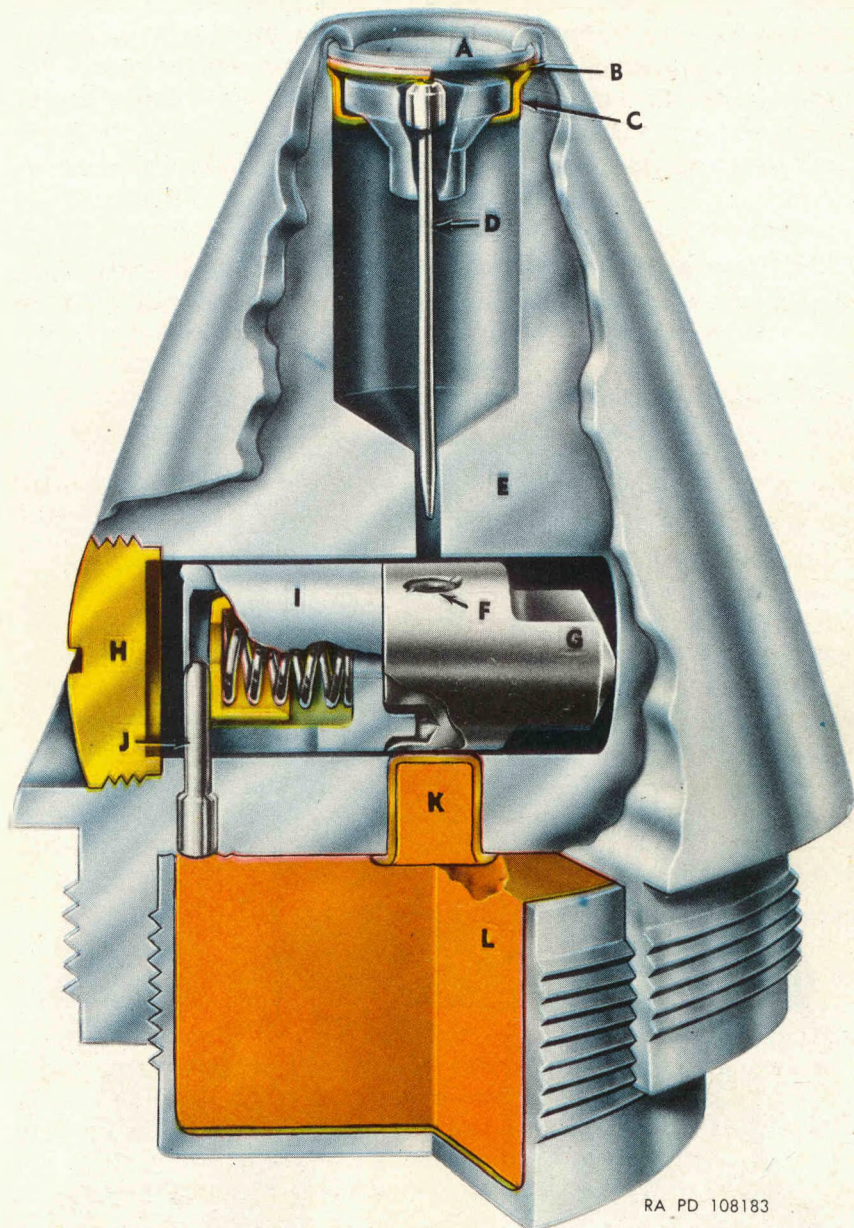
a. GENERAL. The M89 fuze (fig. 176) is a single-action type providing superquick functioning on target impact. It arms at relatively low speeds of rotation for use with 57-mm recoilless rifle ammunition.

b. DATA. Length, visible, 1.72 inches; over-all, 2.52 inches; weight, 0.37 pound; thread size, 1.7-14NS-1.

c. DESCRIPTION. The fuze is made up of either a one-piece aluminum body (E), or, as an alternative, of a body and a head which screws into the body and is staked in position. Mechanism consists of a lightweight firing pin (D) seated in a cavity at the forward end of the fuze and held in a fixed position prior to impact at the target by a gilding metal firing pin support (C). The striker cavity is closed at the outer end by an aluminum closing disk (A) supported by a brass washer (B). A rotor (G) housed in a cavity perpendicular to the fuze vertical axis holds the detonator (F). The rotor with its detonator is held in an unarmed position by a lock assembly (I) by means of two nipples which seat in two drill holes in the rotor under tension of the lock spring against the lock. A body pin (J) serves to hold the spring and spring cup in proper position and as a guide during outward movement of the lock. A closing plug (H) seals the rotor cavity against moisture and foreign matter. Explosive elements consist of the detonator, a lead charge of tetryl (K) and a 200-grain booster charge of tetryl (L) held in an externally threaded aluminum booster cup which is screwed and staked into the base of the fuze.

d. SAFETY DEVICES. Boresafety is provided by the rotor and lock mechanisms. The firing pin is protected against premature functioning by its cup support which is designed to withstand a load up to 40 pounds.

e. FUNCTIONING. After firing and upon the establishment of



RA PD 108183

Figure 176. Fuze, PD, M89.

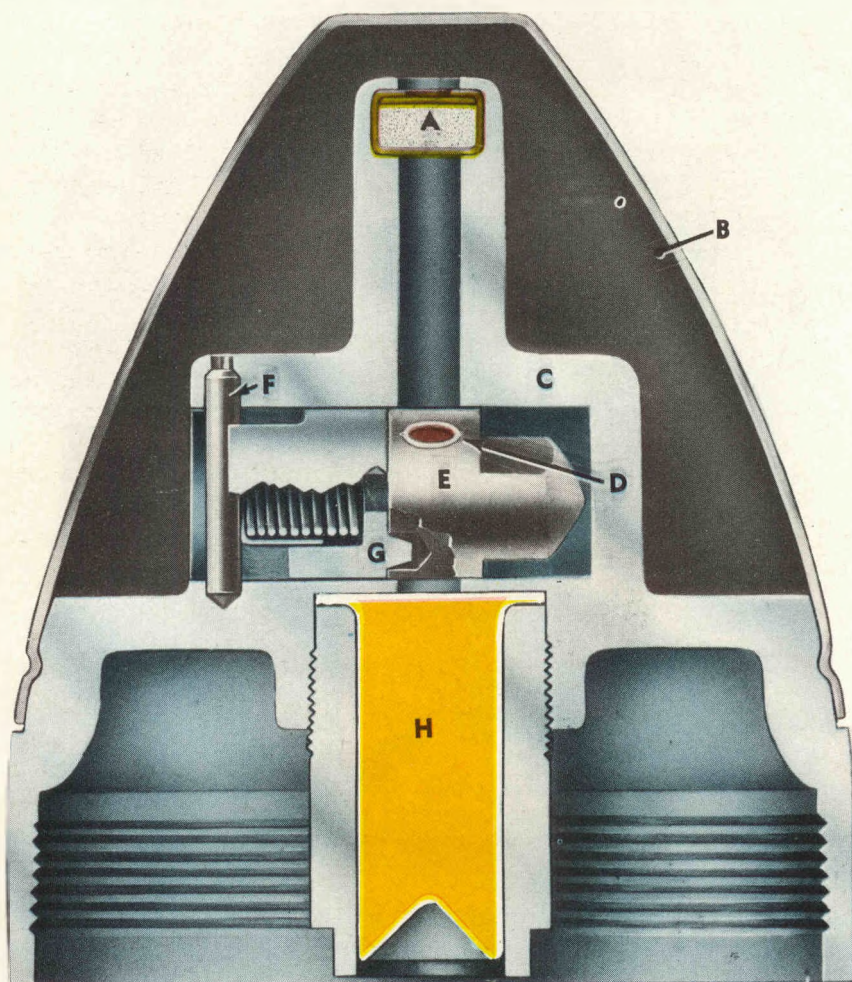
sufficient rotational force, the lock moves outward against the tension of the lock spring, releasing the rotor. After setback is over, the rotor turns to the armed position (detonator parallel to fuze axis and aligned with firing pin). This position is retained

until impact, whereupon the aluminum closing disk is perforated or crushed and the firing pin is driven through its cup support and against the detonator. Action of the detonator is transmitted through the lead charge to the booster charge, the latter causing functioning of the shell bursting charge.

f. PREPARATION FOR FIRING. There are no preparations.

271. Fuze, PI, M90

a. GENERAL. The M90 fuze (fig. 177) is a single-action, super-quick fuze designed for use with 57-mm HE, AT shell M307 for



RA PD 108184

Figure 177. Fuze, PI, M90.

recoilless rifles of that caliber. The fuze has rotor and lock mechanisms similar to the M89 fuze (par. 270, fig. 176) but differs in functioning in that the M90 has no striker, initiation being caused by impact of the target directly against the primer. Also, direction of the force of detonation is controlled within the limits in the M90 model by use of a shaped auxiliary detonating charge. A third feature is the internal (instead of the usual external) threading for seating on the shell. The M57-mm HE, AT shell M307 has external nose threads for fuzing purposes.

b. DATA. Length, visible (also over-all), 2.52 inches; weight, 0.256 pound; thread size, 2.093-18NS-1.

c. DESCRIPTION. The fuze consists of a die-cast body (C) with a neck which houses the primer (A) at the extreme forward end. A cavity in the middle of the fuze body, extending across and perpendicular to the fuze axis holds a rotor (E) and a lock (G) assembly similar to that in the M89 fuze (par. 270) and which functions in the same manner. An auxiliary detonator assembly screwed into the base of the fuze body holds a shaped auxiliary detonating charge (H). The entire forward part of the fuze body and its mechanism is covered by a thin steel ogive (B).

d. SAFETY DEVICES. Boresafety is provided for by the rotor and lock assembly, which holds the detonator (D) in the unarmed position prior to firing.

e. FUNCTIONING. Upon firing, the rotor and lock assemblies function as described in paragraph 270 to place the fuze in an armed position during flight. Upon impact, the ogive is crushed and the primer action is initiated. Action of the primer (A) is transmitted through the detonator (D) to the auxiliary detonating charge (H), which, in its turn, causes the shell to function by initiating the booster pellet at the rear end of the shell flash tube at the base of the shell.

f. PREPARATION FOR FIRING. There are no preparations.

272. Fuze, MTSQ, M500 and Fuze, MTSQ, M501

The fuze M500 has been designed to replace TSQ fuze M55A3 and mechanical time fuze M67 series. The M501 fuze has been designed to replace TSQ fuze M54. The M500, like the M55A3, has a booster attached; the M501, like the M54, has no booster. Otherwise, the M500 and M501 are exactly alike. These fuzes are described as "mechanical time superquick." They are, in effect, a combination of the mechanical time feature of the M67 series and the superquick feature of the M48 series. The M500 and M501 are designed for time settings up to 75 seconds as in the case of the M67 series. The M500 is authorized for issue for all applications where the mechanical time M67 series and time and super-

quick M55 series fuzes were authorized. Some rounds on hand are assembled with the M67 series or the M55A3 fuze. The M501 is authorized for issue for all applications where the TSQ fuze M54 was authorized. Some rounds on hand are assembled with the M54.

273. Fuze, MTSQ, M502

This fuze has been designed to replace the M43 series fuzes. It consists essentially of the 30-second fuze M43A4 combined with a supersensitive superquick impact element patterned after that included in the PD fuze M56 (par. 256). The M502 is authorized for issue for all applications where the M43 series fuzes were authorized. Some rounds on hand are assembled with the M43A3 and M43A4 fuzes.

274. Fuze, PD, M503 (T190)

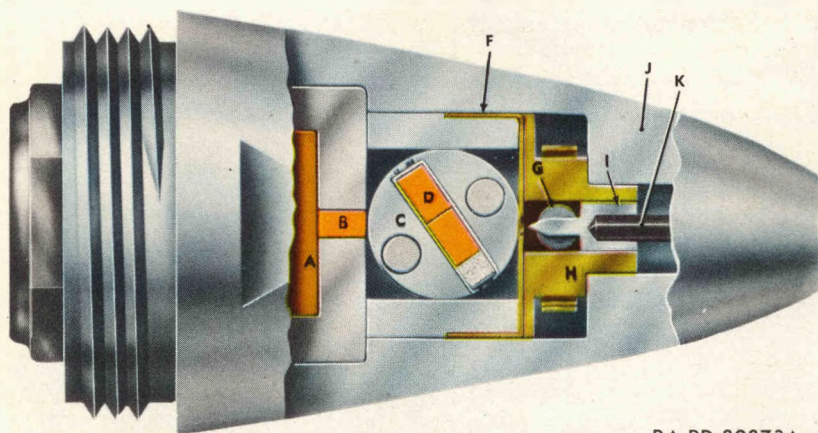
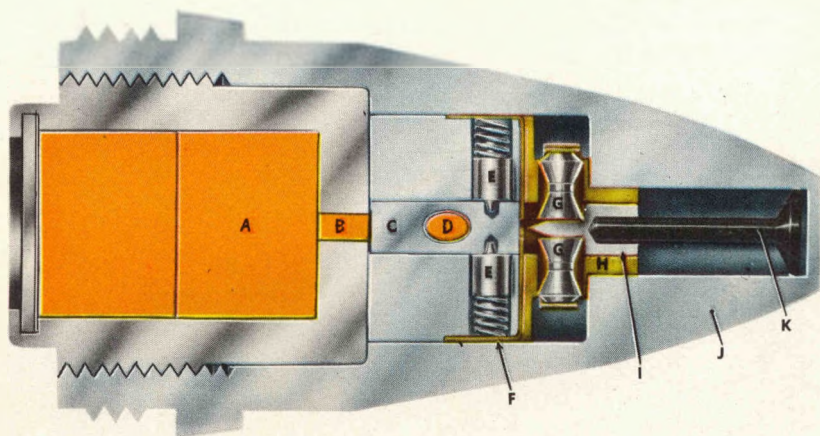
This fuze is standard for use with HE cartridge M306A1, TP M306A1, and smoke WP M308A1, in the 57-mm rifles. It replaces the fuze M89 in new rounds. The M503 incorporates a spherical rotor as an inertia element, thereby making the fuze graze sensitive. The use of the spherical rotor not only provides detonator safety and graze sensitivity in a simple design but also achieves the added characteristics of delayed arming for a range of about 70 feet from the weapon, with reliable arming obtained at a range of 100 feet.

275. Fuze, PD, MK 27 (Navy)

a. GENERAL. The Mk 27 (fig. 178) is a point detonating fuze of Navy origin which has been standardized for Army procurement for use with 40-mm high-explosive ammunition. It is a single-action superquick type constructed to function on light impact.

b. DATA. Length, visible, 1.9 inches; over-all, 2.45 inches; weight, 0.22 pound; thread size, 1.18-14NS-2.

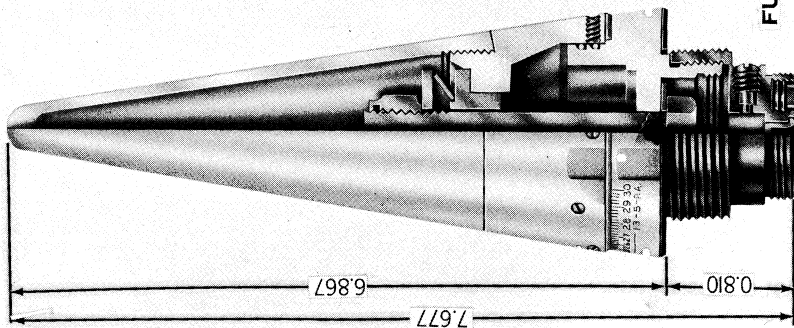
c. DESCRIPTION. The fuze mechanism consists of a firing pin (I), a striker (K), and a rotor assembly (F) holding a disk-shaped rotor (C). The explosive train consists of a detonator (D), a tetryl booster lead (B), and a tetryl booster charge (A). The fuze is made up of two major parts: a body (J) recessed to hold the firing pin with its striker, and the rotor assembly; and a base plug which holds the booster lead and booster charge. The base plug also serves to seat the rotor assembly securely in its recess when the fuze is assembled. The rotor is seated in the rotor assembly so that it can revolve only on an axis perpendicular to the



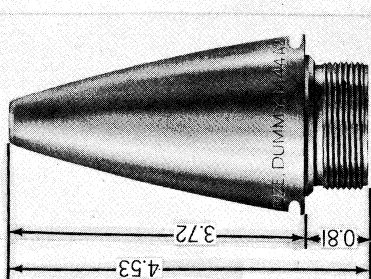
RA PD 80873A

Figure 178. Fuze, PD, MK 27 (Navy).

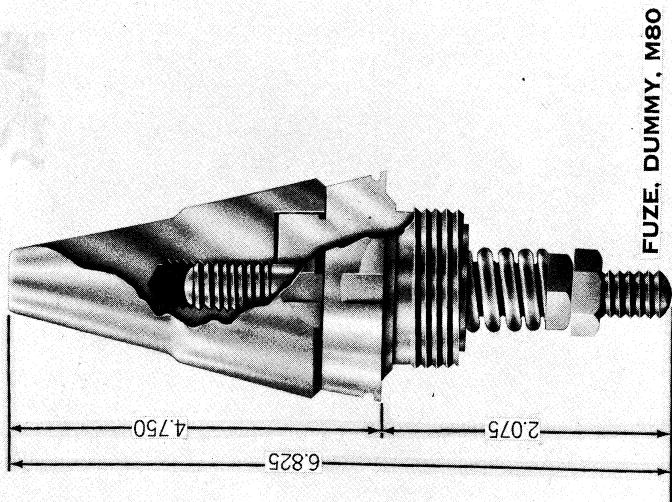
major axis of the fuze, and normally holds the detonator out of alinement with both the booster and the firing pin. Two centrifugally actuated plunger pins (E) under spring tension lock the rotor in the unarmed position until a prescribed minimum centrifugal force has been established. A bushing (H) in the forward



FUZE, DUMMY, M79



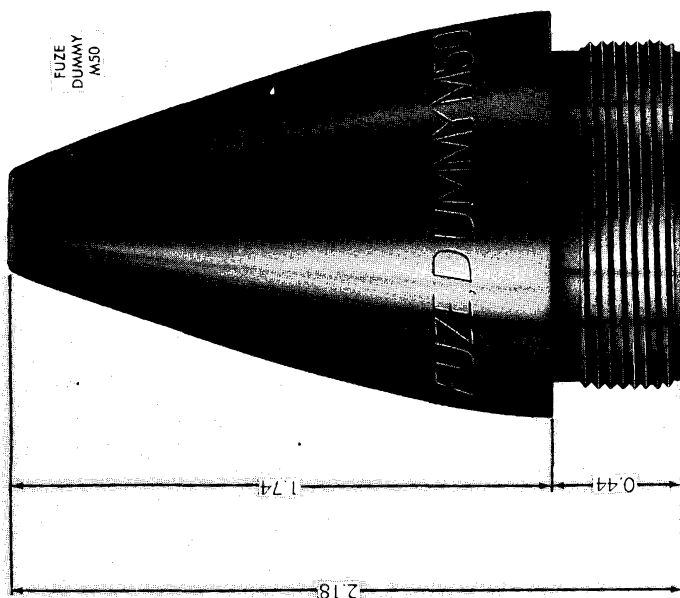
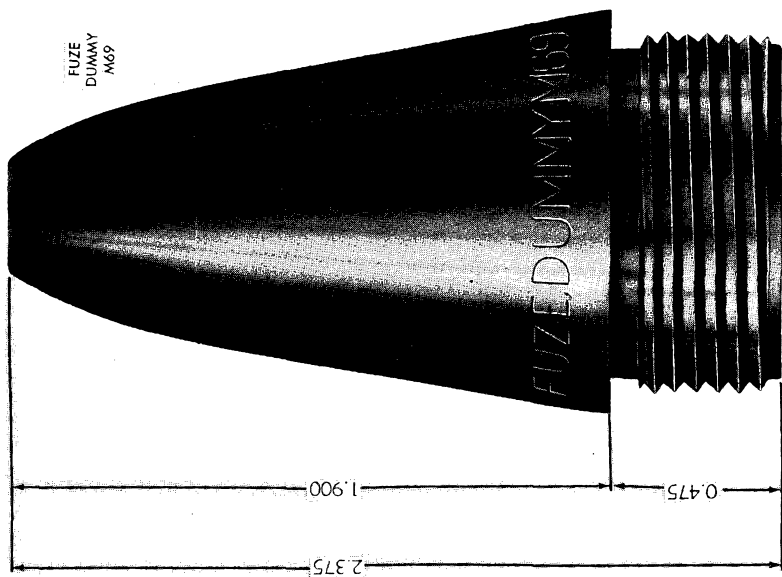
FUZE, DUMMY, M44A2



FUZE, DUMMY, M80

RA PD 109524

Figure 179. Dummy fuzes—simulated time fuzes.



RA PD 80701A

Figure 180. Dummy fuzes—simulated small caliber fuzes.

end of the rotor assembly recess forms a guide for the firing pin. A peg-like striker is secured to the forward end of the firing pin and occupies a narrow recess extending almost to the front end of the fuze, providing for increased sensitivity on impact. The firing pin is supported by two spring-held plunger pins (G) until sufficient centrifugal force has been established after firing to overcome the resistance of the plunger springs.

d. **FUNCTIONING.** No action takes place upon firing until a prescribed centrifugal force has been set up by rotation of the projectile in its travel, whereupon the plunger pins holding the rotor and those supporting the firing pin move outward. Upon release from its pins, the rotor revolves, bringing the detonator into alinement with the firing pin and the booster. Upon the outward movement of its plunger pins, the firing pin has an unobstructed passage to the detonator, but remains at the forward end of the fuze until impact, due to creep action. On impact, the striker rebounds from the impact, which is transmitted through the thin front section of the nose and forces the firing pin against the detonator. Action of the detonator is transmitted to the lead and booster charge, whereupon functioning of the booster charge causes the shell to explode.

e. **PREPARATION FOR FIRING.** There is no preparation for firing.

276. Dummy Fuzes

a. **GENERAL.** Dummy fuzes (figs. 179 through 181) are provided for use with ammunition, such as target practice and drill, which does not require a normal full-functioning fuze. Fuzes may be manufactured especially for the purpose (dummy fuzes), or may be assembled from burned out or rejected inert parts of service fuzes (inert fuzes). Whether assembled from service parts or especially manufactured for the purpose, the assemblies are completely inert. In general, the fuzes are intended to simulate a specific model, or one type of service fuze. Contour and weight of the service fuze which is being simulated are approximated closely in the dummy fuze for use with practice ammunition, and to give the proper "feel" when used with drill ammunition. This policy also permits the use of drill ammunition in conjunction with fuze setters for training in preparing ammunition for firing and in servicing the piece. Most dummy fuzes are extremely simple in construction but essential features of the simulated service fuze are incorporated in some types. Instances are FUZE, dummy, M59 and M73, which have a setting screw and registration similar to that in M48 and M51 type fuzes.

b. **DATA.** Dummy fuzes now in use are listed in table VI together with essential information thereon.

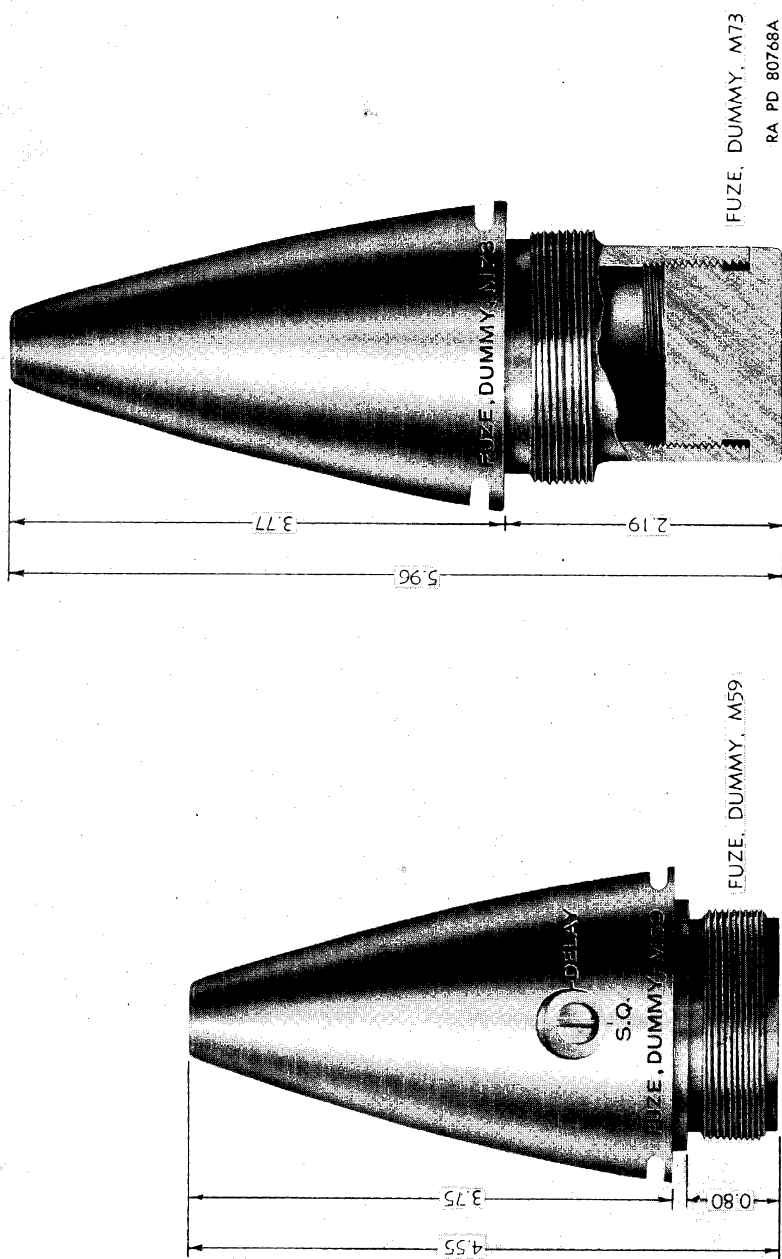


Figure 181. Dummy fuzes—simulated M48 and M51 series fuzes.

FUZE, DUMMY, M73
RA PD 80768A

FUZE, DUMMY, M59

Table VI. Dummy Fuze Data

Fuze	Materials used in construction	Length (in)		Wt	Thread size	Inter-changeability ¹	Ammunition with which used	Service fuze simulated
		Over-all	Visible					
FUZE, dummy, M44A2.	Manganese bronze; or naval brass; or aluminum alloy; or copper-silicon alloy; or silver-iron.	4.53	3.72	1.90	1.7-14NS-1	(*)	M12 drill cartridge for 90-mm guns; M71 TP round for 90-mm guns. ²	FUZE, time, mechanical, M43 (all mods), w/o booster. ³
FUZE, dummy, M50.	M50—plastic--- M50B1—steel (ogive with 360° under crimp to base). M50B2—steel (1-piece). M50B3—steel (ogive side crimped to threaded base).	2.18	1.74	2.56	1.125-20NS-1	(**)	M21 drill cartridge for 37-mm guns M1A2 and AN-M9. M55A1 TP round for 37-mm guns M1A2, M10, and AN-M9.	FUZE, PD, M56.

See page 332 for footnotes.

FUZE, dummy, M59.	Steel -----	4.55	3.75
FUZE, dummy, M69.	M69—plastic; (or aluminum alloy). M69B1—steel M69B2—zinc alloy.	2.375	1.90
FUZE, dummy, M73.	Steel -----	5.71	3.77
FUZE, dummy, M79.	Aluminum alloy and brass.	7.677	6.867

See page 332 for footnotes.

1.4	1.7-14NS-1	(***)	M14 drill cartridge for 105-mm how. M16 drill cartridge for 75-mm gun. M19 drill cartridge for 75-mm how. M20 drill cartridge for 76-mm gun. M71 TP round for 90-mm gun. ²	FUZE, PD, M48A2, M51A4 w/o booster (in- cluding selec- tive setting screw and registration).
0.225	1.18-14NS-1	(**)	M91 TP-T round for 40-mm gun. Mk 2 TP-T round for 40-mm gun. M25 drill cartridge for 40-mm gun.	FUZE, PD, Mk 27 (Navy).
2.15	2-12NS-1	(**)	M71 TP round for 90-mm guns. ⁴ M48 TP round for 75- mm subcaliber guns. ⁶ M309 TP round for 75-mm rifle.	FUZE, PD, M48A2 w/booster, and M51A4.
2.72	2-12NS-1	(**)	M15 dummy projectile for 120-mm gun.	FUZE, time, mechanical, M61A1.

Table VI. Dummy Fuze Data—Continued

Fuze	Materials used in construction	Length (in)		Wt	Thread size	Interchangeability ¹	Ammunition with which used	Service fuze simulated
		Over-all	Visible					
FUZE, dummy M80.	Steel body, brass nose.	6.825	4.750	3.37	1.7-14NS-1	(*)	M12 drill cartridge for 90-mm guns. M71 TP round for 90-mm guns. ²	FUZE, time, mechanical, M43A4, including provision for simulating adjustment. ³
FUZE, dummy, M88.	Steel body, gilding metal closing cap.	3.18	0.80	1.41	1.5-12NS-1LH	(**)	Formerly used with TP-T round M67 for 105-mm howitzers.	FUZE, BD, M91.

¹ Interchangeability:

* FUZE, dummy, M44A2, and FUZE, dummy, M80, may be used interchangeably in drill except when the drill cartridge is to be used in conjunction with automatic fuze setters.

** These fuzes are adaptable for use only in the ammunition for which they are authorized.

*** FUZE, dummy, M59, may also be used as a replacement for the FUZE, dummy, M73, in the M48 TP round for 75-mm guns when an inert M20 or M20A1 booster is used in conjunction with the M59 fuze. The M59 fuze is threaded to suit the internal threading of the M20 and M20A1 booster; the booster is threaded externally to suit the nose threads of the M48 practice shell.

² FUZE, dummy, M44A2; FUZE, dummy, M59; and FUZE, dummy, M80, are alternative fuzes for FUZE, dummy, M73, for use with the M71 TP round.

³ FUZE, dummy, M44A2, and M80 also simulate FUZE, PD, M48A2, with respect to forward contour, and may be used interchangeably with FUZE, dummy, M59, when the differences in weight do not affect the desired results.

⁴ FUZE, dummy, M73, is standard for this round. For alternatives, see footnote 2.

⁵ FUZE, dummy, M73, is alternative fuze for the inert PD, M48 fuze for use with this round.

Section II. PROPELLING CHARGES

277. General

a. GENERAL DISCUSSION.

- (1) *Assembly.* Propelling charges consist of propellant powder (essentially nitrocellulose plus other ingredients) with an igniter of black powder, assembled in a suitable container. Generally, in fixed, semifixed, and separated rounds, the full igniter charge is present in a tube attached to the percussion element of the primer. In certain cases, however, such as ammunition for the 75-mm rifle, a supplementary igniter charge is located in the forward end of the cartridge case. See section III, this chapter, for a description of artillery primers. In separate-loading rounds, the igniter charge is assembled in a bag sewed to the base end of the propelling charge bag and in some cases includes a core running through the center of the propelling charge bag. See paragraph 9c for a brief listing of different types of propellant powders.
- (2) *Types of grains.* To control the burning of propellant powder to obtain the desired performance in a particular weapon, the powder is manufactured in several types of grains, shown in figures 182 and 183. See TM 9-1900 and TM 9-2900 for discussions of the types of powder grains and compositions.
- (3) *Flashless and smokeless characteristics.* Whether the ammunition upon firing has flashless, smokeless, or flashless-smokeless characteristics depends chiefly upon the chemical composition of the propellant, the design of the ignition system, and the characteristics of the weapon in which fired. Variable factors which must be allowed for in the original design of the flashless-smokeless ammunition are weapon temperature, degree of wear of weapon, and weather conditions. The terms "FNH" and "NH" were used originally to differentiate between pyro powder and the later-developed less-hygroscopic compositions. The terms "FNH" and "NH" were intended to imply that the propellant was flashless-nonhygroscopic or nonhygroscopic, respectively. This practice has been discontinued; propellant compositions now are given model designations. In order to indicate the performance of ammunition, the word "FLASHLESS," "SMOKELESS," or "FLASHLESS-SMOKE-

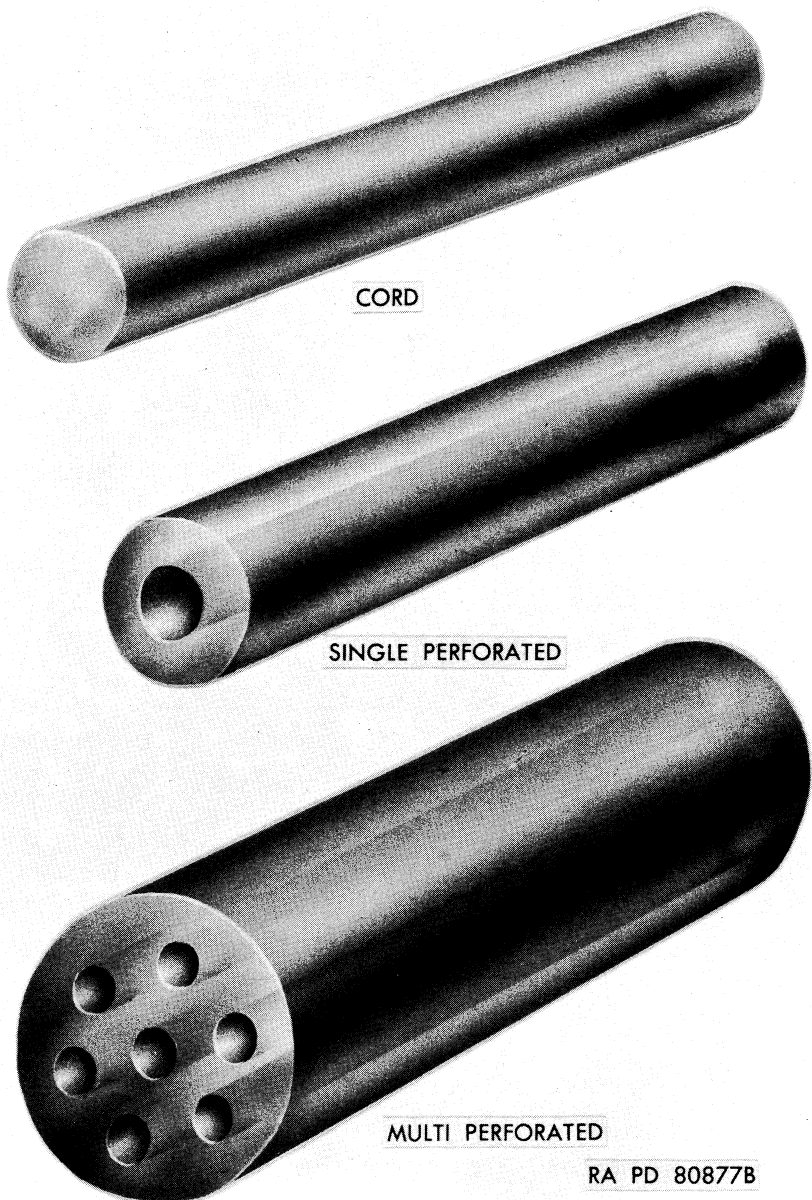


Figure 182. Types of powder grains.

LESS" is stenciled on each complete round and on packing containers. Flashless ammunition does not flash more than 5 percent of the time in weapons having average wear and under average conditions. Smokeless ammunition produces less than half the amount of smoke

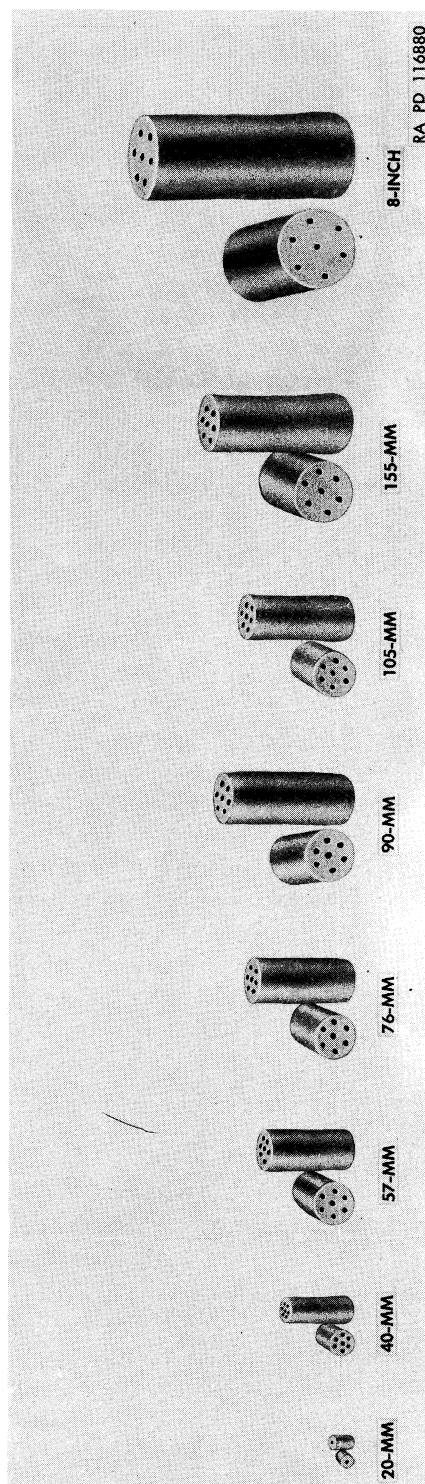


Figure 183. Comparative sizes of powder grains.

produced by ammunition not so designated. Complete rounds having both of these characteristics are designated "Flashless-Smokeless."

- (4) *Flash reducers.* For certain weapons, a flash reducer, consisting of a charge of black powder and of a cooling agent (an inorganic salt such as potassium sulfate), assembled in cloth bags, may be added to a propelling charge to aid in reducing flash upon firing. These flash reducers are intended primarily for night firing.

b. CONTAINERS FOR PROPELLING CHARGES. The powder grains comprising a propelling charge are assembled in suitable containers, cartridge cases, or cartridge bags, so that the exact quantity of powder may be loaded conveniently into the weapon.

c. FIXED, SEMIFIXED, AND SEPARATED CHARGES.

- (1) *Cartridge case.* A cartridge case, made of drawn brass or steel, serves as the container for the propelling charge in the case of fixed and semifixed artillery ammunition. It has a profile and size to conform to the chamber of the weapon for which the case is intended. The head of the case is relatively thick and has a flange to permit mechanical extraction and to seat the round in the gun. Those rounds used in automatic guns usually have cartridge cases with extracting grooves instead of flanges or rims. The cartridge case holds the primer, propelling charge, and the projectile (except for separated charges) so that the assembly can be inserted into the weapon in one operation. A secondary function is to provide for obturation. The mouth of the case is sufficiently thin to be expanded by the pressure of the burning gases to a tight fit against the side of the weapon chamber, thereby preventing the escape of gas to the rear.
- (2) *Propelling charge in fixed ammunition.* The propelling charge in a round of fixed ammunition is loose powder in the cartridge case. In some instances where the charge is not large enough to fill the case completely, a distance wadding, usually a cardboard disk and cylinder, is inserted in the neck of the cartridge case, between the powder charge and the base of the projectile. In some cases where the primer charge is insufficient for satisfactory ignition of the propelling charge, a supplementary igniter charge of black powder is attached to the distance wadding to supplement the primer ignition.
- (3) *Propelling charge in semifixed ammunition.* The propelling charge in a round of semifixed ammunition is in cartridge bags in the cartridge case. Since the car-

tridge case is fitted loosely to the projectile, some of the bags of powder of the charge may be removed prior to firing to provide for zone firing.

- (4) *Propelling charge in separated ammunition.* In "separated" ammunition, the separate-loading propelling charge is contained in a cartridge case. The charge is loaded loosely in a brass cartridge case which is closed by a plug made of palmetto pulp or cork. An igniter may be placed around the primer to insure proper ignition.

d. MORTAR PROPELLING CHARGES.

- (1) The propelling charges for mortar ammunition are made up of removable parts or increments to provide for zone firing and an ignition cartridge. The increments consist of stitched pads of sheet powder having a hole in the center of each increment. In present practice, each increment is sealed in a cellophane bag and "A1" is added to the model designation of the increment; for example, M1A1, M2A1, and M3A1. One increment is fitted into each of the spaces between the blades of the fin; or the sheet-type increments may fit around the "boom" just ahead of the fins. The ignition cartridges are inserted into the hollow base of the fin assemblies ahead of the primer.
- (2) In case all the increments are removed from a round for firing charge 0, the ignition cartridge serves solely as the propellant.

e. SEPARATE-LOADING CHARGES.

- (1) Cartridge bags form a suitable and convenient means of containing the smokeless powder charge in separate-loading ammunition. Cartridge bag cloth normally is made of silk. Bags made of rayon sometimes are used to replace silk. Only certain ash-free grades of this fabric are suitable, however; otherwise, there might be smoldering fragments in the bore of the cannon after firing. This would be particularly undesirable, as the products of combustion of smokeless powder are inflammable when mixed with the requisite amount of air, thus resulting in a reignition of gases known as a "flareback" (par. 12l). Cartridge-igniter pads are made of silk and the cloth is similar to cartridge bag cloth except that it is more closely woven to prevent the black ignition powder from sifting through. In order to indicate clearly that they contain black powder, all igniters are dyed bright red.
- (2) As a precaution to prevent flareback, in addition to the

use of certain ash-free grades of fabric in cartridge bags, the weapon chamber is wet-sponged after each shot is fired.

- (3) Separate-loading propelling charges in general, are of the multisection type which may be subdivided into "base an increment," "equal section," and "unequal section" types.
 - (a) The "base and increment" type of propelling charge consists of a base section or charge and one or more increments. The increments may be of equal or unequal weights but usually weigh less than the base section. With some types, one igniter pad is attached to the base end of the base section only, while other types have a core-type igniter in the base section and sometimes in one or more increments as well.
 - (b) The "equal section" charge also is known as an "ali-quot part" charge. As the name implies, these charges are divided into a given number of equal sections. In those designs in which the igniter pad is separate, tying straps are provided for attaching the igniter to the propellant charges. In other designs, the igniting charge is divided into parts, there being an igniter pad attached to the base end of each section.
 - (c) The "unequal section" type consists of one full charge, either divided into separate bags of unequal portions of the whole, or divided into separate bags of fractional proportions to the whole, such as three sections and two sections.
- (4) In certain cases, two types of propelling charge are provided for one howitzer—one for inner, the other for outer zones of fire. The cloth of the bags for the inner zones is dyed green to distinguish that charge from the other type which is assembled in undyed (white) bags. Accordingly, these two types are called "green bag" and "white bag" charges.
- (5) Igniter pads for certain earlier charges may be issued with commercial safety pins holding them in place during shipment. If so, the charge should not be placed in the gun with the igniter fastened thereto by safety pins; before firing, the safety pins should be removed and the igniter pad attached to the charge by sewing it on, the stitching being caught in at least three places 120° apart. The stitching should be through the edge of the igniter pad outside of the black powder. Care must be taken to have this red igniter pad at the rear of the charge, as the

charge probably will fail to ignite upon firing if the igniter pad is not in its proper place.

- (6) Only one igniter should be used with a powder charge, regardless of the number of sections making up the charge or the number of igniters furnished. It is the practice to pack one igniter in each cartridge storage case. Surplus igniters remaining after a practice should be destroyed.
- (7) Separate-loading propelling charge data are given in table VII.

Table VII. Separate-Loading Propelling Charge Data

Nomenclature	Maximum length (in)	Maximum diameter (in)	Nominal weight (approx) (lb)
CHARGE, propelling, M19, for 155-mm gun M2.	37.4	6.5	31
CHARGE, propelling, M3, for 155-mm howitzer M1.	16.	5.	5
CHARGE, propelling, M4, for 155-mm howitzer M1.	21.	5.8	13
CHARGE, propelling, M4A1, for 155-mm howitzer M1.	21.	5.8	13
CHARGE, propelling, M9, for 8-in gun M1, 240-lb proj.	50.5	8.2	75
CHARGE, propelling, M10, for 8-in gun M1, 240-lb and 260-lb proj.	58.5	9.	105
CHARGE, propelling, M13, for 8-in gun M1----	57.5	8.4	90
CHARGE, propelling, M1, for 8-in howitzer----	21.	6.5	13
CHARGE, propelling, M2, for 8-in howitzer----	24.	7.75	28
CHARGE, propelling, M23, for 240-mm howitzer M1.	50.	8.4	78

f. IGNITER-PROTECTOR CAPS.

- (1) On single-section charges, in order to protect the igniting charge of black powder in the ends of the charge, igniter-protector caps are furnished. These usually consist of cup-shaped cloth covers about 5 inches deep which fit over each end of the single-section charge. They are fastened to the charge by means of a drawstring at the open end of the igniter-protector cap and by a wide cloth trace which passes longitudinally around the charge over the igniter-protector caps, the ends of the trace being tied together at one end. Igniter-protector caps are furnished also on multisection charges when they are shipped with the igniter pad in place. Only one igniter-

protector cap is furnished, since the igniter is on only one end of the charge.

- (2) The igniter-protector cap is made of heavy cloth, or heavy paper, for 155-mm charges, with a disk of thick felt sewed on the inside of the bottom. A cloth handle is sewed on the outside of the bottom to facilitate removal of the cap. The igniter-protector cap must be removed from the charge before loading the charge in the gun, otherwise the flame from the primer will not ignite the charge because it cannot penetrate the cap.
- (3) The side of the igniter-protector cap is stenciled with the words IGNITER PROTECTOR CAP (formerly PRIMER PROTECTOR CAP) followed by the size and model of the weapon. The words REMOVE CAP BEFORE INSERTING IN GUN are stenciled in two places on the bottom and in one place on the side of the igniter-protector cap.

g. IDENTIFICATION OF SEPARATE-LOADING PROPELLING CHARGES. Separate-loading propelling charges may be identified from—

- (1) Marking on the charge (par. 11*d*(2)(*c*)).
- (2) Marking on packing containers (par. 16*f*).
- (3) From the propelling charge data tag which usually is tied to one of the typing straps.

Note. This tag must be removed before inserting the charge in the weapon.

h. PACKING AND SHIPPING DATA. Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL's P-2, P-8, R-2, and R-6.

278. Charge, Propelling, for 20-mm Guns

Ammunition for 20-mm guns is of the fixed type. Powder M12, weight 0.07 pound, is the standard propellant for loading in 20-mm ammunition; it is composed of single perforated grains.

279. Charge, Propelling, for 37-mm Guns

Ammunition for 37-mm guns is of the fixed type. The weight of powder charge varies from approximately 2 to 9 ounces of powder, depending on the model of the gun. For some guns, single-perforated grains are used; for others, multiperforated grains.

280. Charge, Propelling, for 40-mm Guns

Ammunition for 40-mm guns is of the fixed type. Powder M1, about 0.65 to 0.72 pound, is used as the propellant.

281. Charge, Propelling, for 57-mm Guns and Rifles

Ammunition for 57-mm guns and rifles is of the fixed type. Powder of M6 composition, about 2½ pounds in weight, is used for the gun; and of M10 composition, about 1 pound weight, for the rifle.

282. Charge, Propelling, for 60-mm Mortars

The propelling charge for 60-mm mortars consists of an ignition cartridge and four increments. The ignition cartridge M5A1 serves as the propelling charge for extremely short ranges. Increments provided for zone firing consist of stitched bundles of sheet powder, each having a hole in the center and a slit from the hole to the outer edge. See section VI, chapter 2.

283. Charge, Propelling, for 75-mm Guns and Rifles

a. FOR GUN. Ammunition for 75-mm guns is of the fixed type. The propelling charge for the gun consists of powder M1 or M2. Three weights of charge are used. The propelling charge weighing 0.56 pound is referred to as the reduced charge. This type of charge is used with high-explosive and chemical shell. The propelling charge weighing 1.13 pounds is called the normal charge. It is intended for normal firing of the HE and chemical shell at normal muzzle velocity (1,500 fps). The charge weighing 2 pounds is called the supercharge, and is intended for extreme velocities and ranges. Approximately this same weight of charge is used also with armor-piercing projectiles.

b. FOR RIFLE. For the 75-mm rifle, the charge is fixed and consists of approximately 3 pounds of smokeless powder M10.

284. Charge, Propelling, for 75-mm Howitzers

Ammunition for the 75-mm howitzers is of the fixed and semi-fixed type. In the case of the fixed type, the charge for the HE, AT-T round, consists of double base M2 powder weighing 0.41 pound, and is poured loosely in the cartridge case. The charge for the M89B1 smoke round consists of M2 powder and weighs 0.19 pound. In the case of the semifixed rounds, the propelling charge (single base M1 powder) consists of a base section, which is secured to the base of the cartridge case, and three increments. The charge for the HE M41A1 and M48 rounds and for the M64 gas and smoke rounds weighs 1.06 pounds. Each of the increments is connected in sequence by means of a string to the base charge (sec. VIII, ch. 2).

285. Charge, Propelling, for 76-mm Guns

Ammunition for the 76-mm gun is of the fixed type. The propellant consists of M6 powder of about $3\frac{3}{4}$ pounds' weight. The reduced charge weighs about $1\frac{1}{8}$ pounds. Dependent upon performance in the weapon, 76-mm rounds are designated as flashless, smokeless, or flashless-smokeless (par. 118e).

286. Charge, Propelling, for 81-mm Mortars

These propelling charges consist of an ignition cartridge and propellant increments of stitched sheet powder similar to those used for the 60-mm mortar. Either four or six increments comprise a full charge, depending on the weight of shell. The weight of the propellant increments for the HE M43A1, TP M43A1, and TP M44 rounds is 700 grains; the weight for the HE M56, the smoke M57, and illuminating M301 rounds is 820 grains. All increments of all types of charges are removable as required for zone firing (sec. XI, ch. 2).

287. Charge, Propelling, for 90-mm Guns

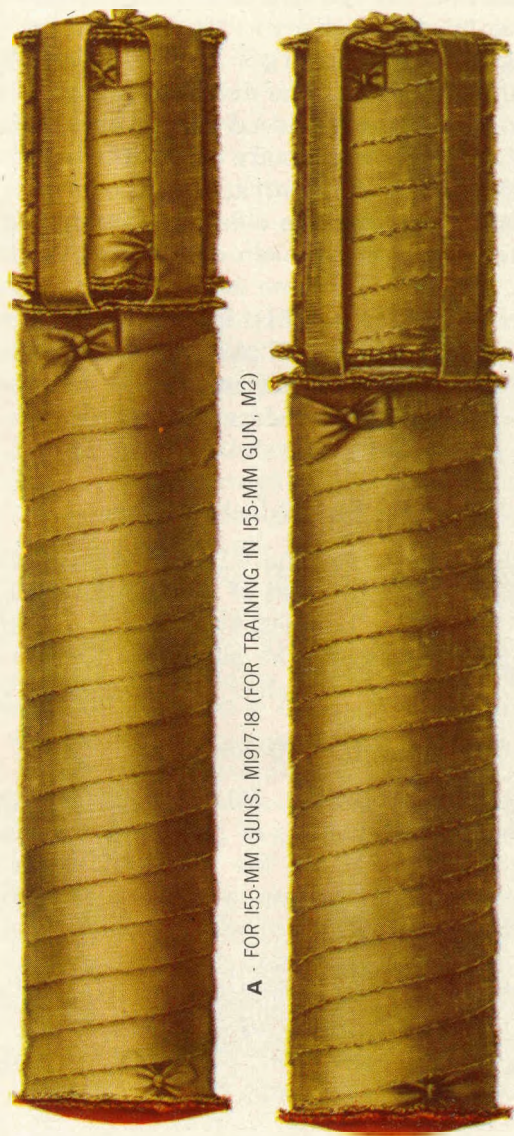
Ammunition for 90-mm guns M1, M2, M3, and T8 is of the fixed type. A propelling charge of powder is held loosely in the cartridge case with or without the assistance of a distance wad. The charge for the APC projectile and for HE projectiles, time fuze, is M6 powder; that for HE projectile, impact fuze, is M15 propellant. Dependent upon performance in the weapon, 90-mm rounds are designated as flashless, smokeless, or flashless-smokeless (par. 277a (3)).

288. Charge, Propelling, for 105-mm Howitzers

a. The propelling charge for HE semifixed ammunition for 105-mm howitzers is divided into parts to provide for zone firing. The propellant powder used is the M1 type. For the M2A1 and M4 howitzers, the full (outer zone) charge consists of a base charge and six increments, thereby providing for seven zones of fire with the M1 high-explosive projectile, and the M84 and M60 smoke shell. The assembled charge weighs approximately 3 pounds. The powder for each increment is assembled in a cloth bag on which is marked the number of the increment. The increments are of unequal weight and therefore are not interchangeable.

b. Although assembled with removable projectile, the HE, AT round has a fixed (nonadjustable) propelling charge in a single cloth bag (sec. XIII, ch. 2). The charge weighs about 1.54 pounds.

c. The latest type charge for 105-mm howitzers M2A1 and M4



A - FOR 155-MM GUNS, M1917-18 (FOR TRAINING IN 155-MM GUN, M2)

B - FOR 155-MM GUN, M2

Figure 184. Separate-loading propelling charges for 155-mm guns.



RA PD 80881A

is termed "dualgran." It consists of a charge of dual granulation wherein a quick-burning powder is used in charges 1 and 2 and a slow-burning powder in charges 3, 4, 5, 6, and 7. The total charge weighs 2.75 pounds. The dualgran charge is used with a long primer and incorporates a lead foil, in charge 5, as a decoppering agent. Larger increments are doughnut-shaped and smaller charges are designed to be bent around the primer (fig. 108). Less muzzle flash than with the older type, improved uniformity of performance, and accuracy are obtained with this dualgran charge.

d. REDUCER, flash, M4 (T4) is provided for reduction of flash in night firing with the M2A1 and M4 howitzers. It consists of 438 grains of black powder in a square cotton cloth bag. It should be noted that no flash reducer is needed when firing dualgran charges.

289. Charge, Propelling, for 4.2-Inch Mortars

The propelling charge for the 4.2-inch mortar consists of an ignition cartridge and 25½ rings of propellant powder assembled in the form of four 5-ring bundles, five single rings, and a one-half ring. The rings required for the particular zone to be fired are assembled to the cartridge container. See section XIV, chapter 2.

290. Charge, Propelling, for 120-mm Guns

a. The CHARGE, propelling, M15, for 120-mm gun, is made up of approximately 24 pounds of M6 powder loaded loosely in the CASE, cartridge, M24. In the mouth of the case is a plug made of palmetto pulp or plastic, which extends 1.80 inches beyond the cartridge case when shellacked in place. Due to the large quantity of propellant powder used, an igniter charge of 8 ounces of black powder is placed around the M1B1A2 primer to help ignite the propellant powder. This igniter is contained in a cartridge cloth bag which has a hole in the center through which the primer projects (sec. XV, ch. 2, and fig. 120).

b. The CHARGE, propelling, dummy, M13, for 120-mm gun, simulates the service charge. It consists of an inert filler, loaded loosely in the service cartridge case, and held in place by a wood plug.

291. Charge, Propelling, for 155-mm Guns

a. The propelling charges for the 155-mm gun are of the base and increment type. Each charge consists of propellant powder M6 in wrapped cloth bags. An igniter containing an igniter charge of black powder is sewed to the rear end of the base sec-

tion. The M19 charge for the 155-mm gun M2 (B, fig. 184) is approximately 6½ inches in diameter and 37 inches long (it should not be confused with the propelling charge for the now obsolete 155-mm guns M1917-18 (A, fig. 184) which is approximately the same over-all length but somewhat smaller in diameter (approximately 5.8 inches)). The increment section is attached to the base section by means of four tying straps. The full charge (base and increment) is known as the supercharge and is used only for extreme ranges. The base section only (increment section removed) is known as the normal charge and is used for all ranges up to the maximum obtainable with it. (See table VIII.) The CHARGE, propelling, M19, for 155-mm gun M2, is standard for use in this gun. It contains M6 propellant powder and weighs 31 pounds.

b. CHARGE, propelling, dummy (21.4-lb base with 10.8-lb increment), M100, for 155-mm guns, simulates the service charge M19 for the 155-mm gun M2, in general design and contour. It is similar to the dummy charge Mk 1 in construction.

c. REDUCER, flash, M1 (fig. 185) is tied around the propelling charges of the 155-mm gun rounds by means of silk tie strings. It consists of two cotton strips, dyed scarlet, linked together with silk strings. Each strip contains three channels which are filled with chemicals. The two outside channels of each strip contain a mixture of 60 percent potassium sulfate and 40 percent black powder. The center channel contains all black powder. Each strip is divided into two sections—the base section and the increment charge. When using the flash reducer with the normal propelling

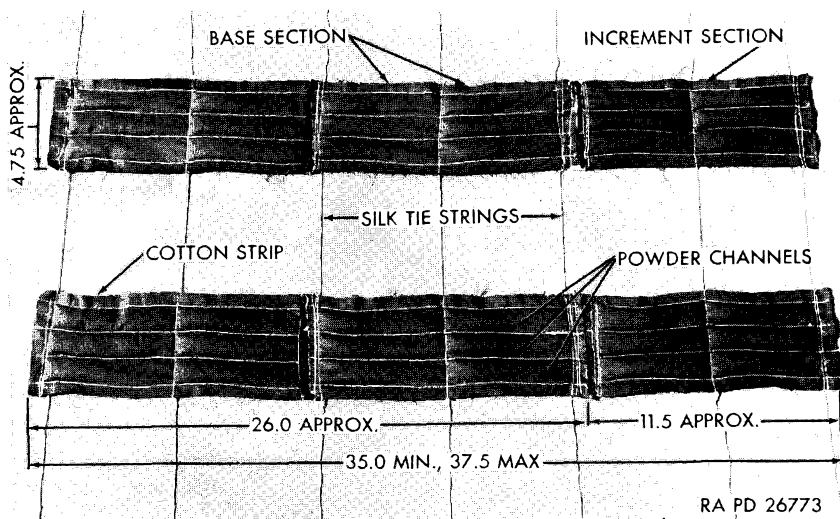
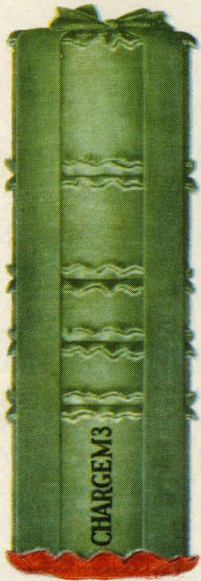
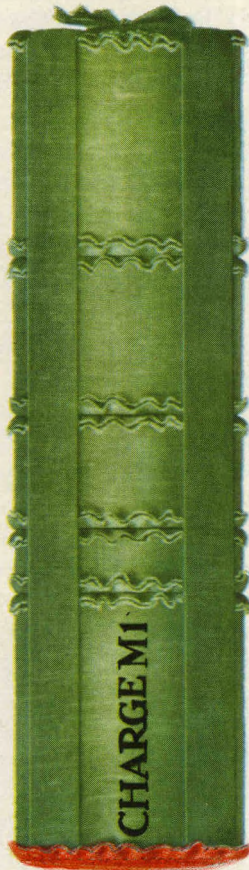


Figure 185. Reducer, flash, M1.



A—FOR 155MM HOWITZER M1



B—FOR 8 IN HOWITZER M2

RA PD 80879C

Figure 186. Separate-loading green bag propelling charges for howitzers.

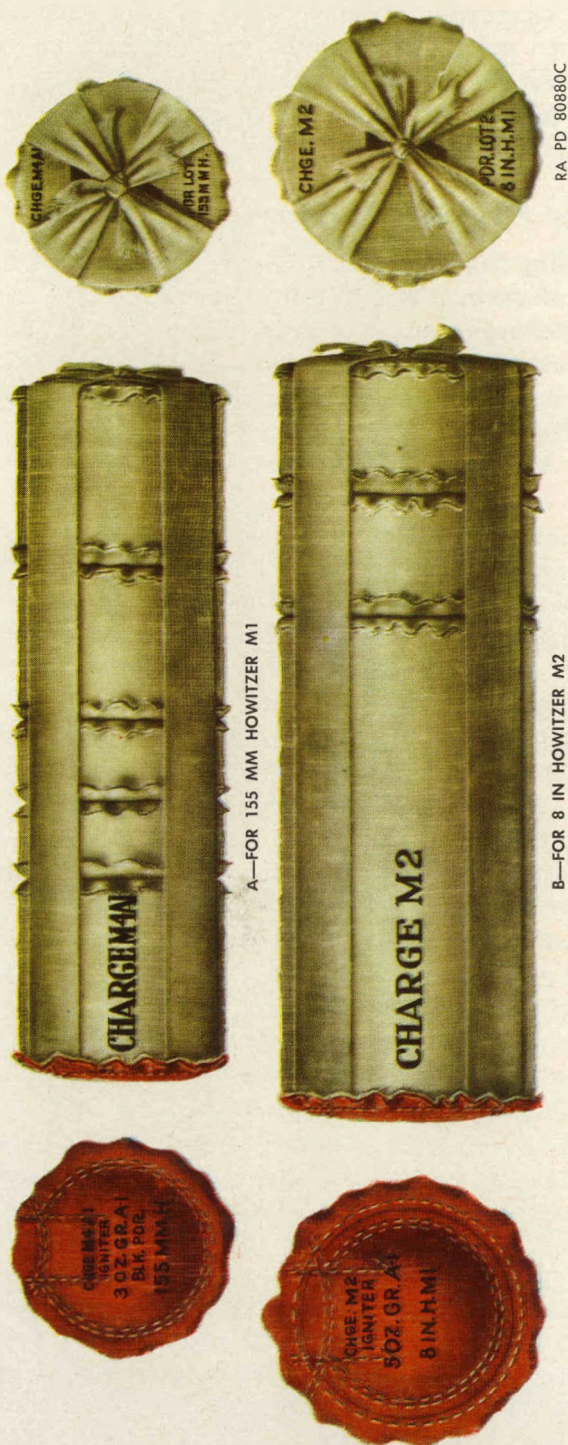


Figure 187. Separate-loading white bag propelling charges for howitzers.

charge, the increment section of each strip is removed and discarded. When using the supercharge, both base and increment sections of each strip are used.

Caution: REDUCER, flash, M1 should be handled in the same manner as any other explosive charge containing black powder.

292. Charge, Propelling, for 155-mm Howitzers

a. Propelling charges for the 155-mm howitzers are divided into increments of unequal size to provide complete coverage for zone firings. The charges consist of propellant powder M1 in cloth bags to which is attached the igniter charge of black powder, contained in an igniter cloth bag. This igniter pad is sewed to the rear (breech end) of the base section. Four tying straps are sewed to the base section for attaching the increments. For data, see table VII.

b. The charges for 155-mm howitzer M1 comprise the M3 green bag (A, fig. 186), designed for firings in zones 1 to 5 exclusively, and the M4 white bag (zones 5, 6, and 7) and the M4A1 white bag (A, fig. 187) (zones 3, 4, 5, 6, and 7) charges. The M3 (green bag) consists of a base charge (charge 1) and four increments. The M4 (white bag) consists of a base charge (charge 5) and two increments; the M4A1 (white bag) consists of a base charge (charge 3) and four increments.

Caution: As noted above, the green bag and the white bag charges are quite different in design and in the type of powder loaded in each. Therefore, sections of green bag charges never will be mixed or used with sections of the white bag charges, and the use of charges having increments of more than one color definitely is prohibited.

c. CHARGE, propelling, dummy (base and six increments), M2, for 155-mm howitzers, simulates a service propelling charge. It has a base and six increment sections made up of lead-weighted wood cylinders covered with cotton duck.

d. CHARGE, propelling, dummy (base and six increments), Mk 1, for 155-mm howitzers, resembles the M2 dummy charge in general design and contour, except that it is approximately 1.5 inches longer.

e. REDUCER, flash, M2 (T2) is intended for use with the 155-mm howitzer M1. It consists of a red cotton cloth bag approximately 4 inches square. Each bag contains 1½ ounces of flash reducing mixture consisting of potassium sulfate and black powder. No flash reducer is necessary for flashlessness with the M3 (green bag) type of charge.

293. Charge, Propelling, for 8-Inch Guns

a. Propelling charges for the 8-inch gun M1 are of the base and increment type. The service charges consist of propellant powder M6.

b. CHARGE, propelling, M13, for 8-inch gun M1 (formerly designated CHARGE, propelling, base and 2 increments M13, for 8-inch gun M) (fig. 188), is the standard charge for the gun and replaces the M9 and M10 types (*c* and *d* below). It is preferred over those types at all ranges because of greater accuracy. It consists of a base section and two increments. The full charge (2,850 fps) is used for extreme-range firing, the base and one increment are used for medium-range firing, and the base charge is used by itself for firing in the shorter ranges. An igniting charge of 12 ounces of black powder is contained in an igniter pad sewed to an end of the base charge. The base charge is equipped with four tying straps which are passed through loops on the sides of the increments, and are tied over the end increment. The powder grains in this charge are 1.3 inches long and 0.55 inch wide.

c. CHARGE, propelling, M9, for 8-inch gun M1, 240-lb projector (formerly designated CHARGE, propelling, base and increment, NH powder, M9 (green bag), for 8-inch gun M1) (fig. 188), uses its full charge (2,600 fps) for medium-range firing, and the base charge only is used for firing in the shorter ranges. An igniting charge of 8 ounces of black powder is contained in an igniter pad sewed to an end of the base charge. This pad is equipped with four tying straps which are passed through loops on the sides of the base and increment, and are tied over the increment. At the junction of the base and increment a cord is tied around the four tying straps to increase the rigidity of the charge.

d. CHARGE, propelling, M10, for 8-inch gun M1, 240-lb and 260-lb projector (formerly designated CHARGE, propelling, base and increment M10 (white bag), for 8-inch gun M1) (fig. 188), uses its full charge (2,850 fps) for extreme-range firings only, and the base charge (2,600 fps) is used by itself for medium-range firing. The M9 green bag type described in *c* above is preferred at medium ranges because of improved accuracy as compared with the M10. The igniting charge and the general design of this base-and-increment type charge are quite similar to that of the M9, except for the large size, particularly the greater diameter.

e. CHARGE, propelling, dummy, M7, for 8-inch gun M1, 240-lb and 260-lb projector (formerly designated CHARGE, propelling, dummy, M7, base and increment, for 8-inch gun M1), simulates the M9 green bag charge for the 8-inch gun M1 in size, weight, and general appearance.

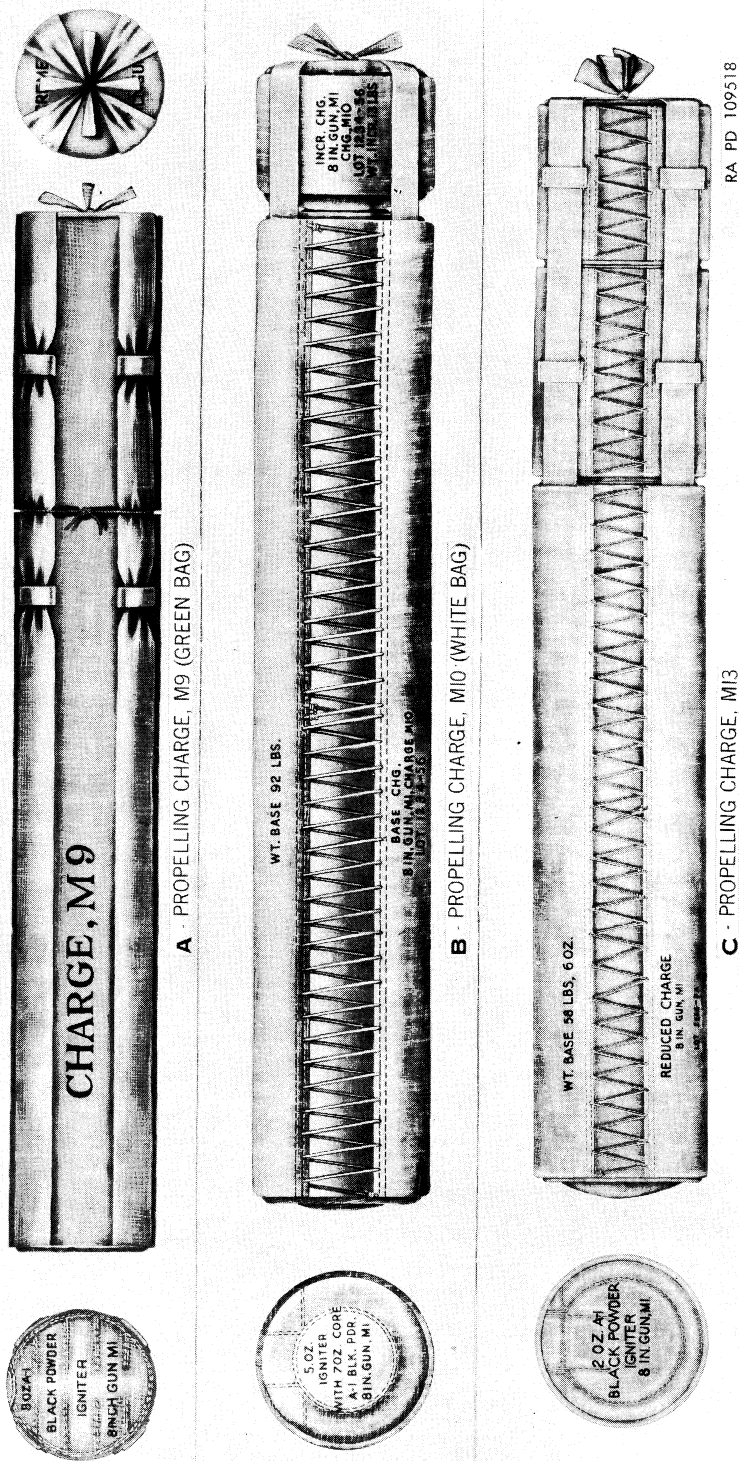


Figure 188. Separate-loading propelling charges for 8-inch gun M1.

294. Charge, Propelling, for 8-Inch Howitzers

a. The service propelling charges for the 8-inch howitzer M2 are divided into unequal increments to provide for zone firing. The charge consists of propellant powder M1 in cloth bags, to which the igniter charge of 5 ounces of black powder in the form of an igniter pad is rigidly attached. The igniter pad is sewed to the rear (breech end) of the base section. Four tying straps sewed to the base section are for attaching the increments. There are two types of propelling charge for the 8-inch howitzer M2. See table VII for data.

b. CHARGE, propelling, M1, for 8-inch howitzer M2 (formerly designated CHARGE, propelling, M1 (green bag), for 8-inch howitzer M2), (B, fig. 186), consists of base charge (charge 1) and four increments designed for firings in zones 1 to 5, inclusive. It is assembled in cartridge bags of green cloth. It is referred to commonly as the "green bag" charge to distinguish it from the CHARGE, propelling, M2 (white bag), for 8-inch howitzer M2 (B, fig. 187). The "white bag" charge consists of a large base section (charge 5) and two increments, assembled in cartridge bags of white cloth, and designed for zones of fire 5 to 7, inclusive. Sections of the green bag charge never will be mixed with sections of the white bag charge, as the latter contains powder of a slower burning type. The use of charges having zone increments of more than one color is, therefore, prohibited. The maximum diameter of the M1 charge is 6.5 inches as compared to 7.75 inches for the M2 charge.

c. CHARGE, propelling, dummy, M4, for 8-inch howitzer (formerly designated CHARGE, propelling, dummy, M4, base and increment, 29-lb., for 8-inch howitzer), simulates the white bag service charge M2. It consists of a base charge and two increment sections. The fillers for the sections consist of blocks of wood, each of which is drilled, counterbored, and weighted with lead to produce the desired weight.

d. REDUCER, flash, M3 (T3) is for use with the 8-inch howitzer M2. It consists of a red cotton cloth bag approximately 7 inches square. Each bag contains 16 ounces of flash reducing mixture consisting of potassium sulfate and black powder. No flash reducer is necessary for flashlessness with the M1 (green bag) type of charge.

295. Charge, Propelling, for 240-mm Howitzers

a. The propelling charges used in this weapon are of the base and increment type. CHARGE, propelling, M23, for 240-mm howitzer M1 (base and 3 increments) (fig. 189), is composed of

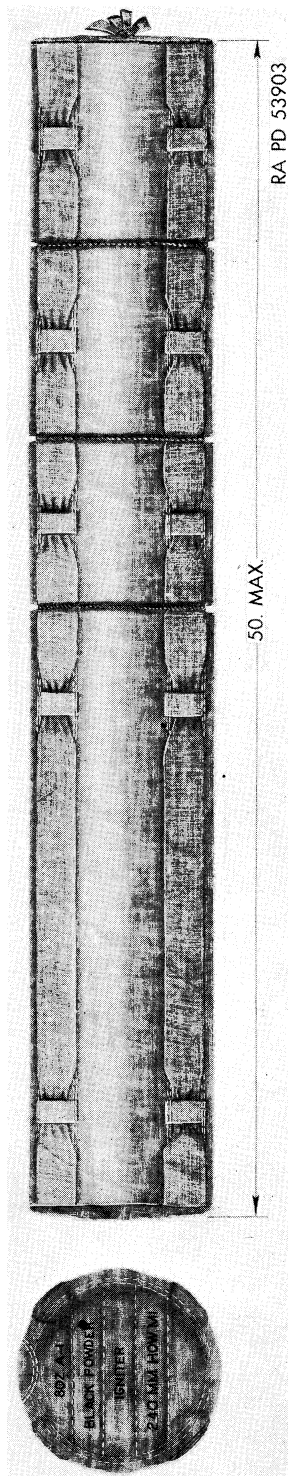


Figure 189. Propelling charge for 240-mm howitzer M1.

a base section and three unequally sized increments. It consists of propellant powder M6 in cloth bags. The full charge is used for maximum range firing and less than a full charge for firing in the lower ranges. An igniter charge of 8 ounces of black powder in the form of an igniter pad is sewed to the end of the base section. This charge is equipped with four tying straps which are passed through loops on the side of the base and increments and are tied over the last increment, thus securing all sections together. At each junction of two sections, a cord is tied around the four tying straps to increase the rigidity of the charge. (See table VIII for data).

b. CHARGE, propelling, dummy, M12, for 240-mm howitzer M1 (formerly designated CHARGE, propelling, dummy, base and 3 increments M12, for 240-mm howitzer M1), simulates the service charge described in *a* above. The filler for the base and three increments consists of cylindrical wood blocks which are drilled, counterbored, and weighted with lead to produce the desired weight. A cotton webbing handle is secured to the igniter end of the propelling charge to aid in extraction from the chamber of the cannon.

296. Powder Temperature Indicators

a. Powder temperature indicators (fig. 190) are supplied in order that powder temperature corrections to firing tables may be made. The indicator consists of the powder temperature thermometer M1 and a cast-iron plug crimped into the mouth of a service cartridge case. The cartridge case contains a standard propelling charge but no primer, the primer hole being sealed. The plug seals the powder in the case and provides a seat for the thermometer. The thermometer is a dial type with a 6-inch stem which extends through a hole in the plug into the propellant powder. The complete indicator is sealed in a fiber container, one end of which has a transparent plastic window through which temperature readings may be taken. The indicator is issued on the basis of two per firing battery. One is retained with ammunition at the gun position, the other at the central battery ammunition dump. Temperature range is -40° F. to $+160^{\circ}$ F.

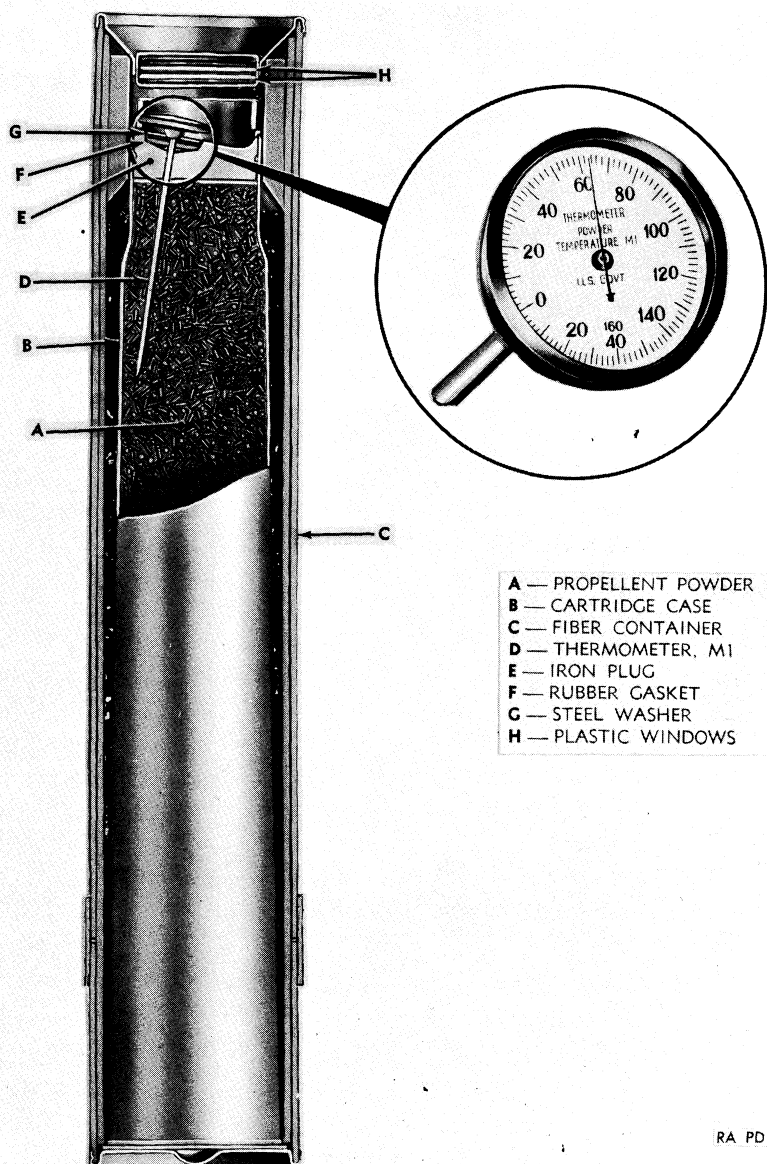
b. The powder temperature indicator M13 is used with 90-mm gun batteries and the powder temperature indicator M15 is used with 120-mm gun batteries.

c. The powder temperature thermometer M1 can be inserted directly into the cloth bags of separate-loading propelling charges.

Section III. PRIMERS AND IGNITION CARTRIDGES

297. General

a. GENERAL DISCUSSION. A primer is used in a propelling charge explosive train (fig. 8) as the component which initiates burning of the propelling charge by a flame. Such primers vary in size and complexity, depending upon their type and the quantity of



RA PD 89338

Figure 190. Powder temperature indicator.

propelling charge to be ignited. For example, the propelling charge of 20-mm rounds is relatively so small that the primer is merely a sensitive element assembly which is inserted directly into the primer pocket of the cartridge case, similar to the M36A1 percussion primer (fig. 191) and the M52A2 electric primer in the 20-mm case (fig. 37); whereas, in the larger caliber rounds, the primer contains a sensitive element of primer mixture or other explosive plus a primer charge of black powder to insure proper ignition of the larger propellant charges, which results in a larger and more complicated primer as illustrated by the longer primers in figure 192. Where sufficient black powder cannot be loaded into the primer body to insure proper ignition, a separate bag of black powder, called an igniter charge assembly, is placed advantageously with the propellant.

b. CLASSIFICATION.

(1) *Classes (by method of initiation).*

- (a) Percussion—initiated by sharp blow from a firing pin in the weapon.
- (b) Electric—initiated by sending a small electric current through a resistance wire imbedded in an explosive or through a conductive primer mixture.

(2) *Types (by weapons with which used).*

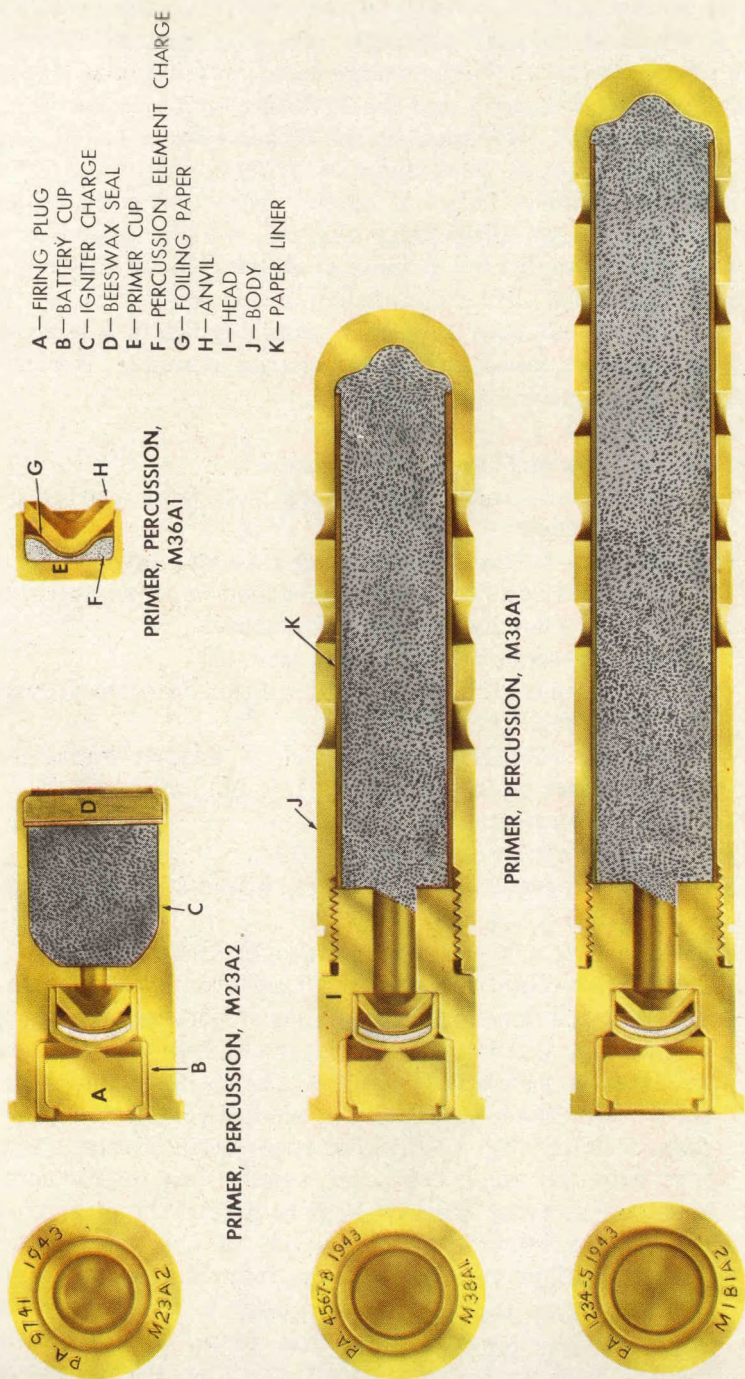
- (a) For use in cartridge case ammunition (20-mm through 120-mm).
- (b) For use directly in breechblock of weapon where cartridge case is not employed (155-mm and upward).
- (c) For use in subcaliber ammunition.
- (d) For use with mortar ammunition.

(3) *Models.* Variations of different classes and types. (See table VIII.)

c. GENERAL DESIGN AND METHOD OF FUNCTIONING.

(1) *Percussion element assembly.* (Typical small arms type.)

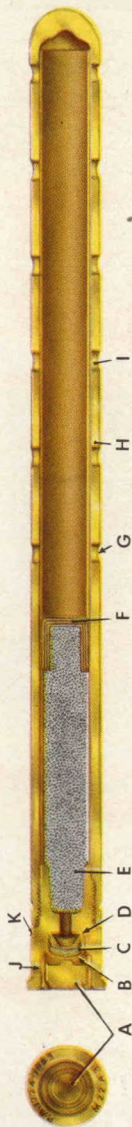
The percussion element assemblies of percussion primers consist of a small external primer cup into which is consolidated a percussion element charge of primer mixture, over which is pressed a shellac-coated foil paper disk, followed by a conical-shaped anvil, pressed point first into the cup. The anvil usually has one or more sections cut away from its base to permit the blast from the primer mixture to travel out of the primer cup. This type of primer functions as follows: The firing pin of the weapon imparts a sharp blow to the primer cup which bends inward under the force, squeezing the primer mixture between itself and the anvil, causing the sensitive mixture to explode. The explosion blast



RA PD 80872A

PRIMER, PERCUSSION, M1B1A2

Figure 191. Percussion primers for fixed and semifixed ammunition.



PRIMER, PERCUSSION, M22A3



PRIMER, PERCUSSION, M31A2



PRIMER, PERCUSSION, M28A2

RA PD 80883A

Figure 192. Percussion primers for fired and semifired ammunition.

Table VIII. *Primer and Ignition Cartridge Data*

Designation and model No.	Type	Length (in.)	Diameter (in.)		Weight (grains)		Ammunition with which used
			Head	Body	Charge	Assembly	
PRIMER, percussion, M1B1A2-----	Cartridge case	3.71	0.62	0.544	100.00	872.5	120-mm gun 75-mm and 105-mm howitzer 75-mm, 76-mm, 90-mm blank 155-mm gun and howitzer 8-in gun and howitzer 240-mm howitzer 4.2-in mortar
PRIMER, percussion, Mk 2A4-----	Breechblock	1.595	0.515	0.348	19.00	198.00	81-mm mortar 60-mm mortar 60-mm mortar 81-mm mortar 81-mm mortar 75-mm HE (reduced and normal charge).
CARTRIDGE, ignition, M2-----	Shotgun shell	2.43	0.889	0.808	120.00		40-mm gun
CARTRIDGE, ignition, M3-----	Shotgun shell	2.64	0.889	0.795	120.00		37-mm HE, practice, sub-caliber
CARTRIDGE, ignition, M4-----	Shotgun shell	1.75	0.728	0.655	47.00		40-mm gun
CARTRIDGE, ignition, M5A1-----	Mortar	1.43	—	0.655	40.00	82.2	75-mm howitzer HE, AT
CARTRIDGE, ignition, M6-----	Mortar	2.23	—	0.795	120.00	190.0	75-mm rifle
CARTRIDGE, ignition, M8-----	Mortar	2.03	—	0.795	120.00	185.0	76-mm gun
PRIMER, percussion, M22A3-----	Cartridge case	7.68	0.62	0.544	65.00	1,693.2	90-mm gun 105-mm howitzer, dualgran 75-mm gun (supercharge)
PRIMER, percussion, Mk 22, or Mk 22 Mod 1 (Navy).	Cartridge case	2.9	0.62	0.54	65.00	960.00	
PRIMER, percussion, M23A2-----	Cartridge case	1.15	0.62	0.555	20.00	345.0	
PRIMER, percussion, M28A2-----	Cartridge case	10.26	0.62	0.544	300.00	2,316.2	
PRIMER, percussion, M31A2-----	Cartridge case	7.68	0.62	0.544	150.00	1,782.2	

PRIMER, percussion, M32-----	Mortar	0.516
PRIMER, percussion, M33-----	Mortar	0.561
PRIMER, percussion, M34-----	Mortar	0.761
PRIMER, percussion, M36A1-----	Cartridge case	0.25
PRIMER, percussion, M38A1-----	Cartridge case	2.84
PRIMER, percussion, M40A1-----	Cartridge case	19.01
PRIMER, percussion, M46-----	Cartridge case	7.68
PRIMER, percussion, M47-----	Cartridge case	10.51
PRIMER, igniting, M48-----	Cartridge case	7.68
PRIMER, percussion, M49-----	Cartridge case	19.01
PRIMER, electric, M52A2-----	Cartridge case	0.256

0.82	0.47	1.65	344.83	60-mm mortar
1.00	0.56	1.65	542.78	81mm mortar (M68 training shell only)
1.00	0.56	1.65	737.45	81-mm mortar
0.332	—	—	25.65	20-mm gun (cartridge case M21A1)
0.62	0.544	55.00	682.5	37-mm gun
				40-mm gun
0.62	0.544	270.00	4,800.00	76-mm gun
				90-mm HVAP-T
0.62	0.544	200.00	1,750.00	57-mm rifle
0.62	0.544	300.00	2,316.2	75-mm rifle
0.62	0.544	65.00	1,692.00	75-mm subcaliber
0.62	0.544	400.00	4,100.00	90-mm gun AP M82
0.331	—	—	24.00	20-mm gun M24

travels around the anvil and out through the open end of the cup. In 20-mm ammunition, this blast continues through the flash hole in the cartridge case to ignite the propelling charge in the case directly.

- (2) *Percussion primer of type used in cartridge case ammunition (37-mm through 120-mm).* The majority of the percussion primers of this type (figs. 191 and 192) follow a standard design containing two subassemblies: a head assembly and a body assembly. The head assembly consists of a head into which is pressed a percussion element assembly followed by a firing plug which, in turn, is held and guided by a battery cup pressed into the head. The head has a center flash hole leading from the percussion element assembly to the primer charge. This head assembly design is unique in that the firing plug supplies a relatively soft firing point (brass in lieu of the hardened steel firing pin point), of known finish and fixed length, which is used only once, thus tending to prevent perforation of the primer cup and ensuing loss of pressure (blowbacks). Furthermore, if (on rare occasion) the primer cup should perforate under pressure between the point on the firing plug and the anvil, the plug would move back and seal against the battery cup to obturate the primer. The body assembly consists of a tube with radially perforated flash holes, which is lined internally by a paper liner, and into which is assembled the loose black powder primer charge. Bodies vary in length, in number of radial vents, and in half closed or open forward ends. If the volume of the primer charge is smaller than that of the body, a cardboard diaphragm is cemented to the liner to locate the charge at the head end of the complete assembly (M22A3 model, fig. 192). Bodies with open forward ends have the end closed by a cardboard diaphragm. The body assembly then is screwed on to the head assembly and crimped, after which the flash holes in the body are sealed against moisture with a suitable sealing compound. The outside of the head is dimensioned to press-fit into the cartridge case. This type of primer functions as follows: A sharp blow from the firing pin of the weapon is transmitted through the firing plug to the primer cup, the cup bends inward under the force, squeezing the primer mixture between itself and the anvil, causing the sensitive primer mixture to explode. The blast from the mixture travels around the anvil, through the flash hole in the head, into

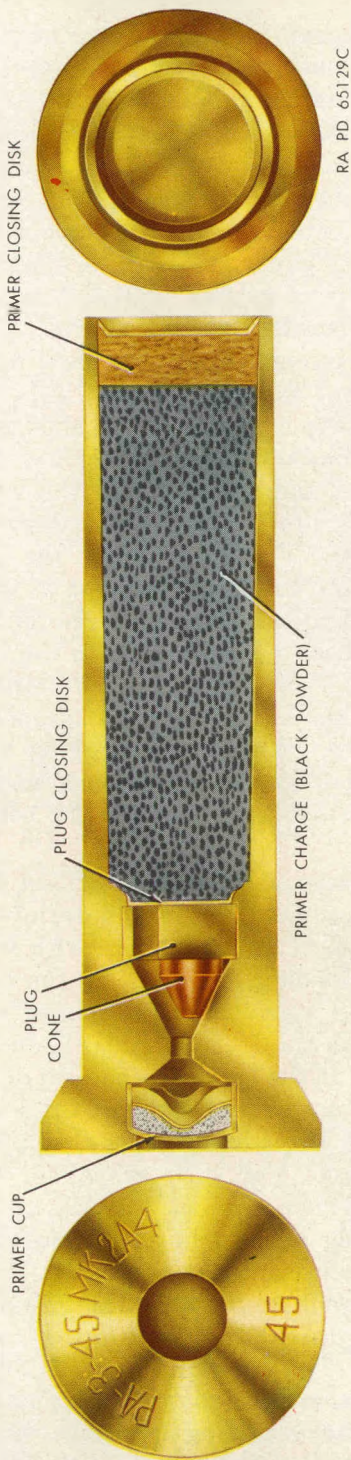


Figure 193. Primer, percussion, MK 2A4.

the primer charge which starts to burn, forcing flames out of the primer body through the radial flash holes, thereby igniting the propelling charge.

- (3) *Percussion primers of type used in breechblock of weapon (155-mm and above).* This type of primer (Mk 2A4, fig. 193) is assembled in the breechblock of the gun at the time the projectile and bags of propellant powder are loaded into the gun. Its design is simpler than the cartridge case type of primer because it contains only a part of the black powder ignition charge. It consists essentially of a relatively small one-piece body, with a percussion element assembly pressed into the head end of the body, a valve arrangement to shut off back pressure, and a small black powder primer charge. It functions as follows: A sharp blow from the weapon firing pin on the primer cup initiates a percussion element in the usual manner. The blast from the primer mixture travels past the valve arrangement to ignite the primer charge. The burning primer charge forces flames ahead, through the flash hole provided in the breechblock, into the chamber, where it ignites the black powder igniter bag sewn to the end of the base propelling charge bag which, in turn, ignites the propelling charge. Pressure of the burning gases works back and seats the soft copper cone (valve) to obturate the body and eliminate blowbacks.
- (4) *Igniting primers used in ammunition for interior-type subcaliber weapons.* When interior-type subcaliber weapons are used in conjunction with weapons designed for separate-loading ammunition, the cartridge case of the subcaliber ammunition is primed with an igniting primer such as the M48 (par. 319), due to the fact that the firing pin in the firing mechanism of the subcalibered weapon does not extend through the breechblock, hence cannot strike the primer of the cartridge in the subcaliber weapon. For such subcaliber firing, a service percussion primer such as the Mk 2A4 is used in the standard firing mechanism of the subcalibered weapon. When this service primer is fired, the flame passes through the vent in the obturator spindle of the breechblock and ignites the igniting primer of the subcaliber ammunition. The basic difference between an igniting and a percussion primer is in the initiating explosive in the head. The initiating explosive in the head of an igniting primer consists of black powder intended to be

ignited by a flame; the initiating explosive of a percussion primer is a sensitive explosive of primer composition intended to be initiated by percussion. Igniting primers function as follows: When the flame from the black powder charge in the Mk 2A4 primer in the breechblock of the subcalibered weapon travels through the flash hole in the obturator spindle, and burns through the paper seal on the cup of the igniting primer, it passes through the hole in the cup, around the valve, through the flash holes in the bushing and head to the primer charge which starts burning. The amplified flame escapes through the radial flash holes of the primer (M48) body and ignites the propelling charge of the subcaliber ammunition. The pressure set up by the burning propelling charge works back to the valve in the head of the igniting primer and forces it against the hole in the cup, thus preventing a blowback.

- (5) *Percussion primers of type used in mortar ammunition.* This type of primer screws into the base of the fin assembly of mortar rounds and is relatively short and squat (fig. 194). It consists of a head, into which is assembled a firing plug and a housing containing a percussion element pressed into one end and a hollow black powder pellet assembled into the other end. The housing is crimped into the head and a paper disk shellacked to the exposed end of the housing holds the pellet in place. An ignition cartridge, essentially a heavy, paper-walled, waxed, cylindrical container holding a propelling charge is assembled into the fin assembly ahead of the primer. This design is a modification of the original shotgun shell design (M3 model, par. 302) which is employed with 81-mm M68 training shell. This type of primer functions as follows: As the round slides down the barrel of the mortar tube, the firing plug of the primer strikes sharply against a fixed firing pin in the base of the mortar and initiates the percussion element assembly in the usual manner. The blast from the exploding primer mixture ignites the black powder pellet and carries on into the end of the ignition cartridge. This blast, amplified by the flames from the burning pellet, ignites the small propellant charge in the cartridge, which, in turn, blows out through radial flash holes in the fin body to ignite the remaining propellant increments (par. 129d) attached to the outside of the fin assembly.

- (6) *Electric primers.* Electric primers are initiated by a small electric current passing through a resistance wire imbedded in the primer mixture or through the primer mixture itself as in the M52A2 electric primer used in ammunition for the 20-mm gun M24 (fig. 37).

298. Packing and Shipping Data

Packing and shipping data appear in Department of the Army Supply Catalog ORD 11 SNL's P-7 and R-3.

299. Primer, Percussion, M1B1A2 (fig. 191)

This primer is used with ammunition for 120-mm guns, 75-mm and 105-mm howitzers, and blank ammunition for 75-mm, 76-mm, and 90-mm weapons. It is held in the cartridge case by means of a force fit between the primer head and the primer pocket. The design is of the standard cartridge case type (par. 297c(2)). An alternative primer is the M1A2, which differs from the M1B1A2 primer in the design of the brass tube.

300. Primer, Percussion, MK 2A4 (fig. 193)

This primer is used in 155-mm howitzers, 155-mm guns, 8-inch howitzers, 8-inch guns M1, and 240-mm howitzers. Its design is that of the type used directly in breechblock of weapon (par. 297c(3)). Mk 2A4 primers in which the primer charge was held in place by a paper closing disk, beeswax, and a seal of shellac varnish have been obsoleted. A $\frac{1}{16}$ -inch thick cork disk and a shellac seal is used to hold the primer charge in place in primers of present manufacture.

301. Cartridge, Ignition, M2

This cartridge, which contains both the primer and the ignition charge, is used with 4.2-inch mortar ammunition. It essentially is a blank-loaded shotgun shell containing a charge of 120 grains of propellant powder.

302. Cartridge, Ignition, M3

This cartridge is issued for use only with the 81-mm M68 training shell and contains both the primer and the propelling charge. The body assembly design essentially is that of shotgun shell, made of commercial cartridge paper, having a brass base with the paper body bulged outward just forward of the metal base. A com-

mercial percussion primer is pressed into the brass base, a propelling charge is loaded into the body, followed by a chipboard disk, a lead disk, and an outer disk of chipboard and bond paper. The disks are secured by crimping the open end of the paper body inward, after which the entire assembly is dipped in molten paraffin. The bulge in the body is utilized for holding the assembly in the fin of the ammunition. The charge is 120 grains of propellant powder M9.

303. Cartridge, Ignition, M4

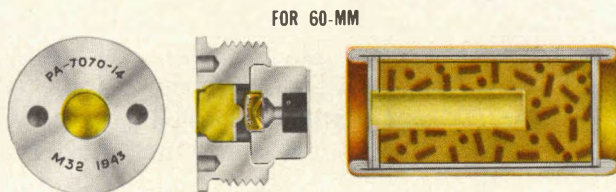
This cartridge is issued for use with the 60-mm mortar M69 training shell only. It is identical in design with the M3 ignition cartridge (par. 302), except that it is smaller and has a 47-grain charge of commercial powder.

304. Cartridge, Ignition, M5A1

This cartridge (fig. 194) essentially is a cylindrical paper container for a propelling charge which must be used in conjunction with the M32 primer (par. 312) in 60-mm mortar ammunition. This cartridge also is used in conjunction with the M32 primer as the basic propelling force for the 3-inch subcaliber shell M5 which is used with 3-inch subcaliber equipment for the 4.2-inch mortar.

PRIMER, PERCUSSION, M32

CARTRIDGE, IGNITION, M5A1



PRIMER, PERCUSSION, M34

CARTRIDGE, IGNITION, M8

RA PD 80870B

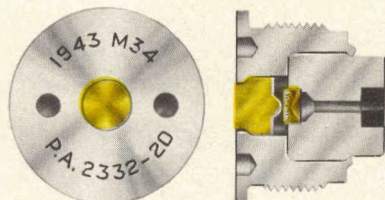


Figure 194. Primers and ignition cartridge for use with mortar ammunition.

The body of the cartridge consists of an outer tube and a shorter inner tube both made from layers of paraffined cartridge paper. A chipboard washer, with a paper tube cemented into a center hole, and thin paper disks cemented to one face of the washer and over the other end of the tube, is assembled into one end of the body with the small tube extending into the body. The outer tube of the body is crimped inward to secure the washer tube assembly in place. A charge of M9 propellant is loaded into the body and a chipboard closing disk is crimped into the remaining open end of the body. The half of the body containing the washer and tube closure is colored red, while the remaining half with the chipboard disk closure is colored yellow, to facilitate inspection during and after assembly into the fin of the round. The red end must be assembled adjacent to the primer.

305. Cartridge, Ignition, M6

This cartridge essentially is a cylindrical paper container for a propellant charge which must be used in conjunction with the M34 primer (par. 313) in the heavier 81-mm mortar ammunition. Its construction is similar to that of the M5A1 ignition cartridge (par. 304), except that the end closures consist of a heavy chipboard washer with a thin paper disk cemented to one face, the faces being assembled adjacent to the charge of M9 propellant.

306. Cartridge, Ignition, M8 (fig. 194)

This cartridge is used with the M34 primer (par. 313) in the lighter 81-mm mortar rounds and is identical with the M6 ignition cartridge (par. 305) except that it is 0.20 inch shorter.

307. Primer, Percussion, M22A3 (fig. 192)

This primer is assembled in fixed 75-mm high-explosive rounds using reduced and normal propelling charges for the 75-mm tank guns. The design is of the standard cartridge case type (par. 297c(2)).

308. Primer, Percussion, MK 22, or MK 22 Mod 1 (Navy)

This primer is of the cartridge case type (par. 297c(2)). It is an alternate for use in 40-mm gun rounds in place of the standard M38A1 primer described in paragraph 315. The firing plug is retained in position by a belleville spring.

309. Primer, Percussion, M23A2 **(fig. 191)**

This primer is standard for assembly with the target practice round M51A2 and HE M63 round for the 37-mm guns M3A1 and M6, the M63 Mod 1 practice round for the 37-mm subcaliber out-bore guns, the Mk 2 HE-T cartridges of earlier manufacture for 40-mm guns, and 75-mm howitzer HE, AT-T rounds. This primer is so short that primer charge cavity is extruded from the head with the forward end left open. The percussion element, firing plug, and battery cup is the same as that in the standard design of head assembly (par. 297c(2)). There are no vents in the side walls of the primer. A closing disk, of onionskin paper, is placed over the primer charge and the remaining void is filled with molten beeswax.

310. Primer, Percussion, M28A2 **(fig. 192)**

This primer is standard for use with 75-mm rifle ammunition, older 76-mm ammunition, 90-mm ammunition; and new dualgran 105-mm howitzer ammunition. The design is of the standard cartridge case type (par. 297c(2)). Alternative primer is the PRIMER, percussion, M28B2 (steel). Rounds of earlier manufacture may have the PRIMER, percussion, M28A1 or M28A1B1.

311. Primer, Percussion, M31A2

This primer is used with all supercharge rounds of 75-mm gun, armor-piercing and high-explosive projectiles, requiring a primer of higher black powder capacity than the M22A3, or the M1B1A2. The design is of the standard cartridge case type (par. 297c(2)).

312. Primer, Percussion, M32 **(fig. 194)**

This primer, for use with 60-mm mortar shell and 3-inch sub-caliber mortar shell, is of the standard design of the mortar ammunition type (par. 297c(5)). The head and housing are made of steel or brass.

313. Primer, Percussion, M34 **(fig. 194)**

This primer, for use with 81-mm mortar shell, is of the standard design of the mortar ammunition type (par. 297c(5)). It differs from the M32 primer for 60-mm mortar only in that the head and housing are larger in size; the loading is identical.

314. Primer, Percussion, M36A1 (fig. 191)

This is the standard percussion primer for assembly in the 20-mm cartridge case M21A1. Its design is identical to that of a percussion element assembly (par. 297c(1)).

315. Primer, Percussion, M38A1 (fig. 191)

This primer supersedes the M32A2 primer (par. 309) for use with 37-mm ammunition. It also is standard for use with 40-mm rounds of Army procurement. The design is of the standard cartridge case type (par. 297c(2)).

316. Primer, Percussion, M40A1

This primer is used with ammunition for 76-mm guns and with the 90-mm HVA-P round, is of the standard cartridge case type (par. 297c(2)), and is 19 inches long. It consists of a brass head with increased thread area, in combination with a steel primer body. The primer body is made of steel and has an open forward end.

317. Primer, Percussion, M46

This primer is used with rounds for the 57-mm rifle. It is of the cartridge case type but head assembly is not of the standard design (par. 297c(2)) in that it does not contain a firing plug and battery cup. The firing pin of the weapon strikes the primer cup directly.

318. Primer, Percussion, M47

This primer is of the standard cartridge case type (par. 297c(2)) and is used in 75-mm rifle ammunition. The body has an open end.

319. Primer, Igniting, M48

This primer is used in the TP round M48 for the 75-mm sub-caliber gun M25 which is used in the 155-mm seacoast gun M2. It has the same body and igniter charge as the M1B1A2 primer. It differs from the M1B1A2 primer and other percussion primers in not having a percussion element. Instead, a primer cup with a centrally located hole, a protective foil paper cover, and a tripod type valve are used. The flame from a service primer in the breechblock of the weapon subcaliber passes through the primer

cup hole, valve, and vent to ignite the black powder charge. Upon development of the pressure of burning gases, the valve closes the primer cup hole.

320. Primer, Percussion, M49

This primer is of the cartridge case type (par. 297c(2)) and is used with the M82 armor-piercing rounds in the 90-mm guns. The body has an open end.

321. Primer, Electric, M52A2

This primer (figs. 37, 38, and 39) is a small electrical element assembly (pars. 23, 25, and 27) used with 20-mm ammunition in aircraft gun M24. It consists of a brass cup with a hole in the cupped end, into which is assembled a brass button separated from the cup by an insulator, followed by a consolidated charge of a conductive primer mixture, a shellacked foil paper disk; finally, a thin gilding metal support cup is pressed into the body. The electrical path is from the face of the button exposed through the hole in the cup, through the button, through the conductive mixture to the cup. The primer is initiated by electrical energy.

Section IV. BOOSTERS, ADAPTERS AND BOOSTER ASSEMBLIES, AND BURSTERS

322. Boosters

Since the bursting charges of high-explosive shell are relatively insensitive to shock, a comparatively large detonating charge is necessary to insure a high-order detonation of the bursting charge. The use of more sensitive explosives, such as mercury fulminate or lead azide, in the quantities required for the purpose would create excessive hazards in handling and firing. Therefore, such explosives are used only in small amounts as initiating and intermediate detonating charges. A separate charge of somewhat less sensitivity (usually tetryl) is provided for detonating the high-explosive charge of the shell; because its function is to increase or "boost" the effectiveness of the explosive train, this charge is known as a booster charge. The booster charge may be incorporated within the fuze itself, or may be encased in a thin casing of metal or plastic which is screwed permanently to the fuze and handled as a unit with the fuze. The assembled casing with booster charge is known as a booster. Most types are provided with a boresafety mechanism; these boosters usually contain one or more other charges in addition to the booster charge, such as

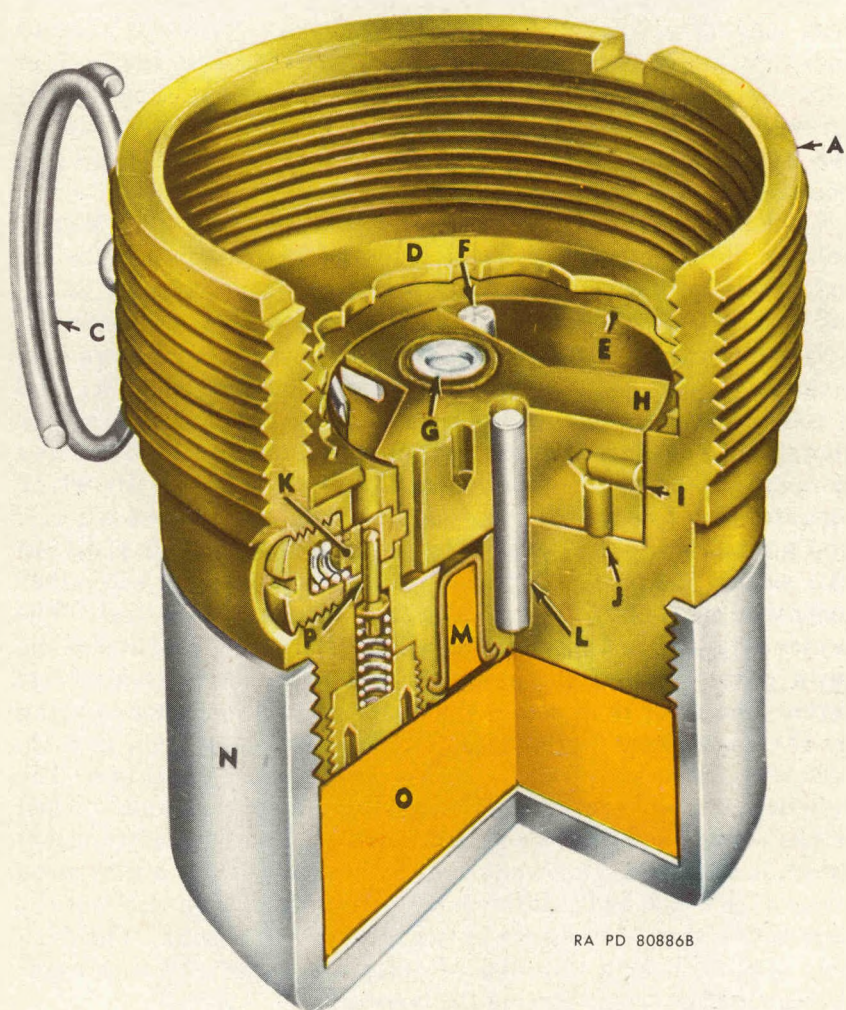
an intermediate detonator and/or a lead charge. Types in use are described in this section.

323. Booster, M20, M20A1, and M20A2

The M20 booster and modifications were used in conjunction with point fuzes, both impact and time types, to effect the functioning of fixed and semifixed high-explosive projectiles. The M20A2 differed from the M20A1 only in slight design changes and never was put into production. The M20A1 differs from the M20 only in that it has a larger flash hole in the rotor cover; in other respects, construction and functioning are the same. The booster can be used in projectiles having a threaded fuze hole with a 2-inch diameter, 12 TPI, and with all fuzes having a threaded base 1.7 inches in diameter, 14 TPI, subject to certain conditions. These boosters were standard only in fixed and semifixed ammunition of 75-mm to 120-mm caliber and in the 8-inch high-explosive shell M103, which were issued and shipped with the fuze assembled to the shell. The M20A2 booster was the same as the M21A4 booster except that it had no cotter pin assembly. Since, in present manufacture, boosters are attached securely to the fuze, no requirement exists for the M20A2 booster. The M20A2 booster has been replaced by the M21A4 booster. Description for the M21A4 booster in paragraph 324 applies to the older M20A2 booster except for the cotter pin assembly.

324. Booster, M21, M21A1, M21A2, and M21A4

a. GENERAL. In basic respects, construction and functioning of the M21, M21A1, M21A2, and M21A4 booster (fig. 195) are the same as for the M20 boosters described in paragraph 323. However, M21 boosters are fitted with a safety (cotter) pin with full ring (C) which holds the rotor in the unarmed position prior to assembling the fuze with booster to the projectile. The M21 and M21A1 boosters differ from the M20, the M21A2, and the M21A4 designs also in that the centrifugal pin lock pin (P) is omitted. The only difference between the M21 and M21A1 models is in the size of the flash hole in the rotor cover. In the M21A2, a two-piece centrifugal pin lock pin, making use of a ball and socket joint to permit some "play," is incorporated in the booster. In the M21A4, the most recent production model, the centrifugal pin lock pin was replaced by a single-piece type. A shoulder also is provided between the centrifugal pin and lock pin cavities under which the single-piece lock pin can catch when acted upon by the combined setback and centrifugal forces. Upon standardization, the M21 series replaced the M20 series for use with separately issued point



RA PD 80886B

Figure 195. Booster, M21A4.

fuzes and, to date, this booster or a modification thereof has been used with such fuzes in separate-loading projectiles. However, the boosters will fit any projectile (75-mm and larger) with a threaded fuze hole with a 2-inch diameter, 12 TPI, and receive all fuzes having a threaded base 1.7 inches in diameter, 14 TPI. In normal use, the M21 type booster is assembled to the fuze during manufacture, the fuze and booster being handled thereafter as a unit. At present, the M21A4 booster has become standard for use in all fixed, semifixed, or separate-loading shell. On earlier models,

a small hole is drilled and tapped in the threaded upper portion of the booster to accommodate a setscrew for securing the fuze to the booster. The setscrew is staked in position after assembly. A recent loading and assembly practice has been to stake a small shoulder of the fuze body into the wrench slots of the booster body, thus eliminating the need of assembling and staking the setscrew. This practice now is superseded by use of a blind hole in the threaded section of the booster body, at which point the booster will be staked to the fuze in future production.

b. DESCRIPTION. The following description for the M21A4 booster also is applicable to all M20 and M21 boosters with the exceptions cited in *a* above (letters in parentheses refer to fig. 195). The booster is made up of two major parts: a booster cup (N) which contains a tetryl booster charge (O) and screws onto a threaded brass body (A) containing tetryl booster lead (M), and a rotor assembly. The rotor assembly is made up of a rotor (H) containing a lead azide-tetryl flash initiated detonator (G), a centrifugally actuated pin (K), a centrifugal pin lock pin (P) which operates under setback, a rotor stop pin (F), a rotor lock pin (I), and a rotor lock pin lock (J). The rotor is seated on its pivot pin (L) so that the detonator normally is out of alinement with other explosive elements in the booster and the assembled fuze. The center of gravity of the rotor assembly is off the centerline of the pivot center so that the assembly will rotate under centrifugal force. The rotor is locked in the unarmed position prior to firing by the spring-held centrifugal pin. The centrifugal pin, in turn, is held in the locking position by the centrifugal pin lock pin. The function of the rotor stop pin is to stop the rotor assembly when it has rotated to alined or armed position. The boresafety mechanism is covered at the forward end of the booster by a thin brass cover (D) which has a flash hole to permit the transmission of the fuze action to the detonator in the rotor of the booster. The flash hole is covered by a thin disk of onionskin paper (E) to prevent foreign matter from entering the booster.

c. FUNCTIONING. Upon firing, setback forces the centrifugal pin lock pin rearward against its spring, freeing the centrifugal pin. Centrifugal force moves the forward end of the lock pin under the shoulder in the lock pin cavity. This prevents the lock pin from returning to its original position. When the projectile reaches the required rotational velocity, the centrifugal pin moves outward against its spring. This releases the rotor which then rotates to the alined or armed position against the stop pin, whereupon the rotor lock pin moves radially outward under centrifugal force from its cavity in the rotor partially and into the hole in the booster body. Creep force causes the rotor lock pin lock to move

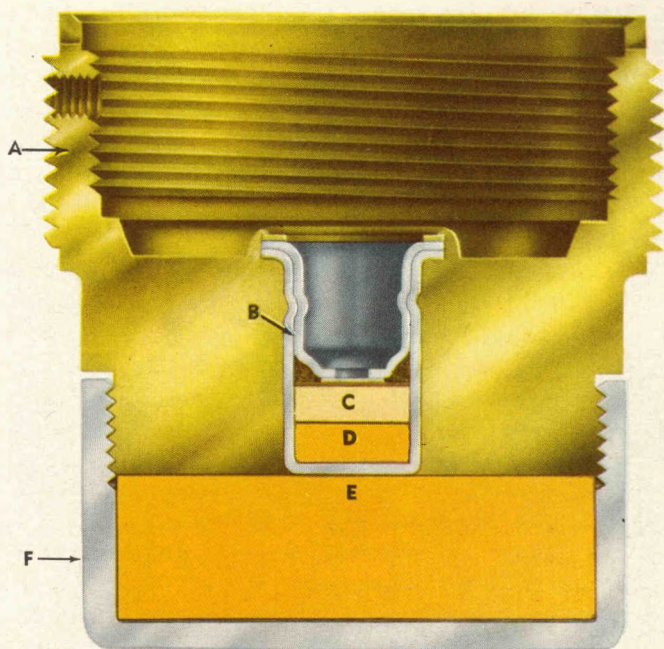


Figure 196. Booster, M22.

axially forward into the space behind the rotor lock pin, preventing the rotor lock pin from returning to its original position. Thus, the booster is locked in the armed position throughout the flight of the projectile. Action of the booster detonator is initiated by the detonating elements, or magazine charge (in time fuzes), of the fuze. Explosion of this detonator is transmitted through the booster lead to the booster charge. The booster charge, in turn, detonates the high-explosive charge of the projectile.

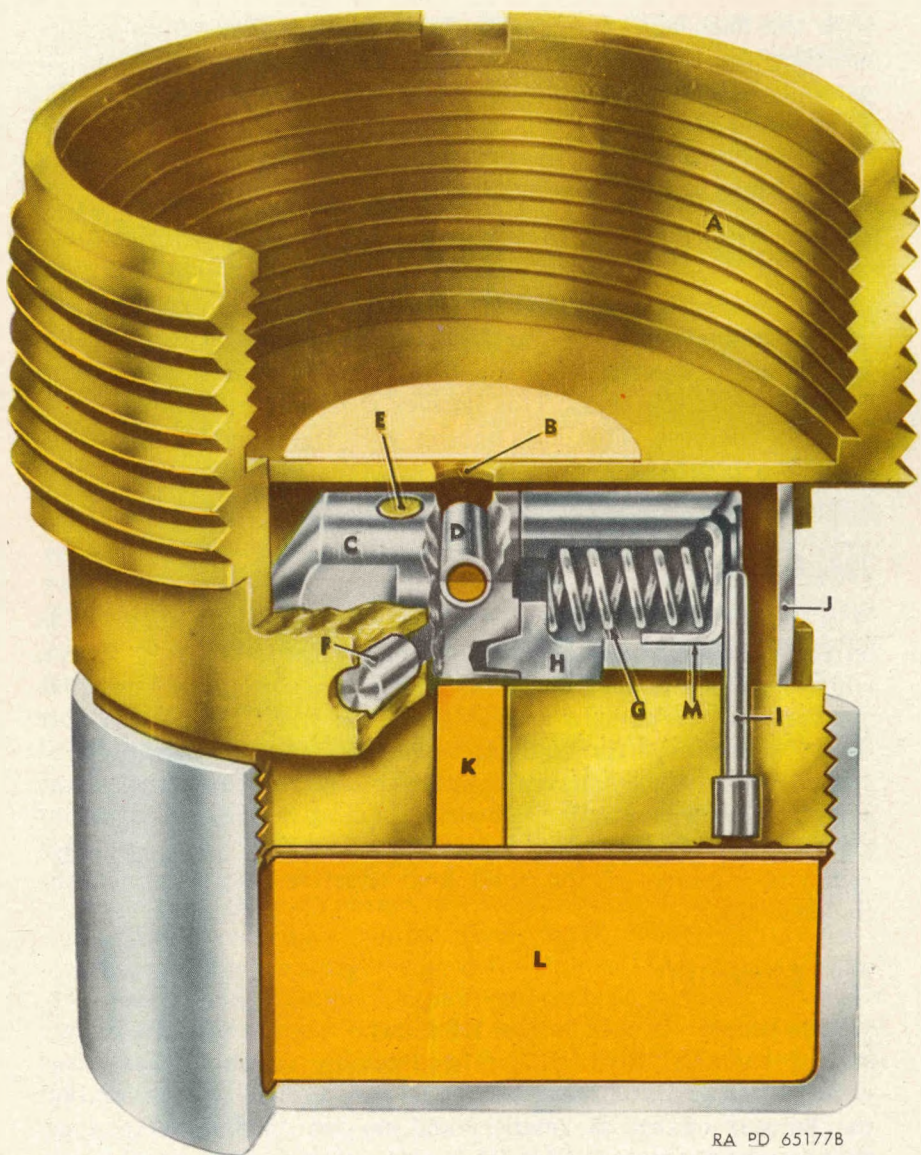
d. PREPARATION FOR FIRING. For firing the M21 series of boosters, the safety (cutter) pin must be removed before inserting the fuze and booster assembly into the shell. There is no preparation for firing boosters of the M20 series.

325. Booster, M22

The M22 booster (fig. 196) is used in conjunction with the M57 superquick fuze in 105-mm howitzer chemical shell to explode the shell burster charge. In outward respects, the booster is similar to the M20 and M21 series boosters, and has the same threading. Internally, the booster differs in that the rotor assembly is omitted, the body (A) being solid except for a drill hole through the center. This seats a detonator assembly (B) containing two pellets, one lead azide (C) and the other tetryl (D). The booster charge (E) is contained in a booster cup (F) screwed on the base end of the booster. Due to the omission of the rotor, the booster is not of the boresafe type. The M57 fuze w/M22 booster has been superseded recently by the M51A5 fuze for the 105-mm howitzer chemical shell.

326. Booster, M24

The M24 booster (fig. 197) has been standardized as an alternative for all modifications of the M20 and M21 boosters, for all purposes for which these are authorized. It also is used with the M48A3 or M48A2 fuze, or the M51A5 or M51A4 fuze without booster, to make up the M81 rocket fuze. The M24 booster consists of the brass body (A), which is threaded internally to take standard fuzes, and externally to fit in 2-12NS adapters or shell threads. The flash hole (B) opens into the rotor chamber. The rotor (C) contains the detonator (D) and holds it out of line until the fuze arms. The rotor is flat on diametrically opposite sides at its ends so that it is unbalanced until centrifugal action causes it to right itself. In so doing, its detonator is alined with both the flash hole and the booster lead. The rotor is held in the unarmed position by the lock (H) which has two protrusions on the end facing the rotor fitting into two corresponding holes in the rotor. The other



RA PD 65177B

Figure 197. Booster, M24..

end of the lock contains a slot, engaging the fixed body or guide pin (I) which permits the lock to move in a radial direction but prevents it from rotating. The lock is held engaged to the rotor by the centrifugal spring (G), one end of which is held stationary through the lock cup (M) against the fixed body pin (I). The rotor chamber is closed by a plate (J). On firing the shell, centrifugal force causes the lock to move outward against the spring and release the rotor which turns so that the detonator is alined

with the flash hole and the booster lead (K). On reaching this position, the rotor is locked in place by the lock pin (E) which partially enters the lock pin cavity as far as the closing plug (F). The booster charge (L) consists of a tetryl pellet. As a manufacturing modification, the booster body may be made of drawn brass with a brass insert. This modification is designated M24B1.

327. Booster, M25

This booster is a modified M21A4 booster, containing three external threads instead of six. A cotter pin with pull ring, which is located in the booster body, must be removed prior to assembling the booster to the shell. This booster is issued only for use with the M78 CP fuze. This M25 booster with the M78 fuze is used to convert a standard high-explosive artillery shell into a concrete-piercing shell. See paragraph 264 and figure 170.

328. Bursters

In chemical shell, the function of the explosive charge is to burst the shell casing and disperse the chemical contents. Hence, when used in chemical shell, the charges generally are known as burster charges, and the assembly as a burster. The burster, like the booster charge for high-explosive shell, consists essentially of a high-explosive charge in a suitable thin-walled container. Some early designs were similar to boosters, but modern types consist of a long assembly extending into the shell cavity. This insures a complete rupture of the shell and effective dispersion of the chemical filler.

329. Burster, M1

This burster is used in the M2 burster casing with the 81-mm mortar chemical shell M57. The assembly resembles that used with 75-mm gun and howitzer shell (par. 332) but differs in that the burster charge is smaller, and no intermediate detonating charges are necessary. The M1 burster consists of approximately 0.037 pound of tetryl loaded under pressure in an aluminum-alloy tubing 0.39 inch in diameter and 9.82 inches long. The M2 burster casing is made up of a seamless steel tubing with internal dimensions approximately the same as the external measurements of the burster, seated at the forward end in a steel sleeve. The assembly is constructed so it will be a press fit in the adapter of the M57 shell, and extends approximately three-quarters of the length of the shell cavity. Action of the burster is initiated by the M52 fuze, which has a booster charge assembled therein.

330. Burster, M5

This burster is used in the M5 burster casing with the M60 chemical shell for 105-mm howitzers. The assembly essentially is the same as the M1 burster in the M2 casing, described in paragraph 329, in construction and manner of functioning, but differs in various details. The M5 burster charge of tetrytol (70 percent tetryl, 30 percent TNT) is somewhat heavier, weighing approximately 0.26 pound, and is cast rather than pressed into the tube. The charge (A) is loaded in an alloy-steel tube 12.42 inches long; the over-all length of the assembly is 12.62 inches and extends the full length of the shell cavity. The burster assembly has no auxiliary charges.

331. Burster, M6

This burster is used in the M1 burster casing with the M104 chemical shell for 155-mm guns. The assembly also is standard for the chemical shell M105 and M110 for 155-mm howitzers. These shell are adapted for the M51 fuze or modifications, which include an M21-series booster assembled to the fuze. In construction and functioning, the burster assembly basically is the same as the M5 described in paragraph 330; differences are chiefly with respect to size and weight of the charge. The M6 burster charge consists of approximately 0.41 pound of tetryl or tetrytol, a relatively heavy charge being necessary, due to the large size of the shell as compared with those with which the other assemblies of this type are used. The assembly is 20.67 inches long and extends the full length of the shell cavity.

332. Burster, M8

This burster is used in the M6 burster casing in conjunction with INITIATOR, burster, M1, to rupture the casing and disperse the filler of the M64 chemical shell for 75-mm guns and howitzers and the M311 (T40) smoke shell for the 75-mm rifle. It extends the full length of the shell cavity. The burster casing is a press fit in the shell adapter and the burster charge is a loose fit in the casing. The burster consists of a 1-ounce tetryl charge loaded under pressure in an aluminum-alloy tubing approximately one-half inch in diameter and 7.9 inches long. Cast tetrytol may be used. The M6 burster casing is made up of a seamless steel tubing brazed at the forward end in a steel sleeve. The tubing is approximately $1\frac{3}{8}$ inches longer than the burster to allow space forward of the burster charge for INITIATOR, burster, M1. INITI-

ATOR, burster, M1 is required for proper functioning of the burster charge since the M48A2 fuze has no booster charge in its explosive train. The INITIATOR, burster, M1 is held in position against the front end of the burster by a retention device.

333. Burster, M19

This burster is used in the M8 burster casing with the 60-mm mortar WP smoke shell M302. It extends approximately three-quarters of the length of the shell cavity. The burster consists of approximately 0.017 pound of tetrytol in an aluminum tube approximately 3.9 inches in length and 0.38 inch in diameter. The M8 burster casing is made up of a seamless steel tubing seated in the forward end of the shell cavity in a steel sleeve. The assembly is press-fitted in the adapter of the shell. Action of the burster is initiated by the M82 point detonating fuze.

334. Burster, M21

This burster is used in the M9 burster casing with the M308 chemical shell for 57-mm rifles. The burster extends the full length of the shell cavity. The burster casing is a press fit in the shell adapter. It consists of seamless steel tubing, 0.565 inch in diameter and 2.83 inches long, brazed into a steel sleeve at the forward end of the tubing. The burster charge consists of 74 grains of pressed tetryl in an aluminum-alloy tubing. A paper disk is assembled at each end of the charge. No detonator is assembled in this burster. The PD fuze M89 is used to detonate the burster.

335. Burster, M23

This burster is used in the M12 burster casing with the M312 WP smoke shell for 76-mm guns. The burster extends approximately seven-eighths of the length of the shell cavity. The burster casing is a press fit in the shell adapter. It is made up of seamless steel tubing 1 inch in diameter and 6.54 inches in length and is brazed in a steel sleeve at the forward end of the shell cavity. The burster charge consists of 524 grains tetrytol or 504 grains of pressed tetryl in an aluminum-alloy tubing. An intermediate detonator is required for proper function of the burster charge since the M48A2 fuze, which is standard for these chemical shell, has no booster charge in its explosive train. The detonator assembly is held in position against the front end of the burster by a retaining spring washer.

336. Burster, M24

This burster is used in the M13 burster casing with the 90-mm gun WP smoke shell M313. The burster extends the full length of the shell cavity. The burster casing is a press fit into the shell adapter. It is made of seamless steel tubing which is brazed into a steel sleeve at the forward end of the shell cavity. The burster charge consists of approximately 1,019 grains of tetrytol loaded into an aluminum-alloy tubing 0.755 inch in diameter and 10.408 inches long. The M48A3 fuze is standard for this shell and the burster requires an intermediate detonator to assure proper functioning.

337. Supplementary Charge

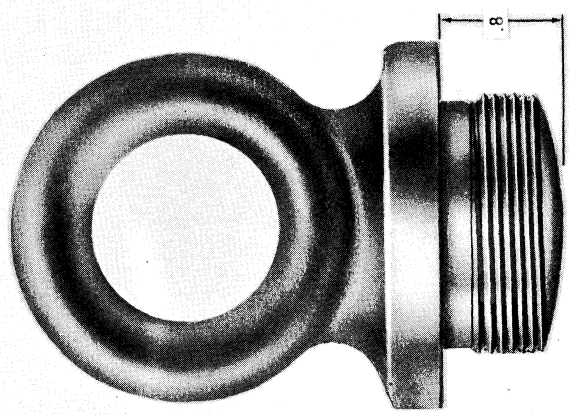
a. This charge (fig. 4), assembled in deep-cavity shell, consists of a cylindrical cardboard container filled with 0.263 pound of TNT. A $\frac{3}{8}$ -inch thick felt pad is cemented to one end of the container to cushion the charge when the fuze is inserted, and to protect it from the shock of setback. A loop of cloth tape is attached to the opposite end to facilitate the withdrawal of the charge from the shell. The over-all length of the charge is approximately 3 inches, and the diameter is approximately $1\frac{3}{4}$ inches.

b. The supplementary charge is placed in deep-cavity shell with the felt pad toward the base of the shell and with the loop of cloth tape in such a position that it may be grasped to lift the charge out of the cavity. Subsequent assembly of time or impact fuze (plus its booster) to the shell will compress the felt pad slightly and thus hold the charge securely in the cavity. In the future, supplementary charge containers will be made from aluminum.

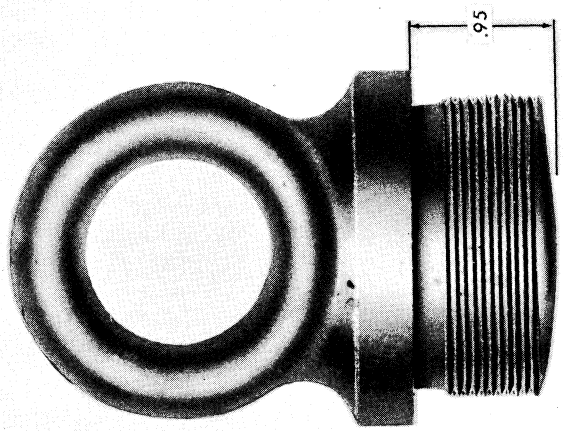
338. Adapters

The openings in the nose of most modern projectiles are threaded to conform to the requirements of the fuzes or fuze with booster combinations. With this and the greater standardization of fuze threading, interchangeability is obtained without modifications. However, in some high-explosive shell of earlier design, openings in the nose are considerably larger than required by the fuzes, in order to facilitate manufacture and loading of the projectiles. For such shell, a suitably threaded metal bushing, called an adapter, is necessary to reduce the size of the opening to conform to the threaded portion of the fuze. Interchangeability is obtained by using the appropriate size adapter required for different fuzes and projectiles. Chemical shell have adapters in order to provide a means of seating the burster casing.

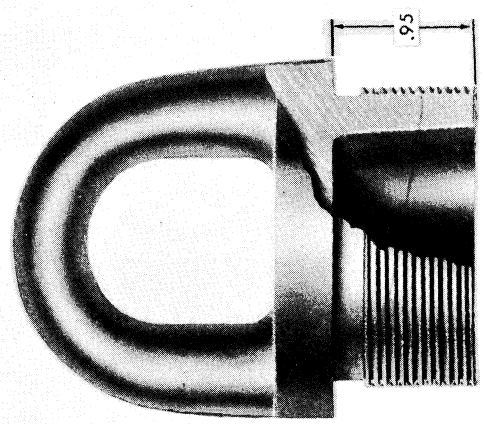
THREADS:
 "C"—1.7-14NS-1
 "G"—2.12NS-1
 "G" (ALT.)—2.12NS-1



TYPE "C"



TYPE "G"



TYPE "G" (ALTERNATIVE)

RA PD 80690C

Figure 198. Eyebolt-lifting plugs.

Section V. EYEBOLT-LIFTING PLUGS, CLOSING PLUGS, AND GROMMETS

339. Eyebolt-Lifting Plugs

Separate-loading projectiles which are issued and shipped unfuzed are fitted with a suitable plug, commonly called eyebolt-lifting plug, to protect against the entrance of foreign material into the fuze hole during shipment, storage, and handling and to provide a means for lifting these heavy shell. The plug is a screw-in type made of steel or malleable iron, with an eyebolt on the outer surface to facilitate handling. In deep-cavity shell, a short piece of cardboard tubing called "spacer" is provided and is placed between the supplementary charge and lifting plug to keep the supplementary charge from movement (fig. 4). Several types of eyebolt-lifting plugs are provided, the essential difference between the types being with respect to the size and type of threads. Types of lifting plugs most generally encountered in the field, and characteristics thereof, are given in table IX. (See also fig. 198.)

340. Closing Plugs

In unfuzed deep-cavity fixed and semifixed ammunition, normally packed in individual sealed containers, a closing plug pro-

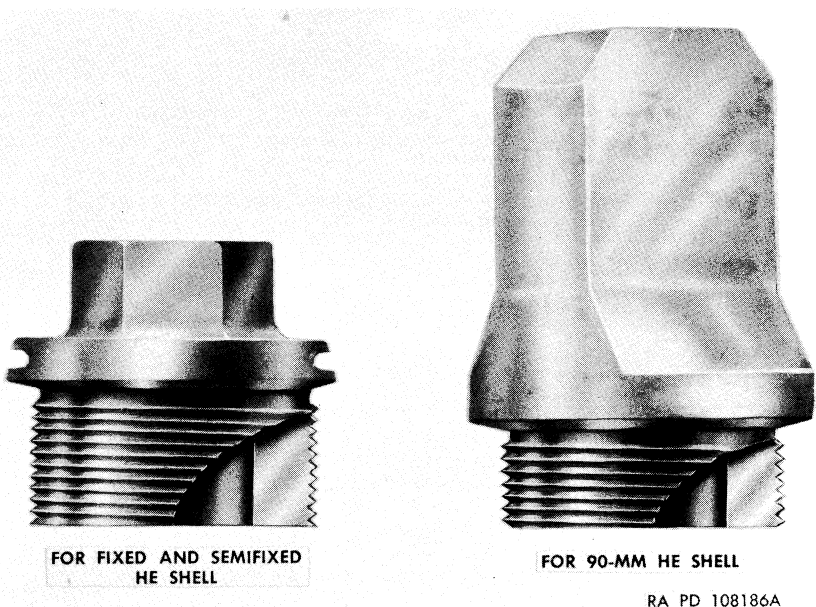


Figure 199. Closing plugs for fixed and semifixed deep-cavity HE shell.

fects against the entrance of foreign matter into the fuze hole during shipment, storage, and handling. Closing plugs are threaded and have heads suitable for prescribed packing containers and for wrenches to assemble to or remove from shell. Some shell, notably the 57-mm M307 HE, AT shell, have a base filling hole permanently closed with a closing plug. Closing plugs of older manufacture are made of steel; those of present manufacture, of aluminum. A short piece of cardboard tubing called "spacer" is provided and is placed between the supplementary charge and closing plug to keep the supplementary charge from movement (fig. 4). Types of closing plugs generally encountered in the field, and characteristics thereof, are given in table X. (See also fig. 199.)

Table IX. Types of Eyebolt-Lifting Plugs

Ammunition with which used	Thread size	Over-all length (in)	Diameter of eyebolt (in)	Weight (lb)
Type "C" SHELL, smoke, BE, M116, for 155-mm howitzers. SHELL, illuminating, M118, for 155-mm guns and howitzers.	1.7-14NS-1	3.65	2.29	1.45
Type "G" SHELL, gas or smoke, M104, for 155-mm guns. SHELL, HE or empty, M101, for 155-mm guns. SHELL, HE, M102, and M107, for 155-mm howitzers. SHELL, gas or smoke, M105, and M110, for 155-mm howitzers. SHELL, HE, M103, for 8-inch guns. SHELL, HE, M106, for 8-inch howitzers. SHELL, HE, M114, for 240-mm howitzers.	2-12NS-1	3.85	2.29	1.75

341. Grommets

a. TYPES. To provide the necessary protection for the relatively soft rotating bands, projectiles shipped without packing are fitted with a grommet or ring of suitable material. Several types have been manufactured, the earliest of which is a rope grommet cut to required length and looped at both ends. When one grommet is required, it is placed directly over or in front of the rotating band or, in the case of double-banded shell, between the

Table X. Types of Closing Plugs

Piece-mark No.	Ammunition with which used	Thread Size	Over-all length (in)	Diameter of plug	Weight (lb)
75-14 -575A	SHELL, fixed or semifixed, HE, w/o fuze, for VT fuze, for 75-mm howitzers; for 90-mm guns M1, M2, M3, and T8; or for 105-mm howitzers M2A1 and M4; packed in fiber containers.	2-12NS-1	2.12	2.412	0.39
75-14 -575C	SHELL, fixed, HE, w/o fuze, for VT fuze, for 90-mm guns M1, M2, M3, and T8, packed in metal containers.	2-12NS-1	3.74	2.412	0.93

bands. Two grommets are required for oversea shipments, one placed behind and one in front of the band. Rope grommets are secured in position by hemp twine drawn tightly through the two end loops and secured by a slipknot (fig. 200). The current approved type for 155-mm, 8-inch, and 240-mm projectiles (fig. 201), consists of a split ring of thin steel faced on the inner surface by a fiber liner of approximately $\frac{1}{8}$ -inch thickness. This grommet covers the entire rotating band and seats on the projectile without pressure on the band. It is secured in position by soft wire drawn tightly through the notches provided in the rim for the purpose, as described in *b* below. A less widely used third type (the rubber grommet), designed for use with 155-mm shell,

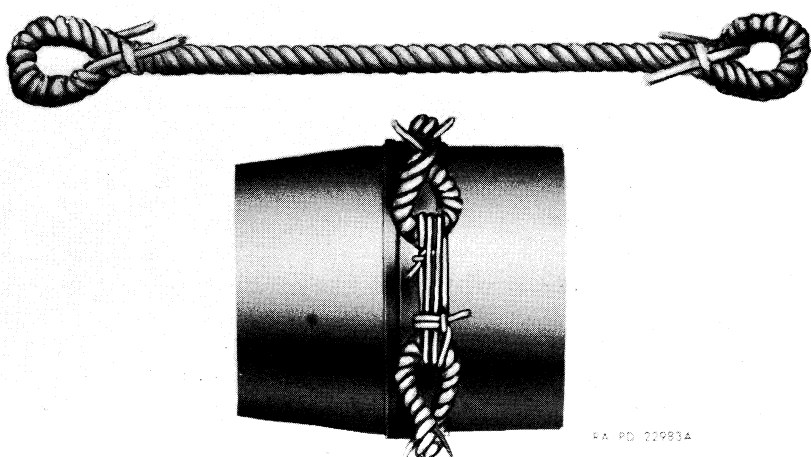


Figure 200. Rope grommet.

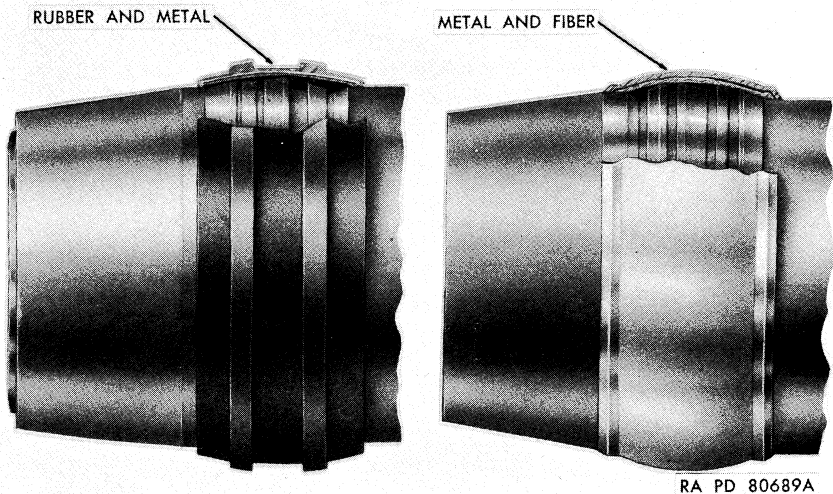


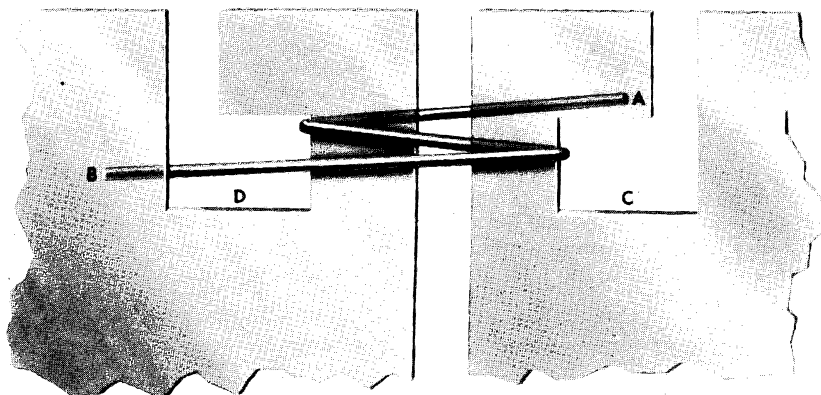
Figure 201. Grommets for separate-loading projectiles.

is similar to the fiber-steel grommet in that it covers the entire rotating band. However, it is made up of a steel core with a rubber cushioning faced on the end and lower surfaces with cotton sheeting (fig. 201). This type, as well as the rope grommet, no longer is being placed on newly issued projectiles.

b. METHOD OF SECURING METAL-FIBER GROMMETS. Metal-fiber grommets may be assembled to the projectile by either of the following methods:

(1) *Method A* (fig. 202).

- (a) Make a hairpin bend in the typing wire 2 inches from end A. Slip end A into the typing slot D, moving the end inside of the metal grommet toward tying slot C as far as the hairpin bend will allow it to go.
- (b) Weave the long end B from tying slot D outside of the metal grommet, passing the wire through the metal jacket opening, between the grommet and the shell, then through tying slot C.
- (c) Press the metal grommet as tight to the shell as possible and, while holding in place, pull the wire tight with pliers and bend the wire toward the tying slot D. While holding the wire tight, tap the bend lightly with a hammer so that it will have the smallest possible radius.
- (d) Push the end B through tying slot D between the shell and the grommet as far as it will go.
- (e) It is most essential that the band be held as tight to the shell as possible during the wire-tying operation. It is recommended that a suitable jig be improvised



RA PD 65133

Figure 202. Assembly of metal-fiber grommet—method A.

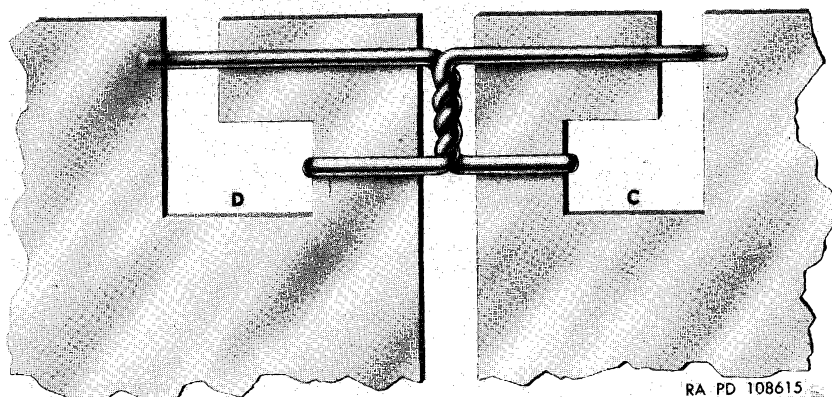
locally to hold the band firmly to the shell during the above operation.

(2) *Method B.*

- (a) Using 17-gage upset-end Bates wire tie or equivalent, insert the wire in tying slots C and D, as shown in figure 203. Length of wire used should be 6 inches for 155-mm shell and 8 inches for 240-mm and 8-inch shell.
- (b) Grasp the ends of the wire with a tying tool and twist not less than $2\frac{1}{2}$ full turns.

Note. If pliers are used, the wires should be pulled taut and the twist made as close to the grommet as possible.

- (c) After the twist has been made, the twisted ends should be tucked under the edges of slots, as shown, and bent flat against the grommet.



RA PD 108615

Figure 203. Assembly of metal-fiber grommet—method B.

CHAPTER 4

DESTRUCTION OF AMMUNITION TO PREVENT ENEMY USE

342. General

a. Destruction of ammunition 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 ammunition 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, ammunition and its components must be damaged so badly that they cannot be restored to usable condition in the combat zone. Equally important, the *same* essential components of all ammunition must be destroyed so that the enemy cannot assemble complete rounds from undamaged components.

d. If destruction of ammunition 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.
- (2) Observance of appropriate safety precautions.

343. Methods

Ammunition can be destroyed most quickly by burning or detonation. The following methods, in order of preference, are considered the most satisfactory for destruction of ammunition to prevent enemy use.

a. METHOD NO. 1—BURNING. Packed high-explosive rounds, and packed or unpacked propelling charges, small-arms ammunition,

primers, igniting cartridges, etc., can be destroyed most rapidly by burning. The ammunition may be piled in the containers (except small-arms cartridges which should be broken out) with all available inflammable material such as wood, rags, and brush. Gasoline should be poured over the pile and ignited from cover. Fires should be sufficiently intense to spoil ammunition in metal containers. Rounds that come through the fire unexploded will be in the nature of duds, that is, in a condition dangerous to handle.

b. METHOD NO. 2—DETONATION. Unpacked fixed and semifixed high-explosive rounds, separate-loading high-explosive shell, and packed or unpacked high-explosive items such as bursters or caps, may be destroyed by placing them in contact in piles and detonating them with an appropriate number of charges of TNT, using blasting caps and sufficient safety fuze to permit reaching cover at 200 yards. The amounts of TNT required are about one-half pound of TNT per 100 pounds of unpacked ammunition, and 1 pound of TNT for 100 pounds of ammunition as packed in wooden or metal containers. Prime each charge of TNT for simultaneous detonation in accordance with FM 5-25. If primed with safety fuze, light fuze and take cover. If arranged for electrical ignition, take cover and fire.

APPENDIX

REFERENCES

1. Publication Indexes

The following publication 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:

Index of Administrative Publications.....	SR 310-20-5
Index of Army Motion Pictures and Film Strips.....	SR 110-1-1
Index of Army Training Publications.....	SR 310-20-3
Index of Blank Forms and Army Personnel Classification Tests	SR 310-20-6
Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, Modification Work Orders, Tables of Or- ganization and Equipment, Reduction Tables, Tables of Allowances, Tables of Organization, Tables of Equipment, and Tables of Basic Al- lowances	SR 310-20-4
Introduction and Index (supply catalogs).....	ORD 1
Military Training Aids.....	FM 21-8
Ordnance Major Items and Combinations and Pertinent Publications	SB 9-1

2. Supply Catalogs

The following SNL's of the Department of the Army Supply Catalog pertain to this ammunition:

a. CLEANING AND PRESERVING MATERIALS.

Cleaning, Preserving, and Lubricating Materials; Recoil Fluids, Special Oils, and Miscellaneous Re- lated Items	ORD 3 SNL K-1
---	---------------

b. MEDIUM AND MAJOR CALIBER SEACOAST ARTILLERY, INCLUDING ANTIAIRCRAFT, RAILWAY, AND HEAVY FIELD ARTILLERY.

Subcaliber Ammunition for Harbor Defense, Heavy Field and Railway Artillery.....	ORD 11 SNL P-6
Ammunition for Antiaircraft Artillery.....	ORD 11 SNL P-5
Ammunition Instruction Material for Antiaircraft, Harbor Defense, Heavy Field, and Railway Artillery, including Complete Round Data.....	ORD 11 SNL P-8

Charges, Propelling, Separate Loading 6-in. 155-mm,
8-in. and 240-mm, for Harbor Defense, Heavy
Field, and Railway Artillery-----ORD 11 SNL P-2

Fuzes, Primers, Blank Ammunition, and Miscellan-
eous Items for Antiaircraft, Harbor Defense,
Heavy Field, and Railway Artillery-----ORD 11 SNL P-7

Materials for Renovating and Packaging of Group P
Ammunition -----ORD 11 SNL P-10

Projectiles, Separate Loading, 6-in 155-mm, 8-in,
and 240-mm, for Harbor Defense, Heavy Field,
and Railway Artillery, Including Complete Round
Data -----ORD 11 SNL P-1

c. PACK, LIGHT AND MEDIUM FIELD, AIRCRAFT, TANK, AND ANTI-
TANK ARTILLERY, AND TRENCH-MORTAR AMMUNITION.

Ammunition, Blank, for Pack, Light and Medium
Field, Tank, and Antitank Artillery-----ORD 11 SNL R-5

Ammunition, Fixed and Semifixed, Including Sub-
caliber, for Pack, Light and Medium Field, Air-
craft, Tank, and Antitank Artillery, Including
Complete Round Data-----ORD 11 SNL R-1

Ammunition Instruction Material for Pack, Light
and Medium Field, Aircraft, Tank, and Antitank
Artillery -----ORD 11 SNL R-6

Ammunition, Mortar, Including Fuzes, Propelling
Charges and Other Components-----ORD 11 SNL R-4

Materials for Renovating and Packaging of Group R
Ammunition and Miscellaneous Items-----ORD 11 SNL R-10

Projectiles and Propelling Charges, Separate Load-
ing, for Medium Field Artillery, Including Com-
plete Round Data-----ORD 11 SNL R-2

Service Fuzes and Primers for Pack, Light and
Medium Field, Aircraft, Tank, and Antitank Ar-
tillery -----ORD 11 SNL R-3

d. TOOLS AND SUPPLIES.

Ammunition Surveillance, Testing, and Inspection
Equipment and Supplies-----ORD 6 SNL N-10

General Tools and Supplies for Ordnance Ammuni-
tion Company -----ORD 10 SNL N-17

Special Ammunition Surveillance, Testing, Inspec-
tion, and Renovation of Tools and Supplies--ORD 5 SNL P-11

3. Explanatory Publications

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

a. AMMUNITION, ALL TYPES.

Ammunition Condition Report.....	OO Form 517
Ammunition, General	TM 9-1900
Ammunition: General	SB 9-AMM 1
Ammunition Identification Code (AIC).....	SB 9-AMM 5
Ammunition Inspection Guide.....	TM 9-1904
Ammunition: Renovation	TM 9-1905
Ammunition: Net prices.....	ORD 5-3-6
Ammunition: Restricted or Suspended.....	TB 9-AMM 2
Ammunition: Surveillance Manual.....	OFSB 3-20
Ballistic Data, Performance of Ammunition.....	TM 9-1907
Complete Round Chart.....	OO Form 5981
Characteristics and Employment of Ground Chemical Munitions	FM 3-5
Explosives and Demolitions.....	FM 5-25
Military Explosives	TM 9-2900
Mortar, Chemical, 4.2-Inch.....	TM 3-320
Qualification in Arms and Ammunition Training Allowances	AR 775-10
Regulations for Firing Ammunition for Training, Target Practice, and Combat.....	SR 385-310-1
Rockets	TM 9-1950
Small Arms Ammunition.....	TM 9-1990

b. CLEANING AND PRESERVING MATERIALS.

Cleaning, Preserving, Sealing, Llubricating, and Re- lated Materials Issued for Ordnance Matériel.....	TM 9-850
---	----------

c. MISCELLANEOUS.

Artillery Matériel and Associated Equipment.....	TM 9-2300
Decontamination	TM 3-220
Defense Against Chemical Attack.....	FM 21-40
Dictionary of United States Army Terms.....	TM 20-205
Field Artillery Trainer M3.....	TM 6-225
Honors to Persons.....	AR 600-30
Inspection of Separate Loading Propelling Charges and Bulk Propellants.....	SR 742-140-1
Inspection of Ordnance Matériel.....	TM 9-1100

Military Chemistry and Chemical Agents.....	TM 3-215
Numbering of Department of the Army Publications	SR 310-20-1
Ordnance Safety Manual.....	OO Form 7224
Ordnance Service in the Field.....	FM 9-5
Administration	AR 210-10
Preparation of Ordnance Matériel for Deep Water Fording	TM 9-2853
Protection of Ordnance Matériel in Open Storage	SB 9-47
Reports	SB 9-AMM 8
Reports of (Accidents) (Fires) (Explosions)	SR 385-10-40 series
Reports of Hazardous Conditions.....	SR 385-15-1
Safeguarding Military Information.....	AR 380-5
Salutes and Ceremonies.....	AR 600-25
Small Arms Matériel and Associated Equipment.....	TM 9-2200
Storage	AR 700-10
Department of the Army Supply Catalog System.....	SR 310-20-2
Targets, Target Material, and Training Course Lay-Outs	TM 9-855

4. Firing Tables

Index of Army Training Publications.....	SR 310-20-3
Graphical Firing Tables.....	TM 9-526

INDEX

	Paragraph	Page
Accidents, field report of -----	17	68
Adapters:		
General discussion -----	338	379
Use with blank cartridge -----	41	92
Ammunition, blank:		
Classification -----	5	7
Description of complete round -----	15	51
For—		
37-mm gun M6 -----	42	95
75-mm gun or howitzers:		
Double pellet charge -----	92, 103	133, 146
Single pellet charge -----	91, 102	132, 146
76-mm guns -----	127	160
90-mm guns M1, M1A1, M1A2, M2, M2A1, M3, M3A1, and T8 -----	155	186
105-mm howitzers -----	168	200
Use -----	15	51
Ammunition, drill:		
Classification -----	5	7
Identification -----	11	17
Ammunition, fixed -----	4	4
Ammunition, practice -----	5	7
Ammunition, semifixed -----	4	4
Ammunition, separate-loading -----	4	4
Ammunition, separated -----	4	4
Ammunition, service -----	5	7
Ammunition for—		
20-mm guns -----	18	69
37-mm guns -----	29	78
40-mm guns -----	46	96
57-mm guns -----	53	103
57-mm rifles -----	60	108
60-mm mortars -----	73	115
75-mm guns -----	81	127
75-mm howitzers -----	95	133
75-mm rifles -----	105	147
76-mm guns -----	118	153
81-mm mortars -----	129	161
90-mm guns -----	142	174
105-mm howitzers -----	157	187
4.2-inch mortar -----	171	201
120-mm guns -----	176	207
155-mm guns -----	181	211
155-mm howitzers -----	189	218
8-inch guns -----	201	205
8-inch howitzers -----	206	228
240-mm howitzers -----	212	231
Subcaliber equipment -----	217	233
Ammunition identification code (AIC) -----	7	9
Armor penetration data (table I) -----	14	34

	Paragraph	Page
Armor-piercing cap -----	14	34
Armor-piercing projectile -----	14	34
Booster:		
M20, M20A1, and M20A2 -----	323	370
M21, M21A1, M21A2, and M21A4 -----	324	370
M22 -----	325	374
M24 -----	326	374
M25 -----	264, 327	310, 376
Boosters:		
Description -----	322	369
In fuze interchangeability -----	231	242
Preparation for firing (M21 series) -----	324	370
Boresafety -----	231	242
Bourrelet -----	14	34
Burster:		
M1 -----	329	376
M5 -----	330	377
M6 -----	331	377
M8 -----	332	377
M19 -----	333	378
M21 -----	334	378
M23 -----	335	378
M24 -----	336	379
Bursters, description -----	328	376
Canisters, colored smoke -----	157	187
Care, handling, and preservation:		
General instructions -----	12	30
Handling of shell w/VT fuzes -----	14	34
VT fuzes -----	234	255
Cartridge, AP-T:		
M81A1, 40-mm guns -----	48	99
M95, 20-mm guns AN-2 and M3 -----	20	73
M95 (electric), 20-mm gun M24 -----	21	73
Cartridge, APC-T, M86, 57-mm guns, w/fuze, BD, M72	55	104
Cartridge, ball:		
Cal. .22, long rifle -----	219	235
Cal. 30, M2 -----	220	235
Cal. .50, M2 -----	221	235
Cartridge, blank, 10-gage, 37-mm gun M6 -----	41	92
Cartridge, drill:		
M7, 75-mm guns w/fuze, combination, 21-sec,		
M1907M, inert -----	93	133
M12B2, 90-mm guns M1, M1A1, M1A2, M2, M2A1,		
M3, M3A1, and T8, w/fuze, time, mechanical,		
M43A2, inert -----	156	187
M13, 37-mm gun M6 -----	45	96
M14, 105-mm howitzers, w/fuze, dummy, M59 -----	169	200
M14, 105-mm howitzers, w/fuze, TSQ, M54, inert ---	170	201
M16, 75-mm guns, w/fuze, dummy, M59 -----	94	133
M17, 40-mm guns -----	51	102
M18A2, 20-mm guns AN-M2, M3, and M24 -----	28	78
M19, 75-mm howitzers, w/fuze, dummy, M59 -----	104	147
M20, 76-mm guns, w/fuze, dummy, M59 -----	128	160
M21, 37-mm guns M1A2 and AN-M9, w/fuze, dummy,		
M50B2 -----	43	95

	Paragraph	Page
Cartridge, drill—Continued:		
M22, 57-mm guns -----	58	108
M23, 37-mm gun M10 -----	44	96
M24, 57-mm guns -----	59	108
M25, 40-mm guns -----	52	103
Cartridge, HE:		
M306, 57-mm rifles, w/fuze, PD, M89 -----	63	110
M306A1, 57-mm rifles, w/fuze, PD, M503 -----	62	109
M309, 75-mm rifles, w/fuze, PD, M51A4 (M48A2), 0.05-sec delay -----	108	149
M309A1, 75-mm rifles, w/fuze, PD, M51A5, 0.05-sec delay -----	107	149
Cartridge, HE, AT:		
M307, 57-mm rifles, w/fuze, PI, M90 -----	65	111
M307A1, 57-mm rifles, w/fuze, PI, M90 -----	64	110
M310, 75-mm rifles -----	110	150
Cartridge, HE, AT-T:		
M310, 75-mm rifles -----	111	150
M310A1, 75-mm rifles, w/fuze BD, M91 -----	109	149
Cartridge, HE-T:		
M303, 57-mm guns:		
With fuze, PD, M85 -----	57	108
With fuze, PD, M86 -----	56	106
Mk 2, 40-mm guns, w/fuze, PD, Mk 27:		
SD Mk 3A1 -----	50	102
SD Mk 11 -----	49	99
Cartridge, HEI:		
M97, w/fuze, PD, M75, 20-mm guns AN-M2 and M3 -----	22	73
M97 (electric), w/fuze, PD, M75, for gun M24 -----	23	76
Cartridge, ignition (<i>see also pertinent weapon under</i> <i>Ammunition for</i>):		
Data (table VIII) -----	297	354
Models:		
M2 -----	301	364
M3 -----	302	364
M4 -----	303	365
M5A1 -----	243, 304	272, 365
M6 -----	305	366
M8 -----	306	366
Cartridge, incendiary:		
M96, 20-mm guns AN-M2 and M3 -----	24	76
M96 (electric), 20-mm gun M24 -----	25	77
Cartridge, smoke, WP:		
M308, 57-mm rifles, w/fuze, PD, M89 -----	68	114
M308A1, 57-mm rifles:		
With fuze, PD, M89 -----	67	113
With fuze, PD, M503 -----	66	113
M311, 75-mm rifles:		
With fuze, PD, M48A2 -----	113	152
With fuze, PD, M57 -----	114	152
M311A1, 75-mm rifles, w/fuze, PD, M48A3 -----	112	150
Cartridge, TP:		
M99, 20-mm guns AN-M2 and M3 -----	26	77
M99 (electric), 20-mm gun M24 -----	27	78
M306, 57-mm rifles, w/fuze, PD, M89 -----	71	114

	Paragraph	Page
Cartridge, TP:—Continued		
M306, 57-mm rifles, w/fuze, PD, M89, inert, or fuze dummy, T126 -----	72	114
M306A1, 57-mm rifles:		
With fuze, PD, M89 -----	70	114
With fuze, PD, M503 -----	69	114
M309, 75-mm rifles:		
With fuze, dummy, M73 -----	117	153
With fuze, PD, M51A4, 0.05-sec delay -----	116	153
M309A1, 75-mm rifles, w/fuze, PD, M51A5, 0-05-sec delay -----	115	152
Cartridge cases (<i>see also pertinent weapon under Ammunition for</i>):		
For propelling charges -----	277	333
Charge, propelling:		
M1, 8-inch howitzers -----	294	351
M2, 8-inch howitzers -----	294	351
M3, 155-mm howitzers -----	292	348
M4, 155-mm howitzers -----	292	348
M4A1, 155-mm howitzers -----	292	348
M8, 3-inch training shell M5 -----	229	240
M9, 8-inch guns -----	293	349
M10, 8-inch guns -----	293	349
M13, 8-inch guns -----	293	349
M15, 120-mm guns -----	290	344
M19, 155-mm guns -----	291	344
M23, 240-mm howitzers -----	295	351
For (<i>see also pertinent weapon under Ammunition for</i>):		
20-mm guns -----	278	340
37-mm guns -----	279	340
40-mm guns -----	280	340
57-mm guns and rifles -----	281	341
60-mm mortars -----	282	341
75-mm guns and rifles -----	283	341
75-mm howitzers -----	284	341
76-mm guns -----	285	342
81-mm mortars -----	286	342
90-mm guns -----	287	342
105-mm howitzers -----	288	342
4.2-inch mortars -----	289	344
120-mm guns -----	290	344
155-mm guns -----	291	344
155-mm howitzers -----	292	348
8-inch guns -----	293	349
8-inch howitzers -----	294	351
240-mm howitzers -----	295	351
Charge, propelling, dummy:		
M2, 155-mm howitzers -----	292	348
M4, 8-inch howitzer -----	294	351
M7, 8-inch guns -----	293	349
M12, 240-mm howitzers -----	295	351
M13, 120-mm guns -----	290	344
M100, 155-inm guns -----	291	344
Mk 1, 155-mm guns -----	291	344
Mk 1, 155-mm howitzers -----	292	348

	Paragraph	Page
Charge, smoke, M1 (3-inch training shell M5) -----	229	240
Charge, supplementary -----	337	379
Charges, propelling (<i>see also pertinent weapon under Ammunition for</i>):		
Containers for -----	277	333
Fixed, semifixed, and separated charges -----	277	333
Flashless and smokeless -----	277	333
General -----	277	333
Identification of separate-loading charges -----	277	333
Igniter-protector cap -----	277	333
Separate-loading charges:		
Data (table VII) -----	277	333
Description -----	277	333
Chemical fillers -----	10	17
Chemical shell -----	14	34
Classification:		
Ammunition -----	5	7
Explosives -----	9	14
Fuzes -----	231	242
Primers -----	297	354
Projectiles -----	14	34
Propelling charges -----	277	333
Closing plugs. (<i>See Plugs.</i>)		
Data:		
Ammunition (<i>See pertinent weapon under Ammunition for</i>):		
Angle of impact -----	14	34
Armor penetration (table I) -----	14	34
Fuzes (<i>see also specific fuze</i>):		
Packing and shipping -----	231	242
VT fuzes -----	234	255
Ignition cartridge (table VIII) -----	297	354
Packing and shipping data. (<i>See pertinent weapon under Ammunition for.</i>)		
Primers (<i>See also pertinent weapon under Ammunition for</i>):		
Propelling charges:		
Packing and shipping -----	277	333
Separate-loading charges -----	277	333
Data tags -----	16	54
Deep-cavity high explosive shell:		
For 75-mm howitzers -----	98	141
For 105-mm howitzers -----	159	191
Deep-cavity shell, use with—		
Time or impact fuze -----	14	34
VT fuze -----	14	34
Definitions -----	4	4
Destruction of ammunition:		
General discussion -----	342	386
Methods -----	343	386
Detonators:		
Description (table III) -----	231	242
Identification -----	231	242
Disintegrating belt links. (<i>See Links, disintegrating belt.</i>)		
Dummy fuze data (table VI) -----	276	328

	Paragraph	Page
Explosive train	9	14
Explosives in ammunition	9	14
Eyebolt lifting plugs. (<i>See Plugs.</i>)		
Field artillery trainer M3	230	241
Fillers, chemical	10	17
Firing precautions (fuzes)	231	242
Fixed ammunition	4	4
Fixed charges	277	333
Flarebacks, causes and precautions	12	30
Flash reducer:		
M1, 155-mm guns	291	344
M2 (T2), 155-mm howitzers	292	348
M3 (T3), 8-inch howitzers	294	351
M4 (T4), 105-mm howitzers	288	342
Fuze, BD:		
M58	235	262
M60	237	264
M62A1 and M62	238	265
M66A1	239	265
M68	240	268
M72	241	268
M91	242	270
Fuze, base, practice, M58	236	264
Fuze, CP, M78, M78A1, and booster M25	264	310
Fuze, MTSQ:		
M500	272	323
M501	272	323
M502	273	324
Fuze, PD:		
M2 improved	243	272
M3 improved	244	272
M8	246	272
M9	247	278
M48A2	249	282
M48A3	249	282
M51A4	250	283
M51A4 Mod 3	251	286
M51A5 Mod 3	251	286
M51A5	250	283
M52 and modifications	252	287
M53 and modifications	253	291
M56	256	297
M57	257	298
M74	261	305
M75	262	306
M81 and M81A1	265	312
M82	266	314
M85	268	316
M86	269	318
M89	270	320
M503 (T190)	274	324
Mk 27 (Navy)	275	324
Fuze, PI, M90	271	322

	Paragraph	Page
Fuze, TSQ:		
M5 -----	245	272
M54 -----	254	291
M55 and modifications -----	255	297
M77 -----	263	308
Fuze, time:		
M65A1 -----	259	301
M84 -----	267	314
Fuze, time, mechanical:		
M43 (all modifications) -----	248	278
M61 and M61A1 -----	258	301
M67A3 -----	260	304
Fuze, VT:		
M92 (T74E6) -----	234	255
M93 (T152) -----	234	255
M96 (T76E9) -----	234	255
M97A1 (T80E9) -----	234	255
Fuze setters:		
Description -----	233	253
Models of (table IV) -----	233	253
Fuze wrenches -----	232	252
Fuzes (<i>see also pertinent weapon under Ammunition</i> for):		
Arming methods -----	231	242
Boresafety -----	231	242
Classification -----	231	242
Definition -----	231	242
Description:		
Detonators used in fuzes -----	231	242
Fuzes -----	231	242
Dummy -----	276	328
Dummy fuze data (table VI) -----	276	328
Identification of detonators -----	231	242
Interchangeability -----	231	242
Models of fuze setters (table IV) -----	233	253
Packing and shipping data -----	231	242
Preparation for firing. (<i>See paragraph on particular fuze.</i>)		
Precautions in firing -----	231	242
Safety features (FUZE, PD, M8 and M9) -----	246	272
Safety precautions (FUZE, PD, M8 and M9) -----	246	272
Fuzes, VT:		
Artillery shell fuzed with -----	14	34
Authorized use (table V) -----	234	255
Care, handling, and preservation -----	234	255
Characteristics -----	234	255
Data -----	234	255
Description -----	234	255
Functioning -----	234	255
Storage precautions -----	234	255
Wax coating on -----	12	30
Gas shells for 4.2-in mortars -----	173	203
Grades of ammunition -----	8	14

	Paragraph	Page
Grommets:		
Description	341	382
Methods of securing	341	382
Handling. (<i>See</i> Care, handling, and preservation.)		
High-explosive shell. (<i>See</i> Shell.)		
High explosives	9	14
Hypervelocity armor-piercing shot	14	34
Identification (<i>see also</i> pertinent weapon under		
Ammunition for):		
Code symbols	7	9
Detonators	231	242
Lot number	11	17
Painting and marking	11	17
Igniter-protector cap	277	333
Ignition cartridges. (<i>See</i> Cartridges, ignition.)		
Illuminating shell	14	34
Indicators, powder temperature	296	318
Initiator, burster, M1	332	377
Jungle packs	16	54
Links, disintegrating belts:		
20-mm ammunition	18	69
37-mm ammunition	29	78
Lot number	11	17
Marking:		
Ammunition	11	17
For shipment	16	54
Mortar ammunition (4.2-inch):		
Classification	171	201
Description:		
Propelling charge	289	344
Shell	171	201
Identification	171	201
Packing	171	201
Mortars, propelling charges for	277	333
Nomenclature	6	7
Ogive, description	14	34
Packing (<i>see also</i> pertinent weapon under		
Ammunition for):		
For shipment	16	54
Primers	298	364
Repacking of rounds and components after fuzing--	14	34
Packing and shipping data. (<i>See</i> Data).		
Painting	11	17
Palletization	16	54
Plugs:		
Description:		
Base	14	34
Closing	340	326
Eyebolt lifting	339	381
Types of:		
Closing (table X)	340	381
Eyebolt lifting (table IX)	339	381

	Paragraph	Page
Powder, propellant, for 76-mm gun ammunition -----	118	153
Powder temperature indicators -----	296	353
Precautions:		
Firing fuzes -----	231	242
Flarebacks -----	12	30
In storage -----	13	33
Preparation for firing (<i>see also paragraph on particular fuze</i>):		
Boosters (M21 series) -----	324	370
Preservation. (<i>See Care, handling, and preservation.</i>)		
Primer, electric, M52A2 -----	321	369
Primer, igniting, M48 -----	319	368
Primer, percussion:		
M1B1A2 -----	299	364
M22A3 -----	307	366
M23A2 -----	309	367
M28A2 -----	310	367
M31A2 -----	311	367
M32 -----	312	367
M34 -----	313	367
M36A1 -----	314	368
M38A1 -----	315	368
M40A1 -----	316	368
M46 -----	317	368
M47 -----	318	368
M49 -----	320	369
Mk 2A4 -----	300	364
Mk 22 or Mk 22 Mod 1 (Navy) -----	308	308
Primer and ignition cartridge data (table VIII) -----	297	354
Primers (<i>see also pertinent weapon under Ammunition for</i>).		
Classification -----	297	354
Data (table VIII) -----	297	354
Design and method of functioning -----	297	354
General -----	297	354
Packing and shipping -----	298	364
Projectile, AP, M112, 155-mm guns -----	183	213
Projectile, common:		
Mk 14, 8-inch guns -----	203	226
Mk (all Mods), 8-inch guns -----	203	226
Projectile, dummy:		
M7, 155-mm guns or howitzers -----	188, 200	217, 205
M12, 240-mm howitzers -----	216	232
M13, 8-inch guns -----	205	228
M14, 8-inch howitzers -----	210	230
M15, 120-mm guns, w/fuze, dummy, M79 -----	180	211
Mk 1A1, 8-inch howitzers -----	211	231
Projectile, fixed, APC-T:		
M61A1, 75-mm guns -----	83	128
M62A1, 76-mm guns, flashless-smokeless -----	120	154
M82, 90-mm guns:		
Flashless -----	144, 146	176, 178
Smokeless -----	145, 147	178
Projectiles:		
Components -----	14	34

	Paragraph	Page
Projectiles:—Continued		
Description	14	34
General discussion	14	34
Types of:		
Armor-piercing shell	14	34
Chemical shell	14	34
Dummy cartridges	14	34
High-explosive shell	14	34
High-explosive-antitank shell	14	34
Hypervelocity armor-piercing	14	34
Illuminating	14	34
Target-practice	14	34
Propellants, description	9	14
Propelling charges. (<i>See</i> Charge, propelling.)		
Report (field) of accidents	17	68
Rifles. (<i>See</i> Ammunition for.)		
Round, complete, definition	4	4
Safety devices. (<i>See specific items.</i>)		
Semifixed ammunition	4	4
Semifixed charges	277	333
Separate-loading ammunition	4	4
Separate-loading charges	277	333
Separate-loading propelling charge data (table VII)	277	333
Separated charges	277	333
Setter, fuze. (<i>See</i> Fuze setters.)		
Shell:		
Description:		
Artillery (for VT fuze)	14	34
Chemical	14	34
Deep-cavity high-explosive	14	34
High-explosive	14	34
High-explosive antitank	14	34
Illuminating	14	34
For 4.2-inch mortar	171	201
Use of deep-cavity shell with:		
Time or impact fuzes	14	34
VT fuzes	14	34
Shell, empty, M101, 155-mm guns	187	217
Shell, fixed, HE:		
M42A1, 76-mm guns, smokeless:		
With fuze, PD, M51A5:		
0.05-sec delay	122	157
0.05-sec delay, reduced charge	124	158
With fuze, MTSQ, M500	123	158
M48, 75-mm guns:		
Normal charge:		
With fuze, superquick and delay	84, 224	129, 239
With fuze, TSQ and MTSQ	87	131
Reduced charge:		
With fuze, superquick and delay	86	130
With fuze, TSQ and MTSQ	89	131
Supercharge:		
With fuze, superquick and delay	85	130
With fuze, TSQ and MTSQ	88	131
M63, 37-mm gun M6	35	86

	Paragraph	Page
Shell, fixed, HE:—Continued		
M71, 90-mm guns:		
Flashless -----	152	180
Flashless-smokeless -----	152	180
Smokeless -----	152	180
For 90-mm guns -----	152	180
Shell, fixed, HE, AT-T, M66, 75-mm howitzers -----	99	144
Shell, fixed, HE-T:		
M54, 37-mm gun M10, w/fuze, PD, M56 -----	38	90
M54, 37-mm guns M1A2 and AN-M9, w/fuze, PD, M56 -----	31	80
Shell, fixed, smoke, WP:		
M64, 75-mm guns, w/fuze, superquick and delay ----	90	131
M312, 76-mm guns, smokeless, w/fuze, PD, M48A3, 0.05-sec delay -----	125	159
M1313, 90-mm guns -----	154	185
Shell, fixed, TP:		
M48, 75-mm subcaliber gun M25, w/fuze, PD, M48, inert -----	225	239
M48, 75-mm subcaliber gun M1916, w/fuze, PD, M48, inert -----	226	239
M63, Mod 1, 37-mm subcaliber guns -----	222	238
M71, 90-mm guns, w/fuze, dummy, M73 -----	153	185
M92, 37-mm subcaliber guns, w/fuze, PD, M74 ----	223	238
Shell, fixed, TP-T:		
M55A1, 37-mm gun M10, w/fuze, dummy, M50 -----	40	91
M55A1, 37-mm guns M1A2 and AN-M9, w/fuze, dummy, M50 -----	34	84
Shell, gas or smoke:		
M2, 4.2-inch mortars -----	173, 175	203, 205
M104, 155-mm guns -----	186	216
M110, 155-mm howitzers -----	195	222
Shell, HE:		
M3, 4.2-inch mortar M2, w/fuze, PD, M9 -----	174	205
M43A1, 81-mm mortars, w/fuze, PD, M52A1 -----	131	162
M49A2, 60-mm mortars:		
With fuze, PD, M52A1 -----	75	117
With fuze, PD, M52A1B1 -----	76	119
M56, 81-mm mortars:		
With fuze, PD, M52A1 -----	133	166
With fuze, PD, M53A1 -----	134	166
With fuze, TSQ, M77 -----	132	164
M73, 120-mm guns:		
Deep-cavity -----	179	210
Normal-cavity -----	178	208
M101, 155-mm guns -----	184	213
M102, 155-mm howitzers -----	194	221
M103, 8-inch gun M1, w/fuze, PD, M51A5, (M51A4), Mod 3, 0.05-sec delay -----	204	226
M106, 8-inch howitzer M2:		
With suppl chg -----	209	230
Without suppl chg -----	208	229
M107, 155-mm howitzers:		
Adapted for fuze, VT, M96 (T76E6) -----	192	221
With suppl chg -----	191	219

	Paragraph	Page
Shell, HE: - Continued		
M107, 155-mm howitzers-----	193	221
M114, 240-mm howitzer M1:		
With suppl chg-----	215	232
Without suppl chg-----	214	231
Shell, illuminating:		
M83A1, 60-mm mortars, w/fuze, time (fixed), M65A1--	77	121
M118, 155-mm guns or howitzers-----	185,199	204, 205
M301, 81-mm mortars, w/fuze, time, M84-----	139	171
Shell, simifixed, HE:		
M1, 105-mm howitzers:		
Deep-cavity, dualgran-----	159	191
Normal-cavity, dualgran-----	159	191
M48, 75-mm howitzers:		
Deep-cavity, -----	98	141
Normal-cavity-----	97	139
Shell, simifixed, HE, AT-T, M67, 105-mm howitzers:		
M2A1 and M4, w/fuze, BD, M91-----	160	194
Shell, simifixed, illuminating, M314 105-mm howitzers:		
M2A1 and M4, w/fuze, MTSQ, M501-----	166	198
Shell, simifixed, smoke:		
M60, 105-mm howitzers M2A1 and M4, dualgran:		
With fuze, PD, M51A5, FS-----	164	197
With fuze, PD, M51A5, WP-----	163	197
M64, 75-mm howitzers:		
With fuze, PD, M48A3, 0.05-sec delay, FS--	101	146
With fuze, PD, M48A3, 0.05-sec delay, WP--	100	144
M84, 105-mm howitzers M2A1 and M4, dualgran:		
BE, colored-----	162	196
HC, BE w/fuze, MTSQ, M501-----	161	195
Shell, simifixed, TP-T, M67, 105-mmhowitzers M2A1 and M4	167	198
Shell, smoke:		
M2, 4.2-inch mortars-----	175	205
M57, 81-mm mortars, FS, w/fuze:		
PD, M52A1-----	137	169
TSQ, M77-----	138	169
M57,81-mm mortars, WP, w/fuze:		
PD, M52A1-----	136	168
TSQ, M77-----	135	166
M64, 75-mm howitzer, w/fuze, PD, M48A3, 0.05 sec		
Delay-----	228	240
M105, 155-mm howitzers, FS and WP-----	196	222
M116, 155-mm howitzers, M1, colored, BE----	198	224
M116, 155-mm howitzers, HC, BE-----	197	223
M302, 60-mm mortars, WP, w/fuze, PD, M82-----	78	123
Shell, TP:		
M43A1, 81-mm mortars, w/fuze, PD, M52A1-----	140	171
M50A2, for 60-mm mortars, w/fuze, PD, M52A1--	79	124
Shell, Training:		
M5, 3-inch subcaliber mortar M3 -----	229	240

	Paragraph	Page
Shell, Training: - Continued		
M68, 81-mm mortars, w/o fin assembly-----	141	172
M69, 60-mm mortars, w/o fin assembly-----	80	126
Shell, packing and marking for-----	16	54
Shipping Data (See Data.)		
Shot, fixed, AP-T:		
M77, 90-mm guns:		
Flashless-----	148	179
Smokeless-----	149	179
M80, 37-mm gun M10-----	39	91
Shot, fixed, APC-T:		
M51, 37-mm gun M6-----	36	86
M59A1, 37-mm gun:		
AN-M9-----	33	84
M1A2 and AN-M9-----	32	82
Shot, fixed, HVAP-T:		
M93, 76-mm guns, smokeless-----	121	156
M304, 90-mm guns, smokeless-----	150	179
Shot, fixed, HVAP-T – Continued:		
M315A1, 76-mm guns, smokeless-----	126	160
M317A1, 90-mm guns, smokeless-----	151	180
Shot, fixed, TP-T, M51A2, 37-mm gun M6-----	37	89
Shot, hypervelocity, armor-piercing-----	14	34
Stenciling-----	11	17
Storage precautions:		
General-----	13	33
Shell with VT fuzes-----	14	34
VT fuzes-----	234	255
Subcaliber ammunition:		
For 3-inch subcaliber equipment-----	229	240
General discussion-----	217	233
Subcaliber material and ammunition-----	217	233
Supplementary charge-----	337	379
Target practice Shell (<i>see also</i> Shell)-----	14	34
Tracer, description-----	14	34
Trainer, field artillery, M3-----	230	241
VT fuzes. (see Fuzes, VT)		
Wax coating on VT fuzes-----	12	30
Weight-zone markings (<i>see also pertinent weapon under</i> Ammunition for):		
General -----	11	17
Shell, 4.2-inch mortar-----	171	201
Windshield, description.....	14	34
Wrench, fuze. (<i>See</i> Fuze wrenches)		