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TECHNICAL MANUAL

AIRMUNITIONS GENERAL

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INTRODUCTION

This manual provides information on general airmunitions items used by, or in support of, United States Air Force activities. Information is furnished for the classification, identification, and use of these items. The airmunitions described include those procured and issued by the Departments of the Air Force, Army, and Navy. Specific data pertaining to dimension or composition of Chemical Corps or Navy designed items may be found in pertinent Department of the Army and Department of the Navy publications (Refer to Appendix). Information pertaining to nuclear or biological munitions has not been included (refer to specific Technical Manuals). General information pertaining to care, handling, packing, and marking of airmunitions is contained. For more specific data on maintenance, storage, handling, inspection, or destruction, refer to applicable technical manuals.

The appendix contains a list of current references, including supply and technical manuals, forms, and other available authorized publications applicable to this manual.

Whenever the words SHALL or WILL appear in this technical manual, it shall be construed to mean that the requirements are binding. The word SHOULD indicates a nonmandatory desire or a preferred method of accomplishment. The word MAY is used to indicate an acceptable or suggested means of accomplishment.

Users of this manual are encouraged to submit comments or recommendations for changes for improvement. Deficiencies noted in this manual should be reported to Headquarters, OOAMA (OOYST), Hill Air Force Base, Utah, 84401, in accordance with Section VIII, T.O. 00-5-1.

SECTION I
GENERAL SAFETY REQUIREMENTS

1-1. INTRODUCTION.

1-2. GENERAL. These safety requirements and precautions will be complied with by munitions personnel during storage, handling and inspection of conventional munitions. All personnel engaged directly as well as indirectly in operations in which ammunition, explosives and/or other hazardous material is involved should be thoroughly trained in explosive safety and capable of recognizing hazardous explosive exposures. Thinking safety and working safely must become a firmly established habit when working with or in the vicinity of items capable of exhibiting a hazard due to the nature of their explosive, flammable or toxic fillers.

1-3. REQUIREMENTS. The safety requirements set forth in AFM 127-100 will be complied with. The absence of a safety requirement in this T.O. or in the above reference does not necessarily indicate that no safeguards are needed. If immediately dangerous ammunition is encountered, all operations in the immediate vicinity will be shut down, personnel evacuated to a safe location and EOD or other authorized personnel called to render assistance in elimination of the hazard. Operations will not be resumed until the hazard has been eliminated.

SECTION II
DEFINITION OF TERMS

2-1. INTRODUCTION.

2-2. The terms used in conjunction with various items, classification, and use are standard throughout all airmunitions activities and are covered in the applicable sections of the manual. A complete definition of terms used within this manual is not furnished. The following definitions are simple descriptions of terms and phrases commonly used in conjunction with explosives. These are listed to provide a degree of uniformity of description in the use of technical information throughout the manual.

2-3. DEFINITIONS.

2-4. AIRMUNITIONS. Airmunitions are those items of military ammunition used by Air Force aircraft, weapons, or personnel. They are used in direct or indirect support of tactical or strategic objectives.

2-5. AUTOIGNITION TEMPERATURE. This temperature is the minimum temperature that combustible materials in contact with air will ignite, without an ignition source, and will continue to support combustion.

2-6. BIOLOGICAL WARFARE (BW). The military use of biological agents to produce death or disease in man, animals, and growing plants, is called biological warfare.

2-7. BRISANCE. The ability of an explosive to shatter its surrounding medium by very rapid expansion of gases and energy is called brisance.

2-8. CHEMICAL MUNITION. Chemical munitions are those items of ammunition such as bombs, rockets, and grenades, containing a chemical agent(s). Such agents include war gases, smokes, and incendiaries.

2-9. COMPLETE ROUND. A complete round of ammunition consists of all the necessary components to fire the system once.

2-10. DEFLAGRATE. Deflagration is a rapid burning action that consumes an explosive mass at a rate less than that normally considered to be a detonation. Propellants would normally fall within this category.

2-11. DEMILITARIZE. The term demilitarize means to mutilate, disarm or accomplish any other action required to render explosives unusable for military use.

2-12. DETONATE. Detonation is a very rapid decomposition of the mass, normally at speeds upward of 1500 feet per second. High explosives fall within this category.

2-13. ELECTROEXPLOSIVE DEVICE. Any explosive device such as a blasting cap, squib, explosive switch, explosive valve, igniter, etc., which is designed to be initiated by an electric current, is an electroexplosive device.

2-14. EXPLOSION PROOF. The term explosion proof, as used in connection with electrical equipment, means that such equipment is enclosed in a case, which is capable of withstanding an internal burning or explosion of elements contained inside the case and prevent ignition by spark, flash or explosion of any outside gas or vapor surrounding the enclosure.

2-15. EXPLOSIVES. The term explosives includes all ammunition, biological and chemical fillers, demolition material, solid rocket motors, liquid propellants, cartridges, pyrotechnics, mines, bombs, grenades, warheads of all types, explosive elements of ejection and aircrew egress systems, explosive components of missile systems and space systems, and assembled kits and devices containing explosives material. The terms explosives, explosives weight, net weight, and other like terms, refer to the fillers of an explosive item. Fillers may be propellants, TNT, Composition B, pyrotechnics, chemical agents, biological agents, etc.

2-16. EXPLOSIVES AREA OR LOCATION. An explosives area or location is any area or location specifically designated and set aside from other areas, and used for manufacturing, maintenance, storage, demilitarization, shipping and receiving, and other similar type explosives operations. Such areas may also be referred to as explosives parking or loading areas when armed or explosives-loaded aircraft are involved.

2-17. EXPLOSIVE HAZARD. An explosive hazard is any condition which may result in the occurrence, or contribute to the severity, of an explosives accident or incident.

2-18. EXPLOSIVES SAFETY DISTANCE (QUANTITY-DISTANCE). The prescribed minimum distance between various classes and quantities (net weight) of explosives and between such explosives and specified exposures (inhabited buildings, public highways, public railways, petroleum, aircraft, etc.) affording an acceptable degree of protection and safety is called the explosives safety distance.

2-19. EXPOSED EXPLOSIVES. Exposed explosives are as follows:

a. Explosives that are actually visable (such as unpackaged bulk explosives, disassembled or open components, etc.) and are susceptible to initiation directly by static or mechanical spark.

b. Explosives that create (or accidentally create) explosive dust or give off vapors, fumes or gases in explosive concentrations.

2-20. EXUDATE. Impurities in an explosive compound will sometimes leech out, or exude, from the mass due to heat, sweating, or chemical reaction. In bombs this material will usually ooze out around the fuze seat liner and drop onto the floor. Some exudate is extremely sensitive because it contains minute particles of explosive.

2-21. HIGH ORDER DETONATION. A detonation wherein all of the explosive is detonated at its maximum rate of detonation is called a high order detonation.

2-22. HYGROSCOPIC. The ability or capacity of a medium to absorb water is called hygroscopicity. If the explosive is hygroscopic the rate of detonation will be lower.

2-23. INERT. (As applicable to explosives). Inert items are those containing no explosives, active chemicals or pyrotechnics but not necessarily noncombustible.

2-24. LOW ORDER DETONATION. When only a portion of the explosive mass detonates, usually lower than its maximum rate of detonation, it is called a low order detonation.

2-25. MAGAZINE. A magazine is any building or structure, except an operating building, used for the storage of explosives. Magazines are of two general types: igloo (earth covered) and above ground (non-earth covered).

2-26. MASS-DETONATING EXPLOSIVES. Mass-detonating explosives are explosives that can be expected to explode and consume most of the entire mass virtually instantaneously when a small portion is subject to fire, severe concussion or impact, impulse of an initiating agent, or to the effect of a considerable discharge of energy from without. Explosives of this category, when detonated, cause severe structural damage to adjacent objects and may induce simultaneous detonation of other explosives stored sufficiently close to the initial explosion. When the explosives are located on or near the surface of the ground, a mass detonation is normally characterized by a crater. High explosives (TNT, etc.), black powder, certain combinations used in propellants, certain pyrotechnics, other similar explosives alone or in combination, and some complete items containing different classes of explosives in various components may be found in this category.

2-27. MILITARY AMMUNITION. Military ammunition is that type of munition that consists of explosive or chemical agents, with their characteristic mechanical devices, designed for use against military objectives.

2-28. POWER. The ability of an explosive to displace its surrounding medium. The ability to do work. The power of an explosive is governed by the rate of deflagration, temperature of the explosive, and the volume of gas liberated.

2-29. PROPAGATING EXPLOSION. A propagating explosion is the communication of an explosion (detonation or deflagration) from one explosive source to another by fire, fragment or blast (shock wave), where the time interval between explosions is sufficient to limit the total over-pressure at any given time to that which each explosion produces independently. (This condition, where detonation occurs, would be evidenced by a distinct shock wave from each detonation with a discernible pressure drop between each explosion.)

2-30. WEIGHT OF EXPLOSIVE. Explosive weights used in this manual will be construed to mean filler of the item in grams, grains, or pounds as indicated. The term explosive will include high explosive, low explosive or chemical depending upon the item referred to. Conversion of grain, gram, and pound is: 7000 grains equal 1 pound, 454 grams equal 1 pound, 15.4 grains equal 1 gram, and 28.35 grams equal 1 ounce.

SECTION III
CLASSIFICATION OF ITEMS

3-1. INTRODUCTION.

3-2. Airmunitions are classified according to their characteristics, i.e., type, standardization, use, etc.

3-3. TYPE.

3-4. SMALL ARMS AMMUNITION. Small arms ammunition consists of cartridges used in rifles, carbines, revolvers, pistols, submachineguns, machineguns, and shotgun shells.

3-5. AIRCRAFT CANNON AMMUNITION. Aircraft cannon ammunition consists of cartridges used in automatic aircraft cannon against ground, seaborne or aircraft targets. The cartridges are fixed, complete rounds, and the projectiles may be ball, high-explosive, incendiary, armor-piercing, or a combination.

3-6. CARTRIDGE ACTUATED DEVICES (CAD) AND PROPELLANT ACTUATED DEVICES (PAD). Cartridge actuated and propellant actuated devices are devices designed to facilitate an emergency escape from high speed aircraft, or perform other mechanical function in weapon systems.

3-7. GRENADES. Grenades are explosive- or chemical-filled projectiles of a size and shape convenient for throwing by hand or projecting from a rifle.

3-8. AIRCRAFT BOMBS, DISPENSERS, AND FUZES. Aircraft bombs are containers filled with an explosive, chemical, or other agent. They are fuzed, stabilized, and designed for release from aircraft against ground targets. Dispensers are either mechanical devices attached to the aircraft, or free falling mechanical devices designed to dispense a quantity of smaller items over a large target area. Fuzes are mechanical devices designed for the specific purpose of causing the bomb to function as intended, or for opening clusters at prescribed times. Two fuzes are usually used in bombs to obtain different effects, flexibility in use, or reliability in functioning.

3-9. PYROTECHNICS. Pyrotechnics consist of containers filled with low-explosive composition, designed for release from aircraft or for projection from the ground for illumination or signals.

3-10. AIRCRAFT ROCKETS (UNGUIDED MISSILES). Aircraft rockets are propellant-type motors, filled with solid or liquid propellant, fitted with rocket heads containing high-explosive or chemical agents. Guidance is provided by the launch aircraft to the extent of pointing the rocket in a predicted collision course with the target. A guidance system is not incorporated in the complete round.

3-11. JET-ASSIST-TAKE-OFF (JATO). JATO's consist of propellant-type motors used to furnish auxiliary thrust in the launching of aircraft, rockets, guided missiles, target drones, and mine clearing detonating cables.

3-12. GUIDED MISSILES. Guided missiles consist of propellant-type motors fitted with warheads containing high-explosive or other active agent and equipped with electronic guidance devices. Guided missiles may be air-launched or launched from fixed or mobile ground sites.

3-13. DEMOLITION MATERIALS. Demolition materials consist of explosives and explosive charges designed for use in demolition and in connection with blasting for military construction.

3-14. STANDARDIZATION, USE, AND FORM.

3-15. Airmunitions are classified according to standardization as Standard, Substitute Standard, or Limited Standard; according to form of issue as Fixed, Semifixed or Separated; and according to filler as Explosive, Chemical, Leaflet, Inert, or Empty.

3-16. STORAGE.

3-17. Airmunitions are classified for storage purposes into quantity-distance classes 1 through 8.

3-18. STORAGE COMPATIBILITY.

3-19. Airmunitions are presently grouped for compatibility in storage into 17 groups, lettered A through Q. (Refer to AFM 127-100.)

3-20. SHIPPING REGULATIONS.

3-21. Agent T.C. George's ICC Freight Tariff No. 15, as amended, classifies ammunition items into class A explosives (which are subdivided into types 1 through 8), class B explosives, and class C explosives. ICC shipping regulations are established accordingly. Regulations pertaining to transportation of these classes of explosives are published by the Bureau of Explosives, 30 Vesey Street, New York, N.Y.

3-22. Movement of explosives by commercial aircraft is governed by regulations of the Federal Aviation Agency (FAA).

3-23. The Military Traffic Management Terminal Service (MTMTS), formerly the Defense Traffic Management Service (DTMS), is a Department of Defense (DOD) agency, which regulates and monitors

all military shipments including ammunition and explosives.

3-24. The United States Coast Guard, Treasury Department, is vested with explosives safety responsibilities for the loading and discharge of military explosives from all domestic and foreign vessels.

3-25. BURNING OR EXPLOSIVE CHARACTERISTICS.

3-26. Explosives, other than liquid propellants, are divided into four groups in accordance with the general burning or explosive characteristics of the materials and the danger of fighting fires in which they are present. The four groups are identified by symbols 1 through 4 (AFM 127-100) as follows:

a. Fire Symbol 1. This symbol will be used for quantity-distance classes 1 and 8 explosives. These materials are principally fire hazards. (See figure 3-1.)

b. Fire Symbol 2. This symbol will be used for quantity-distance class 3. Limited explosions may be expected from fire in these materials. (See figure 3-2.)

c. Fire Symbol 3. This symbol will be used for quantity-distance Class 2 explosives. These materials burn with intense heat. (See figure 3-3.)

d. Fire Symbol 4. This symbol will be used for quantity-distance Classes 4, 5, 6, and 7 explosives and for certain liquid propellants. This symbol is also applicable to all liquid propellant situations that present detonation possibilities. (See figure 3-4.)

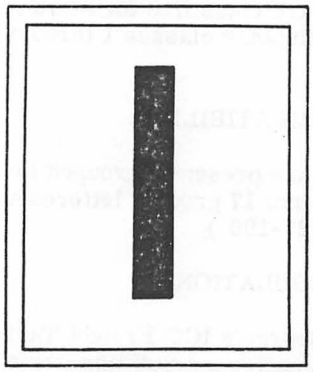


Figure 3-1. Fire Symbol 1



Figure 3-2. Fire Symbol 2



Figure 3-3. Fire Symbol 3



Figure 3-4. Fire Symbol 4

3-27. Liquid propellants independently present a wide variety of hazards that are not directly associated with symbols 1 through 4. Extensive fire fighting guidance for these liquids, based upon the individual characteristics of each commodity, will be found in pertinent publications, as AFM's 160-39, 127-201, and AFP 92-1-2. Therefore, these fire symbols have no application to liquid propellants except for the use of symbol 4 to indicate situations presenting the additional hazard of detonation. EXCEPTION: Fire symbols need not be posted on operational missile sites (e.g., Titan, Thor, etc.) where only single types of weapons systems are involved and written fire fighting plans or instructions exist and personnel concerned have been specifically advised of the hazards involved.

3-28. Chemical and biological warfare (BW) hazard markers will be used to identify chemicals, nerve gas (G agents), and BW munitions in operating buildings and storage facilities for fire fighting purposes. The type or types of markers used will depend not only upon the type of agent but also upon the absence or presence of explosive components. If munitions contain an explosive component, hazard markers will be used in conjunction with fire symbols. Chemical, nerve gas, and BW munitions, which contain no explosives, will be identified by the appropriate hazard marker(s), as described in figures 3-5 through 3-10.

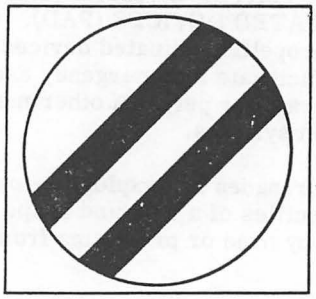


Figure 3-5. Persistent Poison Gas

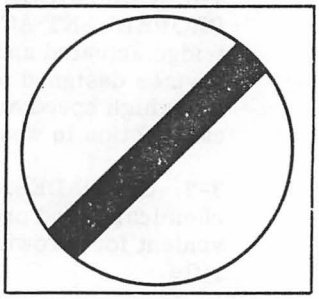


Figure 3-6. Non-Persistent Poison Gas

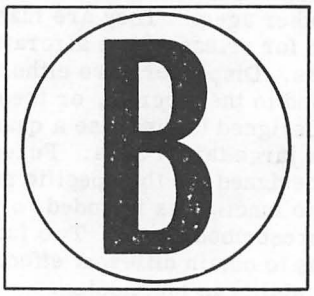


Figure 3-7. BW Agents

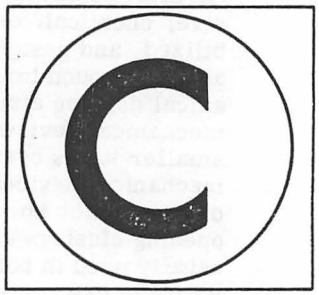


Figure 3-8. WP Munitions

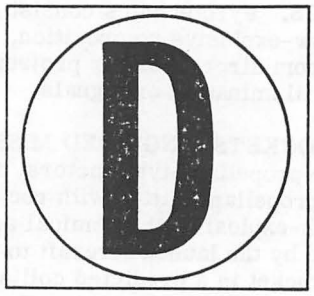


Figure 3-9. Incendiaries

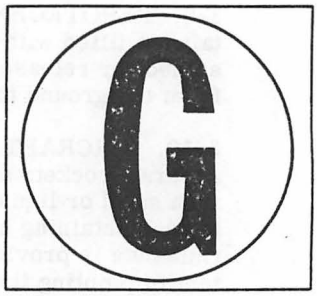


Figure 3-10. Nerve Gas (G Agents)

3-29. SECURITY.

3-30. Airmunitions are classified in accordance with security regulations as unclassified, confidential, secret, or top secret. (Refer to AFR 205 series.)

3-31. IDENTIFICATION.

3-32. Airmunitions are identified by painting and marking on items, containers, and packing boxes. This identification does not include grade except in the case of small arms cartridges. For purposes of record, the standard nomenclature of the item, lot number, and the Federal Stock Number (or Department of Defense Code Number), completely identifies the airmunition. Once removed from packing, airmunitions may be identified by the painting and marking on the items. Other essential information may also be obtained from the marking on airmunition items, packing containers, and ammunition data cards. Included in both the marking and the standard nomenclature are the following:

a. Name or type or abbreviation thereof.

b. Caliber, weight, or size.

c. Model designation.

d. Federal stock number (FSN).

3-33. Where required, additional information is included such as the model and type of fuze and the model of the weapon in which the item is fired.

3-34. The lot number is marked on the ammunition or shipping container but is not a part of the nomenclature. However, when referring to specific ammunition in shipping documents and field reports, it is necessary to mention the lot number, FSN, and standard nomenclature. (Refer to AFR 67-79 and AFM 67-1.)

3-35. TYPE DESIGNATION. This is an identifying symbol used with nomenclature to distinguish different models and types of items or equipment within categories and to indicate modifications and changes thereto.

NOTE

Only one type identification will be assigned to items of military supply that are physically and functionally interchangeable.

3-36. MARK OR MODEL. Ammunition items are assigned identifying numbers as they are developed. When a particular design has been accepted for limited procurement and service test, the model designation of the development item is indicated by the letter T or letters XM and an Arabic number, and modifications are indicated by the addition of E and an Arabic number. To identify a particular design, a model designation becomes an essential part of the nomenclature and is included in the markings of the item.

3-37. The present system of Army model designation consists of the letter M followed by an Arabic number, for example, M1. Modifications are indicated by adding the letter A and the appropriate Arabic number. 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 alternate (substitute) design, material, or manufacture. Certain items standardized for use by both Army and Navy are designated by the letter combination AN preceding the model number.

3-38. Model designation of items of Navy design consists of the letters MK signifying the word Mark, followed by an Arabic number with a modification (Mod) number, for example, MK 6 Mod 2.

3-39. Model designation for items of Air Force design consists of a component or unit indicator (consisting of two letters of the alphabet) accompanied by a purpose indicator (consisting of one letter). This is followed by a dash, a model number, a slash and an equipment designator. Thus, BLU-10/B is an example of a complete round model number for the 250-pound fire bomb.

3-40. AMMUNITION LOT NUMBER. At the time of manufacture, every item of ammunition is assigned a lot number. Where the size of the item permits, the lot number is marked on the item itself to ensure permanency of this means of identification. In addition to this lot number, there is assigned to each complete round of fixed and semifixed ammunition an ammunition lot number, which serves to identify the conditions under which the round was assembled and the components used in the assembly. This ammunition lot number is marked on every complete round of ammunition (except where the item is too small) and 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. An ammunition lot consists of a number of items manufactured from similar materials under similar conditions, which may be expected to function alike. The lot number consists, in general, of the loader's initials or symbol and the number of the lot. (Refer to 11A13-1-3.)

3-41. CALIBRATION OF LOTS. Calibration data for certain lots of ammunition are provided in order to effect improvement in the relative accuracy. The data accounts for variations among ammunition lots due to differences in muzzle velocity level (interior ballistics) and differences in ballistic coefficient (exterior ballistics). The application of corrections determined from the data is intended to reduce variations in performance due to the employment of individual ammunition-weapon combinations.

3-42. AMMUNITION DATA CARD. An ammunition data card will be prepared at the time the explosive type items enter the Air Force inventory. (Refer to AFM 310-1. It shall be the responsibility of the contractor to prepare the data cards in the required numbers. An ammunition data card, 5 by 8 inches in

size, will be made for each lot of ammunition. The form of the data card for inert items shall be basically the same as that for loaded items. Ammunition data cards are used for the following purposes:

a. Provide minimum controls for identification of units and groups of units containing explosive mixtures procured by the Air Force.

b. Provide a permanent file of data required to maintain administrative control of such items entering the Air Force Inventory.

c. Provide a means of identifying all items containing an explosive lot (or batch) which proves defective.

3-43. FEDERAL STOCK NUMBER AND DEPARTMENT OF DEFENSE AMMUNITION CODE. The Federal stock number (FSN), e.g., FSN 1325-028-5298, has replaced the ammunition identification code (AIC) and the Ordnance stock number. There is a different Federal stock number for each item of supply. The first four digits in a Federal stock number are always the Federal supply classification (FSC) class to which the item belongs. The next seven digits constitute the Federal item identification number (FIIN). The dash between the third and fourth digits in the FIIN serves to reduce errors in transmitting. There is a different FIIN for each item. A Department of Defense identification code (DODIC) is added as a suffix to the Federal stock number, e.g., 1325-028-5298 (E450). The DODIC must not be confused with the DOD ammunition code (DODAC), which is an eight-character representation consisting of the four-character FSC code number and a second part consisting of a letter and three digits. Thus for example, 1325-E450, a typical DODAC, consists of FSC class 1325 and DODIC E450. The DODIC, when suffixed to more than one FSN, indicates the items are interchangeable for issue and use. (Refer to 1300 series Federal Stock Catalogs.)

3-44. NOMENCLATURE. Standard nomenclature is established so that every item of ammunition supplied may be specifically identified by name. It consists of the type, size, and model of each item. Its use for all purposes of record is mandatory, except where the use of the FSN or DODIC is authorized. The use of exact nomenclature in the requisitioning, shipment, storage, issue, recording, and use of ammunition items will keep errors to a minimum.

3-45. GRADING. Airmunitions are manufactured to rigorous specifications and are thoroughly inspected before acceptance. Airmunitions in storage are periodically inspected and tested in accordance with specific instructions of the Airmunitions Wing OOAMA. Each lot of small arms ammunition is graded primarily on the qualities that make that lot especially suitable for use in a particular class of weapons such as aircraft and antiaircraft machineguns, rifles and ground machineguns. (Refer to 11A13-1-3.)

3-46. SERVICEABILITY CRITERIA. Airmunitions, other than small arms ammunition, are serviceable for all design applications, and are restricted or suspended, as a result of surveillance tests. T.O. 11A-1-1 provides Air Force personnel with information pertinent to suspensions and restrictions on all types of airmunitions used by the Air Force. Safety supplements are periodically sent to the field to maintain current status of T.O. 11A-1-1.

3-47. PRIORITY OF ISSUE. Subject to special instructions from the Airmunitions Wing, OOAMA, airmunitions of appropriate type and model will be used in the following order: limited standard, substitute standard, and standard. These categories are listed in the status column of Federal Stock List 1300 series. Within this rule airmunitions that have had the longest or least favorable storage will be used first. Among lots of equal age and serviceability, priority of issue will be given to the smallest lot.

3-48. To prevent the building up of excess stocks in the field, transfers from one station to another should be arranged within the command if no stock of appropriate grade for immediate use is on hand. If this action is not feasible, information should be requested from the Airmunitions Wing, OOAMA.

3-49. Priority of issue for small arms ammunition lots is established by the Airmunitions Wing, OOAMA, or in special instructions.

3-50. Certain items because of their scarcity, cost, or technical nature are known as regulated items. Close supervision is exercised over these items in order to ensure distribution to appropriate units and commands in accordance with Department of the Air Force priorities. Factors governing the issue of regulated items are as follows:

a. Shelf life: Shelf life is the life expectancy under prescribed packing and storage conditions and begins from the date of manufacture.

b. Service life: Service life is the life expectancy of an item when removed from prescribed packaging or it is installed in operating configuration. Further details will be found in the applicable item technical orders.

3-51. PAINTING AND MARKING.

3-52. PAINTING. Ammunition is painted primarily to prevent rust. Secondary purposes are to provide, by color, a ready means of identification as to type and to camouflage the ammunition by use of lusterless paint. In 1960, the Military Standard Ammunition Color Coding (MIL-STD-709) was implemented for Air Force, Army and Navy ammunition items. The new standard directed that all new items would be color coded and marked in accordance with the new system. It also provided for the items presently in stock to be exempt from a massive remarking and repainting program for economical reasons. As a result many groups of items will be encountered in the field which are marked under both systems.

3-53. For grenades, rockets, JATO's guided missiles, demolition material, and miscellaneous explosive devices, color and markings are shown in figure 3-11.

3-54. Under the previous system of marking and painting, high explosive bombs were painted olive drab, with 1-inch yellow bands painted at the nose and tail ends of the bomb body. Refer to MIL-STD-709 for color coding and marking under the new system.

3-55. Small arms cartridges do not require painting. However, the bullet tips of some cartridges are painted a distinctive color to aid in ready identification as to type.

3-56. Pyrotechnics are not marked in accordance with the general color scheme but, where color markings are used, they indicate the color of the pyrotechnic effect produced. In general, however, pyrotechnics are painted gray with marking in black. If the body of the item is aluminum or magnesium, it may not be painted. See MIL-STD-709 for more specific information.

3-57. MARKING. The marking stenciled and/or stamped on ammunition includes all information necessary for complete identification. Storage, handling, and inspection procedures of applicable technical orders provided for maintenance of markings.

3-58. General marking requirements for the manufacture or inerting of all explosive items, or components for use in training or for display will be found in T.O. 11A-1-53.

3-59. PACKING AND MARKING.

3-60. Ammunition is packaged and containers are marked in accordance with pertinent drawings and specifications. Containers are designed to withstand conditions normally encountered in handling, storage, and transportation and to comply with ICC regulations. Marking of containers includes all information required for complete identification of their contents and for compliance with ICC regulations.

3-61. PRECAUTIONS IN USE.

3-62. Airmunitions must be handled with appropriate care at all times. Explosive elements, such as in primers and fuzes, are sensitive to undue shock and high temperature. In order to keep ammunition in a serviceable condition ready for immediate issue and use, due consideration should be given to the following general rules:

a. Store ammunition in the original containers in a dry, well-ventilated place protected from the direct rays of the sun and other sources of excessive heat.

b. Keep sensitive initiators such as blasting caps, igniters, primers, and fuzes separate from other explosives.

c. Keep ammunition and its containers clean and dry and protected from possible damage.

d. The testing, modification, or disassembly of explosives items will not be permitted under any circumstances except the following (AFM 127-100):

(1) When and as specifically authorized by applicable Technical Orders.

(2) When prior approval has been granted by the appropriate AMA or cognizant agency of the Air Force Systems Command.

(3) When disassembly is required in the course of emergency Explosive Ordnance Disposal (EOD) Operations.

TYPE OF AMMUNITION	COLOR AND MARKINGS
Armor-piercing (projectile w/HE)	Black w/marking in yellow
Armor-piercing (projectile w/o explosive)	Black w/marking in white
High-explosive	Olive drab w/marking in yellow
Illuminating Chemical: Harassing Agent Casualty Agent G-Series Agents Persistent Nonpersistent Training and riot control gases Smoke Incendiary	One white band and marking in white Gray w/red band(s) and markings Gray w/green band(s) and markings Three bands one-half inch apart Two bands one-half inch apart One band Gray w/one red band marking in red Gray w/one yellow band and marking in yellow (Rifle smoke grenades-one band of the color of smoke produced) Light red w/marking in black
Practice	Blue w/marking in white
Dummy (inert)	Blue w/marking in black (bronze or brass assemblies are unpainted)

Figure 3-11. Color and Markings for Various Types of Ammunition, Except Bombs, Pyrotechnics, and Small Arms Cartridges

e. Do not open sealed containers or remove protective or safety devices until just before use, except as required for inspection.

f. Return airmunitions prepared for use but not used to its original packing and mark it appropriately. Use such airmunitions first in subsequent issues in order to keep stocks of opened packings to a minimum.

g. The use of live airmunitions as a substitute for authorized inert, empty, or dummy airmunitions is prohibited. Such substitution must be considered as hazardous and will not be permitted under any circumstances.

SECTION IV
DESCRIPTION OF FORMS AND REPORTS

4-1. INTRODUCTION.

4-2. FORMS, RECORDS, AND REPORTS

4-3. All classified forms, records, and reports must be handled in accordance with AFR-205-1. Lot and serial numbers of the affected items will be included in all reports. For a listing of all forms, refer to the current AFR 0-9. Refer to AFM 67-1, AFR 67-44, and AFR 67-70 regarding forms for issue, receipt, and storage of airmunitions.

4-4. FIELD REPORT OF ACCIDENTS.

4-5. Any accident involving injury to personnel or damage to materiel will be reported in accordance with AFR 127-4.

4-6. MALFUNCTIONS INVOLVING AIRMUNITIONS OR EXPLOSIVES.

4-7. A malfunction is defined as the failure of a munition item to function in accordance with the design, intent, and expected performance when fired, launched, tactically employed, or subjected to non-functional tests. Malfunctions do not include accidents, and incidents resulting from negligence, malpractice, or implications in other situations such as vehicle accidents or fires. Malfunctions, however, do include abnormal or premature functioning of a munition item incident to normal handling, maintenance, storage, transportation, and tactical deployment.

4-8. When a malfunction involving an item of airmunitions occurs, the using unit commanding officer will immediately report all available facts concerning the malfunction.

4-9. Airmunition malfunction reports will be submitted in accordance with AFR 127-2 and -4.

4-10. DAMAGED OR IMPROPER SHIPMENT.

4-11. Damaged or improper shipments of airmunitions will be reported in accordance with AFR 71-4.

4-12. DISPOSITION OF UNSERVICEABLE MUNITIONS AND COMPONENTS.

4-13. Unserviceable ammunition and components will be reported thru appropriate channels to OOAMA, Hill Air Force Base, Utah 84401, on an Ammunition Disposition Report (AF Form 191) in accordance with AFM 67-1 for disposition instructions. Unsatisfactory reports will be submitted in accordance with T.O. 00-35D-54. Refer to T.O. 11A-1-10 for use of AFTO Form 15.

4-14. SECURITY.

4-15. Airmunitions should be afforded adequate physical security at all times.

SECTION V
PROPELLANTS

5-1. INTRODUCTION.

5-2. Propellants are liquid or solid compositions used to propel a projectile, rocket, missile, etc. All propellants used by the military are explosive in nature.

5-3. SOLID PROPELLANTS.

5-4. Most explosives currently used as solid propellants have a nitrocellulose base. Various organic and inorganic substances are added to the nitrocellulose base during manufacture to give improved qualities for special purposes. These propellants are distinguished by M- or T- numbers and by such terms as single-base, double-base, and composite, and by commercial trade names or symbols. Black powder, formerly classed as a propellant, is no longer used as such but is used as a delay element, as an igniting charge for propellants, in flash reducers, or for other special purposes.

5-5. CLASSIFICATION. Solid propellants are classified in accordance with their compositions as follows:

a. Single-base Propellant. Compositions that are principally gelatinized nitrocellulose and contain no high-explosive ingredient, such as nitroglycerin, are single-base compounds(e.g., guncotton).

b. Double-base Propellant. Compositions that are predominately nitrocellulose and nitroglycerin are double-base compounds.

c. Composite Propellant. Compositions that do not contain significant amounts of nitrocellulose or nitroglycerin and are mechanical mixtures of a fuel with an inorganic oxidant are composite compounds. A part or all of the fuel may also serve as a binding agent.

5-6. PHYSICAL CHARACTERISTICS. Solid propellants are manufactured in the form of flakes, balls, sheets, cords, or perforated cylindrical grains. (See figure 5-1.) They are made of different shapes to obtain certain types of burning. The cylindrical grains are made in various diameters and lengths. For small size grains, either no perforation or a single perforation is required. However, for larger grains, equally spaced perforations are present in order to have an increasing burning surface area. The critical dimension is the web size, that is, the average thickness of the grain between burning surfaces. Web size or web thickness influences the initial rate of burning of the propellant grain.

5-7. BURNING ACTION. Unconfined nitrocellulose propellant burns relatively slow and even but, when confined, the rate of burning increases with temperature and pressure. In order not to exceed the permissible chamber pressure of the weapon in which it is to be used, the rate of burning of the propellant has to be controlled. At any given pressure, the rate of burning is proportional to the propellant surface free to burn. (See figure 5-2.) Therefore, propellants are made into accurate sizes and definite shapes referred to as grains. The basic rates of burning are as follows:

a. Degressive Burning. As the surface areas of the cord and strip form of propellant change with burning, the surface of the grain decreases. The burning action of these grain is classified as degressive.

b. Neutral Burning. As a single-perforated grain burns (figure 5-2), the outer surface decreases and the inner surface increases. The result of the two actions is that the total surface remains approximately the same in area. The burning of this type of grain is known as neutral.

c. Progressive Burning. When the multiperforated grain burns (figure 5-2), the total surface area increases, since the perforated grain burns from the inside and outside at the same time. This type of burning is called progressive.

5-8. SLIVERS. When a multiperforated grain is not completely consumed, portions of the grain remain in the form of slivers (figure 5-3) and may be ejected as such from the weapon or combustion chamber.

5-9. USE. Nitrocellulose propellants are used for small arms and larger-caliber ammunition. The perforated form of grain is the one most commonly used in the United States military propellants. Single perforated grains are used for small arms cartridges, grenade cartridges, and some rockets. Multiperforated grains are used for larger caliber weapons.

5-10. SINGLE-BASE PROPELLANTS.

5-11. Single-base propellants contain nitrocellulose as their chief ingredient. One of the first standardized nitrocellulose propellants was termed pyrocellulose. Single-base compositions are now used in artillery, small arms, and grenade cartridges.

5-12. SMOKELESS AND FLASHLESS CHARACTERISTICS. Pyrocellulose propellant is unduly hygroscopic and gives bright flashes when fired. It was replaced before World War II by propellants designated, Flashless Nonhygroscopic (FNH) and Nonhygroscopic (NH), single-base propellants. These propellants are not truly nonhygroscopic, but they are less hygroscopic than pyrocellulose. This method of designation has since been replaced and propellant

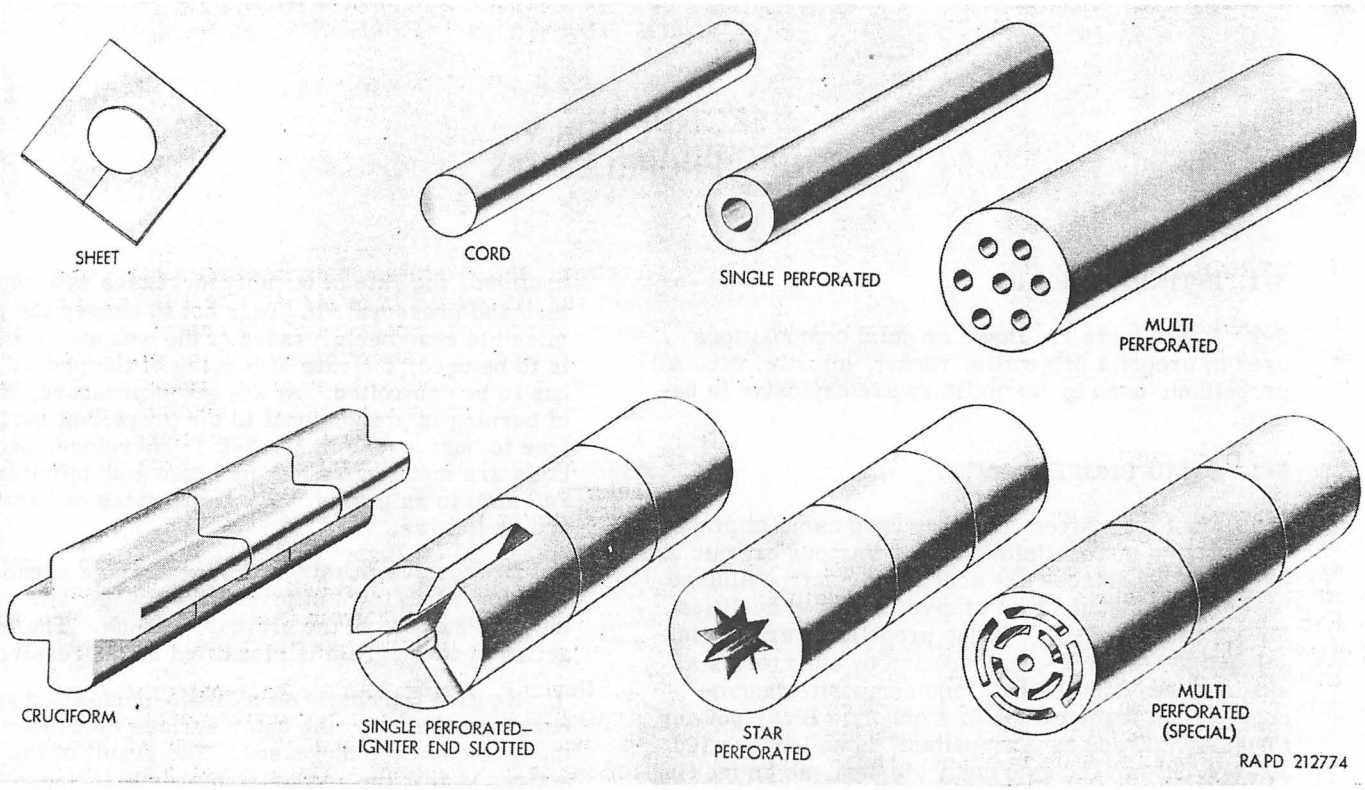


Figure 5-1. Examples of Propellant Grain Shapes and Forms

compositions are now identified by standard M- or T-numbers. Whether ammunition upon being fired is flashless, smokeless, or both, depends on the weapon in which it is used, the type of ignition used, weapon wear, the temperature of the weapon, ambient temperature conditions, and the quantity and composition of the propellant. Some double-base propellants also have flashless and smokeless characteristics.

5-13. EC BLANK POWDER. EC blank powder, one of the earliest partially colloided nitrocellulose single-base compositions developed, is used in caliber .30 blank ammunition. It is usually orange or salmon pink in color. Though it is soft and light, it resembles coarse sand. It is more sensitive to friction, shock, and heat than completely colloided nitrocellulose propellants. When exposed, it absorbs moisture readily and therefore must be protected from the atmosphere. It burns rapidly in the open and explodes if confined. It is usually exploded by flame from a primer or fuze.

5-14. DOUBLE-BASE PROPELLANTS.

5-15. Double-base propellants are those having nitrocellulose and nitroglycerin as their major ingredients, accompanied by one or more minor ingredients such as centralite, vaseline phthalate esters, inorganic

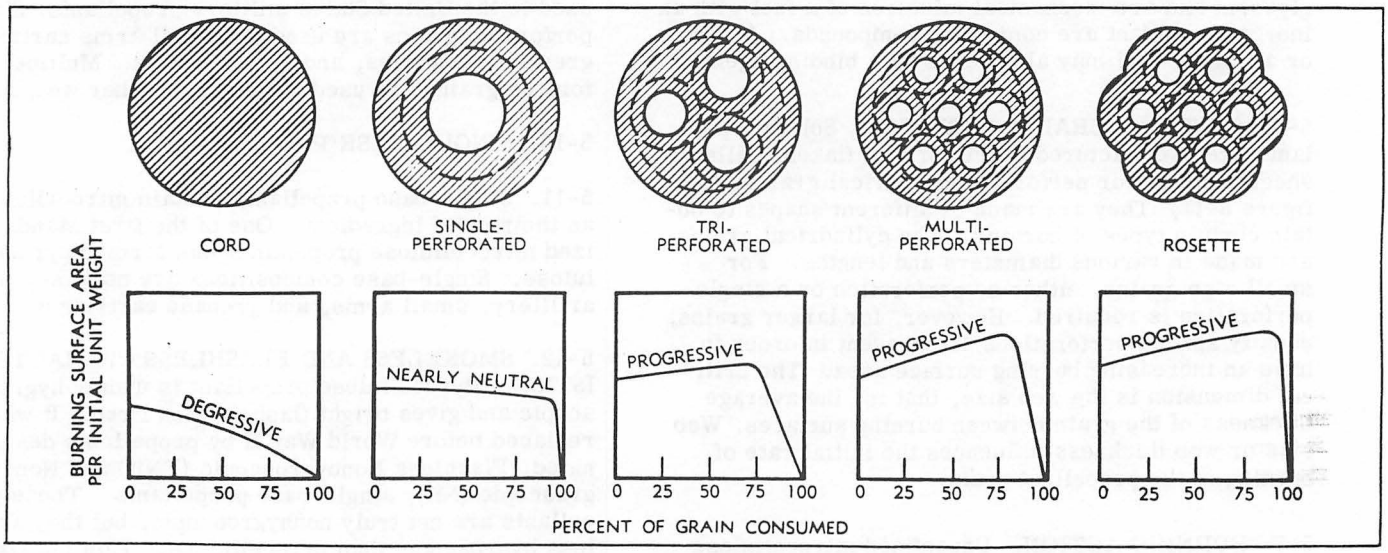


Figure 5-2. Comparative Burning Rates of Propellant Grain Shapes

salts, etc. These propellants may contain from 15 to 43 percent nitroglycerin. The minor ingredients are used for various purposes, such as to ensure stability, reduce flash or flame temperature (or both), and improve ignitability. The usual practice is to use nitrocellulose of about 13.15 to 13.25 percent nitrogen. Nitroguanidine is used in some double-base propellants, not only to add to the ballistic potential, but to act as a flash reducing agent as well. Double-base propellants are gray-green to black in color, and the grains are similar in size and shape to the single-base propellants. Generally speaking, double-base propellants are easily ignited, have high burning rates, high flame temperature, and high force, but they erode weapons badly and are more dangerous and costly to manufacture than nitrocellulose propellants. For these reasons and because glycerin is not an abundant material, double-base propellants have tended to be used only where some of the advantageous properties mentioned are especially desireable. They have found their principal uses in propellants for shotguns, pistols, mortars, and rockets; and have been generally avoided in rifled weapons (except pistols).

5-16. BALL-GRAIN PROPELLANT. Double-base propellants are also manufactured in the form of spherical pellets or balls approximately 0.02 or 0.03 inch in diameter. These ball-grains are rapidly replacing other forms of grains in loading small-arms ammunition because of the rapidity and economy of manufacture and the flexibility of the process. Ball-grains are produced by dissolving wet nitrocellulose in a solvent, such as ethyl acetate, and adding diphenylamine and chalk. For double-base propellants, nitroglycerin would be added to the above composition. By adding a protective colloid and agitating the composition, the solution is dispersed in the form of small globules. When the solvent is removed by heating, the propellant solidifies in the form of spherical pellets or balls. These balls of propellant are coated with dinitrotoluene, centralite, or diphenylphthalate to slow the initial phase of the burning process and to act as a moisture proofing agent. The propellant is then dried and coated with a glaze of graphite.

5-17. COMPOSITE PROPELLANTS.

5-18. Composite propellants are principally solid gas producing materials, which contain neither nitrocellulose nor nitroglycerin. They are usually a physical mixture of an organic fuel, an oxidizer, and an organic binding agent. Unlike the single- and double-base propellants that are manufactured principally by extrusion techniques, composite propellants are molded or cast to form a single element or grain. They may be coated on the surface with cellulose acetate or other inhibitor material to control the grain burning action. Composite propellant designated as T9 (principally ammonium picrate and potassium nitrate) is representative of such propellants. In form and shape, composite propellants may be as shown in figures 5-1 and 5-4, which illustrate some of the various forms of propellant grains employed in JATOs and foreign and United States rockets and missiles.

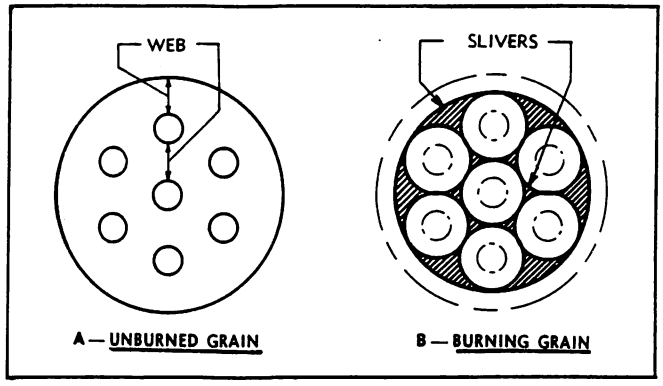


Figure 5-3. Progressive Burning of Propellant Grains (Multi-perforated)

5-19. Composite propellants are balanced for control of burning action similar to single-base and double-base propellant compositions.

5-20. SMALL ARMS PROPELLANTS.

5-21. Propellants for small arms are usually coated with dinitrotoluene, which acts as a moisture-proofing agent, causes the first phase of the burning process to take place at a relatively slow rate, and has some antiflashing action. In addition, the propellants are usually glazed with graphite to facilitate the uniform action of automatic loading machines and to avoid the development of large static charges in blending and loading and thus present a black polished appearance. The propellant grains are small, and in the presence of abnormal temperatures they are subject to more rapid deterioration than the larger grains. Many small arms propellants are nearly as sensitive to friction as black powder. Therefore, precautions

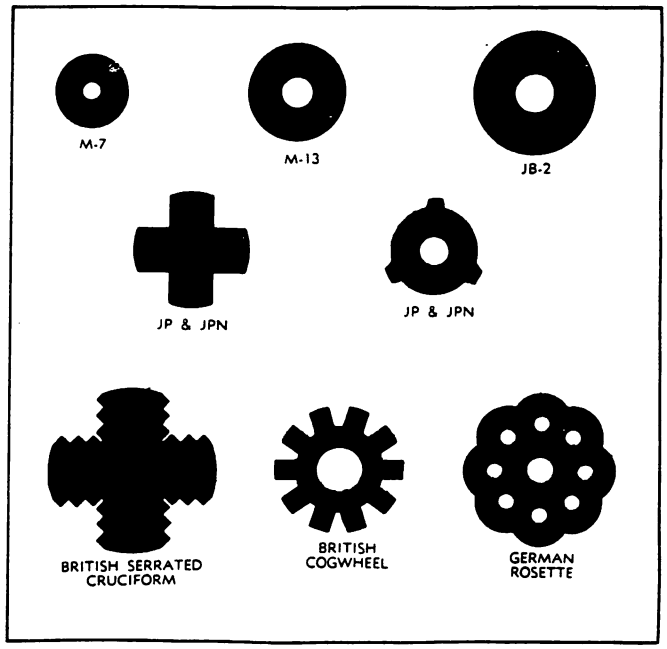


Figure 5-4. Forms of Rocket Propellant Grains (United States and Foreign)

used in handling black powder should be observed for small arms propellants.

5-22. LIQUID PROPELLANTS.

5-23. Liquid propellants have been explored in an attempt to find propellants for large size rockets and missiles that can be controlled in combustion better than solid propellants. They may include any viscous or nonviscous fluid or liquified gas that is principally an organic fuel and a strong oxidizer. With or without catalysts, stabilizers, and auxiliary additives (when fed through an arrangement of connecting feed lines, valves, controls, and metering devices), liquid propellants can be reacted or combusted instantaneously, to produce gaseous products for propelling rockets at velocities greater than the speed of sound (supersonic speeds, approximately 650 mph and over).

5-24. CLASSIFICATION. Liquid propellants can be classified in accordance with the type of reaction system that is involved, either as a monopropellant or a bipropellant, as follows:

a. Monopropellant (e.g. Hydrazine) systems include a composite mixture or compound of fuel and an oxidizer, delivered by means of a pump or from a pressurized tank, for eventual reaction in the chamber of the JATO or rocket. To initiate a reaction in such system, a separate source of ignition is required.

b. Bipropellant systems include a fuel and oxidizer each contained separately in containers for dual feed, carburetion, and combustion within the reaction chamber. Their reaction may be initiated by either the intimate contact of the fuel with the oxidizer, as may be the case of hydrazine and nitric acid, or by external influence (electrical spark ignition or catalysts), as is the case of a hydrocarbon (alcohol) and liquid oxygen.

5-25. CHARACTERISTICS. Liquid propellants differ from solid propellants, primarily in that they are more adaptable to control of long-term combustion reactions, the former being very adaptable for dynamic regulation and control while the latter is statically controlled by the propellant composition and grain design. Like some chemical agents and explosives, liquid propellants are hazardous, toxic, flammable, sensitive, and must be recognized for their inherent dangerous properties.

5-26. USES. The common combustible and flammable materials that have been used as fuels and oxidizers in liquid propellant systems are as follows:

a. Fuels are: alcohols (ethyl, methyl, furfural); kerosene, aviation gasoline; octane, heptane, pentane, hydrocarbons; aniline, monoethylaniline, hydrazine, diborane, pentaborane, aluminum borohydride, liquid hydrogen, and anhydrous ammonia.

b. Oxidizers are: white fuming and red fuming nitric acids (WFNA and RFNA); nitrogentetroxide; liquid oxygen, hydrogen peroxide.

5-27. Liquid propellant materials have been employed in rockets and guided missiles. Development of liquic propellants for use in small arms and artillery weapons is now underway.

SECTION VI
LOW EXPLOSIVES

6-1. INTRODUCTION.

6-2. To understand the composition and functioning of a complete round of ammunition, a basic knowledge of the characteristics and uses of military explosives is necessary. In order that ammunition may function at the time and place desired, it is necessary to employ different kinds of explosives, each of which has a specific role, either as a propellant or as a bursting charge. Explosives suitable for one purpose may be entirely unsatisfactory for another. Thus, the explosive used to burst a forged steel projectile would not only be unsuited but also highly dangerous if used for ejecting and propelling projectiles out of the weapon or propelling missiles and bodies. Similarly, the explosives used in initiators, such as in primers and fuzes, are so sensitive to shock that only small quantities can be used safely. Other characteristics of various types of explosives (propellants and high explosives) are outlined in Sections V and VII of this manual.

6-3. DEFINITION. By definition, an explosive includes any chemical compound or mechanical mixture that, under the influence of a flame or a spark, undergoes a sudden chemical change (decomposition) with the liberation of energy in the form of heat and light and accompanied by a large volume of gases.

NOTE

The definition of Low Explosive contained herein is for military explosive classification only. It does not necessarily coincide with the interpretation of the Interstate Commerce Commission Shipping Classification Regulations.

6-4. LOW EXPLOSIVES. Military explosives are divided into a class of low explosives or high explosives, according to their rates of decomposition. Low explosives are mostly solid combustible materials that decompose rapidly but do not normally explode. This action is known as deflagration. Upon ignition and decomposition, they develop a large volume of gases that produce enough pressure to propel a missile in a definite direction. The rate of burning is an important characteristic, which depends upon such factors as combustion gas pressure, grain size and form, composition, etc. Low explosives do not usually propagate a detonation. Under certain conditions, however, they react in the same manner as high explosives; that is, they may detonate. The single-base, double-base, and composite propellants, as well as black powder mixtures are typical examples of low explosives.

6-5. REQUIREMENT FOR A LOW EXPLOSIVE. Before an explosive (propellant) can be adopted for military use, it must possess the following principal characteristics:

a. Possess controlled burning rate.

b. Be capable of instant ignition and combustion.

c. Be stable over extended periods of storage under normal conditions.

d. Be balanced for complete combustion and produce a minimum amount of residue.

e. Possess a safe minimum toxic and explosive hazard.

f. Be able to withstand mechanical shock indicent to loading, transportation, and handling by commercial and military carriers.

6-6. LOW-EXPLOSIVE TRAIN. The arrangement of a series of combustible materials, beginning with a small quantity of sensitive explosive and ending with a relatively large quantity of comparatively insensitive explosive, is termed an explosive train. In general there are two explosive trains. (See figure 6-1.) These are the propelling-charge explosive train and the bursting-charge train. In all explosive ammunition one or both of these explosive trains will be found. Typical examples of the trains are as follows:

a. The low-explosive or propelling-charge explosive train is employed for the ejection or propulsion of a body or missile from the weapon. This train may consist of a primer, an igniter or igniting charge, and a propelling charge. Thus, a spit of fire from a small quantity of sensitive explosive (primer) is transmitted in a manner so that a large amount of relatively insensitive explosive (the propelling charge) burns in the proper manner to propel the body forward. A primer is absent in rockets and the igniter is absent in small arms ammunition.

b. In small arms ammunition (cartridges), where the propelling charge is relatively small, the igniter is not required. The components in this train are a percussion primer and a propelling charge. The firing pin explodes the primer and the flame passes through the vent leading to the powder chamber and ignites the propelling charge; the expansion of the resultant gases forces the bullet out through the bore of the weapon.

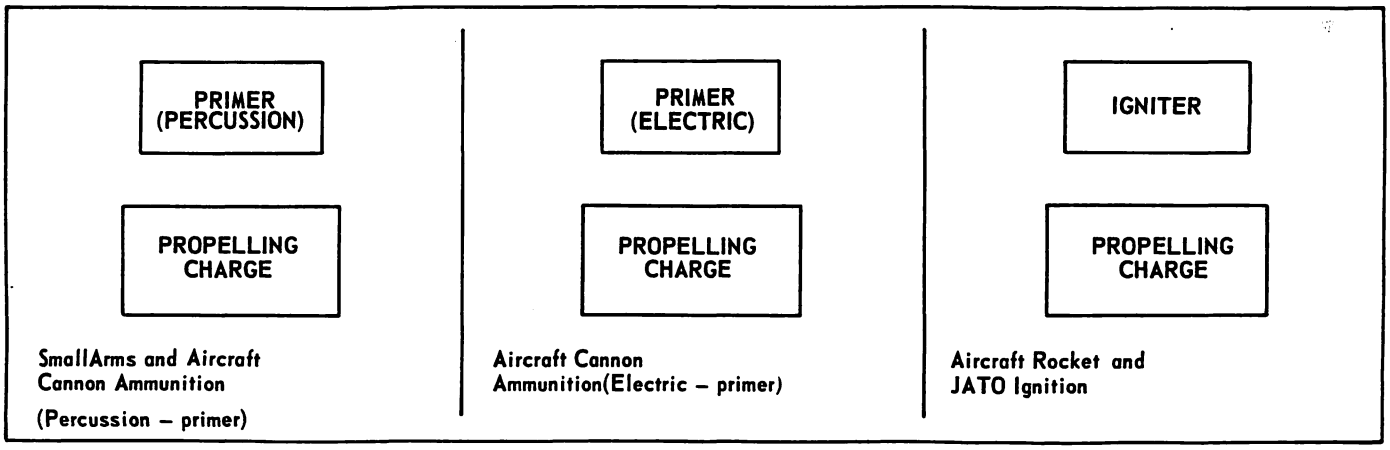


Figure 6-1. Typical Low-Explosive Trains

c. In jet propulsion weapons (rockets and JATOs) the propellant explosive consists of a propelling charge (single or multigrain, double-base, or composite propellant) and an igniter, usually a black powder mixture contained together with an electric squib or squibs that act as the initiator.

6-7. BLACK POWDER.

6-8. CHARACTERISTICS. Black powder, the oldest explosive known, is an intimate uniform mechanical mixture of finely pulverized potassium nitrate (or sodium nitrate), charcoal, and sulfur. Until the development of nitrocellulose propellants, black powder was the only propellant and explosive available. Potassium nitrate is used in most military black powders. It ignites spontaneously at about 300°C and develops a fairly high temperature of combustion 2,300°C to 3,800°C (4,172°F to 6,872°F), which causes erosion in the bore of weapons. Black powder is usually in the form of small, black grains that are polished by tumbling in wooden cylinders. It may be glazed with graphite. It is hygroscopic and subject to rapid deterioration when exposed to moisture. If kept dry, it retains its explosive properties indefinitely. It is one of the most dangerous explosives to handle because of the ease with which it is ignited by heat, friction, or spark.

6-9. USES. Although black powder has been replaced by single- and double-base and composite propellants, it still is used in several grades in the following:

a. Primers and igniters for artillery shell.

b. Delay elements in fuzes.

c. Expelling charge for base ejection smoke, illuminating shell, and pyrotechnics.

d. Saluting and blank fire charges.

f. Burster in incendiary ammunition.

e. Smoke-puff and spotting charges for practice ammunition.

g. Bursting charge for 37-mm explosive shells.

h. Safety fuze.

i. Quick-match.

j. Spotting charges for practice bombs and shells, and subcaliber shells.

k. Time-train rings in time and combination fuzes.

l. Igniter in jet propulsion units.

m. Blasting operations.

6-10. PRECAUTIONS. Black powder is particularly sensitive to shock, friction, heat, flame, or spark. When black powder is handled in cans or bags or when it is not absolutely protected against sparks, the precautions in AFM 127-100 will be strictly observed.

6-11. PYROTECHNIC COMPOSITIONS.

6-12. CHARACTERISTICS. Pyrotechnic compositions with respect to rapidity of action are low explosives because of their low rates of combustion. The composition are essentially homogeneous physical mixtures or blends of powdered chemicals. Fuels, such as magnesium, aluminum, charcoal, sulfur, and metallic hydrides, are mixed with oxidizers, such as the nitrates of barrium, strontium, potassium; the perchlorates of ammonium and potassium; and the peroxides of barium and strontium. They are generally compressed, with or without a binder, into a definite shape or form. They also contain color intensity and waterproofing materials. On ignition and combustion they produce considerable light and decompose or burn by a process known as deflagration. The functional characteristics of pyrotechnic compositions are their luminous intensity (candle power), burning rate, color, color value, and efficiency of light production. Other important characteristics are sensitivity to impact and friction, ignitibility, stability, and hygroscopicity. That is, for military use, pyrotechnic characteristics.

6-13. USES. Pyrotechnic illuminating and igniting compositions are used in a wide variety of ammunition items. The most important uses are---

a. Flares (trip, airport, ground, aircraft, parachute, reconnaissance and landing observation, bombardment, and tow target).

b. Aircraft and ground signals.

c. Photoflash cartridges and bombs.

d. Igniter in incendiaries.

e. Gunflash simulators.

f. Igniter for jet propulsion units (rockets, JATOs, and guided missiles).

g. Signal smokes.

6-14. PRECAUTIONS. Pyrotechnic compositions are hazardous materials. The precautions in AFM 127-100 apply to these compositions.

SECTION VII
HIGH EXPLOSIVES

7-1. INTRODUCTION.

7-2. High explosives are usually nitration products of organic substances, such as toluene, phenol, pentaerythritol, amines, glycerin, and starch and may be nitrogen-containing inorganic substances of mixtures of both. A high explosive may be a pure compound or an intimate mixture of several compounds with additives such as powdered metals (aluminum), plasticizing oils, waxes, etc., which impart desired stability and performance characteristics. A high explosive is characterized by the extreme rapidity with which its decomposition occurs; this action is known as detonation. When initiated by a blow or shock, it will decompose almost instantaneously, either in a manner similar to an extremely rapid combustion or with rupture and rearrangement of the molecules themselves. In either case, gaseous and solid products of reaction are produced. The disruptive effect of the reaction makes some explosives valuable as a bursting charge but precludes their use as a propellant for the reason that the gases formed would develop excessive pressures that might burst the barrel of the weapon.

7-3. TERMS AND DEFINITIONS.

7-4. PRIMER. A primer is a relatively small and sensitive initial explosive train component which, on being actuated, initiates functioning of the explosive train and will not reliably initiate high-explosive charges. In general, primers are classified in accordance with the method of initiation, such as percussion, stab, electric, friction, chemical, etc.

7-5. DETONATOR. A detonator is an explosive train component that can be activated by either a nonexplosive impulse or by the action of a primer and is capable of reliably initiating high-order detonation in a subsequent high-explosive component of the train. When activated by a nonexplosive impulse, a detonator includes the function of a primer. In general, detonators are classified in accordance with the method of initiation; such as percussion, stab, electric, friction, flash, chemical, etc.

7-6. IGNITER. An igniter is usually one of the following devices used to directly, or indirectly, initiate a sequence of ignition:

a. A device containing a readily burning composition, usually in the form of black powder, used to amplify the initiation of a primer in the functioning of a fuze.

b. A device containing a spontaneously combustible material, such as white phosphorus, used to ignite the fillings of incendiary bombs and flame thrower fuels at the time of dispersion or rupture of the bomb casing.

c. A device used to initiate burning of the fuel mixture in a rocket combustion chamber.

7-7. DELAY. A delay is an explosive train component that introduces a controlled time delay in the functioning of the train.

7-8. RELAY. A relay is an element of a fuze explosive train that augments an outside and otherwise inadequate output of a prior explosive component, so as to reliably initiate a succeeding train component. Relays, in general, contain a small single explosive charge, such as lead azide, and are not usually employed to initiate high-explosive charges.

7-9. LEAD. A lead is an explosive train component that consists of a column of high explosive, usually small in diameter, used to transmit detonation from one detonating component to a succeeding high-explosive component. It is generally used to transmit the detonation from a detonator to a booster charge.

7-10. BOOSTER CHARGE. A booster charge is the final high-explosive component of an explosive train that amplifies the detonation from the lead or detonator, so as to reliably detonate the main high-explosive charge of the munition.

7-11. FUZE EXPLOSIVE TRAIN. A fuze explosive train is an arrangement of a series of combustible and explosive elements consisting of a primer, a detonator, a delay, a relay, a lead, and booster charge, one or more of which may be either omitted or combined. The function of the explosive train is to accomplish the controlled augmentation of a relatively small impulse into one of sufficient energy to cause the main charge of the munition to function.

7-12. PRIMER COMPOSITIONS. A primer composition is an explosive that is sensitive to a blow such as that imparted by a firing pin. It is used to transmit shock or a flame to another explosive, a time element, or a detonator. Most military priming compositions consist of mixtures of one or more initial detonating agents, oxidants, fuels, sensitizers, and binding agents. Many compositions contain potassium chlorate, lead thiocyanate, antimony sulfide, lead azide, lead styhpnate, mercury fulminate, and a binding agent. The potassium chlorate acts as an oxidizing agent, the lead thiocyanate as the fuel and as a detonating agent. Other materials such as ground glass and carborundum may also be added to

increase sensitivity to friction. Priming compositions for electric primers and squibs may contain barium nitrate as the oxidizing agent instead of potassium chlorate and lead styphnate or DDNP (diazodinitrophenol) as the initiating explosive. Primer mixtures are used in the percussion elements of artillery primers, in fuzes, and in small arms primers and as the upper layer of a detonator assembly.

7-13. BURSTING CHARGE. This is an encased explosive that, when initiated, is designed to break the metal casing into small fragments.

7-14. HIGH-EXPLOSIVE TRAIN. Explosive train may be defined as a series of steps by which a small, initial amount of energy is built up to the large amount of energy necessary to ensure a high-order detonation for a bursting charge. Fundamentally, an explosive train consists of a detonator, booster, and bursting charge. This sequence is often interrupted by a delay or relay. To illustrate the principle of the explosive train, a 2,000-pound bomb filled with TNT has a fuze of the firing pin type. The TNT by itself will not detonate from the release of the firing pin, because the initial source of energy being a friction or percussion effect of the firing pin is insufficient and must be stepped up to a point where it will detonate the TNT. This is always accomplished by means of an explosive train. Components and performance characteristics in explosive trains are as follows:

a. The detonator sets up a high-explosive wave when initiated by the stab action of a firing pin or by a flame. This detonation is so small and weak that it will not initiate a high-order detonation in the bursting charge, unless a booster is placed between the two. The booster picks up the small explosive wave from the detonator and amplifies it to an extent that the bursting charge is initiated and a high-order detonation results. (See figure 7-1.)

b. To gain the action necessary to control the time and place at which an explosive will function, it is necessary to incorporate other components in a high-explosive train. The action desired may be a burst in the air, a burst instantly upon impact with the target, or a burst shortly after the projectile penetrated the target. The components that may be used to give these various actions are a primer, a black powder delay pellet or train, an upper detonator, or any combination of these components. Regardless of the arrangement of the components, the basic chain will remain the same, other components being placed in front of the basic chain. (See figure 7-2.)

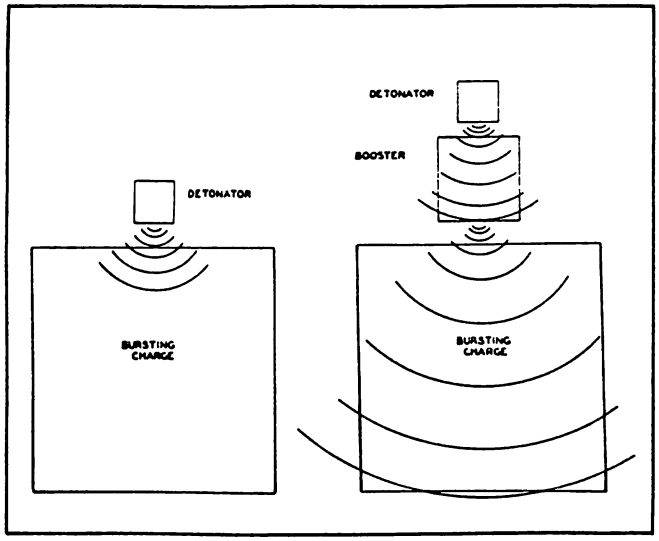


Figure 7-1. Detonating Wave Amplified by Use of Booster

c. The action that causes a bomb to burst in the air may be obtained by placing a primer, which is fired when the bomb is dropped, and a black powder time train in front of the basic chain. The primer ignites the time-train, which burns for the length of time desired, and, in turn, initiates the action of the detonator, booster, and bursting charge. (See scheme B, figure 7-2.)

d. To burst the munition promptly upon impact with the target, a superquick or instantaneous action is necessary. This action is usually obtained by placing an upper detonator in the extreme front of the fuze and a lower detonator in the body near the booster charge. In this manner, the detonating wave is transmitted instantly to the bursting charge. (See scheme C, figure 7-2.)

e. To permit penetration of the target by the munition, a delay action is necessary as included in armor-piercing bombs. This is obtained by placing a primer and delay element ahead of the detonator. In some cases, this combination of primer and delay is inserted between an upper and lower detonator. (See scheme D, figure 7-2.)

f. A variation of the high-explosive train is found in chemical items. In this train there is no large bursting charge such as is found in high-explosives projectiles, as it is only necessary to rupture the shell case and allow the chemical contents to escape. The actual bursting of the case is accomplished by an enlarged booster, known as a burster charge, contained in a tube running down the center of the bomb.

7-15. CLASSIFICATION.

7-16. High explosives may be subdivided into three types, according to their sensitivity, as initiating, booster, and bursting explosives.

7-17. INITIATING HIGH EXPLOSIVES. Initiating high explosives are extremely sensitive to shock, friction, and heat. Under normal conditions, they will not burn, but will detonate if ignited. Their strength and brisance are inferior, but are sufficient to detonate high explosives. Because of their sensitivity, they are used in munitions for initiating and intensifying high-order explosions. Mercury fulminate, lead azide, lead styphante, and diazodinitrophenol are examples of such explosives.

7-18. BOOSTER EXPLOSIVES. Explosives of this type include tetryl, PETN, and RDX. They intermediate sensitivity between initiating explosives and

explosives used as bursting charges such as TNT. They may be ignited by heat, friction, or impact and may detonate when burned in large quantities.

7-19. BURSTING EXPLOSIVES. Bursting explosives include explosive D, amatol, TNT, tetryl, pentolite, picratol, tritonal, RDX compositions, torpex, DBX, HBX, and others.

7-20. DEMOLITION AND FRAGMENTATION EXPLOSIVES.

7-21. TETRYL. Tetryl (trinitrophenylmethylnitramine) is a fine yellow crystalline material. When heated it first melts and then decomposes and explodes. It burns readily and is more easily detonated than TNT or ammonium picrate (explosive D) and is much more sensitive than picric acid. It is detonated by friction, shock, or spark. It is insoluble in water, practically nonhygroscopic. Tetryl is stable at all temperatures that may be encountered in storage. It is toxic when taken internally; on contact, it discolors skin tissue (tobacco stain) and causes dermatitis.

7-22. Brisance tests show tetryl to have a very high shattering power. It is greater in brisance than TNT and is exceeded in standard military explosives only by PETN and some of the newer military explosives, such as RDX.

7-23. The major uses of tetryl are as follows:

a. Tetryl is the standard booster explosive and is sufficiently insensitive when compressed to be used safely as a booster explosive. The violence of its detonation ensures a high-order detonation of the bursting charge. It is used in the form of pressed pellets. Tetryl is a common bursting charge for 20-mm projectiles. It produces appreciably better fragmentation of these shells than TNT. It is also more readily detonated, and yet, in small-caliber shell withstands the force of setback in the weapon. It is also a constituent of tetrytol.

b. Tetryl is used in detonators, the tetryl being pressed into the bottom of the detonator shell and then covered with a small priming charge of mercury fulminate, lead azide, or other initiator.

7-24. PETN (Pentaerythrite Tetranitrate). PETN is one of the strongest known high explosives. It is more sensitive to shock or friction than TNT or tetryl. In its pure form, PETN is a white crystalline powder; however, it may be a light gray due to impurities. It will detonate under a long, slow pressure. PETN in bulk must be stored wet. Its primary use is in booster and bursting charges in small caliber ammunition; upper detonator or in some land mines and shells; explosive core of primacord (detonating cord). When suspended in molten TNT it forms a pentolite explosive of high brisance.

7-25. RDX. RDX, one of the most powerful explosives, is commonly known as cyclonite (cyclotrimethylenetrinitramine), CTMTN, C6; hexogen (H) (German); T4 (Italian) and Tanoyaku (Japanese). It is white crystalline solid having a melting point of 202°C. (397°F.) and is very stable. It has slightly more power and brisance than PETN. It is more easily initiated by mercury fulminate than is tetryl. RDX has been used mainly in mixtures with other explosives, but can be used by itself as a sub-booster, booster, and bursting charge. It is being combined with nitrohydrocarbons, which also permit cast-loading, or with waxes or oils for press-loading. It has a high degree of stability in storage.

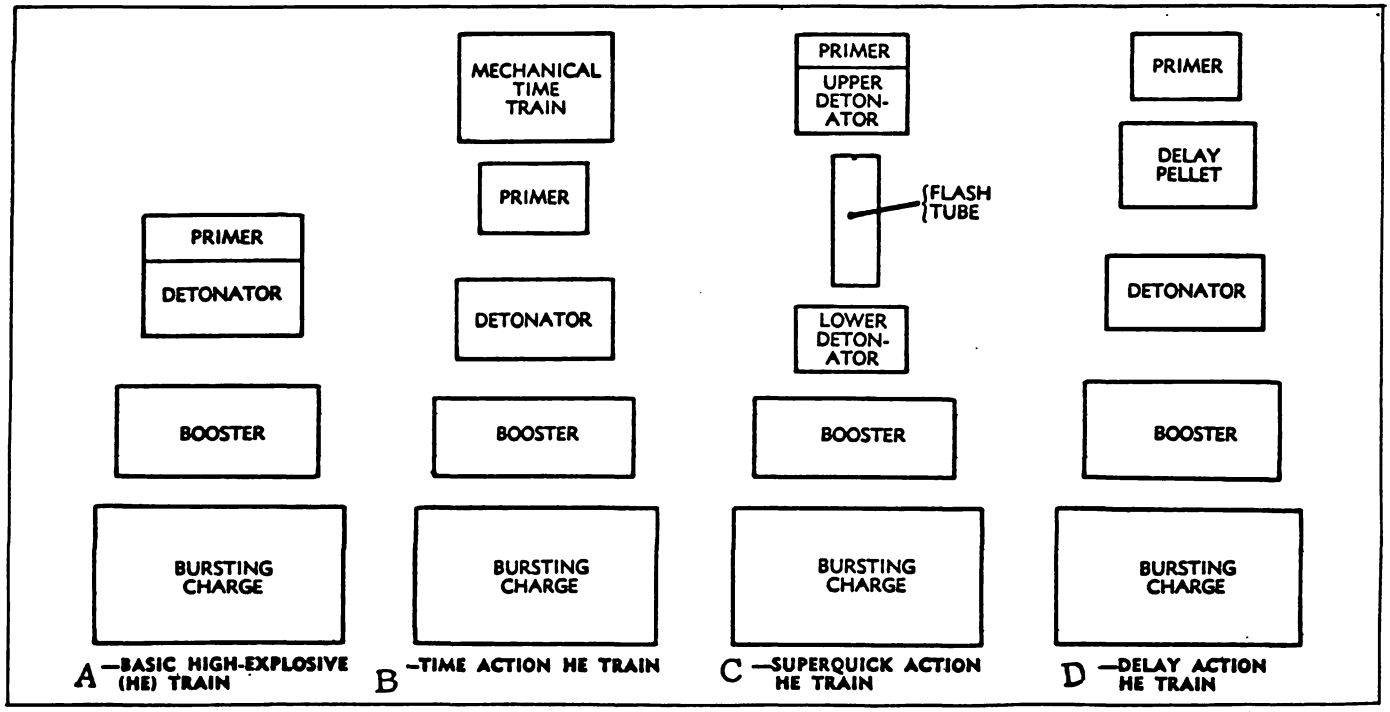


Figure 7-2. Schematic Arrangement of Components of Explosive Trains

7-26. TNT (Trinitrotoluene). Trinitrotoluene, commonly known as TNT, is a constituent of many explosives, such as amatol, pentolite, tetrytol, torpex, tritonal, picratol, ednatol, and composition B and has been used by itself under such names as triton, trotyl, trilite, trinol, and tritolo.

7-27. TNT in a refined form is one of the most stable of high explosives and can be stored over long periods of time. It is relatively insensitive to blows or friction. Confined TNT, when detonated, explodes with violence. When ignited by a flame, unconfined TNT burns slowly without explosion, evolving a heavy oily black smoke; however, burning or rapid heating of large quantities, especially in closed vessels, may cause a violent detonation. It is nonhygroscopic and does not form sensitive compounds with metals, but is readily acted upon by alkalies to form unstable compounds that are very sensitive to heat and impact. It usually resembles a light brown sugar but when pure is crystalline and nearly white. When melted and poured into a shell or bomb it forms a solid crystalline explosive charge. TNT is a very satisfactory military explosive. The melting point of standard grade 1 TNT is 80.2°C. (176°F.). Ammunition loaded with TNT can be stored, handled, and shipped with comparative safety.

WARNING

Exudate can be extremely hazardous and should be removed in accordance with existing directives.

7-28. When stored in warm climates or during warm summer months, some ammunition loaded with TNT may exude an oily brown liquid. This exudate oozes out around the threads at the nose of the bomb and may form a pool on the floor. The exudate is flammable and contains TNT. Pools of exudate should be carefully removed.

7-29. TNT in crystalline form can be detonated readily by a No. 6 blasting cap or when highly compressed by a No. 8 blasting cap. When cast, it is necessary to use a booster charge of pressed tetryl or an explosive of similar brisance to ensure complete detonation.

7-30. The major uses of TNT are as follows:

a. TNT is used as a bursting charge for high-explosive shell and bombs, either alone or mixed with ammonium nitrate to form 50/50 or 80/20 amatol. Flake TNT is used in fragmentation hand grenades. Other military uses of TNT are in mines and for parts of certain shell and bomb bursters.

b. TNT is used to demolish bridges, railroads, fortifications, and other structures. For such purposes TNT is used in the form of a large shaped charge or a small highly compressed block enclosed in a waterproof fiber container that protects it from crumbling in handling. The triton blocks used by the Corps of Engineers are blocks of pressed TNT inclosed in cardboard containers.

c. TNT is suitable for all types of blasting and produces approximately the same effect as the same weight of dynamite of 50 to 60 percent grade. It is also used as a booster surround in some amatol-loaded ammunition.

7-31. AMATOL. Amatol, a mechanical mixture of ammonium nitrate and TNT in various percentages, has approximately the same general characteristics as TNT. It is crystalline, yellow or brownish, and insensitive to friction, but it may be detonated by severe impact. It is less sensitive to detonation than TNT and is readily detonated by mercury fulminate and other detonators. It is hygroscopic and in the presence of moisture attacks copper, brass, and bronze, forming dangerously sensitive compounds. Amatol, 50/50, has approximately the same rate of detonation and brisance as TNT, while amatol, 80/20, is slightly lower in velocity and brisance than TNT. Amatol, 80/20, produces a white smoke on detonation, and amatol, 50/50, produces a smoke less black than straight TNT.

7-32. Amatol, 50/50, consists of 50 percent ammonium nitrate and TNT by weight. When hot, it is sufficiently fluid to be poured or cast like TNT. Amatol, 80/20, consists of 80 percent ammonium nitrate and 20 percent TNT. It resembles wet brown sugar. When hot, it becomes semiplastic (consistency of putty) and in that state it can be pressed into shells and bombs.

7-33. Amatol is a substitute for TNT. Amatol, 50/50, was used for 75-mm and larger shell, and 80/20 amatol was used for shell of 155-mm and larger. Amatol was also used in large bombs. Its primary use, however, is for bangalore torpedoes.

7-34. PICRIC ACID (Trinitrophenol). Picric acid, a nitrated product of phenol under the name of melinite, was adopted as a military high explosive by the French in 1886 and has been used more extensively as a military explosive by foreign nations than by this country. The British designate it as lyddite.

7-35. Picric acid is a lemon-yellow crystalline solid. It is stable but reacts with metals when moist, in some cases forming extremely sensitive compounds. Picric acid is more readily detonated by means of a detonator than TNT but has about the same sensitivity to shock. It is not as toxic as TNT and is also nonhygroscopic although slightly soluble in water. Picric acid has a high melting point--approximately 122°C. (251.6°F.).

7-36. Picric acid is chiefly used for conversion to ammonium picrate (explosive D) and to form bursting-charge mixtures with other nitro compounds.

7-37. AMMONIUM PICRATE (Explosive D). Ammonium picrate is the least sensitive to shock and friction of all military explosives. This makes it well suited for use as a bursting charge in armor-piercing projectiles. It is slightly inferior in explosive strength to TNT. When heated, it does not melt but decomposes and explodes. It reacts slowly with metals, and when wet it may form sensitive and

dangerous compounds with iron, copper, and lead. It is difficult to detonate. When ignited in the open it will burn readily like tar or resin.

7-38. Explosive D is used as a bursting charge for armor-piercing bombs and in other types of projectiles that must withstand severe shock and stresses before detonating.

7-39. Special Precautions. The following precautions should be observed:

a. Ammonium picrate, which has been pressed at a loading plant and removed from a munition, is very much more sensitive to shock or blow than fresh ammonium picrate. It should be protected against coming in contact with lead, iron, or copper because it forms sensitive compounds.

b. Although less sensitive than TNT, it can be exploded by severe shock or friction, is highly flammable, and may detonate when heated to a high temperature.

7-40. PICRATOL. Picratol is a mixture of 52 percent explosive D and 48 percent TNT. It can be poured like straight TNT and has approximately the same resistance to shock as that of straight explosive D. The brisance of picratol is between that of explosive D and TNT. Picratol is nonhygroscopic. Picratol is a standard filler employed for all semi-armor-piercing bombs.

7-41. PENTOLITE. Pentolite is a 50/50 mixture of PETN and TNT and is commonly known as pentol (German) and pentritol. Pentolite has largely been displaced by composition B. Pentolite should not be drilled to form booster cavities; forming tools should be used. It is superior to TNT in explosive strength and is less sensitive than PETN. It may be melt-loaded and is satisfactory for the following uses:

a. As a bursting charge in small caliber shells, e.g., 20-mm.

b. In shaped-charge ammunition of many types, e.g., antitank rifle grenades, and bazookas.

c. In rockets and shaped demolition charges.

d. In some ammunition, as a booster or booster-surround.

7-42. TETRYTOL. Tetrytol is a uniform mixture of 75 percent tetryl and 25 percent TNT. It has higher brisance than TNT and is more effective in cutting through steel and in demolition work. It is less sensitive to shock and friction than tetryl and only slightly more sensitive than TNT. Tetrytol is stable in storage but exudes at 65 C. (149°F.). Tetrytol is nonhygroscopic and is suitable for underwater demolition, since submergence for 24 hours does not appreciably affect its characteristics. Tetrytol is used in chain and individual demolition blocks and in certain destructors.

WARNING

The block must not be broken into fragments, as this may cause detonation.

7-43. NITROSTARCH EXPLOSIVES. Nitrostarch, gray in color, is nitrated cornstarch used to sensitize combustibles and oxidizing agents in much the same manner that nitroglycerin is used in dynamite. It is highly flammable, and can be ignited by the slightest spark, as may result from friction and burns, with explosive violence. Nitrostarch is less sensitive than dry guncotton or nitroglycerin. Nitrostarch explosives are readily detonated by a No. 6 blasting cap.

7-44. A nitrostarch demolition explosive is used as a substitute for TNT and is available as: four 1/4-pound units, each 1/4-pound unit containing three 1/12-pound small size pellets (briquets) wrapped in paraffined paper with markings to indicate the location of holes for the blasting caps; 1/2-pound blocks; and 1-pound blocks. TNT formulas for computing small charges are directly applicable to the nitrostarch demolition explosive.

7-45. DYNAMITE. Commercial blasting explosives with the exception of black powder are referred to as dynamite. There are several types, each type being subdivided into a series of grades, each type and grade differing in one or more characteristics. Dynamite consists essentially of nitroglycerin absorbed in a porous material. Each composition generally is designated as either a straight, ammonia, gelatin, or ammonia-gelatin dynamite and generally available as paraffin coated 1/2-pound sticks or cartridges, rated according to the percent by weight of nitroglycerin content.

7-46. Dynamite of from 50- to 60-percent nitroglycerin content is equivalent on an equal weight basis to TNT in explosive strength. Dynamite of 40-percent is equivalent to TNT in the ratio of 1-1/4 pounds of dynamite to 1 pound TNT. Straight dynamite is more sensitive to shock and friction than TNT and is capable of being detonated by the action of a rifle bullet. Generally, the higher percentages of dynamite have very good water resistance. Explosion of the common types of dynamite produces poisonous fumes, which are dangerous in confined places. Dynamite, as well as other nitroglycerin explosives, are adversely affected by extreme cold, dynamite freezes at -20°F., consequently, it is unsatisfactory for service under low-temperature arctic conditions.

7-47. Dynamite is used as a substitute for nitrostarch or TNT for training purposes. It is also employed by the Corps of Engineers for trench, harbor, dam, flood control, and mining demolitions. The following limitations are applicable to its use:

a. Not to be issued or used for destruction of duds.

b. Not to be supplied for training in use of demolition equipment.

c. Not to be carried in combat vehicles subject to extreme of temperature.

7-48. EDNATOL. Ednatol is a mixture of haleite or explosive H (ethylenedinitramine) and TNT and is one of the most powerful explosives. It is less sensitive than tetryl, PETN, or RDX. Ednatol is equivalent to tetryl in brisance. It can be cast in the same manner as amatol. It has no tendency to combine with metals in the absence of moisture and has no toxic effect. In the presence of moisture, haleite hydrolyzes slightly giving an acid reaction; hydrolysis of ednatol is not appreciable. Ednatol is very stable and can be stored for long periods; it is nonhygroscopic. Ednatol may be used for the same purpose as pentolite, namely, in rockets, grenades, and high-explosive antitank munitions. As an explosive for producing blast effect, it is superior to amatol, pentolite, and composition C-3 and nearly equal to composition B.

7-49. TRITONAL. Tritonal is a generic term for explosives containing TNT and powdered aluminum, generally in the ratio of 80/20. It produces a greater blast effect than TNT or composition B. Because of the aluminum powder constituent, the inclusion of moisture in the mixture must be avoided. It is used in light-case and general-purpose bombs.

7-50. HBX. HBX is an aluminized (powdered aluminum) explosive having the same order of sensitivity as composition B. HBX may produce pressure within a casing due to gassing. It is used as a bursting charge in mines, depth bombs, depth charges, and torpedoes.

7-51. COMPOSITION A. Composition A (comp A) is a mixture containing 91 percent RDX and 9 percent beeswax; a composition that is semiplastic in nature. When the beeswax was replaced by a wax derived from petroleum and with subsequent changes in the method of adding the desensitizer, the designation was changed to composition A-2. Recently the composition has been redesignated as composition A-3, because of changes in the granulation of RDX and the method of manufacture. Composition A-3 is granular in form, resembling tetryl. It is usually buff in color and is press-loaded in minor-caliber (20-, 37-, and 40-mm) shell. It is 30 percent stronger than TNT; strength is usually dependent on the amount of wax binder.

7-52. COMPOSITION B. Composition B (comp B) is a (59/40/1) mixture of RDX, TNT, and beeswax. Its color may vary from dirty white, light yellow, to brownish yellow. It is less sensitive than tetryl but more sensitive than TNT. It is intermediate between TNT and RDX, with respect to sensitivity and initiation. It is only inferior to tritonal and torpex with respect to blast effect. Composition B is an authorized filling for Army-Navy (AN) standard aircraft bombs, mines, torpedoes, antitank artillery shells (76- and 105-mm), demolition charges, and in rockets. Composition B containing 60 percent RDX and 40 percent TNT, exclusive of wax, is known as composition B-2, a nonstandard explosive. Because of its greater sensitivity to impact, composition B-2 is not as suitable as composition B for use in bombs.

7-53. COMPOSITION C (Series). Composition C, sometimes referred to as PE, is a plastic explosive. The original composition C was 88-percent RDX and 12-percent inert plasticizer. C-2 was developed with 80-percent RDX and 20-percent explosive plasticizer. Disadvantages of the earlier compositions led to the development of C-3, a composition of 77-percent RDX and 23-percent explosive plasticizer, with a partial substitution for a part of the RDX with tetryl. In cold weather Composition C-3 became hard to handle and was not pliable, resulting in the more recent development of Composition C-4. Composition C-4 is now the standardized composition for plastic explosive. The first three compositions were brown in color, normally the consistency of putty, and had the tendency to leach out (sweat out) the plasticizing oils. The leach out of the oils reduced the amount of plasticizer protection for the RDX crystals and made the explosive too sensitive to use in the field.

7-54. Composition C-2 is putty-like in composition and about 35 percent stronger than TNT. It was employed as a demolition charge.

7-55. Composition C-3 is slightly inferior to composition B as an explosive for producing blast effect. It is considerably less sensitive than TNT and may not always be detonated by a No. 8 blasting cap, but will always be detonated by the special Corps of Engineers blasting caps. It was used principally as a commando and demolition explosive, either with or without a container. It is also used as a filler in some types of munitions. If its plasticity is lost by long storage at low temperatures, it may be restored to satisfactory plasticity by molding with the hands after warming by immersion in warm water. It must not be exposed to open flame, as it catches fire easily and burns with an intense flame. If burned in large quantities, the heat generated may cause it to explode. Its explosion produces poisonous gases in such quantities that its use in closed spaces is dangerous. Existing inventories of this material are being exhausted and replaced with a standardized composition C-4.

7-56. Composition C-4 is a (91/9) RDX and plastic explosive composition. It is a semiplastic putty-like material, dirty white to light brown in color, less sensitive, more stable, less volatile, and more brisant than composition C-3. It is a nonhygroscopic material that has found application in demolition blocks and specialized uses.

7-57. DBX. DBX is a (21/21/40/18) RDX, ammonium nitrate, TNT, and aluminum powder composition. It is gray in color, with a melting point between 80° and 90°C. (176° and 194°F.). It will react with metals in the same manner as amatol. Because DBX contains ammonium nitrate, it is slightly hygroscopic. It resembles torpex in sensitivity, strength, and brisance.

7-58. INITIATING AND PRIMING EXPLOSIVES.

7-59. MERCURY FULMINATE. Mercury fulminate is a heavy crystalline solid. It is white when pure, but ordinarily has a faint brownish-yellow or grayish tint. It is extremely sensitive to heat, friction,

spark, flame, or shock, detonating completely in nearly every instance. Its sensitivity varies with temperature. It has been found that its sensitivity is dependent in part on crystal size. It is nonhygroscopic and may be safely stored for long periods of time at moderate temperatures when wet. However, it will not stand long-term storage at elevated temperatures. For all practical purposes, mercury fulminate has been replaced by lead azide and lead styphnate. It was used on limited scale in a few primers, in fuze detonators, and in blasting caps. It may be used alone or mixed with potassium chlorate. At present this material is no longer included in standard ammunition.

7-60. LEAD AZIDE. Lead azide, one of the most stable initiators, is used to detonate high explosives. It is a fine-grained, cream-colored compound. It is sensitive to flame and impact but is not certain to detonate by the action of a firing pin (stab-action). It is not easily decomposed on long continued storage at moderately elevated temperatures. It flashes at a much higher temperature than mercury fulminate. A smaller weight of lead azide than of mercury fulminate is required to detonate an equal amount of TNT, tetryl, etc. Lead azide has replaced mercury fulminate because of its properties; it stands up better in storage, and is less hazardous to manufacture. It is used in primer mixtures, in detonator assemblies, and fuzes. When in contact with copper metal, it forms a supersensitive explosive.

7-61. LEAD STYPHNATE. This explosive has been widely employed commercially and as an initiator for foreign military explosives. Recently, it has been adopted by the United States military. It may be pale straw, deep yellow, orange-yellow, or reddish-brown in color. Lead styphnate is slightly less sensitive than mercury fulminate and has about the same strength as lead azide. It should be stored under water in conductive rubber containers. It is used in detonators to lower the ignition temperature of lead azide. As a primer it produces a very good flame. It is more easily ignited by an electrical spark than is mercury fulminate, lead azide, or DDNP. As a substitute for mercury fulminate in primer compositions, lead styphnate offers sensitivity, stability, and ample flame. It is useless as a detonator, except as a sensitizing agent when employed in lead azide friction-type primers or lead azide detonators.

7-62. DIAZODINITROPHENOL (DDNP). Extensively employed in commercial blasting caps, this explosive has found a place in military priming compositions and detonators. It is nonhygroscopic and greenish yellow to brown in color. Its sensitivity to impact is equal to mercury fulminate; however, it is much less sensitive to friction (about that of lead azide). If pressed into a blasting cap shell with a reinforcing cap and a piece of black powder safety fuze is crimped in the shell, a charge of DDNP undergoes detonation when ignited. For the less sensitive high explosives (explosive D and cast TNT), it is a better initiator of detonation than mercury fulminate. For the more sensitive high explosives, DDNP is not superior to lead azide. It is not as stable as lead azide but markedly superior to mercury fulminate. It is used to some extent in leading fuze detonators and the manufacture of priming compositions.

SECTION VIII
CHEMICAL AGENTS

8-1. INTRODUCTION.

8-2. A military chemical agent is a substance that produces a toxic (casualty) or an irritating (harassing) effect, a screening smoke, an incendiary action, or a combination of these.

8-3. CLASSIFICATION.

8-4. Chemical agents are compounds and mixtures other than pyrotechnics and are used as fillers (figure 8-1) in artillery shell, mortar shell, grenades, rockets, and bombs. They are classified according to tactical use, physiological effect, and purpose.

8-5. MILITARY GASES. A military gas is any agent or combination of agents that can produce either a toxic or irritating physiological effect. Such agent(s) may be in solid, liquid, or gaseous state (figure 8-2), either before or after dispersion. The gases may be persistent (those remaining effective at point of release for more than 10 minutes) or nonpersistent (those becoming ineffective within 10 minutes). Persistent gases are further divided into moderately persistent (those remaining effective in the open 10 minutes to 12 hours) and highly persistent (those remaining effective in the open longer than 12 hours). The military gases are classified in accordance with their toxic and irritating effects as follows:

a. Casualty gases: Blister and choking gases. Blood and nerve poisons.

b. Training and riot control gases: Vomiting and tear gases.

8-6. SCREENING SMOKES. A screening smoke is a cloud that consists of small particles of solids, liquids, or both, dispersed and suspended in air.

8-7. INCENDIARIES. An incendiary may be a solid, liquid, or a gelled semiplastic material that, by its intense heat and flame, can start fires and scorch combustible and noncombustible materials, as well as injure and inactivate personnel.

8-8. SIMULATED MILITARY GASES. Simulated agents are essentially mild nontoxic harassants (substitute for the real agent) designed specifically for training purposes.

8-9. BLISTER GASES (CASUALTY).

8-10. Blister gases are agents that affect the nose, throat, eyes, lungs, or exposed skin tissue. They harass and produce casualties resultant from the injuries (inflammations, blisters, destruction of body tissue). The principal gases in this group are mustard, mustard mixtures, lewisite, and simulated mustard gases.

8-11. MUSTARD GAS (H). This gas is a dark-brown liquid that slowly evaporates to a colorless gas having the odor of garlic. Distilled mustard gas (HD) may be practically odorless. Its principal physiological effect is to produce skin blisters, although the blistering does not ordinarily appear for several hours after contact. If inhaled, mustard gas vapors have a choking (lung irritant) effect. For complete protection against mustard (H, HD), mustard T (HT), or the nitrogen mustards (HN-1, HN-2, HN-3), both protective mask and protective clothing are necessary. HN-1 vapor and liquid are dangerous. HN-1 attacks the respiratory tract as does H gas, but to a lesser degree, and has especially dangerous effects on the eyes that may result in permanent injury or blindness. The tactical use of mustard gas and its mixtures is to neutralize areas, contaminate materiel, restrict aggressor movements, and inflict casualties. These agents can be dispersed by artillery and mortar shell and from aircraft bombs. Food contaminated by mustard gases or its mixtures is unfit for use.

8-12. LEWISITE GAS (L). Lewisite gas is a dark-brown liquid that evaporates to a colorless gas and has an odor of geraniums. In addition to being a blister and choking gas, lewisite acts as an arsenical poison. The protective mask and protective clothing are necessary against L. Lewisite is best destroyed with bleach, DANC solution, or an alcoholic solution of caustic soda. If lewisite is destroyed by burning, there is a danger of contaminating the atmosphere with poisonous arsenic oxide. The tactical use of L and the methods of projection are the same as those for H. It renders food and water permanently unfit for use.

8-13. SIMULATED H AGENTS. These agents possess physical properties that are similar to mustard gas and generally include a dye, an odoriferous constituent, or both. Unusually nontoxic, such material is employed as a substitute filler for the agent in munitions in simulated military training exercises. A simulated agent may be harmless or partially harmful. The following principal materials are used:

a. Molasses residuum (MR) is a nontoxic (25 percent solution) thick, sirupy, viscous liquid with a molasses odor. When dispersed from aircraft, chemical spray tanks, artillery shell, mortar shell, or bombs, the spray patterns resemble those of mustard gas (H).

GROUP A, NERVE GASES-Chemical Agents Requiring Complete Protective Clothing Plus Gas Masks			
SYMBOL	NAME	MARKINGS	
		PRESENT	PREVIOUS
G V	G Agents	Gray background, with three 1/2 inch green bands spaced 1/2 inch apart.	
GROUP A, BLISTER GASES-Chemical Agents Requiring Complete Protective Clothing Plus Gas Masks			
H	Mustard	Gray background, H Gas and two 1/2 inch bands spaced 1/2 inch apart all in green	H Gas and 2 bands (All in green)
HD	Mustard (distilled)	Gray background, HD Gas and two 1/2 inch bands spaced 1/2 inch apart, all green	HD Gas and 2 bands (All in green)
HT	Mustard (T mixture)	Gray background, HT Gas and two 1/2 inch bands spaced 1/2 inch apart, all in green	HT Gas and 2 bands (All in green)
L	Lewisite	Gray background, L Gas and two 1/2 inch bands spaced 1/2 inch apart, all in green	L Gas and 2 bands (All in green)
HN-1	Nitrogen Mustard	Gray background, HN-1 Gas and two 1/2 inch bands spaced 1/2 inch apart, all in green	HN-1 Gas and 2 bands (All in green)
GROUP B, TOXIC & SMOKE-Chemical Agents Requiring Gas Masks			
BZ	BZ Agent	Gray background, BZ Gas and two 1/2 inch bands spaced 1/2 inch apart, all in red	
CG	Phosgene	Gray background, CG Gas and one 1/2 inch band, all in green	CG Gas and 1 band (All in green)
CL	Chlorine	Gray background, CL Gas and one 1/2 inch band, all in green	CL Gas and 1 band (All in green)
CS	O-chlorobenzal-malononitrile	Gray background, CS Gas and one 1/2 inch band, all in red	
AC	Hydrocyanic Acid	Gray background, AC Gas and one 1/2 inch band, all in green	AC Gas and 1 band (All in green)
CK	Cyanogen Chloride	Gray background, CK Gas and one 1/2 inch band, all in green	CK Gas and 1 band (All in green)
CN	Chloraceto-Phenone	Gray background, CN Gas and one 1/2 inch band, all in red	CN Gas and 1 band (All in red)
CNS	Tear Gas Solution	Gray background, CNS Gas and one 1/2 inch band, all in red	CNS Gas and 1 band (All in red)
CNB	Tear Gas Solution	Gray background, CNB Gas and one 1/2 inch band, all in red	CNB Gas and 1 band (All in red)
PS	Chloropicrin	Gray background, PS Gas and two 1/2 inch green bands spaced 1/2 inch apart, all in green	PS Gas and 2 bands (All in green)
DM	Adamsite	Gray background, DM Gas and one 1/2 inch red band	DM Gas and 1 band (All in red)
DA	Diphenylchorcarsine	Gray background, DA Gas and one 1/2 inch red band	DA Gas and 1 band (All in red)
FS	Sulfur trioxide-Chloro-sulfonic acid mixture	Light green background, FS Smoke in white letters or FS smoke adjacent to one 1/2 inch band all in light green	FS Smoke and 1 band (All in yellow)

Figure 8-1. Fillings and Markings of Chemical Munitions (Sheet 1 of 2)

GROUP B, TOXIC & SMOKE-Chemical Agents Requiring Gas Masks (Continued)			
		MARKINGS	
SYMBOL	NAME	PRESENT	PREVIOUS
FM	Titanium tetrachloride	Light green background, FM smoke in white letters or FM Smoke adjacent to one 1/2 inch band, all in light green	FM Smoke and 1 band (All in yellow)
GROUP C-Spontaneously Flammable Chemical Agents			
WP	White Phosphorus	Light green background with the lettering for WP light red	WP Smoke and 1 band (All in yellow)
PWP	White Phosphorus (plasticized)	Light green background with the lettering for PWP light red	PWP Smoke and 1 band (All in yellow)
GROUP D-Incendiary and Readily Flammable Chemical Agents			
IM	Incendiary oil	Light red background & IM Incendiary in black or in light red letters adjacent to a 1/2 inch light red band	IM Incendiary and 1 band (All in purple)
NP	Incendiary oil	Light red background & NP incendiary in black or in light red letters adjacent to a 1/2 inch light red band	NP Incendiary and 1 band (All in purple)
PTI	Incendiary Mixture	Light red background & PTI Incendiary in black or in light red letters adjacent to a 1/2 inch light red band	PTI Incendiary and 1 band (All in purple)
TH	Thermite	Light red background & TH Incendiary in black or in light red letters adjacent to a 1/2 inch light red band	TH Incendiary and 1 band (All in purple)
HC	Hexachloroethane burning mixture	Light green background, HC Smoke in white letters or in light green letters adjacent to a light green band	HC Smoke and 1 band (All in yellow)
CN	CN Burning Mixtures	Gray background with one 1/2 inch red band	CN Gas and 1 band (All in yellow)
CN-DM	CN-DM Burning Mixtures	Gray background with one 1/2 inch red band	CN-DM Gas and 1 band (All in red)
	Colored Burning Mixtures	Light green background with a series of the letter "C" in a color approximating that of the smoke encircling the item	Smoke (name of color and 1 band) (All in yellow)

Figure 8-1. Fillings and Markings of Chemical Munitions (Sheet 2 of 2)

b. Asbestine suspension (AS) is a nontoxic suspension of finely ground asbestos in water. It may or may not include butyric acid (odor of rancid butter), a material that imparts a disagreeable lingering scent to the mixture. With butyric acid, it is known as an asbestine-butric acid suspension; without butyric, it is known as an asbestine suspension. AS is dispersed as a spray from aircraft. When dispersed, it will adhere like MR to surfaces and personnel and show up in contrast to the surrounding medium.

8-14. CHOKING GASES.

8-15. Choking gases affect the nose, throat, and lungs of unprotected personnel. They cause casualties resulting from a lack of oxygen. The principal gas in this group is phosgene. Phosgene (CG) appears on projection as a whitish cloud, changing to a colorless gas. In high concentrations, one or two breaths may be fatal in a few hours. CG produces but a slight irritation of the sensory nerves in the upper air passages; therefore, any personnel exposed to this gas are likely to inhale it more than they would equivalent concentrations of other olfactory sensitizing gases. Phosgene is insidious in its action; consequently, personnel exposed to it often have little or no warning symptoms until it is too late to avoid serious poisoning. CG as a chemical agent can be employed effectively at very low temperatures, since it freezes below -155 F.

8-16. BLOOD AND NERVE POISONS.

8-17. Blood and nerve poisons, when absorbed by the blood stream, affect the nervous system, respiratory system, or muscular functions of the body, to cause

Agents	Chemical Agent; Formula; Symbol	Use	State at 20 C.	Eye and Skin Toxicity	Rate of Action	Physiological Action	Protection Required	Odor
CHOKING AGENTS	Phosgene $COCl_2$ CG	Delayed-or immediate-action casualty agent	Colorless gas	None	Immediate to 3 hours	Damages and floods lungs	Protective mask	New-mown hay; green corn
	Diphosgene $ClCOOCCl_3$ DP	Delayed-or immediate-action casualty agent	Colorless liquid	Slightly lacrimatory	Immediate to 3 hours	Damages and floods lungs	Protective mask	New-mown hay; green corn
NERVE AGENTS	Sarin $(CH_3)_2N(C_2H_5O)CNPO$ GA	Quick-action casualty agent	Colorless to brown liquid	Very high	Very rapid	Cessation of breath and death may follow	Protective mask and clothing	Faintly fruity; none when pure
	Sarin $CH_3(C_3H_7O)FPO$ GB	Quick-action casualty agent	Colorless liquid	Very high	Very rapid	Cessation of breath and death may follow	Protective mask and clothing	Almost none when pure
	Soman $CH_3(C_6H_{13}O)FPO$ GD	Quick-action casualty agent	Colorless liquid	Very high	Very rapid	Cessation of breath and death may follow	Protective mask and clothing	Fruity; camphor odor when impure
	VX	Quick-action casualty agent	Colorless liquid	Very high	Rapid	Produces casualties when inhaled or absorbed	Protective mask and clothing	Odorless
BLOOD AGENTS	Hydrogen cyanide HCN AC	Quick-action casualty agent	Colorless gas or liquid	Moderate	Very rapid	Interferes with use of oxygen by body tissues; accelerates rate of breathing	Protective mask and clothing	Peach kernels
	Cyanogen chloride CNCl CK	Quick-action casualty agent	Colorless gas	Low-lacrimatory and irritating		Chokes, irritates, causes slow breathing rate	Protective mask	Somewhat like AC; can go unnoticed
	Arsine AnH_3 SA	Delayed-action casualty agent	Colorless gas	None	Delayed action -2 hours to as much as 11 days	Damages blood, liver, and kidneys	Protective mask	Mild garlic
BLISTER AGENTS	Distilled mustard $(ClCH_2CH_2)_2S$ HD	Delayed-action casualty agent	Colorless to pale yellow liquid	Eyes very susceptible; skin less so	Delayed-hours to days	Blisters; destroys tissues; injures blood vessels	Protective mask and clothing	Garlic
	Nitrogen mustard $(ClCH_2CH_2)_2NC_2H_5$ HN-1	Delayed-action casualty agent	Dark liquid	Eyes susceptible to low concentration; less toxic to skin	Delayed action -12 hours or longer	Blisters; affects respiratory tract; destroys tissues; injures blood vessels	Protective mask and clothing	Fishy or musty
	Nitrogen mustard $(ClCH_2CH_2)_2NCH_3$ HN-2	Delayed-action casualty agent	Dark liquid	Toxic to eyes; blisters skin	Skin effects delayed 12 hours or longer	Similar to HD. Bronchopneumonia may occur after 24 hours	Protective mask and clothing	Soapy in low concentrations; fruity in high concentrations
	Nitrogen mustard $N(CH_2CH_2Cl)_3$ HN-3	Delayed-action casualty agent	Dark liquid	Eyes very susceptible; skin less so	Serious effects same as for HD; minor effects sooner	Similar to HN-2	Protective mask and clothing	None if pure
	Phosgene oxime. dichloroformoxime Cl_2CNOH CX		Colorless solid or liquid	Powerful irritant to eyes and nose	Immediate effects on contact	Violently irritates mucous membrane of eyes and nose; forms wheal rapidly	Protective mask and clothing	Sharp-penetrating
	Lewisite $ClCH:CHAsCl_2$ L	Moderately delayed casualty agent	Dark oily liquid	1,500 mg-min/m^3 exposure severely damages cornea; skin less susceptible	Rapid	Similar to HD plus may cause systemic poisoning	Protective mask and clothing	Variable; may resemble geraniums

Figure 8-2. Characteristics of Military Gases (Sheet 1 of 2)

Agents	Chemical Agent; Formula; Symbol	Use	State at 20 C.	Eye and Skin Toxicity	Rate of Action	Physiological Action	Protection Required	Odor
BLISTER AGENTS (Cont.)	Mustard-lewisite mixture HL	Delayed-action casualty agent	Dark oily liquid	Very high	Prompt stinging; delayed (about 13 hours) blistering	Similar to HD plus may cause systemic poisoning	Protective mask and clothing	Garliclike
	Phenyldichloro-arsine $C_6H_5AsCl_2$ PD	Delayed-action casualty agent	Colorless liquid	633 mg-min/m^3 produces eye casualty; less toxic to skin	Immediate eye effect; skin effects 1/2 to 1 hour	Irritates, causes nausea and vomiting, blisters	Protective mask and clothing	None
	Ethyldichloro-arsine $C_2H_5AsCl_2$ ED	Delayed-action casualty agent	Colorless liquid	Vapor harmful only on long exposure; liquid blisters less than L	Immediate irritation; delayed blistering	Damages respiratory tract, affects eyes, blisters, can cause death	Protective mask and clothing	Fruity but biting; irritating
	Methyldichloro-arsine CH_3AsCl_2 MD	Delayed-action casualty agent	Colorless liquid	Corneal damage possible; blisters less than HD	Rapid	Irritates respiratory tract, injures lungs and eyes, causes systemic poisoning	Protective mask and clothing	None
VOMITING AGENTS	Diphenylchloro-arsine $(C_6H_5)_2AsCl$ DA	Training and riot control agent	White to brown solid	Irritating; not toxic	Very rapid	Like cold symptoms plus headache, vomiting, nausea	Protective mask	None
	Adamsite $NH(C_6H_4)_2AsCl$ DM	Training and riot control agent	Yellow to green solid	Irritating; relatively nontoxic	Very rapid	Like cold symptoms plus headache, vomiting, nausea	Protective mask	None
	Diphenylcyano-arsine $(C_6H_5)_2AsCn$ DC	Training and riot control agent	White to pink solid	Irritating; not toxic	More rapid than DM or DA	Like cold symptoms plus headache, vomiting, nausea	Protective mask	Bitter almond-garlic mixture
TEAR AGENTS	Chloroacetophenone $C_6H_5COCH_2Cl$ CN	Training and riot control agent	Solid	Temporary severe eye irritation; mild skin irritation	Instantaneous	Lacrimatory; irritates respiratory tract	Protective mask	Apple blossoms
	Chloroacetophenone in chloroform CNC	Training and riot control agent	Liquid	Temporary severe eye irritation; mild skin irritation	Instantaneous	Lacrimatory; irritates respiratory tract	Protective mask	Chloroform
	Chloroacetophenone and chloropicrin in chloroform CNS	Training and riot control agent	Liquid	Irritating; not toxic	Instantaneous	Acts as vomiting and choking agent as well as tear agent	Protective mask	Flypaper
	Chloroacetophenone in benzene and carbon tetrachloride CNB	Training and riot control agent	Liquid	Temporary severe eye irritation; mild skin irritation	Instantaneous	Powerfully lacrimatory	Protective mask	Benzene
	Bromobenzylcyanide $C_6H_5CHBrCH$ BBC	Training and riot control agent	Liquid	Irritating; not toxic	Instantaneous	Irritates eyes and respiratory passages	Protective mask	Soured fruit
	O-chlorobenzyl-mulononitrile $ClC_0H_4CHC(CN)_2$ CS	Training and riot control agent	Colorless solid	Highly irritating; not toxic	Instantaneous	Highly irritating; but not toxic	Protective clothing	Pepper
INCAPACITATING AGENT	BZ	Delayed-action temporarily incapacitating agent						

Figure 8-2. Characteristics of Military Gases (Sheet 2 of 2)

temporary or permanent paralysis or instant death. They can immobilize aggressor forces by rendering them helpless. Hydrocyanic acid and cyanogen chloride are representative of such agents.

8-18. Nerve gases are usually colorless to light brown at the point of release. Their odor is faint, sweetish, fruity, or nonexistent. On exposure, personnel will experience nausea, vomiting, and diarrhea; these effects are followed by muscular twitching and convulsions. Due to the extreme toxicity of the nerve gases, these effects are caused by extremely low concentrations of the gases and are quite rapid. Protection requires impermeable clothing and the protective mask.

8-19. HYDROCYANIC ACID (AC). AC is a colorless gas upon release. Its odor is faint and similar to that of bitter almonds or peach kernels. It is not readily detected in the field. On exposure, personnel first experience a rapid stimulation of the respiratory system, later followed by deeper inhalation. Death by paralysis of the respiratory system may occur in a few minutes.

8-20. CYANOGEN CHLORIDE (CK). CK is a colorless liquid. On release in the field, it changes into a colorless gas that is about twice as heavy as air. CK sometimes may be faint in odor, otherwise its odor is sharp and pungent. On contact or exposure, CK will irritate flesh and stimulate a strong flow of tears. Its action is rapid after inhalation, producing paralysis of the respiratory system. Unlike AC, it first produces an involuntary spasm (a warning of its presence) of short duration of the upper respiratory tract. For protection against CK and AC, a protective mask is required.

8-21. TRAINING AND RIOT CONTROL GASES.

8-22. A group of vomiting and tear gases that, when vaporized or dispersed, exist as suspended particles in the atmosphere. They cause partial or complete temporary disability of personnel. The principal ones in this category are chloracetophenone and liquid mixtures of chloracetophenone in hydrocarbon solvents.

8-23. CHLORACETOPHENONE (CN). Commonly known as tear gas and having a fruity apple blossom odor, CN is typical of such agents. It is solid material (white or black in color) that, when converted into a gas, gas-aerosol, or finely divided particles, will cause a profuse flow of tears, necessitating the use of a protective mask for protection. CN in normal concentrations has no permanent injurious effect on the eyes. In high concentrations it irritates the skin, producing a burning and itching sensation. Food and water contaminated by CN possess a disagreeable taste. It is the principal constituent in the filler used in CNS, CNB mortar shell, and CN-DM grenade. It can be used in bursting-type munitions in arctic regions.

8-24. TEAR GAS SOLUTION (CNB). CNB is a 10 percent liquid mixture of CN in equal parts of benzene and carbon tetrachloride. It is a less severe lacrimator and skin irritator than CNS. For this characteristic, it is used as a filler in hand grenades, artillery shell, mortar shell, small bombs, and aircraft spray for all training purposes. It has a characteristic fruity-benzene odor.

8-25. TEAR GAS SOLUTION (CNS). CNS is a 23.2 percent liquid mixture of CN in equal parts of chloropicrin (PS) and chloroform. CNS has an odor similar to fly paper. The protective mask is an effective protector against both CNS and CNB. CNS as well as CNB can be used in grenades, mortar shell, small bombs, and aircraft spray.

8-26. ADAMSITE (DM). DM typifies the vomiting gases. It is a yellow or green solid when pure. It is dispersed by burning-type munitions such as candles and grenades and appears as a yellow smoke with an odor resembling coal smoke. Physiologically, it causes lacrimation, violent sneezing, intense headache, nausea, and temporary physical weakness. For protection, the protective mask is required. DM has only a slight corrosive effect on metals. It renders food and water permanently unfit for use. Very low-temperature (arctic) conditions impose no special limitations on DM or its mixture with CN (CN-DM burning mixture) when dispersed by hand grenade.

8-27. CHLORACETOPHENONE AND DIPHENYLAMIDE CHLORARSINE (CN-DM MIXTURE). The CN-DM burning mixture is a solid mixture of CN and DM including nitrocellulose, a burning ingredient. When ignited, it burns to form an irritating yellowish white smoke. CN-DM vapors cause headache, nausea, sneezing, depressed sick feeling, intense eye irritation, and temporary disability. In hot humid tropical weather, it will irritate exposed skin. A protective mask gives adequate protection against CN-DM smokes and vapors.

8-28. O-CHLOROBENZALMALONONITRILE (CS). CS is white crystalline powder. It has a minimum purity of 96 percent, is insoluble in water and ethanol, but soluble in methylene chloride. The onset of incapacitation is 20 to 60 seconds and the duration of effects is 5 to 10 minutes after the affected individual is removed to fresh air. During this time affected individuals are incapable of effective concerted action. The physiological effects include extreme burning of the eyes accompanied by copious flow of tears; coughing, difficulty in breathing, and chest tightness; involuntary closing of the eyes; stinging sensation of moist skin; running nose; and dizziness or swimming of the head. Heavy concentrations will cause nausea and vomiting in addition to the above effects. Protection is provided by the protective mask and ordinary field clothing secured at the neck, wrist, and ankles.

8-29. INCAPACITATING CHEMICAL AGENTS.

8-30. Incapacitating chemical agents are capable of producing physiological or mental effects that prevent exposed personnel from performing their primary military duties for a significant period of time; there is complete recovery from these effects. The incapacitating agents fall into two general groups.

a. Those which produce temporary physical disability such as paralysis, blindness, or deafness.

b. Those which produce temporary mental aberrations. Unlike the lethal agents, these incapacitants can produce purely temporary effects without permanent damage. In this respect they resemble the riot control agents.

8-31. The incapacitating agents suggest employment where military necessity requires control of a situation but where there is good reason for not harming the surrounding population or even the troops. They also suggest covert uses either to confuse defense or retaliatory forces, or to affect the rationality of an important leadership group at some particularly crucial point.

8-32. INCAPACITATING AGENT BZ. The Chemical Incapacitating Weapons System includes those agents and related munitions and disseminating devices designed to produce an incapacitating effect upon man to meet military requirements. Agent BZ and two munitions have been type-classified Standard B to provide a limited capability to meet these requirements. The physiological effects include interference with ordinary activity; dry, flushed skin, urinary retention; constipation; slowing or mental and physical activity; headache, giddiness, and disorientation; hallucinations; drowsiness; sometimes maniacal behavior; and increase in body temperature.

8-33. SCREENING SMOKES.

8-34. A screening smoke is produced by the dispersion of particles in the atmosphere through the burning of solids or the spraying of liquids. It is used to obscure military movements, blanket the enemy from observation, spot artillery fire and bombing, as well as to disguise cloud gas. Smoke screen producing materials are rated in units for their top obscuring power (TOP). The principal smoke producing agents are white phosphorus, sulfur trioxide-chlorsulfonic acid mixture and hexachlorethanezinc mixture, with obscurring powers in the order listed.

NOTE

TOP is a relative value that indicates the amount of obscurity (due to reflection and refraction of light rays) that 1 pound of smoke producing material will develop under standard and controlled conditions against a 25-candlepower light source.

8-35. WHITE PHOSPHORUS (WP). WP, which has a 3,500 unit TOP, is a white to light yellow, waxlike, luminous substance (phosphorescent in the dark). On ignition it produces a yellow-white flame and dense white smoke. WP is poisonous when taken internally. Its smoke or fumes are not. When dispersed by ammunition, as small particles, it ignites spontaneously on exposure to air and continues to burn on contact with solid materials, even when embedded in human flesh. WP smoke is unpleasant to breathe but harmless; the particles, however, will poison food and water. It is used in bursting-type projectiles, artillery, and mortar shell, grenades, rockets, and bombs. It is used as an igniter in incendiary ammunition that contains flammable fuels (IM, NP, PT1). WP, when used in projectiles and burst on terrain covered with soft deep snow, is smothered and produces approximately 75 percent less smoke.

8-36. PLASTICIZED WHITE PHOSPHORUS (PWP). PWP is a finely divided form of WP suspended in a thickened and gelled xylene rubber mixture. Like WP, it is an effective double purpose screening and incendiary agent that can be dispersed under arctic, tropic, and temperate climatic conditions.

8-37. SULFUR TRIOXIDE-CHLORSULFONIC ACID MIXTURE (FS). FS with a 2,240 unit TOP, second only to WP and PWP, is a liquid with an acrid and acid odor that produces dense white smoke when dispersed in a humid atmosphere. FS smoke is nonpoisonous. Its liquid irritates and inflames contacted skin tissue. A protective mask is required for protection against exposures to heavy concentrations. The mask and protective clothing should be used for protection against combination FS gas and liquid sprays. Liquid FS renders food and water unfit for use; the smoke merely imparts an unpleasant taste. In view of the fact that liquid FS possesses corrosive properties of strong mineral acids, such as sulfuric or hydrochloric, stringent precautions should be observed at all times for protecting nonagressor personnel and noncombat forces and materiel during use and handling. FS is dispersed from mortar shells, grenades, and by aircraft spray from cylinders. Since FS smoke mixtures freeze at low temperatures (approximately -22° F.), smoke shells containing this agent are partially or completely ineffective for use at freezing temperatures. Under tropical and high humidity conditions, FS performs very effectively.

8-38. HEXACHLORETHANE-ZINC MIXTURE (HC). HC, with a 2,000 unit TOP, is a combination of zinc powder, hexachlorethane, ammonium perchlorate, and ammonium chloride. When ignited, it produces zinc chloride that passes into the air as a dense grayish-white smoke. HC is toxic to unprotected personnel exposed to heavy concentrations for short periods or to light concentrations for extended periods of time. A protective mask offers adequate protection against light concentrations. For heavy concentrations and prolonged exposure, a self-contained oxygen mask is required. Food and water are not spoiled by HC, but acquire a disagreeable odor. HC is dispersed effectively from fixed and floating smoke pots, base ejection artillery shell, mortar shell, and grenades under favorable (humid atmospheres and hard terrain) arctic, tropic, or temperate region conditions.

8-39. INCENDIARIES.

8-40. Incendiaries start and intensify fires and harass and cause casualties. The principal incendiary solid mixtures as used in ammunition are thermite and thermate (TH). For functioning in arctic regions on ice or deep snow, TH incendiaries (bomb and grenade) are ineffective, since they bury themselves and smother in melted ice or snow. Because thermite

and thermate generate great heat, they are useful in destroying equipment and vital parts of materiel that might be in danger of capture by the enemy. In bursting ammunition (grenade or bomb), they are employed for casualty as well as incendiary effects.

8-41. THERMITE (TH). Thermite is an intimate uniform mixture of powdered aluminum and iron oxide. On ignition, it produces intense heat (approximately 4,300° F. in a few seconds) with the formation of a white hot mass of molten iron and slag. TH is used in cartridges, bombs, grenades, mortar shell, and artillery shell. TH as a filler is included in thin-walled nonmagnesium metal containers.

8-42. THERMATE (TH3) is essentially a thermite, barium nitrate, sulfur, and lubricating oil composition contained in a heavy-wall body, usually magnesium or a magnesium alloy. When ignited by electrical or mechanical means, the contents and body burn with an intense heat of about 3,700° F. and are difficult to extinguish.

8-43. Magnesium, in fire powder, thin ribbon, or solid form, is a material that ignites and burns with intense heat and white light. It is a material extensively used in pyrotechnic mixtures and incendiary munitions. As a container body with thermate, it is an effective incendiary.

8-44. Aluminum, in powder, flake, or grain form (12 to 120 mesh), is silvery gray in color. When ignited in mixture with strong oxidizing agents, such as nitrates, chlorates, or perchlorates, it will burn with great heat and intensely bright light. In a fine powdered form, it is used as a constituent of explosive mixtures and primer compositions, in flares, and various pyrotechnic devices. The coarse granular form of material is used in incendiary bomb mixtures. In flake form, aluminum powder is used as an ingredient in detonating mixtures. Alloyed with magnesium metal, it is used to make an aluminum-magnesium-alloy powder. Such alloy powder is employed in the same manner as aluminum powder. Special precautions are to be taken when loading or blending aluminum and aluminum-alloy powders to avoid undue exposure to humid atmospheres, dampness, and moisture.

8-45. INCENDIARY OIL (IM). IM is an 88 percent gasoline mixture thickened with fatty soaps, fatty acids, and special chemical additives (isobutyl methacrylate polymer, napthenic acid). It may or may not contain metallic sodium or WP particles for ignition. When dispersed and ignited, IM adheres to combustible and noncombustible surfaces. It burns like ordinary gasoline with a hot orange flame and gives off a black smoke. IM is used as a filler in bombs, grenades, and portable and mechanized flame throwers. Winterized IM incendiary fuels can be dispersed from bombs or grenades and effectively employed under arctic climatic conditions.

8-46. INCENDIARY OIL, NAPALM (NP). NP is a flammable fuel, principally low octane fuel thickened with a napalm thickner (a special gelling mixture of fatty acids and fatty soaps and chemical additives). As a filler with or without metallic sodium or WP particles, NP can be used in munitions in the same manner as IM.

8-47. INCENDIARY OIL, NAPALM B. Napalm B is a transparent, extremely viscous liquid, closely resembling a clear thick syrup. Napalm B is about 25 percent gasoline. Napalm B is used in munitions requiring incendiary gel (e.g. BLU-27/B, and BLU-32/B). Napalm B adheres to the target better than NP and burns with a hotter flame.

8-48. WESTCO MIX (INCENLJEL). Westco mix consists of two solutions, A and B, mixed in the field to form an incendiary gel. Solution A is a crystalized, distilled cottonseed unsaturated fatty acid with an additive. The additive contributes about one-half percent nitrogen as amine and about 5 percent isopropanol. The additive lowers the freezing point of solution A during gelling operation. Solution B is a mixture of concentrated caustic soda and caustic potash. Westco mix (about 7 percent by volumn) is mixed with JP-4 or gasoline to obtain incendiary gel. The excessive caustic hazards of improperly mixed Westco mix have resulted in limited use.

8-49. INCENDIARY MIXTURE (PT1). PT1 is a complex mixture comprised of magnesium dust, magnesium oxide, and carbon with a sufficient amount of petroleum distillate and asphalt to form a paste. The mixture is used as an incendiary bomb filling.

8-50. MARKING AND IDENTIFICATION.

8-51. All ammunition containing chemical agents is identified and marked with distinctive symbols or letters and colors. (Refer to figure 8-1.)

8-52. For the purpose of storage, chemical agents and munitions are segregated into four groups, according to the nature of the filling and their inherent hazards as follows (AFM 127-100):

a. Group A (blister and nerve gases) includes chemical agents requiring complete protective clothing plus protective masks.

b. Group B (toxic and smoke) includes chemical agents requiring protective masks.

c. Group C includes spontaneously flammable chemical agents, such as WP.

d. Group D includes incendiary and readily flammable chemical agents.

SECTION IX
SMALL ARMS AMMUNITION

9-1. INTRODUCTION.

9-2. Small arms ammunition consists of cartridges of various types and sizes used in rifles, survival weapons, carbines, pistols, revolvers, machineguns, submachineguns, and shotguns. Small arms ammunition is commonly referred to as that ammunition for weapons with a bore diameter of 0.5-inch or less, plus shotgun ammunition.

9-3. DEFINITIONS.

9-4. CARTRIDGE. A cartridge is a complete assembly consisting of all the components necessary to fire a weapon once. In most types of small-arms ammunition, a cartridge consists of a cartridge case, primer, propellant, and bullet. A shotgun cartridge differs in that it contains shot, pellets, or a single slug. Construction of a typical cartridge and its components is illustrated in figure 9-1. Types of cartridges and accessories are illustrated in figures 9-2 through 9-21. Cartridge components are tabulated in figures 9-22 through 9-32.

9-5. CARTRIDGE CASE. A cartridge case is a container designed to hold an ammunition primer and propellant to which a bullet may be affixed. Its profile and size conforms to that of the chamber of the weapon in which the cartridge is fired.

9-6. Small-arms cartridge cases (figure 9-7) are either of the centerfire or rimfire type. Centerfire cases are rimmed, semirimmed, or rimless and have either solid or folded heads. Semirimmed and rimless cases always have solid heads, whereas rimmed cases used for low pressure loading may have either solid or folded heads. From the standpoint of shape, cases are known as straight, straight taper, or bottleneck.

9-7. The cartridge case has three functions. It is the means whereby the other components (primer, propellant, and bullet) are assembled into a unit. It provides a waterproof container for the propellant and primer. Another of its functions is to expand and seal the chamber against the escape of gases to the rear when the cartridge is fired. This process of sealing by expansion is termed obturation. An extractor groove or rim, turned in the head of the cartridge case, provides a means of removing the case from the chamber of the weapon. Shotgun cartridges and other cartridges are manufactured with a rim at the cartridge case head to facilitate extraction of the fired case from the weapon.

9-8. The shotgun cartridge case consists of a brass or steel head and a paper or plastic case, or the case may be made entirely of brass or aluminum. The head is reinforced by a base of compressed paper in which the primer pocket is formed. (See figure 9-8.) Some paper or plastic body cartridges have a steel reinforcement called the lining, under the metal head. The paper and plastic body cartridges are waterproofed. The head is attached to the cartridge body by crimping.

9-9. The primer is pressed into the primer pocket of the cartridge case and staked or crimped, and the joint is sealed by a thin film of lacquer or varnish. The cartridge case is then loaded with a charge of propellant powder and the inside of the neck coated with lacquer or other waterproofing compound. The bullet is then inserted, and the mouth of the case crimped into the cannelure of the bullet. For caliber .30 carbine and caliber .45 cartridges, the mouth of the case is not crimped to the bullet but is held in place by the tight fit in the case. In some revolver cartridges, a cannelure in the case prevents the bullet from being seated too deeply.

9-10. PROPELLANT SPACE. Propellant space is the total inside volume of the case with the bullet seated. Propellant space is important in the design of the cartridge because it determines the maximum quantity of propellant that may be used. The pressure of the expanding gases resulting from the burning of the propellant is dependent upon this volume. The manner in which the propellant burns is influenced by any empty space left in the case after the charge is loaded. Shotgun cartridges differ as to propellant space, depending upon specific kind or formula of propellants used. The wad and construction of the base of these cartridges are regulated in manufacture so that there may be space left in the case.

9-11. HEADSPACE. The term headspace is defined as the linear distance from the face of the fully closed bolt of a weapon to one of several different reference points, depending upon the gun chamber design.

9-12. For rimless, bottleneck cartridges, such as 5.56 millimeter, caliber .30, caliber .50, and 7.62 millimeter, headspace is the distance from the shoulder of the chamber against which the shoulder of the cartridge case rests to the face of the closed bolt.

9-13. For other rimless cartridges, such as caliber .30 carbine and caliber .45, headspace is the distance from the shoulder of the chamber against which the

neck of the case rests to the face of the closed bolt. It is thus very nearly equal to the length of the cartridge case.

9-14. For rimfire, rimmed, and semirimmed centerfire cartridges, such as caliber .22, caliber .38, and shorgun cartridges, the extractor rim of the case stops the forward motion of the cartridge. Therefore, headspace is equal to the distance from the rear face of the chamber to the face of the closed bolt. This is very nearly equal to the thickness of the extractor rim.

9-15. PRIMER. A primer is an assembly which ignites the propellant. The primer assembly of centerfire cartridges consists of a brass or gilding-metal cup that contains a primer composition pellet of sensitive explosive, a paper disk (foil), and a brass anvil. A blow from the firing pin of a small-arms weapon on the center of the primer cup compresses the primer composition violently between the cup and the anvil, thus causing the composition to explode. The holes or vents in the anvil allow the flame to pass through the primer vent in the cartridge case, thereby igniting the propellant. The primer composition in the cup is held in place and protected from moisture and electrolytic action by a paper disk. The brass anvil is inserted last. Primers of the noncorrosive type are now being used in the manufacture of small-arms ammunition. In order that primers may function properly, they must be free from such surface defects as folds, wrinkles, scratches, scales, or dents. Other primer defects in cartridges are cocked, broken, or inverted anvils; scratched, torn, or dirty cups; and missing anvils, disks, or pellets. Rimfire ammunition, such as the caliber .22 cartridge, does not contain a primer assembly; the primer composition is spun into the rim of the cartridge case and the propellant is in intimate contact with the composition. In firing, the pin strikes the rim of the case and thus compresses the primer composition and initiates its explosion. Figure 9-9 shows primer components separated and figure 9-10 shows details of several primers.

9-16. PROPELLANT. The propellant is a low explosive substance of fine granulation which, through burning, produces gases at a controlled rate to provide the energy necessary to propel a bullet or missile. There are two types of small-arms propellants generally used, the single-base (nitrocellulose) type and the double-base (nitrocellulose and nitroglycerin) type. The weight of the propellant charge and granulation of the propellant of a particular composition are in accordance with specification requirements. The weight of the propellant charge is not constant; this weight is adjusted for each propellant lot to give the required muzzle velocity with the associated

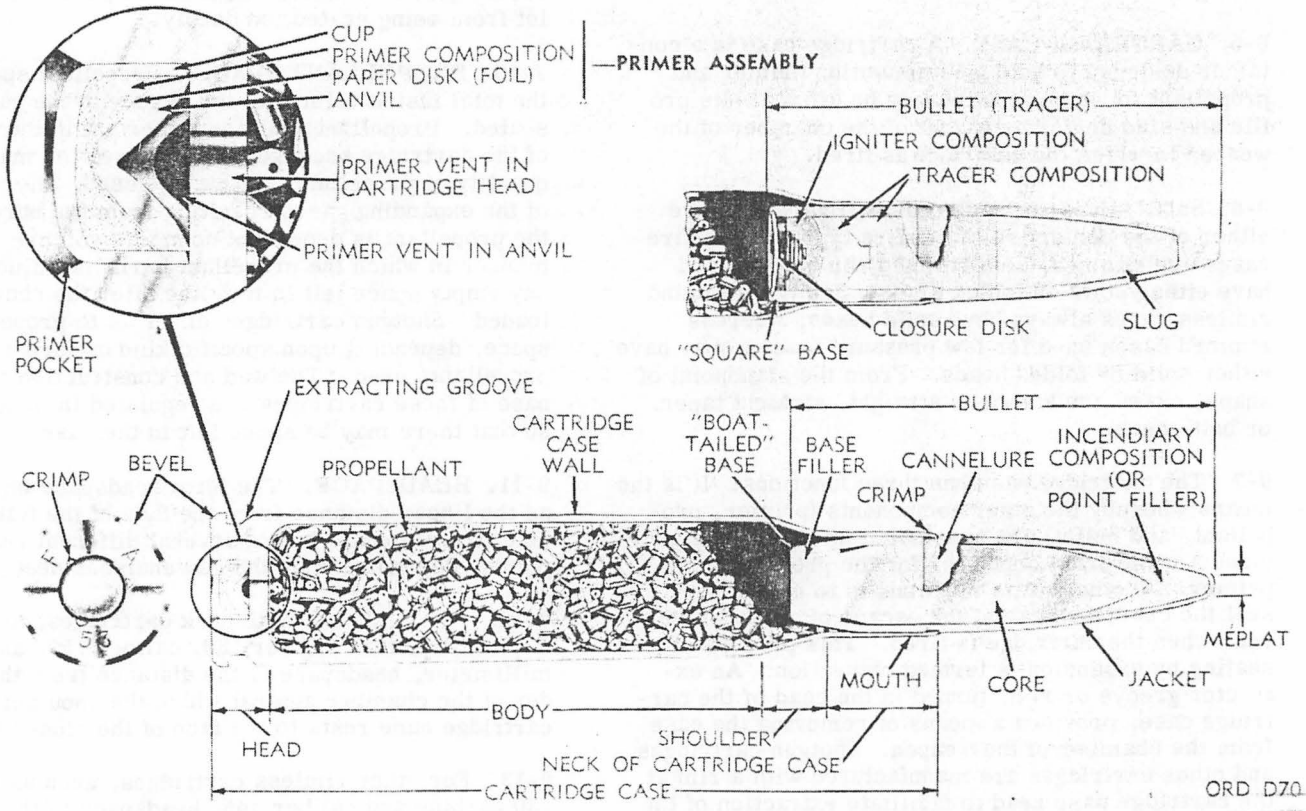


Figure 9-1. Small Arms Cartridge Components and Terminology

chamber pressure within the limits prescribed for the weapon in which it is fired. The charge is assembled loosely in the cartridge case. Small-arms propellants are manufactured in the form of small flakes, pellets, sheets, spherical (ball) grains, or perforated tabular grains. Acceptance requirements for small-arms propellants are outlined in Military Specifications MIL-P-3984. Since the propellant grains of these charges are small, they are subject to more rapid deterioration than larger grains under abnormal temperature conditions. Small-arms propellants are not as sensitive to friction as black powder. Black powder is not used as a basic charge for small-arms ammunition. Its only use in small-arms ammunition at the present time is as an ingredient in manufacturing Lesmok powder for use as a propellant in caliber .22 cartridges, blank cartridges, and to facilitate ignition in grenade cartridges.

9-17. BULLET. A bullet is a projectile fired, or intended to be fired from a small-arms weapon. Two types of bullets are described in this section: the lead bullet and the metal jacketed bullet. Lead bullets were originally manufactured in the shape of a ball, but with the advent of rifling in weapons, this ball was replaced by a cylindrically shaped lead bullet which would engage the rifling. Lead balls or shot are still used in shotgun cartridges. Lead cylindrical bullets of modern design are used in caliber .22 ammunition and in many revolver cartridges. Modern military cartridges and pistol cartridges have bullets which consist of metal jackets surrounding the lead alloy or steel core. The two types of bullets are described as follows:

a. Lead Alloy Bullets. The lead used in this type bullet is combined with tin, antimony, or both, for hardness. This alloying reduces leading of the barrel of the weapon, that is, the tendency of the lead to

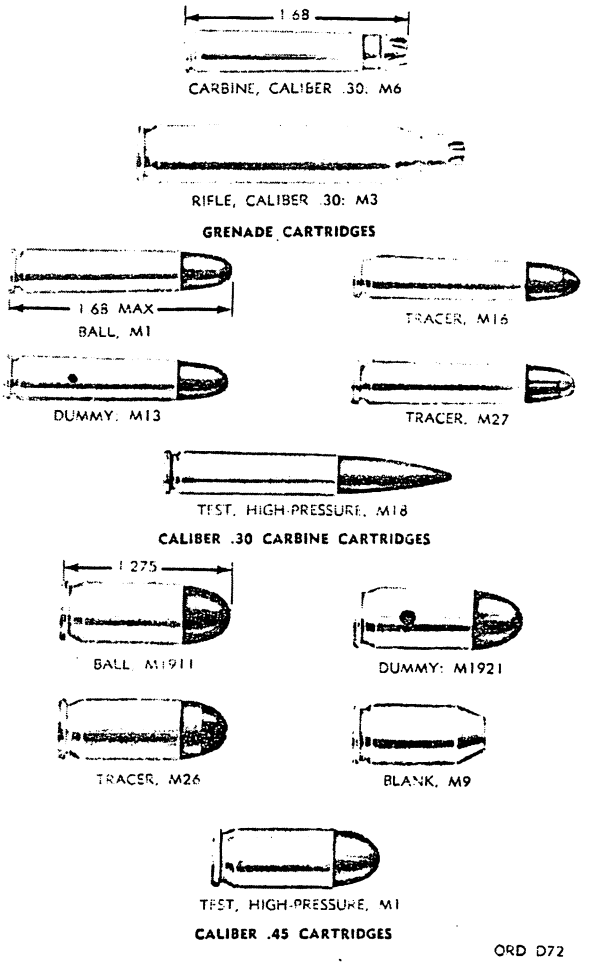


Figure 9-2. Rifle Grenade Cartridges, Carbine Cartridges, and Caliber .45 Cartridges

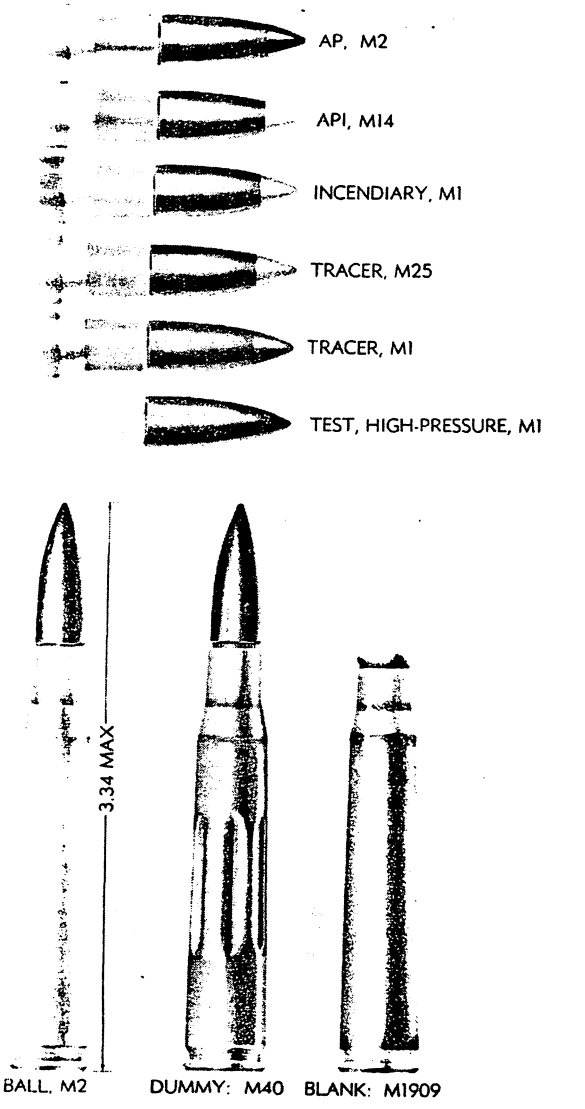


Figure 9-3. Caliber .30 Cartridges

adhere to the barrel in patches. It also helps to prevent the bullet from stripping, that is, jumping the rifling of the weapon. Lead bullets are generally lubricated with a grease or lubricating compound which further prevents leading of the barrel. Two or more cannelures, or grooves, around the bullet contain the lubricant. Outside lubricated bullets, like the caliber .22 and calibers .38 and .45 wadcutters have cannelures and lubricant on the outside when the bullet is assembled in its cartridge case. The cannelures and lubricant of inside lubricated bullets are beneath the neck of the cartridge case and, hence, are not visible in the assembled cartridge.

b. Jacketed Bullets. Jacketed bullets have a lead or steel core covered by an outside jacket of gilding metal or gilding-metal-clad steel and are used to obtain high velocities since lead bullets are not suited for this purpose. Metal-jacketed bullets are used in automatic pistols since lead bullets may be damaged by the loading mechanism. A cannelure may be cut or rolled in the jacket to provide a recess into which the mouth of the case may be crimped at assembly. The cannelure also serves to hold the jacket and core together more firmly. An extra cannelure may be added to identify the bullets prior to assembly.

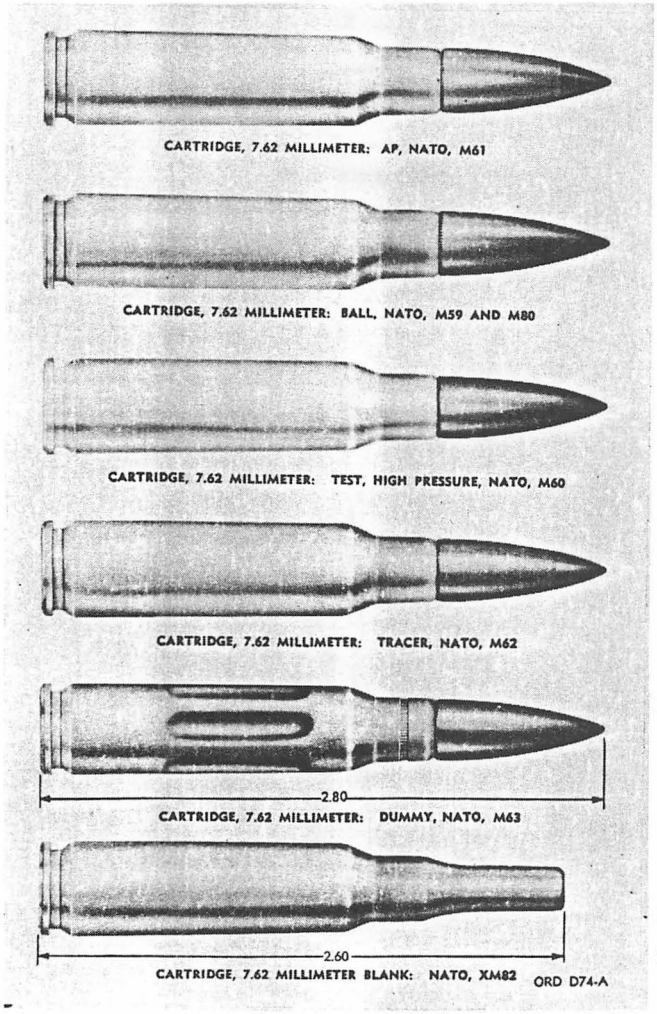


Figure 9-4. Cartridges, 7.62-Millimeter

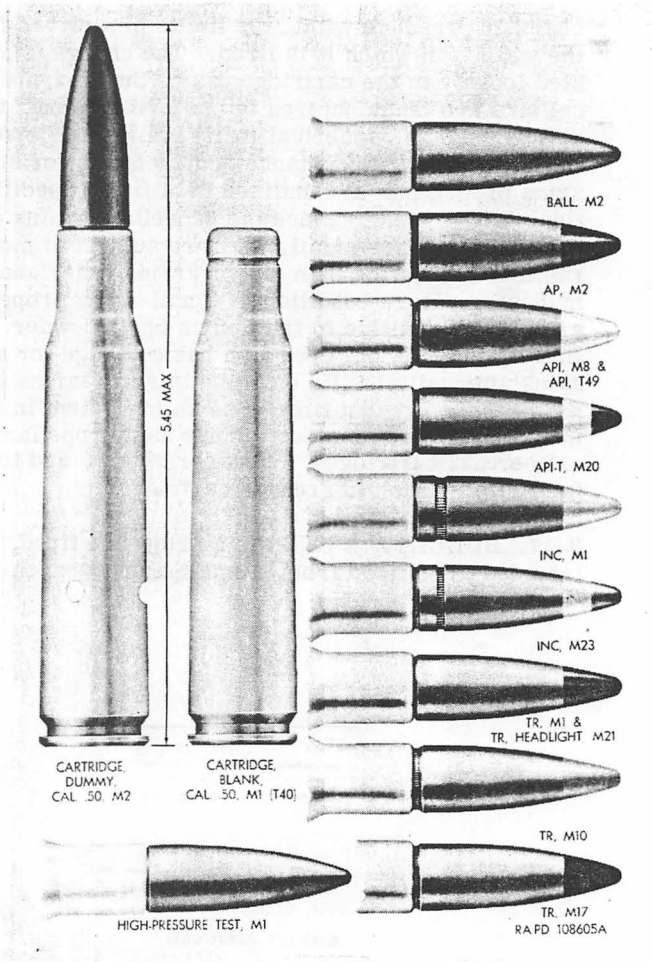


Figure 9-5. Caliber .50 Cartridges

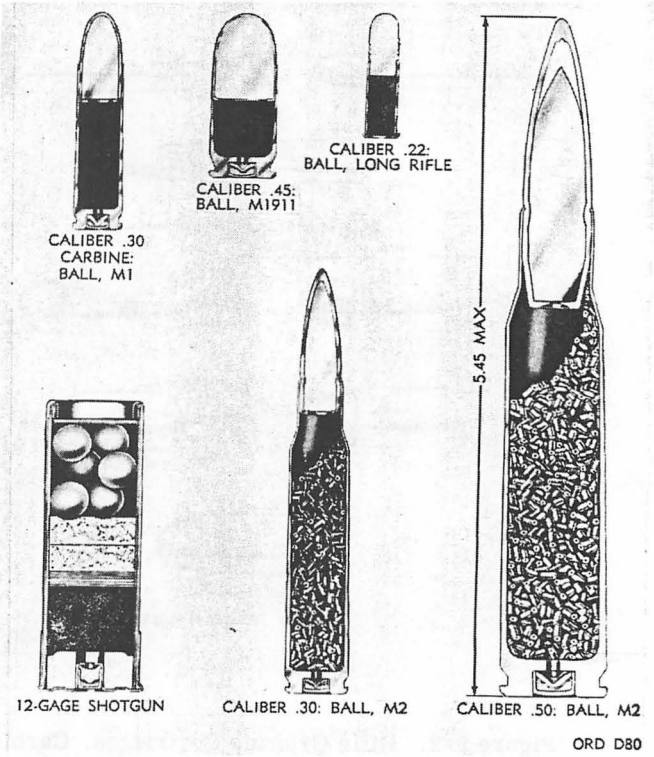


Figure 9-6. Types of Cartridges - Sectioned

9-18. The body of the bullet is cylindrical. The nose may be round, as in the carbine, pistol, and revolver bullets, or ogival (curved taper) as in service rifle and machinegun bullets. The length of ogvie or taper for caliber .30 and caliber .50 bullets is approximately 2-1/2 times the bullet diameter. The base may be square (cylindrical) or boattailed (having a conical taper). A special type of bullet is the wadcutter, or midrange, which has a cylindrical body and a blunt nose with a sharp edge in order that it may cut the target cleanly. The wadcutter bullets are currently used in the caliber .38 special and caliber .45 for competition only.

9-19. SHOT. Shot is a mass or load of numerous, relatively small, lead pellets used in a shotgun cartridge, referred to as birdshot or buckshot. Shotgun

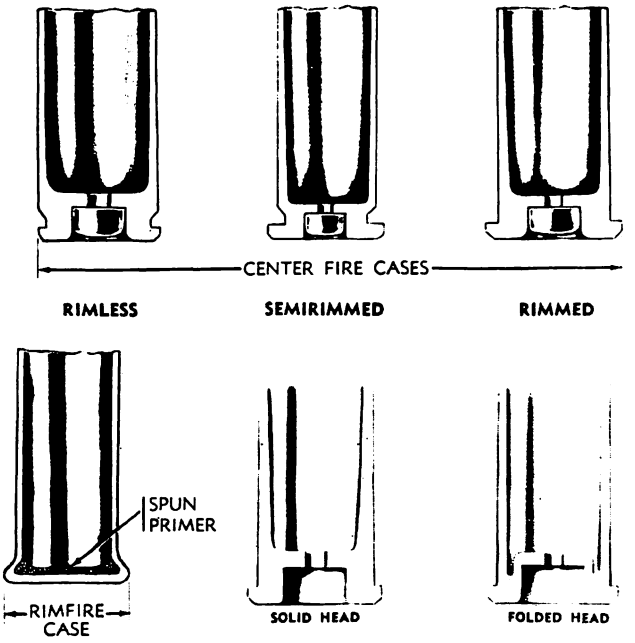


Figure 9-7. Types of Cartridge Cases

cartridges contain a charge of small pellets or shot instead of a single bullet with the exception of the 10-gage blank cartridge.

9-20. Shotgun cartridges are identified as to size by gage. The gage of a shotgun refers to the number of lead balls or shot of the diameter of the bore required to weigh 1 pound. The .410-gage shotgun is an exception in that the diameter of the bore is 0.410-inch. The bore of a 12-gage shotgun measures 0.729-inch in diameter, thus 12 balls or pellets of 0.729-inch would weigh one pound. Refer to figure 9-31 for gage used in shotgun cartridges.

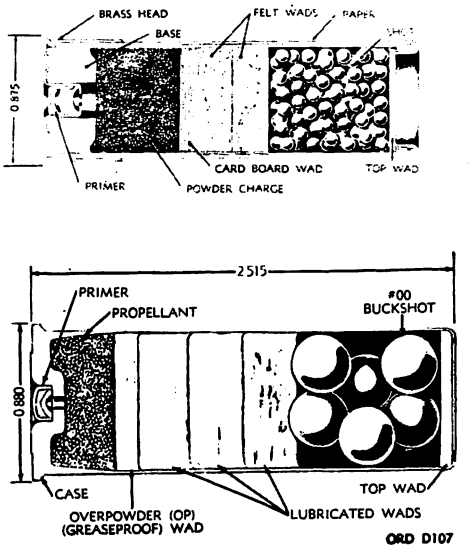


Figure 9-8. Typical Shotgun Shells - Sectioned

9-21. Shot is classed as soft or drop shot if it is made of lead and as chilled shot if it is made of the harder lead-antimony alloy.

9-22. CALIBER. The caliber of a weapon is the diameter of the bore of the weapon measured from the surface of one land to the surface of the land directly opposite. Caliber is usually expressed in inches or in millimeters. When expressed as a decimal without an indication of the unit, the unit inches is understood. For example, a caliber .30 cartridge has a bullet which is about 0.3085-inch in diameter. The lands of the rifling of a weapon are the raised spiral portions of the rifling formed by cutting spiral grooves, generally 0.003- or 0.004-inch deep, into the surface of the bore. The diameter of a lead alloy bullet is generally 0.003-inch greater than the bore diameter between grooves. The diameter of a jacketed bullet generally should not be more than 0.001-inch greater than the diameter between grooves. Bullet diameters for cartridges described in this section are listed in figure 9-32.

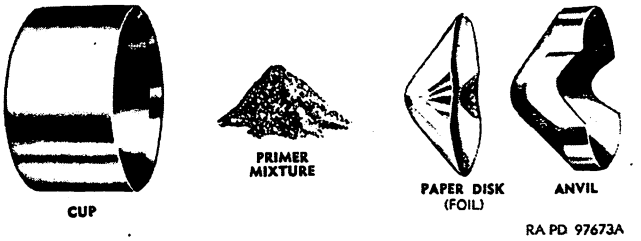


Figure 9-9. Components of Primers - Separated

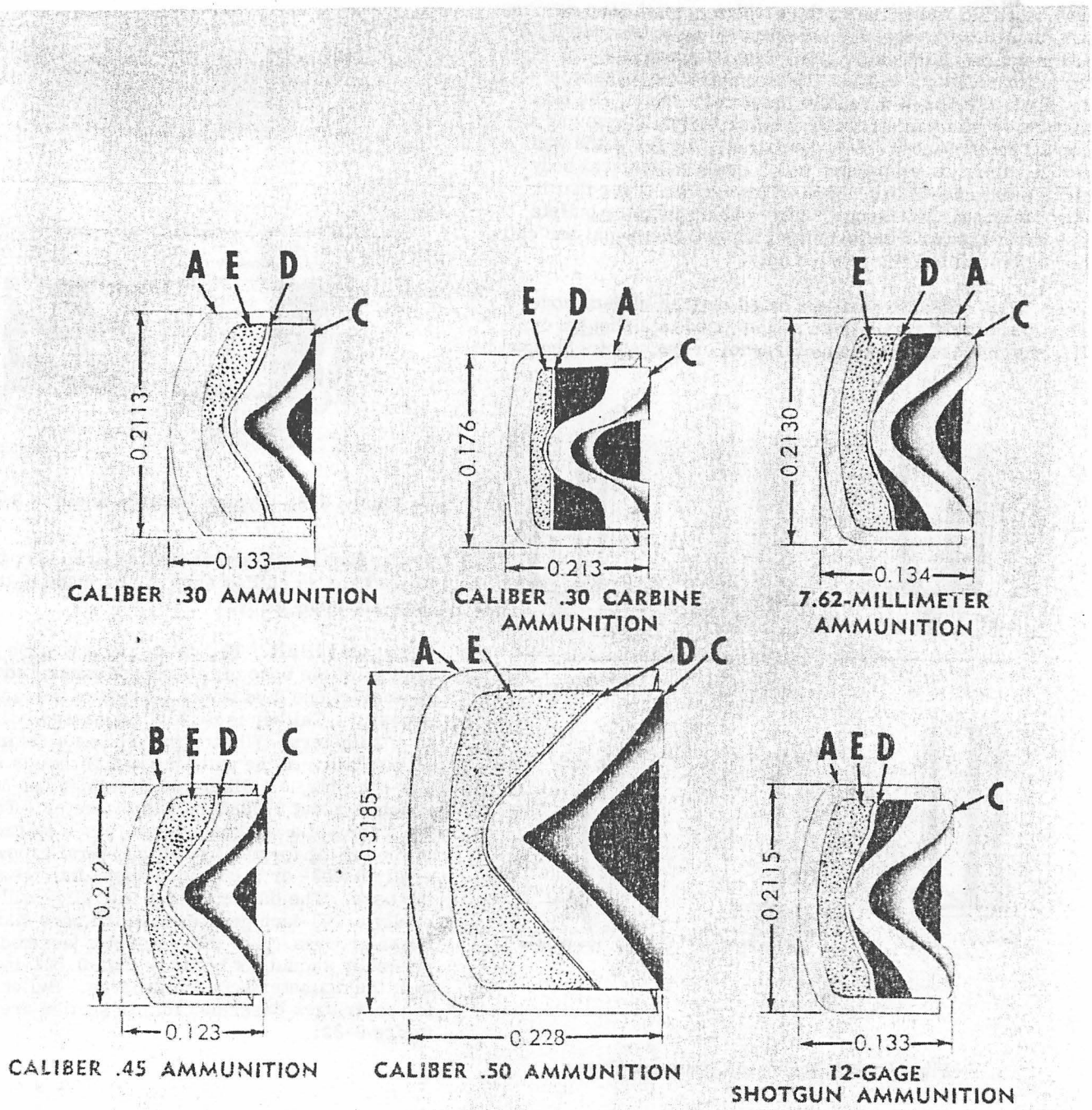


Figure 9-10. Primers - Sectioned

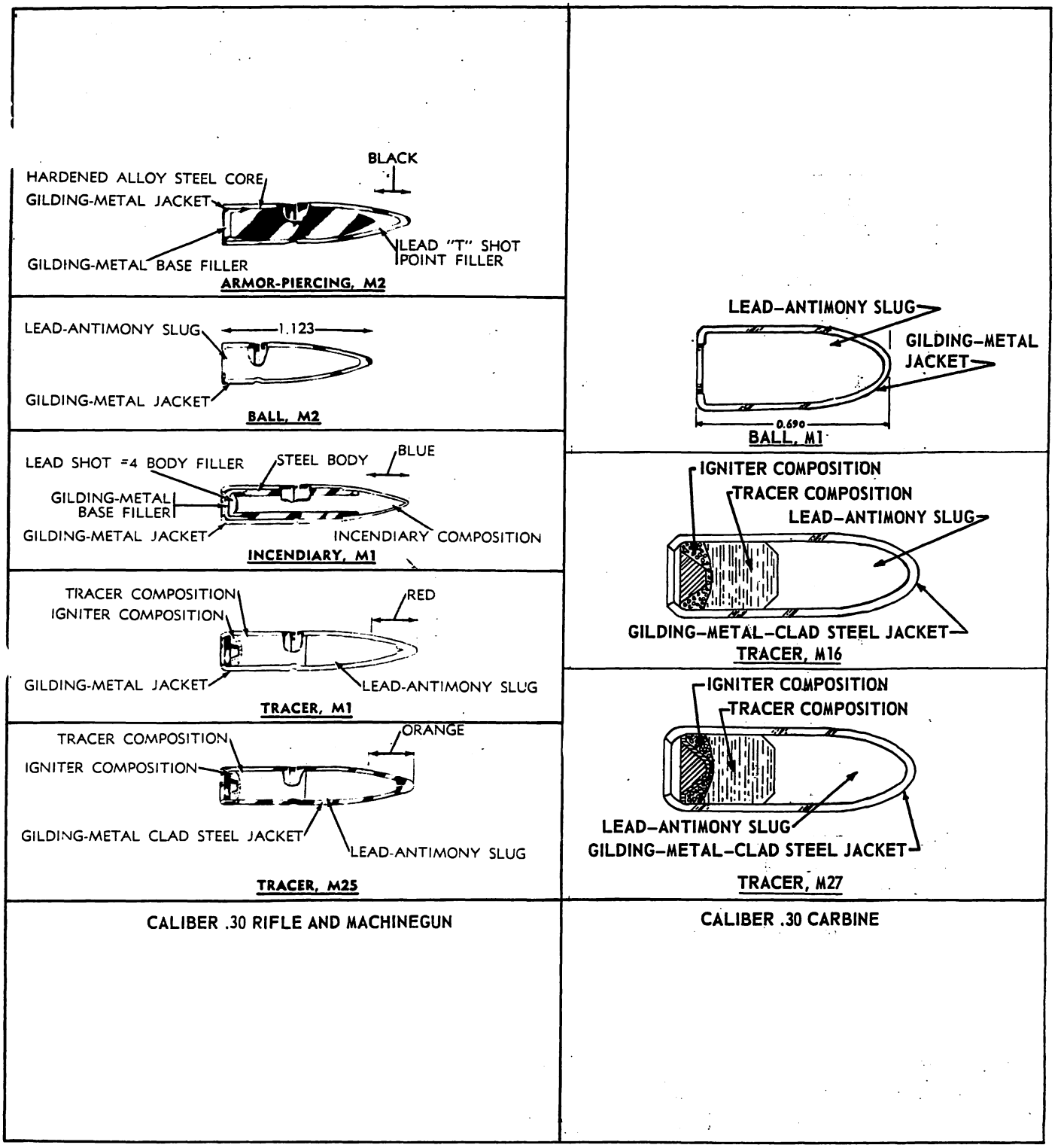
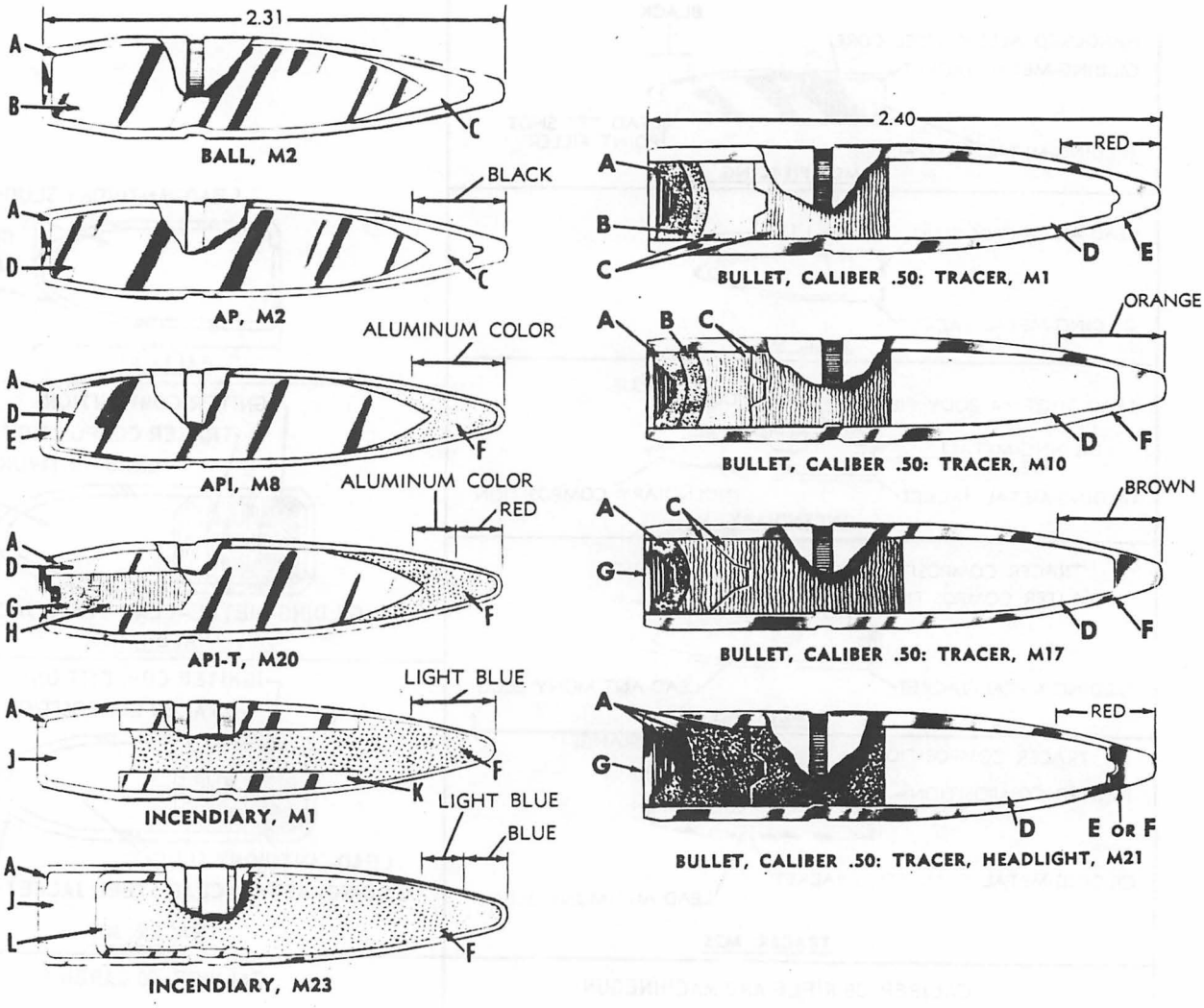


Figure 9-11. Caliber .30 Bullets - Sectioned



A—GILDING-METAL JACKET
B—STEEL CORE
C—LEAD-ANTIMONY POINT FILLER
D—HARDENED ALLOY STEEL CORE
E—LEAD-ANTIMONY BASE FILLER
F—INCENDIARY MIXTURE

G—IGNITER COMPOSITION
H—TRACER
J—LEAD-ANTIMONY SLUG
K—STEEL BODY
L—GILDING-METAL-CLAD STEEL CONTAINER

A—IGNITER COMPOSITION
B—SUB-IGNITER COMPOSITION
C—TRACER COMPOSITION
D—LEAD-ANTIMONY SLUG
E—GILDING-METAL JACKET
F—GILDING-METAL-CLAD STEEL JACKET
G—GILDING-METAL CLOSURE

Figure 9-12. Caliber .50 Bullets - Sectioned

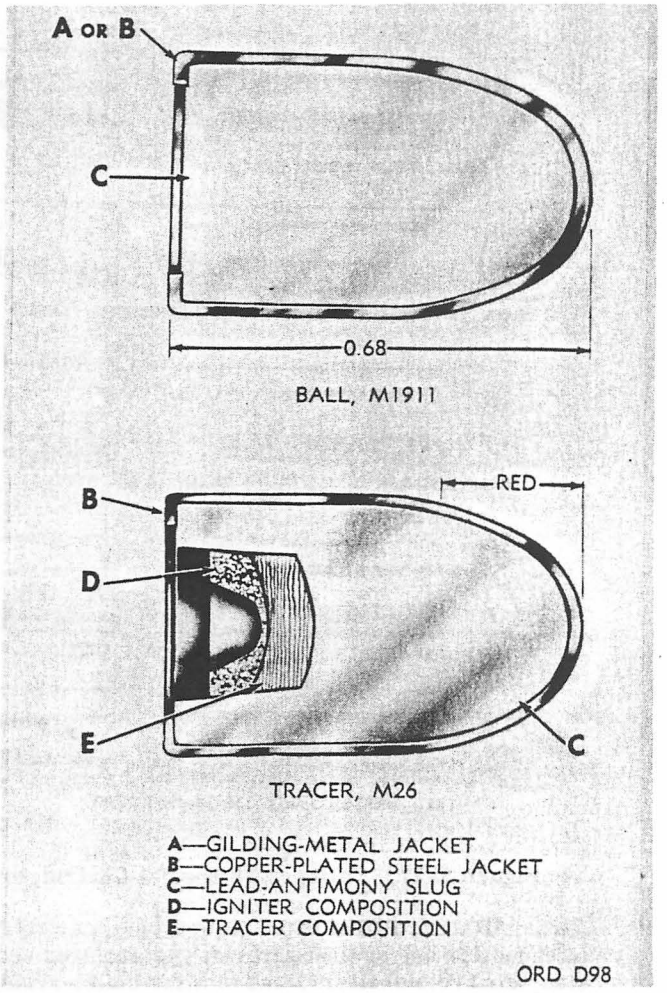


Figure 9-13. Caliber .45 Bullets - Sectioned

9-23. CLASSIFICATION.

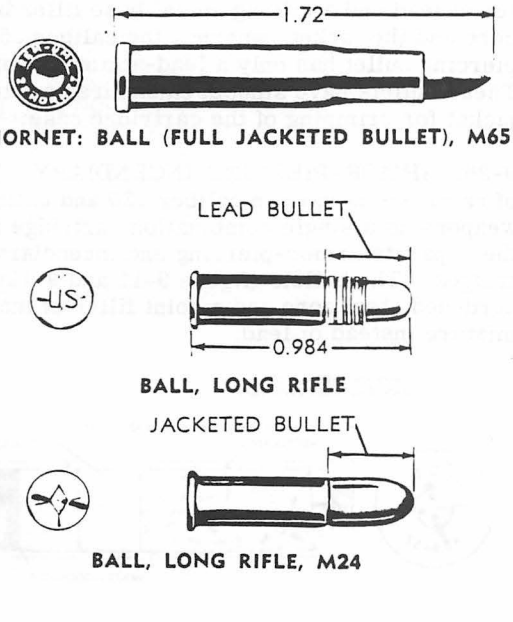
9-24. Depending upon its purpose, small-arms cartridges are classified according to type as follows:

a. Combat (service)

(1) Armor-piercing
(2) Armor-piercing-incendiary
(3) Armor-piercing-incendiary-tracer
(4) Ball
(5) Ball, hornet
(6) Grenade cartridges
(7) Incendiary
(8) Shotgun cartridge
(9) Spotter-tracer
(10) Tracer

b. Noncombat (special)

(1) Blank
(2) Dummy
(3) Miscellaneous
(4) High-pressure test
(5) Match
(6) Practice
(7) Shotgun cartridge



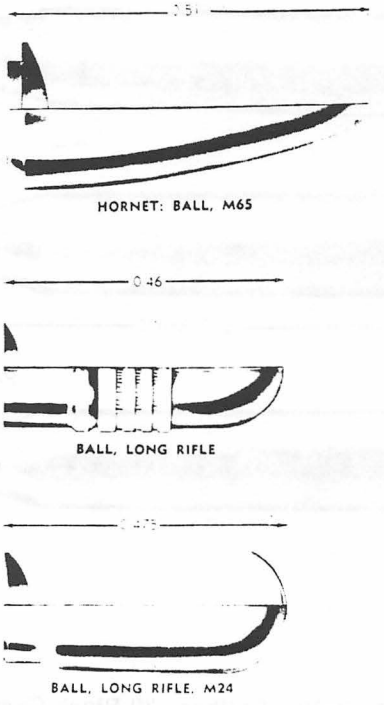


Figure 9-14. Caliber .22 Cartridges

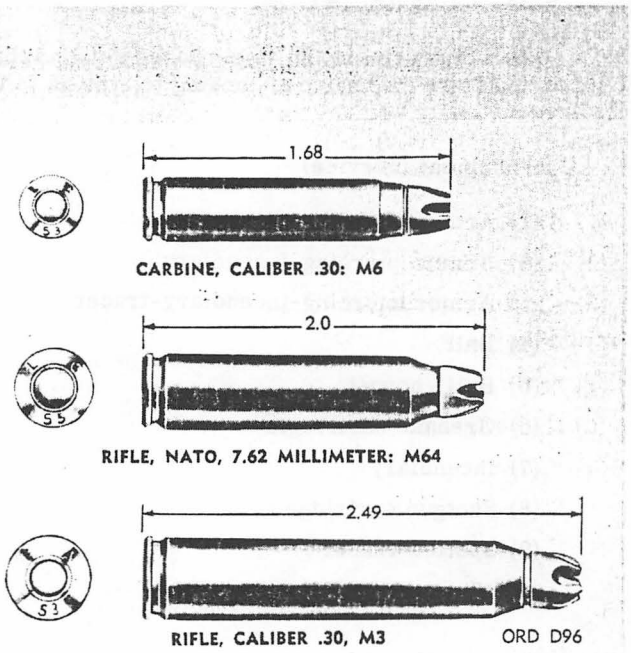


Figure 9-15. Caliber .30 and 7.62-Millimeter Grenade Cartridges

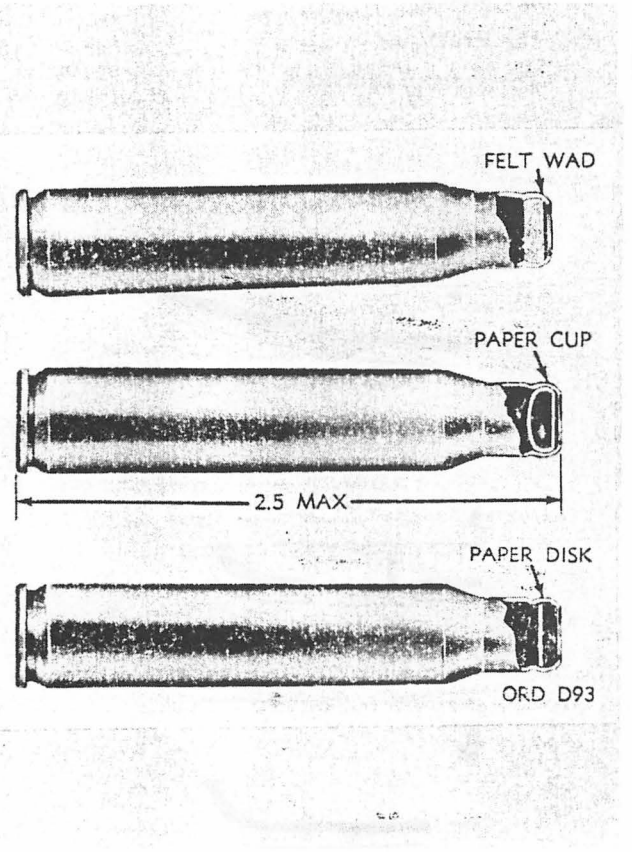


Figure 9-16. Caliber .30 Blank Cartridge, M1909

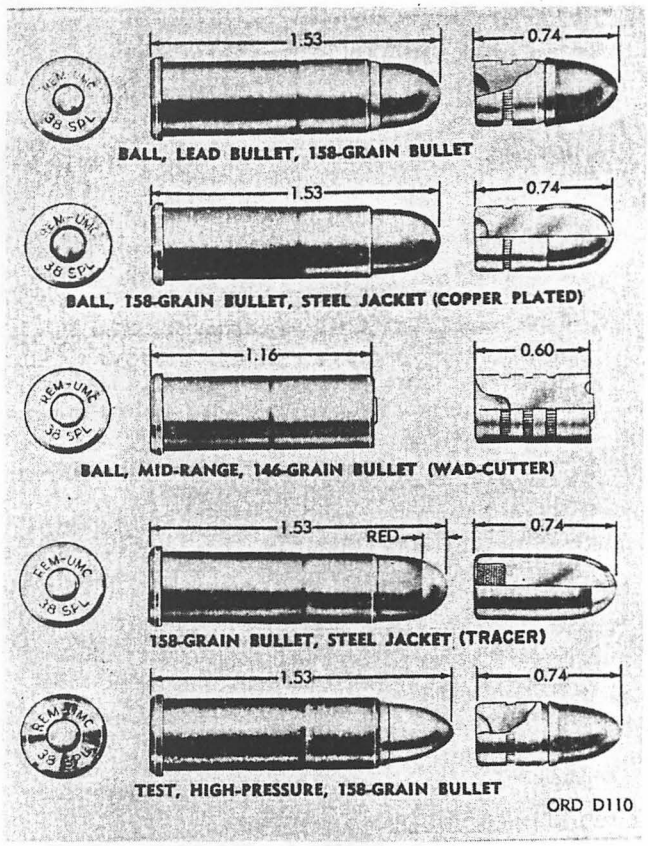


Figure 9-17. Caliber .38 Special Cartridges

9-25. ARMOR-PIERCING. This type of cartridge is intended for use against aircraft and armored vehicles, concrete shelters, and similar bullet-resisting targets. Armor-piercing bullets are jacketed and have a core of hardened steel (figure 9-11 and 9-12), which may be made of tungsten-chromium or manganese-molybdenum steel. The 7.62-MM AP bullet has both a point and base filler of lead-antimony. The caliber .30 armor-piercing bullet has a point filler of lead and a gilding-metal base filler between the core and the jacket, whereas the caliber .50 armor-piercing bullet has only a lead-antimony point filler. These bullets have smooth cannelures cut into the jacket for crimping of the cartridge case.

9-26. ARMOR-PIERCING-INCENDIARY. This type of cartridge is used in caliber .30 and caliber .50 weapons as a single combination cartridge in lieu of the separate armor-piercing and incendiary cartridges. The bullets (figure 9-11 and 9-12) have a hardened steel core and a point filler of incendiary mixture instead of lead.

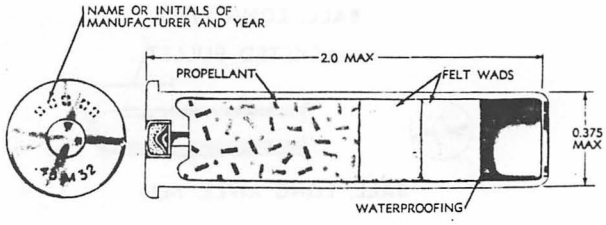


Figure 9-18. Caliber .45, Line Throwing Blank

9-27. ARMOR-PIERCING-INCENDIARY-TRACER. This type of cartridge is used in caliber .50 weapons. The bullets are similar to the armor-piercing-incendiary bullets (figure 9-12) but in addition, have a tracer composition in the base end.

9-28. BALL. This type of cartridge, intended for use against personnel and light material targets, is the oldest service type. It has been replaced for combat purposes, however, by armor-piercing and other types. The term ball, which long since ceased accurately to describe the shape of the modern bullet, has been continued in use to designate that type of bullet and ammunition used for the same purposes as ammunition of very early design, the bullet of which was actually a ball. Ball bullets are of the lead alloy or the metal-jacketed type. The metal-jacketed ball bullets (figure 9-6 and 9-13) have cores or slugs of various compositions, depending on the intended use. Most metal-jacketed ball bullets have a lead-antimony slug. The caliber .50 ball bullet is a metal-jacketed bullet containing a soft steel core with a lead-antimony point filler to ensure similar ballistic properties for ball and armor-piercing cartridges when used in functional packs. The 7.62-MM ball bullet of the cartridge, M59, is a gilding-metal jacketed bullet containing a core of plain carbon steel with a lead-antimony point and base filler.

9-29. BALL, HORNET. This type of cartridge (figure 9-14) is authorized for use in caliber .22 survival rifle M4 and in the upper barrel of caliber .22/.410 gage survival rifle-shotgun M6 and is designed for shooting game for food purposes. It has the conventional 45-grain full-jacketed bullet, M65. Some rounds with the M39 soft point bullet may still be in the field. The M39 is being replaced by the M65 full-jacketed bullet.

9-30. GRENADE. Grenade cartridges (figure 9-15) are special blank cartridges designed for use in propelling grenades and ground signals from launchers attached to rifles or carbines. Rifle grenade cartridges and carbine grenade cartridges are distinguished by a rose-petal crimp at the mouth of the case. The carbine grenade cartridge is no longer used for launching grenades but is authorized for blank fire for training purposes. The 5.56-millimeter grenade cartridge is under procurement.

9-31. INCENDIARY. This type of cartridge is similar to ball or armor-piercing ammunition in outward appearance. It is used for incendiary purposes against aircraft and flammable targets. The bullets contain a mixture (figure 9-11 and 9-12) with a lead-antimony slug at the base end. A hollow steel cylindrical body or a clad steel container may be inserted within the jacket and in front of the base slug. The

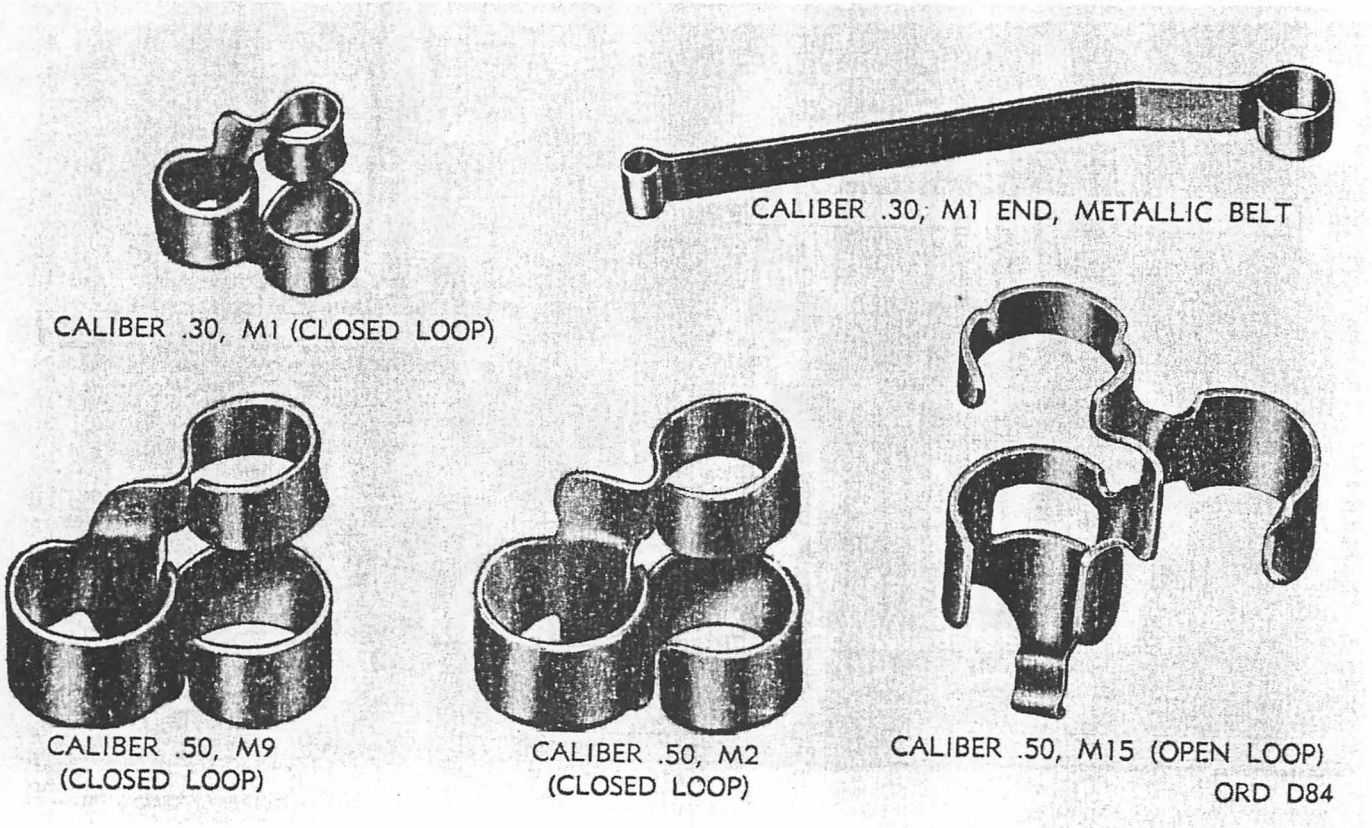


Figure 9-19. Cartridge Links and Metallic Belt End

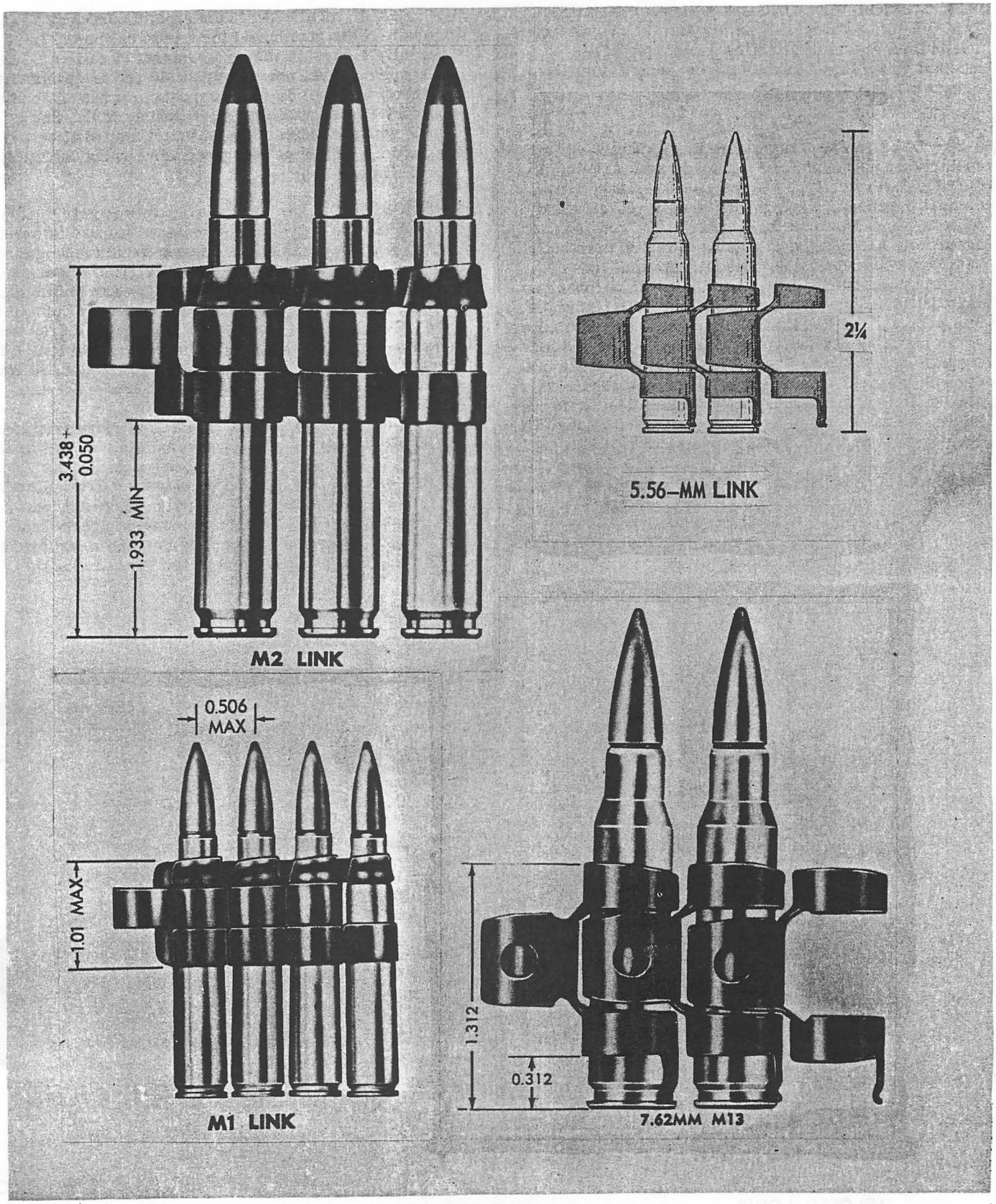


Figure 9-20. Link Cartridges, with Caliber .30, 7.62-Millimeter, and Caliber .50 Ammunition

9-32. SHOTGUN AMMUNITION. Shotgun cartridges (figure 9-8) consist of a brass or steel head, a primer, a paper, plastic, or metal body, a propelling charge, cardboard or felt wads, a load of lead shot, and a closing wad. The paper cases or bodies are waterproofed.

9-33. SPOTTER TRACER. The M48 spotter-tracer bullets contain a tracer element and an incendiary charge which give off a puff of smoke and a flash on impact with the target.

9-34. TRACER. This type of cartridge (figures 9-11, 9-12, and 9-13) is intended for use with other types to show the gunner, by its trace, the path of the bullets, thus assisting in correcting aim. It may also be used for incendiary purposes. The bullets contain a lead-antimony slug in the forward position and a tracer composition in the rear. They have either square or boattailed bases. The bullet jackets are made of gilding-metal or gilding-metal-clad steel. An igniter composition is also present, which is ignited by the burning propellant gases which, in turn, ignites the tracer composition. Some tracer bullets are visible the instant of firing while others have a dim trace for a short distance from the muzzle of the gun and then a bright trace thereafter.

9-35. BLANK. This type of cartridge (figure 9-16) is distinguished by the absence of a bullet. It is used for simulated fire, in maneuvers, and in firing salutes. It is also used in machine guns equipped with blank firing attachments in order to operate these weapons for instructional purposes. EC blank fire propellant is used to produce the noise.

9-36. DUMMY. This type of cartridge is used for practice in loading weapons, to detect flinching of

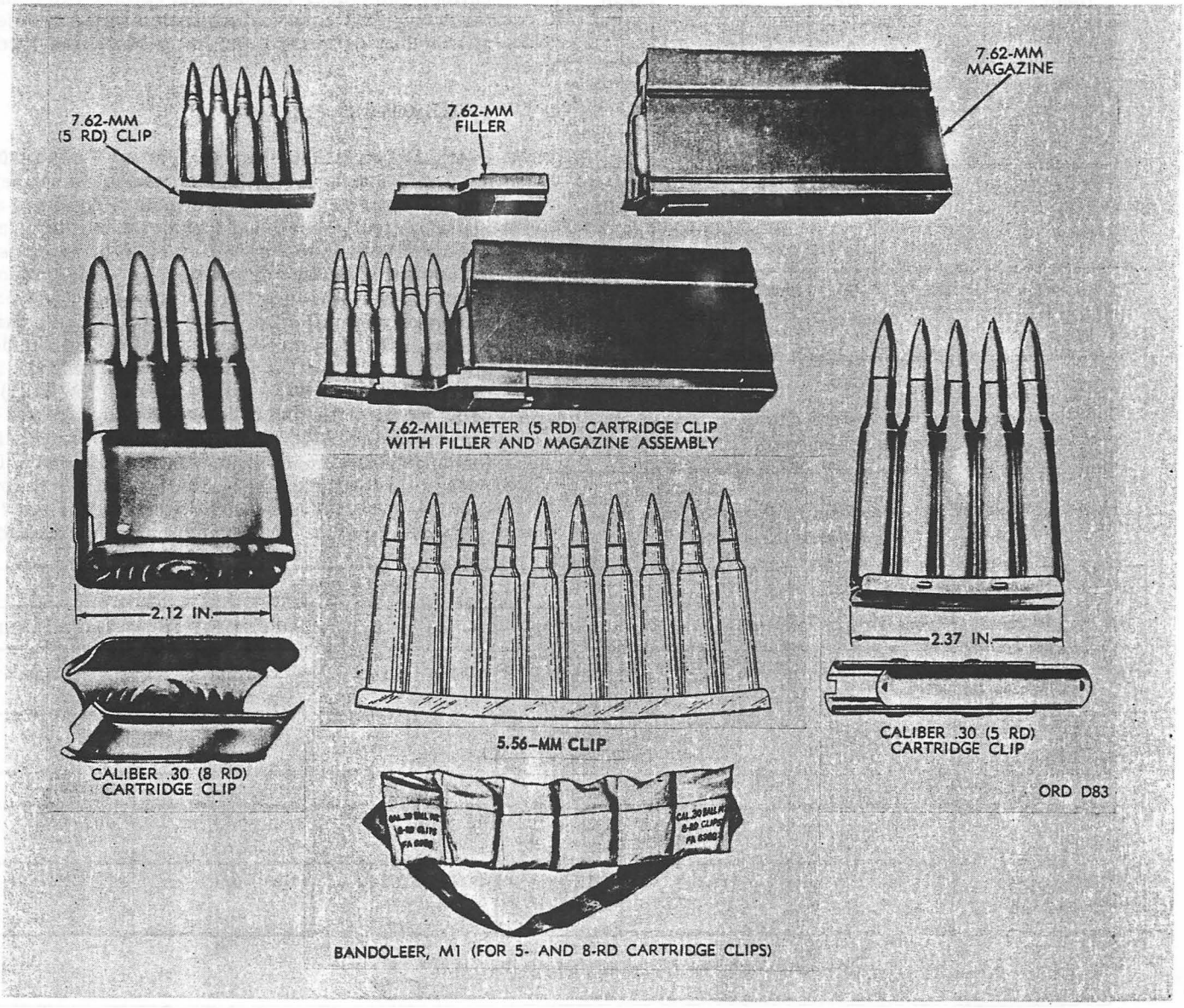


Figure 9-21. Bandoleer, Magazine, Filler, Clips

personnel in firing weapons, and to simulate firing. The cartridge case of older lots of dummy ammunition is tin-coated but the current method of identification is by means of holes through the side of the case and by the empty primer pocket. The ammunition is completely inert but simulates service ammunition in sufficient detail to meet drill requirements. presence of two knurled cannelures is a characteristic of caliber .50 incendiary bullets.

9-37. HIGH PRESSURE TEST. This type of ammunition is manufactured to produce pressures substantially in excess of the specification pressure of the corresponding service items. It is used for proof-firing of weapons at place of manufacture, test, and repair. Due to the excessive pressures developed by this type of ammunition and the consequent danger involved in firing, the weapons under test are fired only by authorized personnel from fixed rests under hoods by means of mechanical firing devices.

Cartridge	Cartridge Case	Propellant	Bullet	
			Jacket	Slug
Long rifle (lead bullet).[1]	Brass[2]..	Smokeless or Lesmok A.	.....	Lead or lead alloy.
Long rifle, M24.[1]	Brass[2]..	Smokeless or Western Ball	Gilding metal.	Lead-antimony.
Long rifle, (commercial).[1]	Brass...	Smokeless	Gilding metal or lead.	Lead or lead alloy.
Hornet, ball, M65.[3]	Brass...	Western Ball	Gilding metal.	Lead-antimony.

[1] Rimfire type primer.
[2] Cartridges may have steel cases.
[3] Commercial centerfire primer.

Figure 9-22. Component Parts of Caliber .22 Ammunition

9-38. MATCH. This cartridge is procured from various manufacturers for use in all rifles, revolvers, pistols, for competition in marksmanship. The bullet is more exacting in standards than regular rounds.

9-39. MISCELLANEOUS SMALL ARMS CARTRIDGES. These cartridges (figures 9-17 and 9-18) consist of various types and calibers used for special or auxiliary purposes. They include caliber .38 special cartridges for use by aircrew and Air Police personnel, caliber .38 tracer rounds, and caliber .45 blank line-throwing cartridges for use with a special projectile attached to a standard line in the Navy line-throwing gun.

9-40. ACCESSORIES.

9-41. Metallic belt links (figures 9-19 and 9-20) are used with 5.56- and 7.62-millimeter and calibers .30 and .50 cartridges in machineguns. The links are made of steel, processed for rust prevention, and are required to meet specific test requirements to assure satisfactory ammunition feed and functioning under all service conditions. A metallic belt end is attached to metallic link belts of caliber .30 cartridges packed in metal boxes for ground machineguns use. The belt end facilitates starting the belt of cartridges through the gun. Clips (figure 9-21) are provided for rifle and carbine cartridges; the 5-round clip for rifles M1903 and M1917, the 9-round clip (nonexpendable in peacetime) for the rifle M1, the 10-round clip for the caliber .30 carbine, the 8-round clip for the 5.56- and the 5-round clip for the 7.62-millimeter rifles. Filler and magazine assemblies

Cartridge	Cart Case	Propellant	BULLET			
			Jacket	Core or Slug	Point Filler	Base Filler
Ball M193	Brass	Western ball	Gilding metal	lead alloy	None	None
Tracer XM196	Brass		Gilding metal			
Grenade	Brass		None	None	None	None
Blank XM200	Brass		None	None	None	None
Dummy XM199	Brass	inert	Gilding metal	lead alloy	None	None
Information to complete table will be furnished when available.						

Figure 9-23. Component Parts of 5.56-Millimeter Ammunition

Cartridge	Cartridge Case	Propellant	BULLET		
			Jacket	(Slug)	Base Filler
Ball, M1	Brass or steel.	Ball or Hercules Flake.	Gilding-metal or Gilding-metal clad steel.	Lead-antimony.	
Dummy, M13.	Brass or steel.	.....	Gilding-metal or Gilding-metal-clad steel.	Lead-antimony.	
High-pressure test, M18.	Brass	Ball or Hercules Flake.	Gilding-metal-clad steel.	Lead-antimony.	
Tracer, M16.	Brass	Ball or Hercules Flake.	Gilding-metal-clad steel.	Lead-antimony.	Tracer and igniter composition.
Tracer, M27.	Brass	Ball or Hercules Flake.	Gilding-metal-clad steel.	Lead-antimony.	Tracer and igniter composition.

Figure 9-24. Component Parts of Caliber .30 Carbine Ammunition (Centerfire Primers are used in all Cartridges)

Cartridge	Cartridge Case	Propellant	BULLET			
			Jacket	Core or Slug	Point Filler	Base Filler
AP, M2	Brass	Smokeless	Gilding-metal	Steel	Lead T-shot	Gilding-metal
API, M14	Brass	Smokeless	Gilding-metal	Steel	Incendiary composition.	Lead-antimony.
Ball, M2	Brass or steel.	Smokeless	Gilding-metal or gilding-metal-clad steel.	Lead-antimony.		
Match, M72	Brass	Smokeless	Gilding-metal	Lead-antimony.		
Blank M1909	Brass or steel.	EC blank.				
Dummy, M40	Brass or steel.	None	Gilding-metal clad-steel.			
HPT, M1	Brass	Smokeless	Gilding-metal or steel.	Lead-antimony.		
Incendiary, M1.	Brass	Smokeless	Gilding-metal	Lead-shot No. 4 body filler.	Incendiary composition.	Gilding-metal.
Tracer, M1	Brass	Smokeless	Gilding-metal or steel.	Lead-antimony.		Tracer and igniter-comp.
Tracer, M25	Brass	Smokeless	Gilding-metal-clad steel.	Lead-antimony.		Tracer and igniter-comp.

Figure 9-25. Component Parts of Caliber .30 Ammunition (Corrosive and Noncorrosive Primers Have Been Used in all Cartridges Listed)

are available for the 5.56- and 7.62- millimeter rifles.

9-42. CARE AND PRECAUTIONS IN HANDLING.

9-43. Small arms ammunition is comparatively safe to handle. However, care must be taken to prevent ammunition boxes from becoming broken or damaged. Broken boxes must be repaired immediately and careful attention given to the transfer of all markings to the new parts of the box. Metal liners and metal cans should be sealed and air-tested if equipment for this work is available.

9-44. AMMUNITION PROTECTION. Cartridges should be carefully protected from mud, sand, dirt, and water. If they get wet or dirty, they should be wiped off at once. If light corrosion or verdigris forms on cartridges, it should be wiped off. However, cartridges should not be polished merely to make them look brighter or better. The primer of a cartridge should be protected from blows by sharp instruments, as such a blow might explode the cartridge. Ammunition should not be exposed to excessive heat or the direct rays of the sun for any considerable length of time. Such exposure is likely to affect the firing qualities of cartridges.

Cartridge	Cartridge Case	Propellant	BULLET			
			Jacket	Core or Slug	Point Filler	Base Filler
Ball, M59	Brass	Double-base, Western ball.	Gilding-metal	Steel	Lead-antimony	Lead-antimony
Ball, M80	Brass	Double-base, Western ball.	Gilding-metal or gilding-metal-clad steel.	Lead		
HPT, M60	Brass	Double-base, Western ball.	Gilding-metal	Lead-antimony.		
AP, M61	Brass	Double-base, Western ball.	Gilding-metal	Steel	Lead-antimony	Lead-antimony
Tracer, M62	Brass	Double-base, Western ball.	Gilding-metal-clad steel.	Lead-antimony		Tracer, sub-igniter and igniter comp 8
Blank, XM82	Brass	SR 4759				
Dummy, M63	Brass	None	Gilding-metal-clad steel.			
Grenade, M64	Brass	Double-base, Western ball.				

Figure 9-26. Component Parts of 7.62-Millimeter Ammunition (Primer No. 36 or Equivalent Used in Cartridges Listed)

Cartridge	Cartridge Case	Propellant	BULLET			
			Jacket	Core or Slug	Point Filler	Base Filler
Ball, Lead	Brass	(1)		Lead-antimony		
Ball, M41	Brass	(1)	Gilding metal	Lead-antimony		
Ball, Copper plated	Brass	(1)	Copper plated steel	Lead-antimony		
Ball, Wad cutter	Brass	(1)		Lead-antimony	Blunt nose	
Tracer	Brass	(1)	Gilding metal	Lead-antimony		Tracer and igniter composition
(1) Propellant may be: Bullseye, Pistol powder No. 5, Pistol powder No. 6, or DuPont No. 80.						

Figure 9-27. Component Parts of Caliber .38 Special Ammunition

Cartridge	Cartridge Case	Propellant	BULLET		
			Jacket	Slug	Tracer
Ball, M1911	Brass or steel	Single-base	Gilding-metal or gilding-metal-clad steel. [1]	Lead-antimony	
Blank, M9	Brass or steel	W.C. blank or ball.			
Dummy, M1921	Brass or steel		Gilding-metal or gilding-metal-clad steel. [1]	Lead-antimony	
HPT, M1	Brass or steel	Single-base	Copper-plated steel	Lead-antimony	
Tracer, M26	Steel	Single-base	Steel. [1]	Lead-antimony	Tracer and igniter composition.

[1] Copper-plated steel or gilding-metal-clad steel.

Figure 9-28. Component Parts of Caliber .45 Ammunition (Corrosive and Noncorrosive Primers are used in Cartridges Listed)

9-45. USE OF OIL OR GREASE. The use of oil or grease on cartridges is dangerous and is prohibited. Oil or grease might cause injurious abrasives to collect in automatic weapons and produce excessive and hazardous pressures when fired.

9-46. PACKING AMD MARKING.

9-47. Small-arms ammunition is identified completely except as to grade, by packing and marking including the ammunition lot number, on original packing containers. Applicable grade of the small-arms ammunition lot is indicated by the Federal stock number.

9-48. PACKING. Dependent on intended use, small arms ammunition is packed in link belts, in clips or bandoleers, or in cartons. When ammunition is removed from the original packing containers, the full identity of the ammunition, including the lot number, nomenclature, and model designation, should be noted on issue slips, temporary containers, or by means of tags attached to ammunition belts. Cartridges for which the ammunition lot number has been lost automatically become grade 3.

9-49. When small-arms ammunition is functionally packed in metallic link belts, the component lot numbers are replaced by a functional lot number. This functional lot number is used solely for identifying the ammunition for accounting and storage purposes, and does not reflect the quality of the ammunition. The functional lot numbers contain the interfix L to denote the ammunition is packed in metallic link belts. Whenever small-arms ammunition is removed from functional packs, the component ammunition lots will revert to the original grade classification.

9-50. MARKING. Small-arms ammunition has the manufacturer's initials and year of manufacture stamped in the metal on the head of the cartridge case. The year is denoted by two figures except that ammunition manufactured in 1944 is stamped either 44 or 4. Match ammunition has the word MATCH stamped alongside the loading date. Subsequent to 15 May 1954, caliber .30 and caliber .50 functional lots will have the component lot in addition to the functional lot number stenciled on the exterior of the hermetically sealed cans or the metal ammunition boxes.

9-51. Some small-arms ammunition bullet tips are painted in various colors to provide a ready means of identification.

9-52. Small arms packing boxes may be either stained brown with marking in yellow or unstained with marking in black. Metal boxes with replaceable covers, which are usually packed in wirebound boxes, are painted olive drab.

9-53. Instead of the lot number, a functional (repacked) lot number may be stenciled on packing boxes containing metallic link belts; the serial number of the functional (repacked) lot number is preceded by the letter L for linked cartridges.

9-54. To provide a further means of quickly identifying type of packing, stenciled silhouettes are used on boxes and crates containing clipped and linked cartridges. These silhouettes indicate whether the ammunition is packed in rifle clips or metallic link belts. The silhouettes are vertical for caliber .30 cartridges and diagonal for caliber .50 cartridges. The absence of stenciled silhouettes on boxes may indicate carton-packed ammunition.

Cartridge	Cartridge Case	Propellant	BULLET			
			Jacket	Core or Slug	Point Filler	Base Filler
AP, M2	Brass	Single-base or double-base ball.	Gilding-metal	Manganese-molybdenum steel.	Lead-antimony	
API, M8	Brass	Single-base	Gilding-metal	Tungsten-chrome steel.[1]	Incendiary comp.	Lead-antimony.
API-T, M20	Brass	Single-base	Gilding-metal	Tungsten-chrome steel.[1]	Incendiary comp.	Tracer and igniter comp.
Ball, M2	Brass	Single-base or double-base ball.	Gilding-metal	Steel	Lead-antimony	
Ball, M33	Brass	Single-base or double-base ball.	Gilding-metal	Steel	Sodium carbonate monohydrate.	Lead-antimony.
Blank, M1	Brass	Double-base ball				
Dummy, M2	Brass[2]	None	Gilding-metal-clad steel or gilding metal.	([3])	([3])	
HPT, M1	Brass	Single-base	Gilding-metal	Front and rear lead-antimony.		
Incendiary, M1.	Brass	Single-base	Gilding-metal	Steel body w/ lead-antimony slug.	Incendiary comp.	Lead-antimony.
Incendiary, M23.	Brass	Single-base or double-base ball.	Gilding-metal-	Gilding-metal-clad steel container w/ lead-antimony slug.	Incendiary comp.	
Tracer, M1	Brass	Single-base or double-base ball.	Gilding-metal-clad steel or gilding-metal.	Lead-antimony		Tracer and igniter comp.
Tracer, M10	Brass	Single-base or double-base ball.	Gilding-metal-clad steel.	Lead-antimony		Tracer and igniter comp.
Tracer, M17	Brass	Single-base	Gilding-metal-clad steel.	Lead-antimony		Tracer and igniter comp.
Tracer, headlight, M21.	Brass	Single-base	Gilding-metal or gilding-metal-clad steel.	Lead-antimony		Tracer and igniter comp.
Spotter, Tracer Tracer, M48, M48A.	Brass	Single-base	Gilding-metal	Lead-antimony	Aluminum-alloy-container and incendiary comp.	Tracer and igniter comp.

1 Alternative material is manganese-molybdenum steel.
2 May also be manufactured with steel cartridge case.
3 After 1 January 1943, no core, slug, or filler was used in manufacture of dummy bullets, M2.

Figure 9-29. Component Parts of Caliber .50 Ammunition (Corrosive and Noncorrosive Type Primers Used in all Cartridges Listed)

Shotgun Cartridges Loaded With	Use		Number of Shot
	Combat (Service) and Training	Hunting	
No. 00 buck-shot, brass case, 12-gage.	Combat and guard.		9
No. 00 buck-shot, paper case, 12-gage.	Combat and guard.		9
No. 6 copper-coated shot, aluminum case, .410-gage.		Small game for survival purposes.	170
No. 6 chilled shot, paper case, .410-gage.		Small game for survival purposes.	170
No. 7-1/2 chilled shot, paper case, .410-gage.		Small game for survival purposes.	260

Figure 9-30. Intended Use of Different Shotgun Cartridges

Gage	Diameter of bore (in.)
10	0.775
12	0.729
.410	0.410

Figure 9-31. Shotgun Gages

Caliber and type	Nominal diameter (in inches)
Cal. .22	0.225
Cal. .30 carbine	0.3075
Cal. .30	0.3085
Cal. .32 auto. Colt (7.65-mm)	0.314
Cal. .32 S & W	0.314
9-mm (Parabellum)	0.3555
Cal. .380 auto. (9-mm short)	0.356
Cal. .38 auto. Colt	0.359
Cal. .38 short Colt	0.375
Cal. .38 S & W	0.359
Cal. .38 special	0.359
Cal. .45	0.4505
Cal. .50	0.5110
7.62-mm	0.3085

Figure 9-32. Bullet Diameters

SECTION X
AIRCRAFT CANNON AMMUNITION

10-1. INTRODUCTION.

10-2. This section describes various 20-MM cartridges (figures 10-1 and 10-2), guns, links, and various packing methods. The cartridges used by the Air Force in M3, M24A1, M39A1, and M61 20-MM aircraft guns are classified as fixed artillery ammunition. The cartridges are also referred to as ammunition rounds.

10-3. DEFINITIONS.

10-4. CARTRIDGE. The term cartridge is applied to the complete assembly of all the components necessary to fire the weapon once. The components are projectile, cartridge case, propellant powder, and primer.

10-5. BALL. Ball is the term originally used to describe small arms ammunition with a solid projectile and no longer accurately describes the 20-MM target practice projectile. The term ball in AF stock should be referred to as target practice (TP) ammunition.

10-6. PROJECTILE. The 20-MM projectile is made of steel with a rotating band of gilding metal near the base. It is made and used in various configurations on different cartridge classifications.

10-7. CARTRIDGE CASE. The case is that portion of a round that acts as a container for the other components during storage, handling, and firing. It also prevents rearward escape of propellant gases during firing. They are usually made of brass, but steel is also used. They have the same bottle shape and construction of small arms ammunition. Case configuration is straight (M21A1) or tapered (M103).

10-8. PROPELLANT POWDER. The propelling charge utilized in aircraft cannon ammunition is the double-base (nitrocellulose-nitroglycerin) type and may contain from 77 to 80 percent nitrocellulose and from 9 to 20 percent nitroglycerin by weight; this type of propellant normally is produced in the form of modified spheres of varying sizes. This propellant contains other chemical additives to minimize smoke and flash, to maintain desired performance throughout long periods of shelf life under extreme climatic conditions, and to permit loading of uniform charges into the cartridges. The double-base propellant currently being loaded in 20-MM cartridges, is commonly referred to as Western Ball propellant.

WARNING

Electric primers may be caused to function by shock. Avoid rough handling.

10-9. PRIMERS. The 20-MM primers are percussion (initiated by a blow from the firing pin, M3 gun only), and electric (initiated by an electric charge from the firing pin). The following primers are used as indicated:

a. Primer. Percussion, M36A1. This percussion primer is used in the assembly of the 20-MM cartridge case M21A1. Only cartridges for the 20-MM gun M3 utilize this primer.

b. Primer, Electric, M52A3. This primer consists of a small electrical element assembly used with 20-MM ammunition in aircraft guns M24A1. 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 a vinylite insulator, followed by a consolidated charge of a conductive primer mixture, a shellacked foil paper disk, finally, a thin gilding-metal cup support is pressed into the body. The insulator is red in color. The charge weighs approximately 2.75-grains. The electrical path is from the firing pin, through the exposed face of the primer button (cup), through the conductive primer composition, through the cup support, and to the cartridge case.

c. Primer, Electric, M52A3B1. This primer is used with 20-MM ammunition in aircraft guns M39A1, and M61. It differs from electric primer M52A3 in height of the cup support, which is slightly less. This results in a reduction in the overall length of the primer and permits a cellulose case vent seal to be assembled in the primer recess of the cartridge case between vent and primer.

10-10. FUZE. The PD fuze M505 (T196E4) is used with the HEI cartridges, replacing the PD fuze M75 which may be found on cartridges of earlier manufacture. Both of these fuzes are single-action, impact-type, percussion fuzes. The PD fuze M505 is relatively boresafe. The fuzes are described as follows:

a. Fuze, Point Detonating, M75. The fuze M75 was used with 20-MM high-explosive-incendiary ammunition of earlier manufacture. It is now authorized for use with the percussion-primer 20-MM HEI cartridge M97 for the 20-MM gun M3 only. 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, by pieces of metal from the body striking the detonator charge, or by compression of the air column (with 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 mechanism usually found in point detonating fuzes is omitted in this design. The fuze

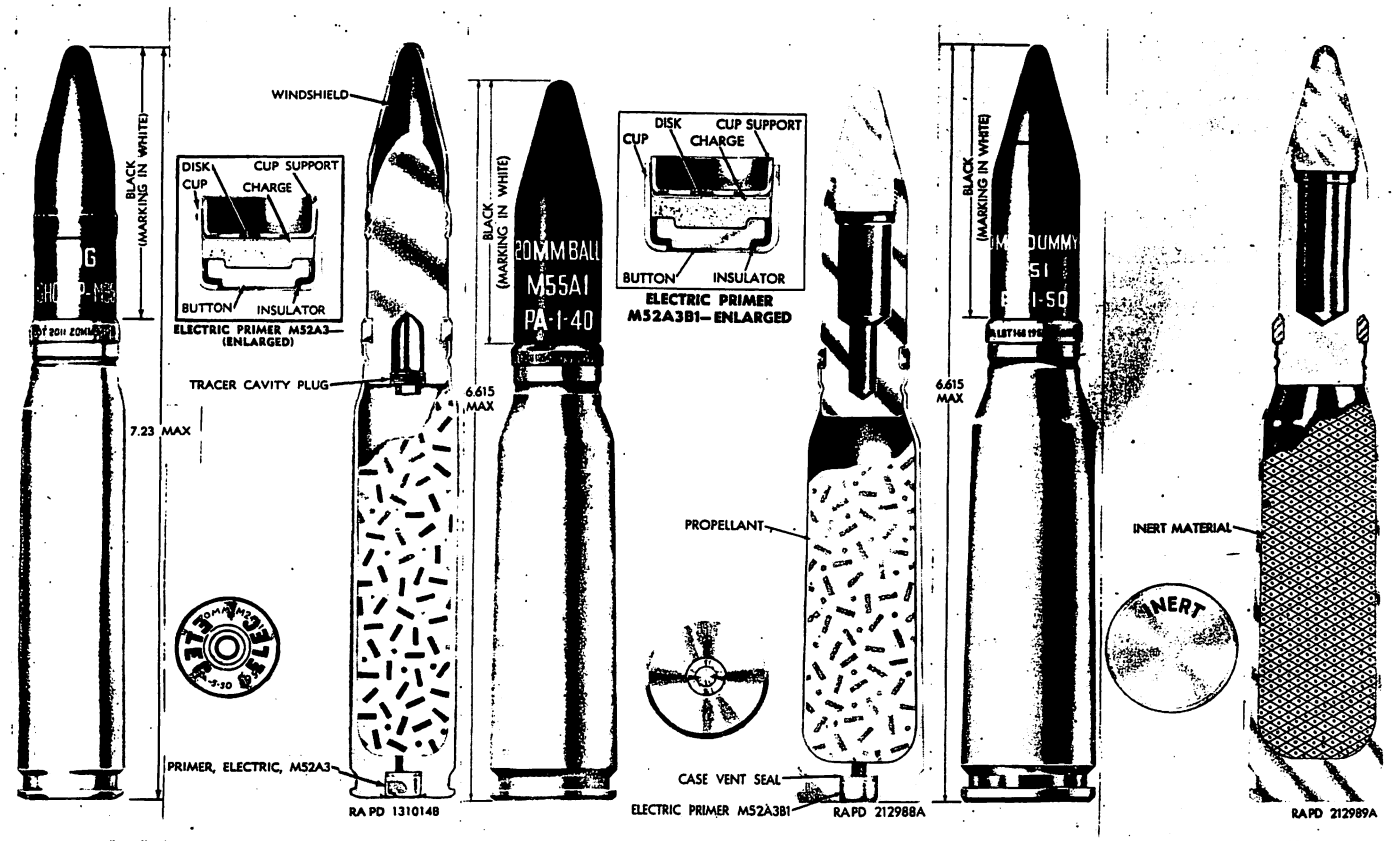


Figure 10-1. Cartridge Components, 20-Millimeter Electric Primer-Typical

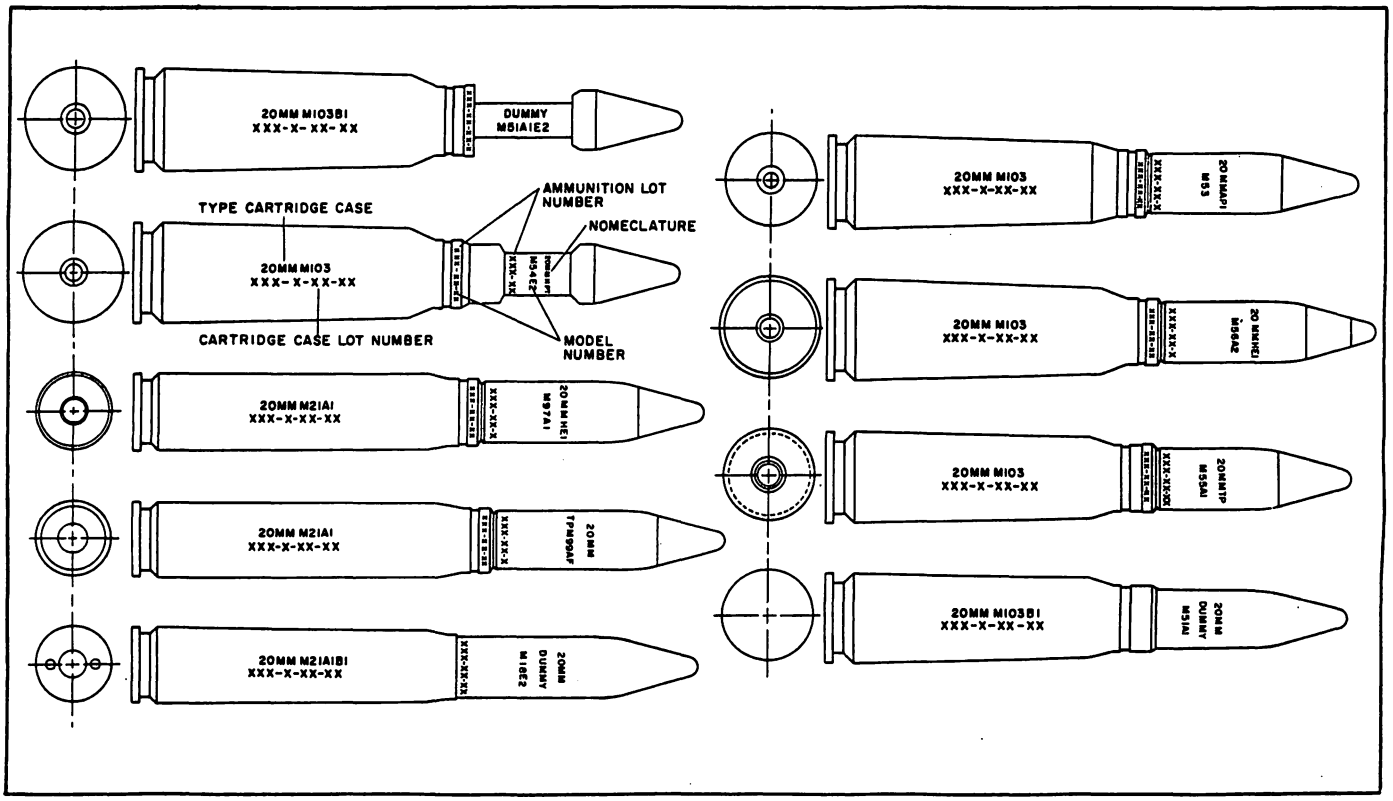


Figure 10-2. Cartridges, 20-MM

consists of two major parts; a body with an air space in the fore-part 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. The explosive train consists of a mercury fulminate detonator charge, an intermediary charge of lead azide, and a tetryl base charge (booster). Since there are no interrupter or other safety devices, the fuze is not considered a boresafe type. Upon firing, no action takes place until impact. Upon impact with sufficiently resistant targets, the head is crushed and the detonator charge 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 projectile to explode.

b. Fuze, Point Detonating, M505 (T196E4). The M505 is used with 20-MM high-explosive incendiary ammunition. It is a single-action superquick fuze intended to function on impact with aircraft targets. The fuze will not function unless the detonator is in line with the firing pin. The fuze (figure 10-3) consists of a body assembly, a rotor assembly, and a booster-holder assembly. The body assembly consists of an aluminum-alloy firing pin and a rotor safety spring of corrosion-resisting steel wire contained in a steel body and covered by a sheet steel cover. The cover is crimped behind the shoulder of the body so that it forms a cap, which covers that portion of the fuze protruding from the projectile. The rotor assembly consists of a brass rotor containing detonator M47 (T32). This assembly is so placed in the cavity of the body that it is held by the free leg of the rotor safety spring against a flat surface of the otherwise spherical rotor so that the detonator is out-of-line to provide mechanical boresafety. The booster-holder assembly, which consists of a steel booster-holder containing booster M123 (T42), is screwed into the base of the fuze body. The fuze has a delayed arming distance of 20 to 35 feet from the muzzle of the gun. Prior to firing the HEI projectile, the rotor containing the detonator, which is out-of-line with the firing pin, and the firing pin are locked in position by the rotor safety spring. Centrifugal force, resulting from the rotation of the projectile causes the free leg of the spring to move, thus allowing the rotor to move in-line with the firing pin. The movement of the rotor safety spring releases the firing pin. The firing pin is now suspended over the detonator. The close fit between the firing pin and the adjacent walls holds the firing pin in position. The fuze functions when the nose of the fuze is crushed against the target, thus forcing the firing pin against the detonator. The detonator in turn initiates the booster. The booster action causes the projectile to explode.

c. The M505A3 fuze (figure 10-3) differs from fuze M505 in the design of the firing pin, in the addition of the U-shape safety spring, and in slight modification of other parts, which, in connection with the use of different sealing compounds during assembly, improve metal parts security and sealing of the fuze. The nose end of the firing pin is slightly crowned instead of spherical and the flat on the end of the firing pin does not have a radius on its edge. The firing pin also has a flange. When the firing pin is assembled in the fuze body, the flange is forward of the nose end of the body. The design of the body is modified to accommodate the rotor safety spring. The arming of this fuze takes place in a similar manner to that of fuze M505. After fuze M505A3 is armed, the flange on the firing pin prevents it from moving back against the detonator until the flange is sheared off when the nose of the fuze is crushed against the target. This fuze is intended to function when the projectile has moved an optimum distance after impact. Modification, especially the design of the firing pin, are for the purpose of obtaining less variation in the time between impact and functioning of the fuze than have been obtained with fuze M505.

10-11. CLASSIFICATION. The 20-MM cartridges used by the Air Force are classified as follows:

a. Practice (TP) (Ball). For use as a training round in preparation for pilot combat efficiency training.

b. Armor-Piercing Incendiary (API). For combined armor-piercing and incendiary effect against aircraft, armored vehicles, and concrete shelters.

c. High-Explosive Incendiary (HEI). For combined explosive incendiary effect against aircraft and light material targets. The projectile has high explosive in the nose and incendiary mixture in the base, or a composite mixture of both elements.

d. Incendiary. This cartridge is used for incendiary effect against aircraft and light material targets.

e. Dummy. These rounds are completely inert and used for testing the mechanism of 20-MM guns. Dummy rounds are also used for ballast on certain aircraft.

10-12. CARTRIDGES FOR 20-MM GUN, M3.

10-13. The 20-MM gun, M3, is a link disintegrating, belt-fed automatic aircraft cannon for use against aircraft and ground or sea-borne targets. At present, the M3 is the only 20-MM gun that fires percussion-primed ammunition. Percussion-primed ammunition manufactured in the United States, that is to be used jointly by the British, must be proof-fired in British guns to determine whether the lot develops sufficiently low chamber pressure for acceptance for firing the British weapons. If the ammunition is accepted by both United States and British services, the words COMMON AMM are marked or printed on the packing boxes. All ammunition for this gun is issued in the form of fixed complete rounds (cartridges). The shape, length, and weight of the cartridges are approximately the same. This weapon has a muzzle velocity of 2,730 feet per second. Characteristics of 20-MM gun M3 cartridges are as follows:

WARNING

Electric-primed ammunition CANNOT be fired in the gun M3.

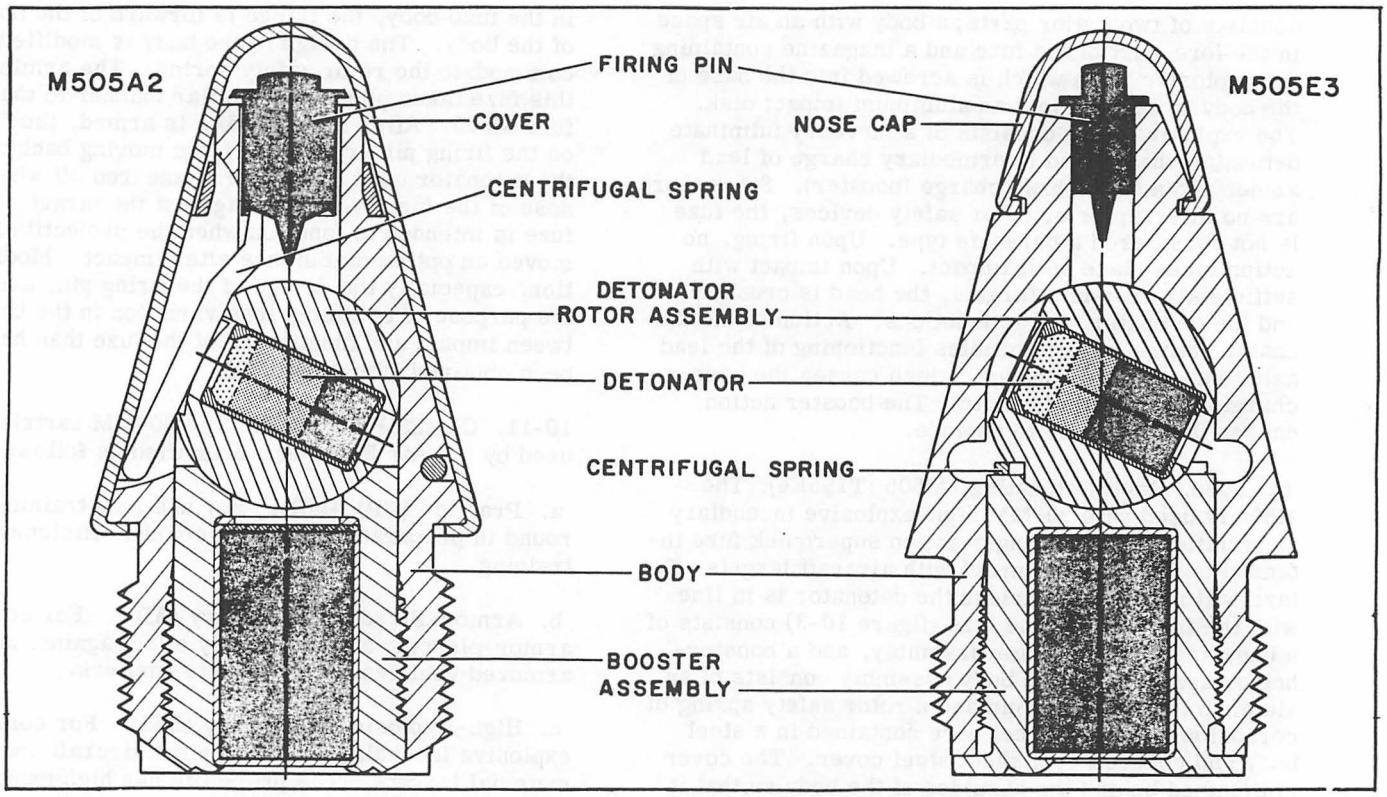


Figure 10-3. Fuze, Point Detonating, M505 Series

a. Identification. The color scheme for the painting and marking of these cartridges for purposes of identification is indicated in figure 10-4. It should be noted that painting and marking of the high-explosive-incendiary and incendiary cartridges differ from the basic color scheme prescribed in MIL-STD-709, but all essential information is provided.

b. Projectile. Dependent upon type of projectile, ammunition for this gun is classified as high-explosive-incendiary (HEI), armor-piercing with tracer (AP-T), incendiary, target-practice (TP), or dummy.

c. Fuze. The PD fuze M505 (T196E4) is used with the HEI cartridges, replacing the PD fuze M75 which may be found on cartridges of earlier manufacture. Both of these fuzes are single-action, impact-type, percussion fuzes. The PD fuze M505 is relatively boresafe.

d. Cartridge Case. The cartridge cases M21A1 (brass) and M21A1B1 (steel) are used with these cartridges. The weight of the cartridge case M21A1 is 0.214 pound, the cartridge case M21A1B1 is approximately 0.025 pound lighter and has a deeper extracting groove machined in the head. A single vent is provided in both cartridge cases.

e. Propelling Charge. The cartridge contains single-base (nitrocellulose) propellant.

f. Primer. The percussion primer M36A1, containing a 2.1-grain charge of primer mixture, is used with these cartridges.

g. Disintegrating Belt Cartridge Links. These links and filler (figure 10-5) are considered as ammunition components. They are listed in United States Air Force Stock List 1300. Metallic belt link M7, M8, or M10 (M8E1) can be used to make up belts for either right-or left-hand 20-MM feed mechanism M3 or AN-M2; however, only one type of link may be used in the same belt. The link M8 is an improvement in design over the link M7. The link M10 (M8E1) differs from the link M8 in finish, heat treatment, and contour design. It can be distinguished from the M8 by the comparatively greater flexibility of the belt and prevents holdups in the ammunition chute. A cartridge link filler is used with the link M10 (M8E1) when it is desired to load belts for double-loop left-hand feed.

10-14. CARTRIDGE, 20 MILLIMETER, AP-T, M95. This cartridge (figure 10-1) is 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.

10-15. CARTRIDGE, 20 MILLIMETER, AP-T, M95, STEEL CASE. This cartridge is the same as the item in paragraph 10-14, except that the steel cartridge case M21A1B1 is substituted for the M21A1.

10-16. CARTRIDGE, 20 MILLIMETER, HEI, M58 (T241), W/FUZE, PD, M505. This cartridge (figure 10-1), which replaces the M97A1, differs from the M97A1 principally in the interior design and loading of the projectile. It provides an adequate ballistic

Nomenclature	Gun	Link	Aircraft	Primer	Case	PROJECTILE			LINKER-DELINKER		
						Explosive Weight Grs and Filler	Fuze	Old Color Code	New Color Code	Nomenclature and Stock No.	Link
Cartridge, 20MM High-Explosive Incendiary (HEI) M97 or M210 Series	M3 Series	M10 (M8E1)	A1H A1E Counter-Insurgency	Percussion M36A1 M36A1E1	Brass M21A1 Wax Coated	Approx 147 Grains	PD M75 M505E3	OD Projectile Red Annulus Silver Fuze Black Lettering	OD Projectile, 1/2-inch Red Band Above Rotating Band, Yellow Lettering	Linker-Delinker, M16 Power 4925-723-1251 (May Be Hand Operated)	M10
Cartridge, 20MM High-Explosive Incendiary (HEI) M97A1	M24 Series	M10 (M8E1)	B-47	Electric M52A3	Brass M21A1 Wax Coated	Approx 147 Grains	PD M505	OD Projectile Red Annulus Silver Fuze Black Lettering	OD Projectile,1/2-inch Red Band Above Rotating Band, Yellow Lettering	Linker-Delinker M13, Hand, 4925-722-6304	M10
Cartridge, 20MM Incendiary (INC) M96	M3 Series	M10 (M8E1)	A1H A1E Counter-Insurgency	Percussion M36A1	Brass M21A1 Wax Coated	88.5 Grains	PD M505	Blue-Gray Projectile, Light Blue Tip, Black Lettering	Same As Above	Repositioner M17 Hand, 4925-730-7594	M10
Cartridge, 20MM Incendiary (INC) M96	M24 Series	M10 (M8E1)	B-47	Electric M2A3	Brass M21A1 Wax Coated	88.5 Grains	PD M505	Blue-Gray Projectile, Light Blue Tip, Black Lettering	Same As Above		
Cartridge, 20MM Target Practice (TP) M99	M3 Series	M10 (M8E1)	A1H A1E Counter-Insurgency	Percussion M36A1	Brass M21A1 Wax Coated	Inert	None	Black Projectile, White Lettering	Blue Projectile, White Lettering		
Cartridge, 20MM Target Practice (TP) M99A1	M24 Series	M10 (M8E1)	B-47	Electric M2A3 M2A3B1	Brass M21A1 Wax Coated	Inert	None	Black Projectile, White Lettering	Blue Projectile, White Lettering		
Cartridge, 20MM Dummy, M18A3	M24 and M3 Series	M10 (M8E1)	B-47 Counter-Insurgency	Steel Plug	Solid Steel Cartridge	Inert	None	Cadmium Plated, Black Lettering	Same As Above		
Cartridge, 20MM Armor-Piercing Incendiary (API) M53	M39 Series	M12 (T61E3)	F-86 F-100 F-101 A5	Electric M2A3B1	Brass M103 Not Waxed	85 Grains	None	Black Projectile, Blue Tip, White Lettering	Black Projectile, Blue Tip, White Lettering		
Cartridge, 20MM Armor-Piercing Incendiary (API) M53	M61 Series	M17 (T99) M14 (T76E1)	B-52 B-58 F-104 Dual Feed System F-105B Dual Feed System F-105D and F Linkless SUU/16 Gun POD	Electric M2A3B1	Brass M103 Not Waxed	85 Grains	None	Black Projectile, Blue Tip, White Lettering	Black Projectile, Blue Tip, White Lettering	Linker-Delinker Power XM28 4925-073-9099	M17
Cartridge, 20MM High-Explosive Incendiary (HEI) M56A1	M39 Series	M12 (T61E3)	Same As Above	Electric M52A3B1	Brass M103 Not Waxed	180 Grains	PD M505A1	OD Projectile Red Annulus Silver Fuze Black Lettering	OD Projectile, 1/2-inch Red Band Above Rotating Band, Yellow		
Cartridge, 20MM High-Explosive Incendiary (HEI) M56A1	M61 Series	M17 (T99) M14 (T76E1)	B-52 B-58 F-104 Dual Feed System F-105B Dual Feed System F-105D and F Linkless	Electric M52A3B1	Brass M103 Not Waxed	180 Grains	PD M505A1	OD Projectile Red Annulus Silver Fuze Black Lettering	OD Projectile, 1/2-inch Red Band Above Rotating Band, Yellow Lettering	Linker-Delinker (T52) Hand, 4925-715-9071 Linker-Delinker T50, Power	M17 M17
Cartridge, 20MM Target Practice (TP) M55A1, M55A2	M39 Series	M12 (T61E3)	F-86 F-100 F-101 A5	Electric M52A3B1	Brass M103 Not Waxed	Inert	None	Black Projectile, White Lettering	Blue Projectile, White Lettering-Nose May or May Not Be Painted	Coupler-Disconnector, Hand, 4925-727-2533	M17
Cartridge, 20MM Target Practice (TP) M55A1, M55A2	M61 Series	M17 (T99) M14 (T76E1)	B-52 B-58 F-104 Dual Feed System F-105B Dual Feed System F-105D and F Linkless	Electric M52A3B1	Brass M103 Not Waxed	Inert	None	Black Projectile, White Lettering	Blue Projectile, White Lettering - Nose May or May Not Be Painted	Linker-Delinker M23 (T51) Power 4925-715-9073 Linker-Delinker M25 Hand, 4925-787-9803	M17
Cartridge, 20MM Dummy M51A1 (M51E8)	M39 Series M61 Series	M17 (T99) M14 (T76E1)	Bulk Packed Checkout Gun System and for Instructions	Brass Plug	M103B1 Inert Loaded/w Laminac	Inert	None	Cadmium-Plated and Zinc Chromate Coated, Black Lettering	Lance Shaped Black Projectile White Lettering		
Cartridge, 20MM Dummy M51A1E1	M39 Series M61 Series	M17 (T99) M14 (T76E1)	Bulk Packed Checkout Gun System and for Instructions	Brass Plug	M103B1 Inert Loaded/w Laminac	Inert	None	Cadmium-Plated and Zinc Chromate Coated, Black Lettering	Lance Shaped Black Projectile White Lettering		
Cartridge, 20MM High-Explosive Incendiary (HEI) M97E2 and M97E3	M24 Series	M10 (M8E1)		Electric M52A3B1	Brass M21A1 Wax Coated	130 Grains	PD M505E3	OD Projectile Red Annulus, Silver Fuze Black Lettering	OD Projectile, 1/2-inch Red Band Above Rotating Band, Yellow Lettering		
Cartridge, 20MM High-Explosive Incendiary (HEI) M56A2	M39 Series	M12 (T61E3)		Electric M52A3B1	Brass M103 No Wax	175 Grains	PD M505E3 M505A2	OD Projectile Red Annulus, Silver Fuze Black Lettering	OD Projectile, 1/2-inch Red Band Above Rotating Band, Yellow Lettering		

Figure 10-4. 20-MM Cartridges, Components, and Markings (Sheet 1 of 2)

Nomenclature	Gun	Link	Aircraft	Primer	Case	PROJECTILE			LINKER-DELINKER		
						Explosive Weight Grs and Filler	Fuze	Old Color Code	New Color Code	Nomenclature and Stock No.	Link
Cartridge, 20MM High-Explosive Incendiary (HEI) M56A2	M61 Series	M17 (T99) M14 (T76E1)	B-52 B-58 F-104 Dual Feed System F-105B Dual Feed System F-105D and F Linkless	Electric M52A3E1	Brass M103	175 Grains	PD M505E3	OD Projectile Red Annulus, Silver Fuze Black Lettering	OD Projectile, 1/2-inch Red Band Above Rotating Band, Yellow Lettering		
Cartridge, 20MM Dummy Dumbbell, Gum Drive Deactivation, M51A1E2	M61 Series	M17 (T99) M14 (T76E1)	Bulk Packed	Brass Plug	M103B1 Inert Loaded/w Laminac	Inert	None	Cadmium-Plated and Chromate Coated, Black Lettering	Lance Shaped Projectile		

Figure 10-4. 20-MM Cartridges, Components, and Markings (Sheet 2 of 2)

match with the M97A1. The M58 is an improvement over the M97A1 in blast, fragmentation, and incendiary effect. The weight of the incendiary charge (MOX-2B) is 0.026 pound. The weight of explosive is 0.03 pound, composed of 0.026 pound of MOX-2B and 0.004 pound of RDX. Upon impact, the charge is functioned with a combined detonative and incendiary effect. A base cover is welded to the base of the projectile for additional safety. The PD fuze M505 is an instantaneous percussion fuze of the impact-type.

10-17. CARTRIDGE, 20 MILLIMETER, HEI, M97, W/FUZE, PD, M75. This cartridge, which is replaced by the M97A1 differs from the M97A1 principally in the fuze. The fuze M75 has no interrupter or other special devices for boresafety. In this respect, it differs from the fuze M505.

10-18. CARTRIDGE, 20 MILLIMETER, HEI, M97A1, W/FUZE, PD, M505. This cartridge is for use against aircraft and light materiel targets, functioning with both explosive and incendiary effect. The high-explosive is tetryl and is located in the nose portion of the projectile, while the incendiary mixture is located in the base. The combined weight of the high-explosive-incendiary filler is 0.017 pound composed of 0.005 pound of incendiary mixture and 0.012 pound of tetryl. Upon impact, its filler is detonated, the shell shattered, 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.

10-19. CARTRIDGE, 20 MILLIMETER, HEI, M97A1, STEEL CASE, W/FUZE, PD, M505. This cartridge is the same as the item in paragraph 10-18, except that the steel cartridge case M21A1B1 is substituted for the M21A1.

10-20. CARTRIDGE, 20 MILLIMETER, INCENDIARY, M96. This cartridge is for use against aircraft, functioning with incendiary effect. The body of the projectile is made of cold-drawn steel. The nose, threaded to screw into the body, is made of a die-cast zinc alloy; it is painted light blue for identification. Both the body and nose are filled with incendiary composition. This projectile does not require a fuze, as functioning is initiated by impact of nose upon target.

10-21. CARTRIDGE, 20 MILLIMETER, INCENDIARY, M96, STEEL CASE. This cartridge is the same as the item in paragraph 10-20, except that the steel cartridge case M21A1B1 is substituted for the M21A1.

10-22. CARTRIDGE, 20 MILLIMETER, DUMMY, M18A3. This cartridge is a completely inert assembly, which is intended to provide a cartridge for drill purposes and for testing the feed mechanism of the weapon. The service projectile and cartridge case are simulated by a one-piece zinc- or cadmium-coated casing made of steel, cold-drawn to size, shape, or weight of the service round. A steel base plug, formed to provide an extractor groove like that on service ammunition, is soldered into the recessed base. Some rounds of earlier manufacture have a threaded base and base plug. 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.

10-23. CARTRIDGE, 20 MILLIMETER, TP, M99. This cartridge (figure 10-2) is for practice firing. The projectile is similar in shape and ballistic properties to the incendiary shell M96 but is hollow and contains no explosive. The nose consists of a zinc die-casting as in the M96 incendiary. Its weight is adjusted to give the projectile a weight of 2,00 grains (0.29 lb.). The projectile body is made of cold-drawn steel.

WARNING

If Cartridge, 20-MM, Test, High-Pressure, M54E2, is discovered in the field, it will not be used. Such rounds will be reported thru appropriate channels to OOAMA (OOYI), Hill Air Force Base, Utah. These rounds are for proof test of the M39A1 and M61 guns only.

10-24. CARTRIDGES FOR 20-MM GUN, M24A1.

10-25. The 20-MM gun, M24A1, is an automatic aircraft cannon for use against aircraft and ground or seaborne targets. It is a combination blowback and gas-operated, air-cooled, belt-fed gun. It can be adapted for belt feeding from either the right- or left-hand side. The gun is designed to fire electric-primed ammunition only. All ammunition for this gun is issued in the form of fixed complete rounds. The cartridges are linked into disintegrating belts by use of cartridge link M10 (figure 10-5). The cartridges for this gun are the same as those fired in 20-MM

gun, M3, except that electric primer M52A3 replaces percussion primer M36A1. Although the model designations are the same for both the electric-primed and percussion-primed cartridges, in the nomenclature of the former, the word electric is inserted before the type of designation. Muzzle velocity is 2,730 feet per second. Cycling rate of this gun is 800 to 1000 rounds per minute. Characteristics of 20-MM gun M24A1 cartridges are as follows:

a. Identification. Painting and marking of these cartridges for purposes of identification is the same as that of cartridges for 20-MM gun, M3, except for the designation ELEC, which is stenciled on the head of the cartridge case with black ink. Some rounds of earlier manufacture have a purple annulus around the primer at the head of the cartridge case, caused by the dye in the waterproofing compound that was used.

b. Projectile. Dependent upon the type of projectile, ammunition for these guns is classified as high-explosive incendiary (HEI), armor-piercing with tracer (AP-T), armor-piercing (AP) (with or without tracer cavity plug), incendiary, target-practice (TP), or dummy.

c. Fuze. The PD fuze, M505 (T196E4), is used with the HEI cartridges. The PD fuze, M505, is a single-action, impact-type, percussion fuze which is relatively boresafe.

d. Cartridge Case. Cartridge cases M21A1 (brass) and M21A1B1 (steel), used with these cartridges, are identical to those used with cartridges for 20-MM gun, M3.

e. Propelling Charge. The cartridges contain ball propellant.

WARNING

Percussion-primed ammunition CANNOT be fired in the M24A1 gun.

f. Primer. Electric primer M52A3B1, containing a 2.75 grain charge of primer mixture, is used with these cartridges. Electric primer M52A3, which differs from the M52A3B1 in the primer charge, may be found in cartridges of earlier manufacture. The insulator of primer M52A2 is colored black, while that of the M52A3B1 is red.

g. Disintegrating Belt Cartridge Links. Belts for 20-MM feed mechanism M2E5 or M2E7 of gun M24A1 are made up of cartridge link M10 (M8E1). Feed mechanism M2E5 and feed mechanism M2E7 consist of two distinct feed mechanisms for each model - a right-hand feed mechanism and a left-hand feed mechanism. Although the same cartridge link is used to form belts for right-hand feed and belts for left-hand feed, the method of loading the belts is different. Belts for either right- or left-hand feed may also be loaded with single-loop leading or with double-loop leading. For double-loop leading, a cartridge filler link is used to close the single loop at the end of the belt.

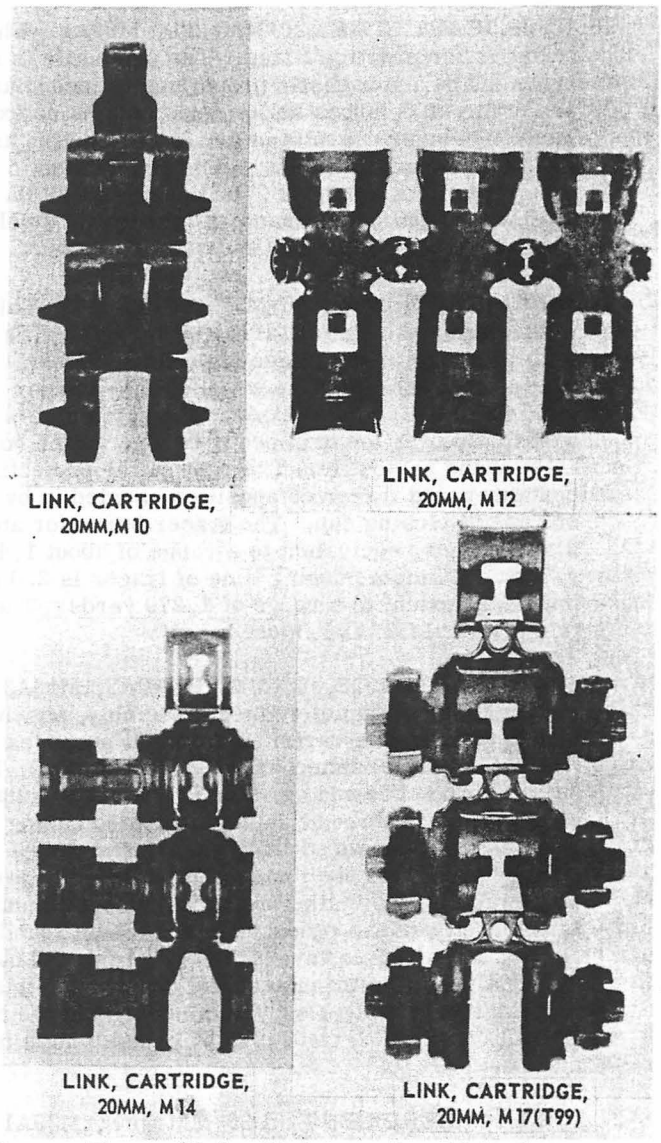


Figure 10-5. Disintegrating Links for 20-Millimeter Cartridges

10-26. CARTRIDGE, 20-MM, HEI, M97A1, W/FUZE, PD, M505. This cartridge is for use against aircraft and light material targets, functioning with both explosive and incendiary effect. The high-explosive is tetryl and is located in the nose portion of the projectile. Upon impact, the filler is detonated; the projectile shattered, and the incendiary composition ignited. The PD, M505 fuze, an instantaneous percussion fuze of the impact-type is used. The thickness of the base is approximately 0.2 inch, and a base cover is welded thereon for additional protection. Electric primer M52A3 is used.

10-27. CARTRIDGE, 20-MM, INCENDIARY, M96. This cartridge is used for incendiary effect. The body of the projectile is made of cold-drawn steel. The nose, threaded to screw into the body, is made of a die-cast zinc alloy. Both the body and nose are filled with incendiary composition. This projectile does not require a fuze, as functioning is initiated by impact of nose upon target. Electric primer M52A3 is used.

10-28. CARTRIDGE, 20-MM, TP, M99A1. This cartridge is for practice firing. The projectile is similar in shape and ballistic properties to incendiary projectile M96, 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. Electric primer M52A3B1 is used.

10-29. CARTRIDGE, 20-MM, AP-T, M95. This cartridge is for use against armored targets. The projectile is a solid shot made from forged steel. A drawn steel windshield is crimped into annular grooves in the projectile body, the portion of the windshield over the crimped area acts 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 electric primer M52A3B1 is used.

10-30. CARTRIDGE, 20-MM, DUMMY, M18A3. This cartridge is a completely inert assembly, which is intended to provide a cartridge for drill purposes and for testing the feed mechanism of the weapon. The service projectile and cartridge case are simulated by a one-piece zinc- or cadmium-coated casing made of steel, cold-drawn to size, shape, and weight of the service round. A steel base plug, formed to provide an extractor groove like that on service ammunition, is soldered into the recessed base. Some rounds of earlier manufacture have a threaded base and base plug. 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.

10-31. CARTRIDGES FOR 20-MM GUN, M39A1.

10-32. The 20-MM gun, M39A1, is an automatic aircraft cannon for use against aircraft and ground or seaborne targets. This gun is a gas-operated, belt-fed, electrically fired weapon having a rate of fire of 1800 rounds per minute. The M8 (T13) and M8A1 chargers used on these guns, utilize the caliber .30 carbine grenade cartridge M6 to develop the necessary gas pressure to start the functioning of the weapon. All ammunition for this gun is issued in the form of fixed complete rounds known as cartridges. The cartridges are electric-primed. Before firing, the cartridges are loaded in ammunition belts of the disintegrating belt type, made up from cartridge link M12 (figure 10-5). The cartridges are approximately 0.6 inch shorter in overall length and approximately 0.19 inch wider at the base of the cartridge case than the cartridges used in the 20-MM guns M3 and M24A1. The cartridges used in the gun M39A1, are also used in 20-MM gun M61. Muzzle velocity of the API, ball, and HEI rounds fired from the gun M39A1 is 3,300 feet per second.

10-33. CARTRIDGES FOR 20-MM GUN, M61 (T171E3).

10-34. The 20-MM gun, M61 (T171E3), is an automatic aircraft cannon for use against aircraft and ground or seaborne targets. The gun is an electrically, hydraulically, or air-turbine powered, belt- or linkless-fed, electrically fired weapon having a rate of fire of 4,000 to 6,000 rounds per minute. When electrically powered, the electric drive M7 is used. It is a rotating, six-barrel gun. A round of ammunition is fired through each barrel, as the barrels rotate once around the longitudinal axis. The cartridges are electric-primed and are identical with the cartridges used for 20-MM gun M39A1. Before firing, the cartridges are loaded in ammunition belts of the disintegrating type, made up from cartridge link M14 or M17. The muzzle velocity of the API, ball, or HEI round is approximately 3,430 feet per second in the 20-MM gun M61. Characteristics of the cartridges used in the 20-MM guns M39A1 and M61 are as follows:

a. Identification. The color scheme for the painting and marking of these cartridges for purposes of identification is indicated in figure 10-4.

b. Projectile. Dependent upon type of projectile, ammunition for these guns is classified as armor-piercing incendiary (API), ball, high-explosive incendiary (HEI), dummy, and high-pressure-test (HPT). The dummy cartridge consists of cartridge case M103 (dummy) assembled to the ball projectile. Prior to standardization, ball cartridge M55 was designated as target practice (TP) cartridge T199. The nomenclature has been changed to ball to have the designation conform to the small-arms system.

c. Fuze. The PD fuze, M505 (T196E4), is the fuze that has been used with the HEI cartridge. This fuze is classified as a single-action, impact-type, percussion fuze and it incorporates features that make it relatively boresafe. In 1957, all production of the fuze M505 was converted to the fuze M505A3. The latter is a modification which was designed for the purpose of replacing the fuze M505 for use with HEI cartridges for 20-MM guns M39A1 and M61.

d. Cartridge Case. Cartridge cases M103 (brass), M103B1 (steel), and M103 (dummy) (brass) are used as components of these cartridges. The weight of the cartridge case M103 is approximately 0.26 pound. The weight of the cartridge case M103B1 is approximately 0.25 pound. The cartridge case M103 (dummy), which is used only with the dummy cartridge, weighs approximately 0.26 pound. In more recent production using primer M52A3B1, a cellulose case vent seal is used to seal the vent before the primer is inserted. Cartridge case M103 (dummy) does not have a primer recess or vent.

e. Propelling Charge. The cartridge cases contain approximately 0.08 pound of double-base Western Ball propellant.

f. Primer. Electric primer M52A3B1 is used with the service cartridges.

g. Disintegrating Belt Cartridge Links. Cartridge links for the 20-MM aircraft guns are considered as ammunition components and are listed in Air Force Stock List 1300.

10-35. CARTRIDGE, 20-MM, ELECTRIC, HEI, M56A3 (T198E1), W/FUZE, PD, M505A3. This cartridge (figure 10-1) is for use against aircraft and light materiel targets, functioning with both detonative and incendiary effect. The projectile body is a steel, relatively thin-walled casing. The total weight of filler is 0.03 pound, composed of incendiary MOX-2B and RDX. The RDX explosive is loaded between the base of the fuze and the incendiary composition, which occupies the rest of the interior of the projectile body. The thickness of the base of the projectile is approximately 0.21 inch and a base cover is welded thereon for additional safety. Upon impact, the charge is functioned with a combined detonative and incendiary effect. Functioning is initiated by the PD fuze M505A3, an instantaneous fuze of the impact type, which is described in paragraph 10-10c. Cartridge case M103, loaded with approximately 0.083 pound of double base (Western Ball) propellant, and the electric primer M52A3B1 are used in this cartridge. A cellulose case vent seal is assembled in the primer recess, between vent and primer.

10-36. CARTRIDGE, 20-MM, ELECTRIC, TP (BALL), M55A1. This cartridge is for use in practice firing; prior to standardization of the basic model, this type of cartridge was referred to as a target practice (TP) cartridge. The nomenclature has been changed to ball in order to have the designation conform to the small-arms system. The projectile of this cartridge consists of body, nose, and rotating band. The body is made of steel; it is hollow and contains no filler. The nose, which may be assembled to the body with screw threads and a thermosetting resin or keyed to the body by swaging, is made of aluminum alloy and is solid. Cartridge M55A1 of current production, which replaces cartridges M55 and M55A1 of earlier design, incorporates several improvements in the design of the projectile. These include better steel for the body, a modified (double-undercut) rotating band seat, and metal parts more securely fastened together. Cartridge case M103 loaded with approximately 0.084 pound of double-base (Western Ball) propellant and electric primer M52A3B1 are used in the cartridge M55A1. A cellulose case vent seal is assembled in the primer recess, between vent and primer. Early production of cartridge M55A1 may contain electric primer M52A3 and no case vent seal and the propellant may be single-base (nitrocellulose).

10-37. CARTRIDGE, 20-MM, ELECTRIC, ARMOR-PIERCING INCENDIARY, M53 (T221E3). This cartridge is for use against armored targets, functioning with a combined incendiary and penetration effect. The body of the projectile is solid shot made from bar alloy steel. The nose, which is made of aluminum alloy, is charged with 3 separately pressed increments of incendiary composition weighing a total of 85 grains. The nose is sealed with a closure disk. A steel adapter is crimped into the annular grooves in the projectile body; the adapter receives the base portion of the nose and is crimped so as to allow the conical base of the closure disk to seat on the tip of the projectile body. This cartridge does not require a fuze, as functioning is initiated by impact of nose upon target. Cartridge case M103 and electric primer M52A3B1 are used in this cartridge. A cellulose case vent seal is assembled in the primer recess between the vent and the primer.

10-38. CARTRIDGE, 20-MM, DUMMY, M51. This cartridge (figure 10-1) is a completely inert assembly that is used for drill purposes, for testing the feeder assembly of the weapon, and for ballast. The service cartridge is simulated by assembling the projectile of ball cartridge M55 or M55A1 with steel cartridge case M103 (dummy). The cartridge case contains approximately 0.086 pound of inert material to produce an average overall weight equal to that of the service cartridges.

10-39. PACKING DATA.

10-40. The cartridges for 20-MM guns M39A1, and M61 are packed in both bulk and functional type packing in steel ammunition box T-46. The T-46 ammunition box is a self-sealing steel ammunition box that is replacing the M23 wooden outer packing box in new production and may contain the following:

a. Bulk (linkless) pack - 150 cartridges. (Some issued in 200 cartridge pack.)

b. M39A1 - M61 Guns - 100 cartridges per belt, 1 belt per box. (Previously packed 50 cartridges per belt, now obsolete.)

10-41. Cartridges for 20-MM guns M3 and M24A1 are contained in both bulk and functional-type packing. Primary bulk packs vary from 10 rounds in a cardboard carton to 55 rounds per steel can; these containers are overpacked (in varying quantities) into metal cans or wooden boxes for shipment and storage. Functional packings are made up of one type, more than one type, or several types, or ratio pack of cartridges in a 40-round link belt which is packed into metal can M21, and overpacked (in varying quantities) into either metal cans or wooden boxes. The belts are either linked for right-hand feed or linked for left-hand feed. For additional information on packing of 20-MM ammunition, refer to United States Air Force Stock List 1300.

10-42. PAINTING AND STENCILING. The self-sealing metal boxes are painted OD and stenciled in

yellow (MIL-STD-709). Repainting of cartridges will not be accomplished solely to comply with MIL-STD-709.

10-43. MARKINGS. Outer packing boxes, crates, metal boxes, and inner containers are fully marked to identify the ammunition contained therein. These markings include the descriptive nomenclature including the word linked and the letters R or L (M10 link, M3 gun), to signify metallic link belts right- or left-hand feed, the ammunition lot number, and the number of rounds. In addition, the outer container is marked with the Federal Stock Number, Department of Defense Code, ICC shipping name, average weight, and cube, and loaded date. Type of pack can be determined by referencing Federal Stock Number in USAF SL 1300 and T.O. 11A-1-46.

10-44. PRECAUTIONS.

WARNING

Ammunition for gun M39A1, or M61 CANNOT be fired in either 20-MM gun M3 or M24A1. Ammunition for either gun M3 or M24A1 CANNOT be fired in gun M39A1 or M61. Ammunition linked for guns M39A1 CANNOT be fired in gun M61. Ammunition linked for gun M61 CANNOT be fired in gun M39A1.

10-45. Complete rounds, particularly rounds with fuzes, will be handled with care at all times. Explosive elements in fuzes and primers are particularly sensitive to shock and high temperature. Particular precautions must be taken with 20-MM cartridges containing electric primers as outlined in AFM 127-100.

SECTION XI
CARTRIDGE/PROPELLANT ACTUATED DEVICES (CAD/PAD)

11-1. INTRODUCTION.

11-2. Many explosive devices are utilized in weapon systems. These devices, commonly called Cartridge Propellant Actuated Devices (CAD/PAD) are designed to perform such operations as removing canopies or escape hatches, positioning seat prior to ejection, stowing equipment, ejecting seat and crewmember, separating crewmember from seat, deploying drogue chutes, etc. CAD/PAD also perform numerous other operations such as jettisoning external stores, actuating fire extinguisher systems, releasing arresting hooks, cutting or separating electrical and hoist cables, missile stage separation, etc.

11-3. DESCRIPTION.

11-4. ACTUATORS, CANOPY. Canopy actuators are pneumatically or electrically actuated units designed to open and close canopies during normal operations and ballistically remove canopies during emergency exit.

11-5. ACTUATORS, ROTARY. Rotary actuators are gas actuated units designed to separate crewmember from the seat after ejection.

11-6. BOLT, EXPLOSIVE. Explosive bolts are gas or electrically actuated, frangible units designed to release attaching components.

11-7. CARTRIDGE, FIRE EXTINGUISHER. Fire extinguisher cartridges are electrically actuated units designed to actuate fire extinguisher systems.

11-8. CARTRIDGE, GUILLOTINE. A guillotine cartridge is a percussion fired cartridge used in the Martin-Baker guillotine to sever the drogue parachute attaching line.

11-9. CARTRIDGE, M30A1. The M30A1 cartridge is a percussion fired cartridge used in the M6A1 ejection seat trainer catapult.

11-10. CARTRIDGE, M57. The M57 cartridge is a percussion fired cartridge used in the M2A1 ejection seat trainer catapult.

11-11. CARTRIDGE SET. The set is used in the Martin-Baker Catapult and Drogue Gun System. It consists of a percussion initiated primary catapult cartridge, two gas initiated auxiliary cartridges, and a percussion initiated Drogue Gun Cartridge.

11-12. CATAPULT. A catapult is a gas actuated unit containing a cartridge designed to forcefully eject the seat and crewmember from the aircraft.

11-13. CATAPULT, ROCKET. A rocket catapult is a gas actuated unit containing a cartridge or other initiating explosive charge and a rocket motor designed to forcefully eject the seat and crewmember from an aircraft.

11-14. CUTTER. A cutter is a mechanical, electrical, or gas pressure actuated unit designed to cut electrical wiring, cables, harness, etc., during the functioning of an aircraft emergency exit system. Cutters are also used to cut shroud lines on drogue chutes, hoist cables on helicopters and parachute reefing lines.

11-15. DESTRUCTORS. Destructors are electrically actuated, frangible units designed to release attaching components.

11-16. GENERATOR, GAS. Gas generators are mechanical or electrically actuated units designed to produce the gas pressure necessary to operate other devices.

11-17. GUN, PARACHUTE DEPLOYMENT. The parachute deployment gun is a mechanically actuated unit designed to fire a projectile attached to the parachute risers to assure immediate parachute deployment.

11-18. INITIATOR. Initiators are mechanical or gas pressure actuated devices designed to produce the gas pressure necessary to actuate other cartridge or propellant actuated devices.

11-19. MECHANISM, FIRING. The firing mechanism is a gas pressure actuated unit designed to provide the gas pressure necessary to actuate F/TF 102 canopy counter balance cylinders during an emergency.

11-20. RELEASE, FIRING PIN (EXACTOR). The firing pin release is a nonexplosive, gas pressure operated unit designed to release the firing pin in the M1 series remover or arm the seat catapult initiator in the F/TF 102 and F106 aircraft.

11-21. REMOVER, CANOPY. A remover is a mechanical or gas pressure actuated unit designed to remove the canopy from the aircraft during an emergency. The M8 and M9 removers also incorporate provisions to electrically open and close the canopy during normal operations.

11-22. THRUSTER. A thruster is an electrical or gas pressure actuated unit designed to mechanically operate other components by extension or retraction of piston rods.

11-23. FUNCTIONING OF COMPONENTS.

11-24. A detailed description of the aircraft system is contained in the applicable aircraft maintenance repair manual. Detailed descriptions for cartridge/propellant actuated devices are contained in the appropriate 11 series technical orders.

11-25. Structurally, an aircraft catapult is composed of three tubes: outer tube, telescoping tube, and inner tube. The telescoping tube of the catapult is attached to the crewmember's seat. A trunnion is used to attach the outer tube to the aircraft structure. The catapult is actuated by gas pressure from the burning propellant of a special blank cartridge incorporated in the catapult. This blank cartridge is fired by a firing pin in the catapult that, in turn, is actuated by gas pressure from a remotely located (in the aircraft) initiator. Pressure, generated within the initiator by an integral special blank cartridge, is transmitted to the catapult through a system of connecting hose or tube. The gas pressure exerts a force on the catapult firing pin, forcing firing pin downward, shearing the shear pin, unlocking the catapult, and the remainder of the movement of the firing pin fires the cartridge in the catapult.

11-26. The remover is actuated just prior to actuation of the catapult. The remover is a telescoping tube ejector similar to a catapult but smaller and somewhat less powerful. One end of the remover is attached to the canopy, the other to the aircraft structure. Upon firing the remover cartridge, the remover is extended axially and the head and inner tube are ejected with the canopy. The M1 series firing pin release, which is not integral with the remover but attached to it, is connected to an initiator, and functions independently of the catapult. The initiator gas pressure operates the exactor plunger, thus releasing the canopy firing pin that fires the remover cartridge. Other canopy removers are gas pressure actuated and do not use a firing pin release.

11-27. Thrusters consist essentially of a cylinder, piston, cartridge, and a firing pin, which is actuated by gas pressure furnished from an initiator. When the thruster cartridge is ignited, the piston is forced down the cylinder, exerting a thrust on the related aircraft component. The various models of thrusters differ in design details such as thrust exerted, length of stroke, etc.

11-28. Initiators provide a source of gas pressure, which actuates another component of the system, such as a catapult or thruster. Initiators may differ in the method of firing; that is, they may be fired mechanically by the operation of some form of lanyard or by gas pressure furnished by the preceding item in the system. Delay initiators incorporate a delay element in the initiator cartridge.

11-29. CARE AND PRECAUTIONS IN HANDLING.

11-30. Due consideration should be given to the observance of appropriate safety precautions in handling cartridge/propellant actuated devices. The following precautions will be observed:

a. All types of cartridge/propellant actuated devices must be handled with care.

b. Air or mechanical pressure should not be applied to the inlet ports of those devices that are initiated by gas pressure. When not installed in an aircraft, these ports should be kept closed with a shipping plug.

c. The cotter pin must not be taken out of M1 series removers until removers are installed in an aircraft and then only if safety pin or firing pin is in place. Do not remove removers from the aircraft unless cotter pin or safety pin is installed.

d. The safety pin will always be inserted in the initiator until just prior to flight. Do not remove the initiator from the aircraft or perform any maintenance on the initiator or in the immediate area unless the safety pin is installed.

NOTE

Disassembly, testing or modification of any CAD/PAD is prohibited without prior approval or direction from OOAMA (OOYI), Hill Air Force Base, Utah.

11-31. PACKING AND MARKING. All cartridge/propellant actuated devices are assembled and shipped as sealed units with cartridges installed therein. Since they are shipped in various quantities, nonstandard packaging is often utilized.

11-32. In addition to nomenclature and ammunition lot number, packages prepared for shipment are marked, in accordance with Interstate Commerce Commission shipping regulations, the same as small-arms ammunition. The Federal Stock Number (FSN) is included in the marking.

SECTION XII
GRENADES

12-1. INTRODUCTION.

12-2. A grenade is a small, short-range missile filled with high-explosive or chemical. It can be placed, thrown, or projected against enemy personnel or material at relatively short ranges. A grenade can also be used for screening or signaling operations. When used as a hand grenade it is thrown in a prescribed manner for each type of grenade used. The rifle grenade is a fin stabilized projectile projected from the M16 rifle, using a special grenade cartridge, to cover the distance from maximum hand grenade to minimum mortar range. The rifle grenade may be used for antiarmor , antipersonnel , smoke, illumination, signaling, or incendiary effect.

12-3. CLASSIFICATION.

12-4. Grenades are classified according to type, filler, and intended use.

12-5. TYPE. Two types of grenades are used by the Air Force, hand and rifle. A hand grenade may be modified into a rifle grenade by the use of a special grenade projection adapter. Rifle grenades are manufactured to a specific design including the projection requirements.

12-6. FILLER. Grenade fillers are classified as explosive, chemical, or inert.

12-7. USE. Grenades are classified according to intended tactical use. They may be used for fragmentation, irritant, screening smoke, signaling smoke, and incendiary effect. Grenades may also be used for riot control and training.

12-8. HAND GRENADES.

12-9. The three general types of hand grenades are service, practice, and training and simulator. (See figure 12-1.) Service hand grenades are classified according to use. Practice hand grenades and simulated or simulator hand grenades are designed to simulate the fragmentation type service hand grenades. All hand grenades are issued fuzed.

12-10. FRAGMENTATION HAND GRENADES. The three types of fragmentation grenades used by the USAF are service, practice, and training. The service grenade is a high-explosive filled combat item. The practice grenade is designed to simulate the service grenade for training personnel in throwing. The training grenade is designed for training personnel in handling prior to throwing the practice or service grenades. Fragmentation grenades are shaped like a large lemon.

12-11. FRAGMENTATION HAND GRENADE, MK2. The MK2 grenade has a cast iron serrated body and is assembled with a detonating fuze. A safety lever, curved to fit the shape of the grenade, is attached to the fuze and held in place by a safety pin. (See figure 12-1.)

12-12. FRAGMENTATION HAND GRENADES, M26, M26A1, AND M26A2. (See figure 12-2.) The M26 series grenades are slightly larger than the MK2 and consist of a thin metal body lined with a wire wound coil in place of the cast iron body used in earlier types of grenades. The M26 series grenades are assembled with the same detonating fuzes used in the MK2.

12-13. CHEMICAL HAND GRENADES. There are three general categories of chemical grenades; riot control, smoke, and incendiary. They employ a variety of fillers. Chemical grenades may be thrown, projected, or placed, depending upon their design, fuzing, and filler. Extreme cold may form ice in the starter mixtures of chemical grenades and cause malfunctions.

12-14. IRRITANT HAND GRENADE, CN-DM, M6. The body of the M6 grenade is a thin sheet metal container with six emission holes in the top and 18 emission holes in the side. The filling is a mixture of tear and vomiting gases. The grenade is assembled with an igniting fuze secured by a safety lever and a safety pin. General configuration of the M6 is shown in figure 12-3.

12-15. TEAR GAS HAND GRENADE, CN, M7A1. The M7A1 grenade body is a thin sheet metal container with four emission holes in the top and one on the bottom. The filling is a semi-solid compound that produces tear gas when ignited. The fuze safety lever, and safety pin of the M7A1 are similar to the CN-DM, M6 grenade. General configuration of the M7A1 is similar to the gas grenade shown in figure 12-3.

12-16. RIOT CONTROL HAND GRENADE, CN, M25A1. (See figure 12-2.) The M25A1 is a ball-shaped bursting hand grenade approximately three inches in diameter. The body is made of two plastic hemispheres cemented together with a fuze well extending through the body of the grenade. The well is closed at the bottom end with a screw plug. A filling is located in one side of the body. The filling is a semi-solid compound that produces tear gas when ignited. A bursting fuze is assembled in the well as an integral part of the grenade. The fuze is kept unarmed by a safety pin.

12-17. SMOKE HAND GRENADE, WP, M15. (See figure 12-3.) The M15 is a bursting smoke grenade

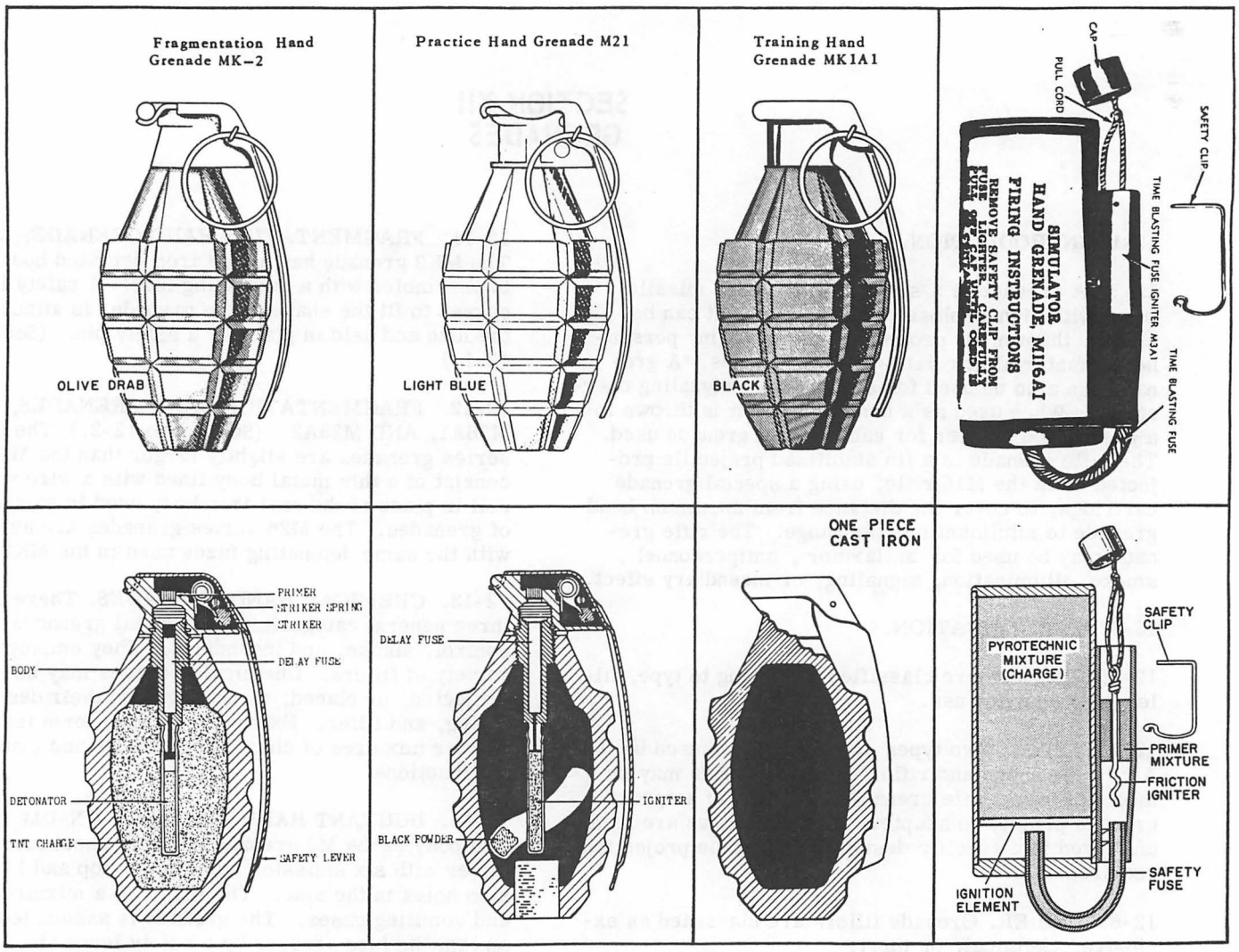


Figure 12-1. General Types of Hand Grenades, Service, Practice, Training, and Simulator

made of a sheet metal cylinder with a steel cap brazed on top and a rounded bottom for night identification. The body is made of heavier steel, as shown in figure 12-3, and does not have emission holes. The M15 uses a detonating fuze which ruptures the grenade body and disburses the WP filler. The fuze is kept safe by a safety pin.

12-18. GRENADE, HAND AND RIFLE, CHEMICAL-BURSTING TYPE M34. (See figure 12-2.) The M34 WP (White Phosphorus) smoke hand grenade is a bursting-type multi-purpose munition used for anti-personnel, screening, and incendiary effect. The M34 WP hand and rifle grenade is a grooved, cylindrical steel container, 2-3/8 inches in diameter, 5-1/2 inches long. The grenade base is tapered so that the grenade can be mounted on an M1A2 grenade projection adapter. The body is grooved to ensure uniform break up of the case. The body contains 15 ounces of WP filler and the M206A2 detonating fuze. Delay time is 4.0 to 5.0 seconds. It scatters WP particles over a 40 yard radius and launch range is approximately 130 yards. The white phosphorus will burn for approximately 60 seconds and ignite any combustible substance it contacts.

12-19. WHITE SMOKE HAND GRENADE, HC, AN-M8. The AN-M8 grenade is a thin sheet steel cylinder with four emission holes in the top. It has an igniting type fuze with a safety lever held by a safety pin. General configuration of the AN-M8 is similar to the incendiary grenade shown in figure 12-3.

12-20. COLORED SMOKE HAND GRENADE, M18. The M18 grenade is a thin sheet metal cylinder with four emission holes in the top and one in the bottom with general configuration of the gas grenade shown in figure 12-3. The M18 grenade is filled with either red, green, violet, or yellow smoke mixture and the top of the grenade is painted the same color as the smoke it produces. It has an igniting fuze with a safety lever held by a safety pin.

12-21. INCENDIARY HAND GRENADE, TH-3, AN-M14. (See figure 12-3.) The AN-M14 grenade provides a source of intense heat for destroying equipment. The body is a thin sheet metal cylinder with four emission holes in the top. The igniting fuze of the grenade is saftied with a lever held by a safety pin. Thermate (TH-3) may explode rather than burn when frozen. Spontaneous ignition of white phosphorus grenades may result from the freezing, and

expansion of residual moisture left in the filler. TH-3 is a mixture of thermite, barium nitrate, and sulphur in an oil binder. It is used for destruction of materials by fire and has no significant physical effect other than burns.

12-22. TRAINING AND PRACTICE HAND GRENADES.

12-23. PRACTICE HAND GRENADE, M21. The M21 grenade has the same serrated body and fuze arrangement as the MK2. It simulates the MK2 fragmentation grenade for throwing practice. The M10A4 or M205A2 fuze of the M21 grenade has a short length of time fuze to simulate a detonator. A small charge of black powder simulates a high-explosive charge. The body is recoverable and may be reused by installing a new fuze, black powder charge and stopper. When activated, the grenade gives off a puff of white smoke accompanied by a loud pop. (See figure 12-1.)

12-24. PRACTICE HAND GRENADE, M30. The M30 grenade simulates all M26 grenades. It has the same wire lined, thin metal body and same fuze arrangement. The M30 has the same fuze and black powder

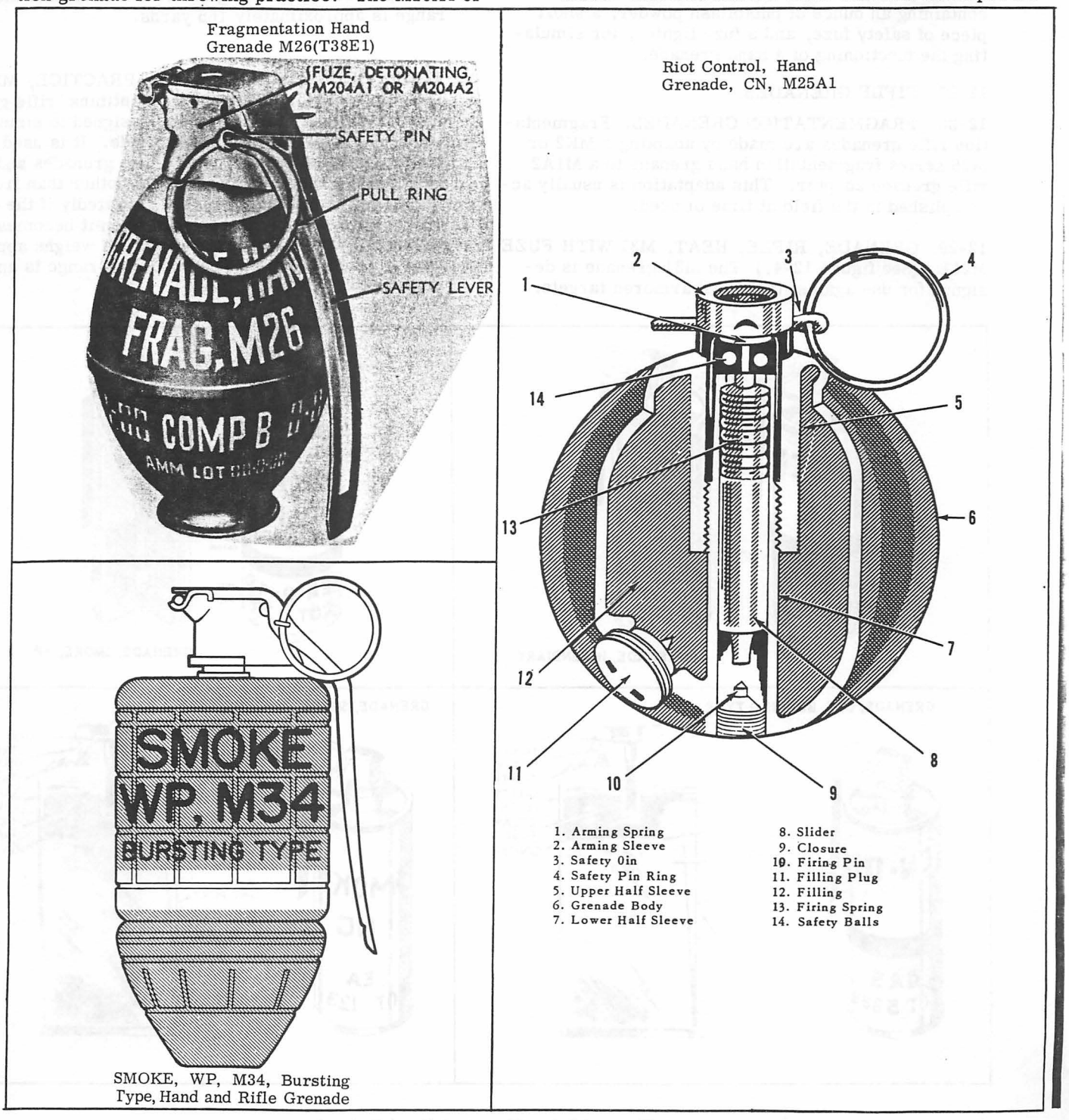


Figure 12-2. Later Developments in Hand Grenades

charge as the M21 practice grenade and it is recoverable and reusable.

12-25. TRAINING HAND GRENADE, MK1A1. (See figure 12-1.) This grenade simulates the MK2 fragmentation grenade in appearance, shape, size, and weight. It is inert and is used only for training in handling and throwing practice.

12-26. SIMULATOR, HAND GRENADE, M116A1. (See figure 12-1.) The Simulator, Hand Grenade, M116A1, consists of a closed cylindrical paper tube containing an ounce of photoflash powder, a short piece of safety fuze, and a fuze lighter, for simulating the functioning of a hand grenade.

12-27. RIFLE GRENADES.

12-28. FRAGMENTATION GRENADES. Fragmentation rifle grenades are made by adapting a MK2 or M26 series fragmentation hand grenade to a M1A2 rifle grenade adapter. This adaptation is usually accomplished in the field at time of need.

12-29. GRENADE, RIFLE, HEAT, M31 WITH FUZE M211. (See figure 12-4.) The M31 grenade is designed for use against tanks and armored targets. The high-explosive antitank (HEAT) rifle grenade M31 consists of a body assembly, stabilizer, and fin assembly. The body contains about 10 ounces of high-explosive in the form of a shaped charge and a base detonator. A point initiating base detonating fuze (M211) is installed in the base of the grenade. Upon impact the M211 fuze, which has a small shaped charge, initiates the M48 base detonator which in turn explodes the main charge. At 0^{o} impact angle the jet from this grenade will penetrate upwards of 10 inches of armor plate or 20 inches of concrete and is effective up to 65^{o} impact angle. The maximum launch range is approximately 165 yards.

12-30. GRENADE, RIFLE, AT, PRACTICE, M29. (See figure 12-5.) The practice antitank rifle grenade is an inert training device designed to simulate the high-explosive antitank grenade. It is used for training in handling and use of rifle grenades and may be fired at a target without damage other than from impact. The M29 may be used repeatedly if the stabilizer fin assembly is replaced when it becomes damaged. It has a cast iron body and weighs approximately 1-1/2 pounds. The maximum range is approximately 165 yards.

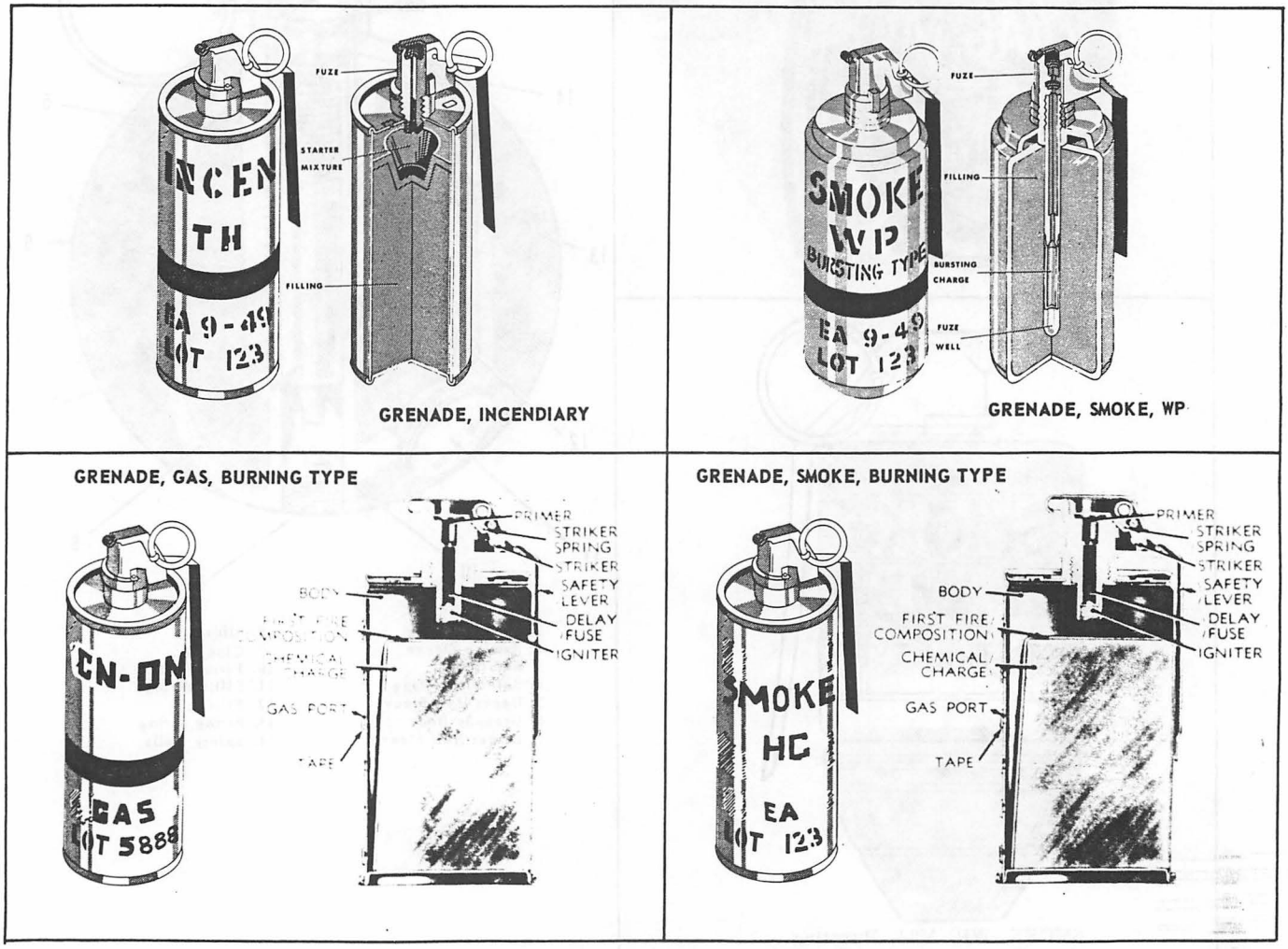


Figure 12-3. Chemical Hand Grenades

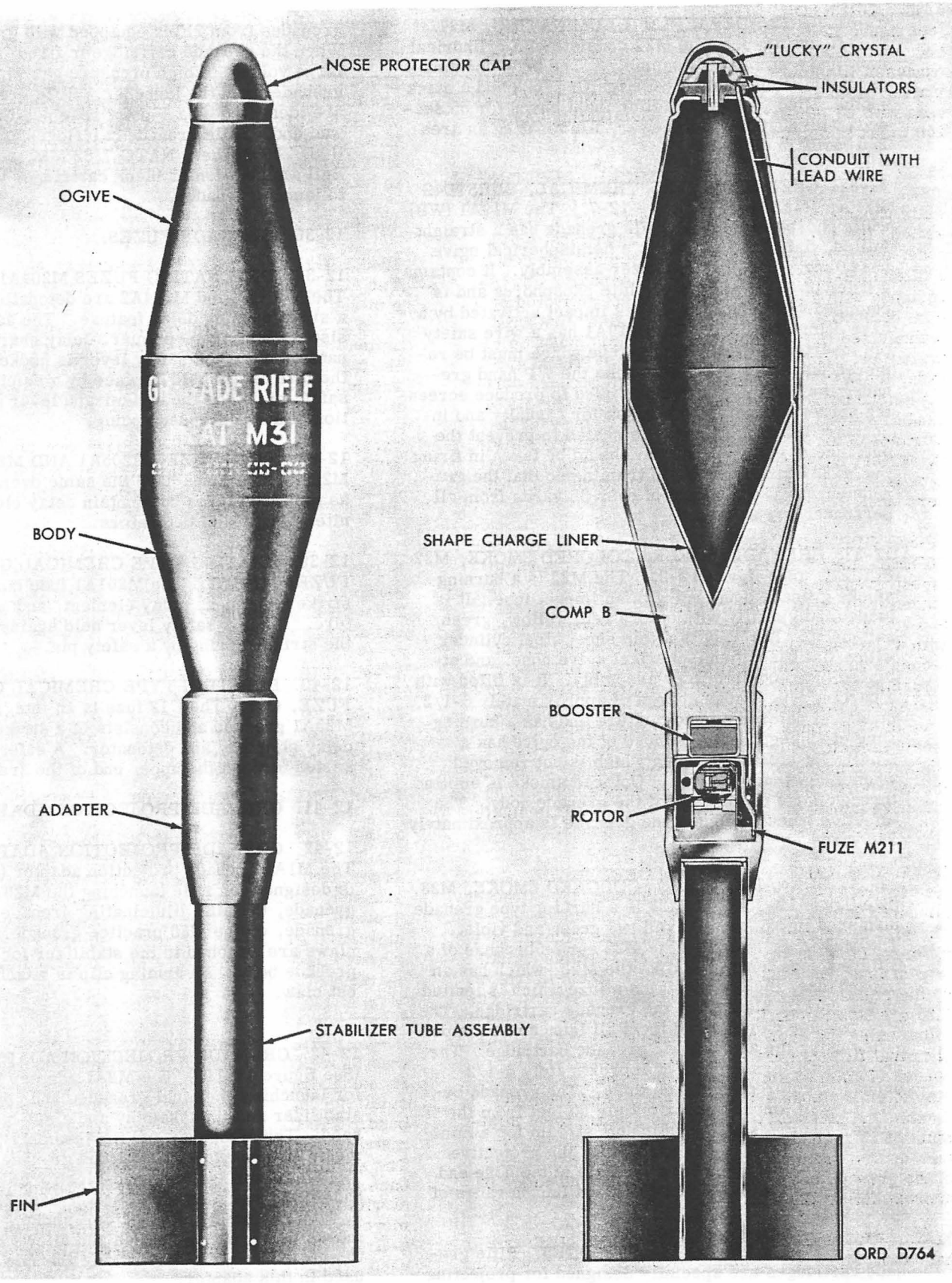


Figure 12-4. Grenade, Rifle, HEAT, M31

12-31. GRENADE, RIFLE ILLUMINATING, M27. (See figure 12-6.) The M27 consists of a cylindrical body and a stabilizer assembly. The body contains 8 ounces of illuminant, a base igniting fuze and a quick match. Upon impact the illuminant burns for 55 seconds with 80,000 candlepower, illuminating an area 240 yards in diameter.

12-32. GRENADE, RIFLE CHEMICAL, BURSTING TYPE, M19A1. (See figure 12-7.) The M19A1 (WP) white phosphorus smoke rifle grenade has a straight-walled, flat based body with a hemispherical ogive nose, and a fuze and stabilizer assembly. It contains a filler of 8-1/2 ounces of white phosphorus and is equipped with a burster that is impact activated by a base detonating fuze. The M19A1 has a wire safety pin inserted in the stabilizer tube which must be removed just prior to firing. Like the WP hand grenade, the WP rifle grenade is used to produce screening smoke but may also be used for casualty and incendiary effect. The body is sealed to prevent the entrance of air. Precaution should be taken in firing the M19A1 rifle grenade in training so that the grenade bursts at a distance of over 35 yards from all personnel.

12-33. GRENADE, RIFLE, COLORED SMOKE, M22 SERIES. (See figure 12-8.) The M22 is a burning smoke grenade equipped with an impact fuze. It is loaded individually with colors red, yellow, green, and violet. The body is a thin sheet steel cylinder with a flat base, hemispherical ogive nose, and attached fuze and stabilizer assembly. It is filled with a burning type smoke charge of approximately 6-1/2 ounces of colored smoke mixture and has a burning time of 45 seconds. The nose of the ogive has a small vent closed by a plug which is not removed when the grenade is fired. Colored smoke is emitted through ports in the base of the grenade body. The effective launch range of the grenade is approximately 220 yards.

12-34. GRENADE, RIFLE, COLORED SMOKE, M23. (See figure 12-9.) The M23 is a burning type grenade furnished in colors red, yellow, green and violet. The M23 is shorter than the M22 series because of a different fuze length. Unlike the M22, which has an impact fuze, the M23 contains a fuze which is ignited by the muzzle blast from the grenade cartridge. The M23 grenade can be fired from all launcher-equipped rifles using the appropriate grenade cartridge. The chemical fillings consist of approximately 6-1/2 ounces of colored smoke mixture. The grenade begins to emit smoke approximately 50 feet from the muzzle and gives off a continuous stream for a minimum of 12 seconds. Before firing, the protective tape must be removed from the hole at the nose end of the grenade body. The M23 has a launch range of approximately 220 yards.

12-35. RIFLE GRENADE CARTRIDGES. Rifle grenade cartridges are specially designed for projecting grenades from rifles equipped with grenade launchers. When the grenade cartridge is fired, it generates a large volume of high pressure gas which propels the grenade from the launcher. Rifle grenade cartridges are identified by a 5-point rose petal crimp on the wad end. Rifle grenade cartridges are furnished in U.S. .30 caliber, NATO 7.62 MM, and in 5.56 MM. Ball ammunition or blank cartridges will not be used to launch grenades.

12-36. GRENADE FUZES.

12-37. DETONATING FUZES M204A1 AND M204A2. The M204A1 and M204A2 are detonating fuzes having a silent burning delay feature. The assembly consists of a striker, primer, delay charge, and detonator. A curved safety lever is hooked to the top of the fuze and is held in place by a safety pin. The safety pin holds the striker and lever against the action of a compressed spring.

12-38. TIME FUZE, M205A1 AND M205A2. The M205 series fuzes have the same overall construction as the M204 fuzes but contain delay elements and igniters instead of detonators.

12-39. IGNITING TYPE CHEMICAL GRENADE FUZE, M201A1. The M201A1 fuze consists of a striker, primer, delay element, and an ignition mixture. It has a safety lever held against the action of the striker spring by a safety pin.

12-40. BURSTING TYPE CHEMICAL GRENADE FUZE, C12. The C12 fuze is an integral part of the M25A1 grenade and consists of a striker, primer, delay element, and detonator. A safety pin is inserted through the upper end of the arming sleeve.

12-41. GRENADE PROJECTION ADAPTERS.

12-42. GRENADE PROJECTION ADAPTER, M1A2. The M1A2 grenade projection adapter (figure 12-10) is designed for rifle launching the M26 fragmentation grenade, the MK1 illuminating grenade, the M34 WP grenade, or the M30 practice grenade. Three spring claws are attached to the stabilizer for gripping the grenade body. An arming clip is attached to the longest claw.

12-43. GRENADE PROJECTION ADAPTER, M2A1. (See figure 12-11.) The M2A1 adapter is designed for launching chemical grenades and consists of a stabilizer and fin assembly and a set-back arming band. The stabilizer and fin assembly is a machined metal tube adaptable to various grenade launchers. The stabilizer has a shroud-type fin at one end and a base plate at the other. The set-back band is of metal with its ends joined by a coil spring. The band moves to the rear at launch and allows the grenade to arm. The MK1 illuminating grenade must not be used in this adapter.

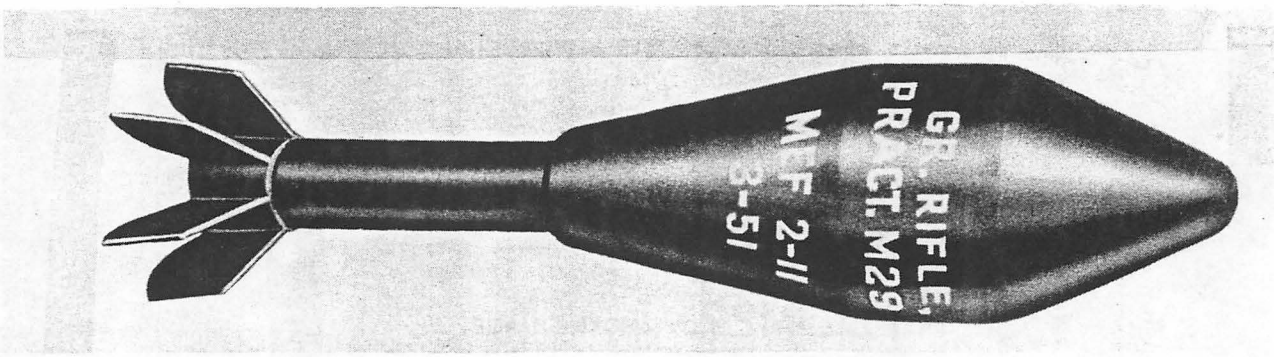


Figure 12-5. Grenade, Rifle, AT, Practice, M29 (T42)

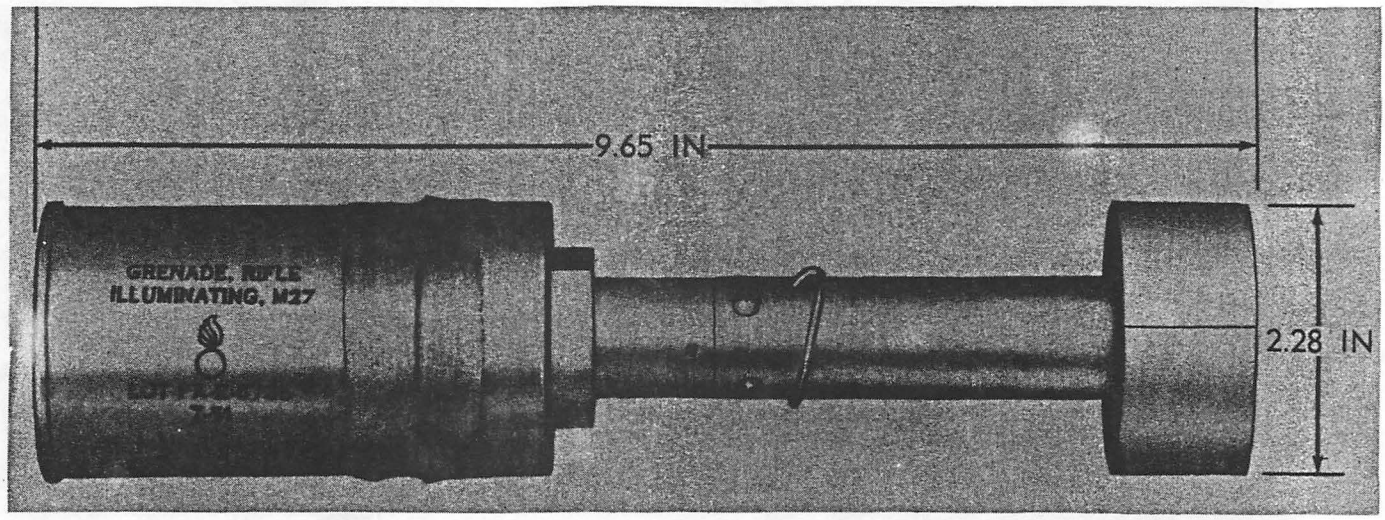


Figure 12-6. Grenade, Rifle, Illuminating, M27

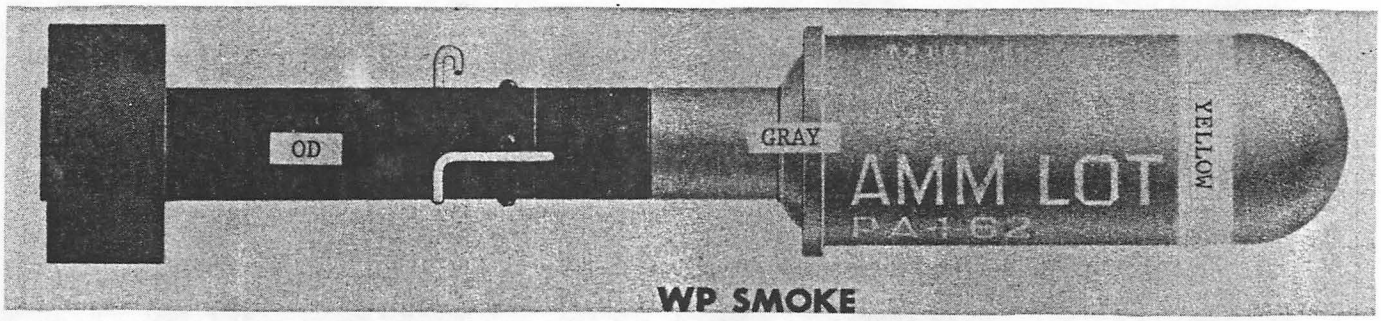


Figure 12-7. Grenade, Chemical, Bursting Type, M19A1

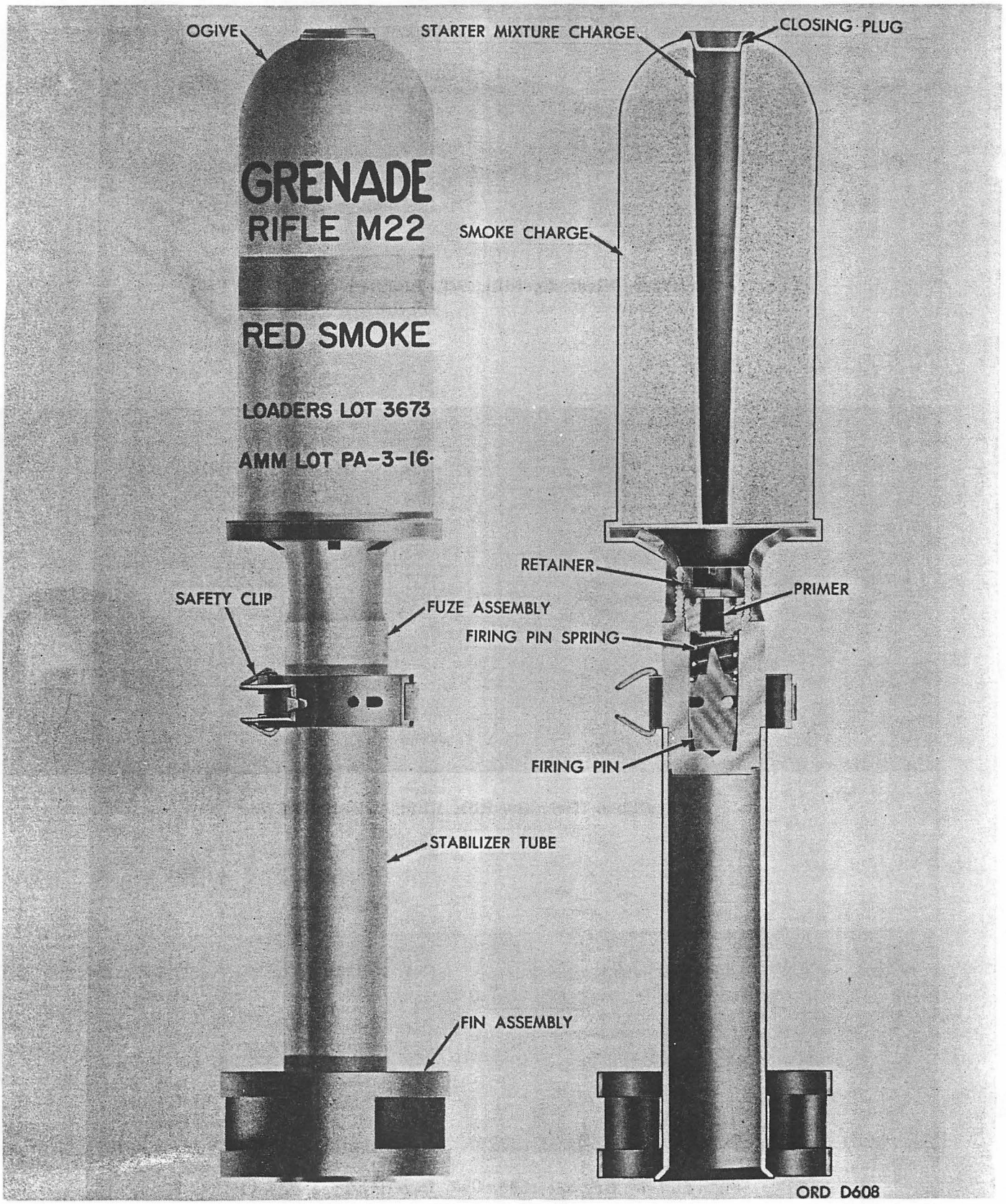


Figure 12-8. Grenade, Rifle, Colored Smoke, M22 Series

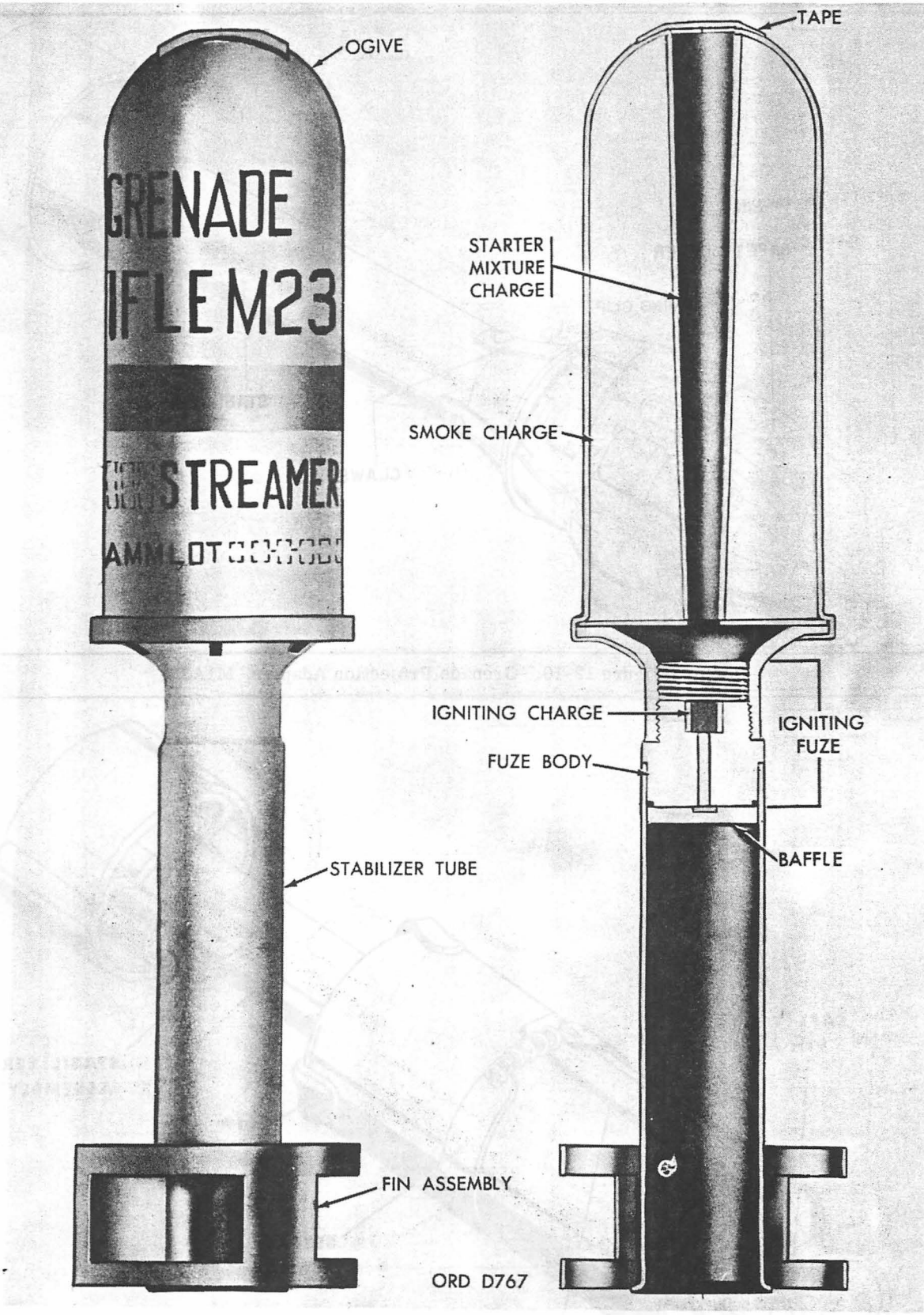


Figure 12-9. Grenade, Rifle, Colored Smoke, M23 (Streamer)

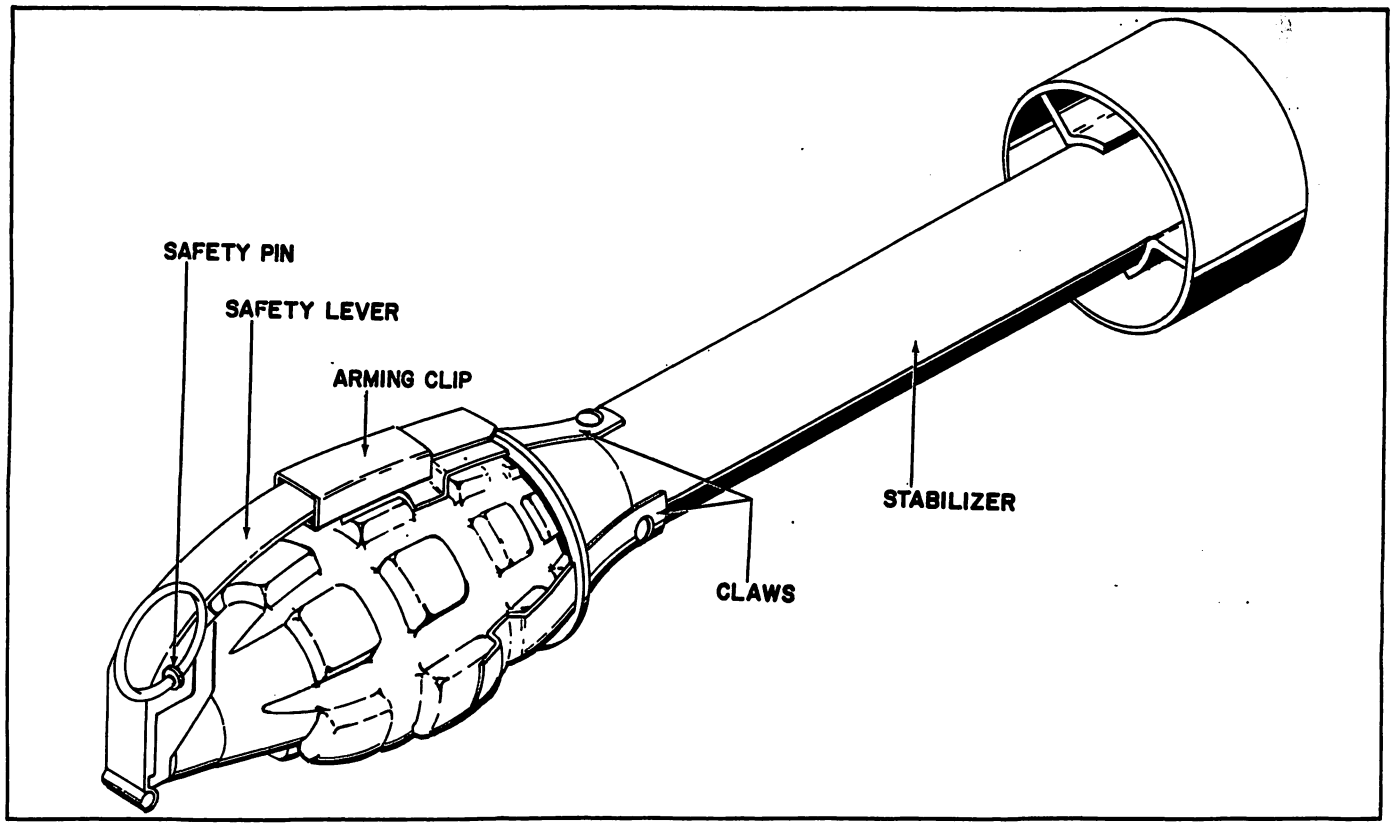


Figure 12-10. Grenade Projection Adapter, M1A2

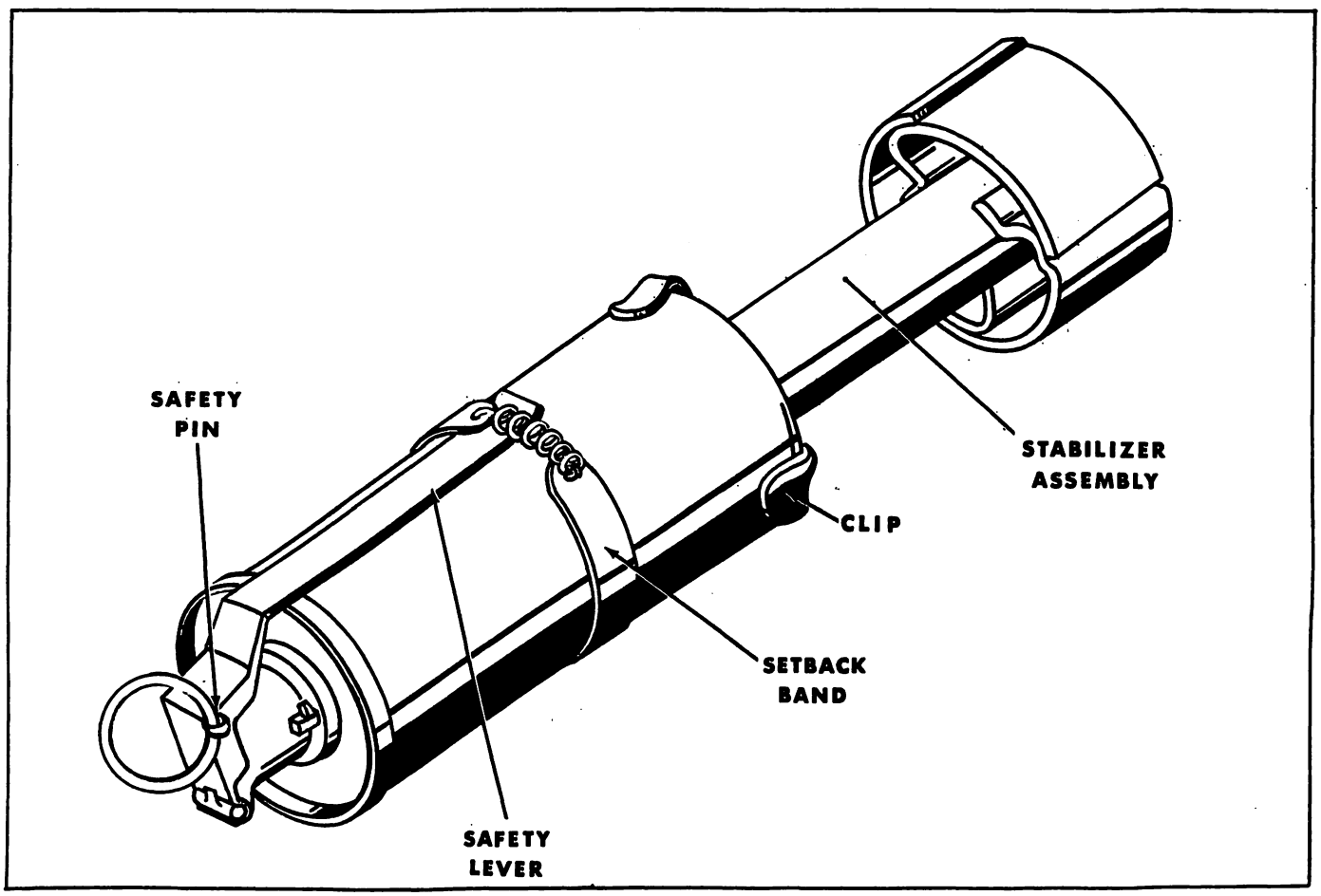


Figure 12-11. Grenade Projection Adapter, M2A1

12-44. COMPLETE ROUND DATA. A complete round consists of all the components necessary for the item to function as intended. Rifle grenades, as issued in present packs, may contain grenade cartridges for both rifle and carbine and auxiliary grenade cartridges. New packs of rifle grenades will contain grenade cartridges for rifles only. Complete rounds of rifle grenades are as follows:

a. ANTITANK (M31).... Filled body, fuze, and stabilizer are issued in one assembly. Launching cartridge may be attached to the stabilizer assembly.

b. ILLUMINATING (M27).... Filled body, fuze and stabilizer are issued in one assembly.

c. PRACTICE (M29).... Empty body and simulated fuze and stabilizer issued in one assembly. Replacement fin assemblies are provided for reuse of the grenades.

d. SMOKE (M22, M23).... Filled body, fuze, and stabilizer are issued in one assembly.

12-45. GRENADE PACKAGING AND MARKING.

12-46. Hand and rifle grenades are usually packed and shipped as fuzed complete round assemblies. Each grenade is packed in an individual fiber or hermetically sealed container in an outer wooden packing box. Box dimensions, cubes, and weight are listed by item in the 1330 class stock list.

12-47. FIBER CONTAINERS. Fiber containers are usually black and they are sealed to make them relatively moisture-proof. The grenade nomenclature and the explosive or chemical color identification are stenciled around the container.

12-48. METAL CONTAINERS. Metal containers are hermetically-sealed cans. They are painted either grey or black. The grenade nomenclature and the explosive or chemical color identification are stenciled around the containers.

12-49. FRAGMENTATION AND PRACTICE HAND GRENADES. Fragmentation and practice grenades are individually packaged in fiber containers with 25 or 40 grenade containers packed in a wooden box. The grenade box has a hinged top equipped with a sealed hasp.

12-50. TRAINING HAND GRENADES. Training grenades are packed 25 each in a divided (egg crated) box. The top of the box is nailed and banded by steel strapping.

12-51. RIFLE GRENADES M31, M29, M27, M19A1, M22, M23A1, M23A2. These grenades are individually packaged in metal or fiber containers. Several individual containers are packaged in a wooden over pack box. The box has cleated ends, a hinged top, rope handles, and is secured by a sealed hasp.

12-52. Tables of leading particulars for hand and rifle grenades are shown in figures 12-12 and 12-13.

NOMENCLATURE	LENGTH (INCHES)	DIAMETER (INCHES)	WEIGHT (POUNDS)	CHEMICAL OR EXPLOSIVE WEIGHT (OUNCES)	FUZE		ADAPTER
					TYPE	MODEL	
Fragmentation Hand Grenade, MK2	4.50	N/A	1.40	1.75 TNT	Deton	M204A1 M204A2 M6A4C	M1A2
Fragmentation Hand Grenade, M26	4.00	N/A	0.85	5.5 Comp B	Deton	M204A1 M204A2	M1A2 M1A2
M26A1	4.00		0.85	5.5 Comp B	Deton	M204A2	M1A2
M26A2	4.00		0.96	6.3 Comp B	Deton	M204A2	M1A2
Practice Hand Grenade, M21	4.50	N/A	1.27	0.10 Black Powder	Ignite	M205A1 M10A4	M1A2
Practice Hand Grenade, M30	4.00	N/A	0.92	0.10 Black Powder	Ignite	M205A1 M205A2	M1A2
Training Hand Grenade, MK1A1	4.50	N/A		Inert	Inert	Inert Simulated	N/A
Irritant Hand Grenade, CN-DM, M6	4.50	2.50	1.40	10.25 CN-DM	Ignite	M201A1	M2A1

Figure 12-12. Table of Leading Particulars, Hand Grenades (Sheet 1 of 2)

NOMENCLATURE	LENGTH (INCHES)	DIAMETER (INCHES)	WEIGHT (POUNDS)	CHEMICAL OR EXPLOSIVE WEIGHT (OUNCES)	FUZE		ADAPTER
					TYPE	MODEL	
Tear Hand Grenade, CN, M7A1	4.50	2.50	1.43	12.50 CN	Ignite	M201A1	M2A1
Riot Hand Grenade, CN M25A1	N/A	3.00	0.22	3.5 CN	Deton	C12	DO NOT USE
Smoke Hand Grenade, WP, M15	4.50	2.37	1.90	15.0 WP	Deton	M206A1	DO NOT USE
White Smoke Hand Grenade, HC, AN-M8	4.50	2.50	1.80	19 types HC	Ignite	M201A1	M2A1
Colored Smoke Hand Grenade, M18	4.50	2.50	1.31	11.5 colored smoke mixture	Ignite	M201A1	M2A1
Indendiary Hand Grenade, TH-3, AN-M14	4.50	2.50	2.20	26.5 TH-3	Ignite	M201A1	M2A1
Grenade, Hand and Rifle, M34	5.50	2.37	1.69	15.0 WP	Deton	M206A2	M1A2

Figure 12-12. Table of Leading Particulars, Hand Grenades (Sheet 2 of 2)

NOMENCLATURE	LENGTH (INCHES)	DIAMETER (INCHES)	WEIGHT (POUNDS)	CHEMICAL OR EXPLOSIVE WEIGHT (POUNDS)	FUZE	
					TYPE	MODEL
Grenade, Rifle HEAT, M31, W/M211 FUZE	16.96	2.6	1.56	0.62 comp B	Impact Detonating	M211 Fuze and M48 Elec Deton
Grenade, Rifle Practice, M29 (T42)	14.5	3.00	1.50	None inert	None	N/A
Grenade, Rifle Illuminating, M27 (T45)	9.65	2.28	1.50	0.50 Illuminant	Base igniting	N/A
Grenade, Rifle Smoke, WP, M19A1	11.31	2.00	1.5	0.53 WP	Mechanical Impact Detonating	N/A
Grenade, Rifle, Smoke, Red, Yellow, Green, Violet, M22, M22A2	10.72	1.8	1.26	0.40 Colored Smoke Mixture	Mechanical Impact Igniter	N/A
Grenade, Rifle, Smoke, M23 Red, Yellow, Green, Violet Streamer	M23A1 9.89	1.8	1.16	0.44 Colored Smoke	Base Igniting	N/A
Grenade, Hand and Rifle WP M34, W/M206A2 FUZE	5.50	2.37	1.69	0.94 WP	Detonating	M206A2

Figure 12-13. Table of Leading Particulars, Rifle Grenades

SECTION XIII
AIRCRAFT BOMBS, DISPENSERS, AND FUZES

13-1. INTRODUCTION.

13-2. A bomb is a type of airmunition designed to be dropped from an aircraft in flight. It will inflict damage or serve a special purpose such as a target identification. It may provide a light source for photography. A bomb consists essentially of a metal container filled with an active charge, a device for stabilizing its flight, a mechanism for exploding the bomb, and safety devices. The metal container, called the bomb body, is usually streamlined with a rounded (ogival) nose and a tapered tail. The stabilizing device (fin) is attached to the tail end of the body and generally consists of a sheet metal fin assembly or a parachute unit. The mechanism for exploding the charge is called a fuze and is generally placed in the nose or tail of the body, or both. Two fuzes may be used in the same bomb for different effects or to ensure reliability of functioning. Safety devices are built into the fuze and are held in place during storage and shipment by seal wires or cotter pins. When the bomb is prepared for use, the seal wire and cotter pins are replaced by an arming wire, which is removed as the bomb is dropped.

13-3. COMPONENTS. (See figure 13-1.) For reasons of safety, the components of a bomb are usually stored and shipped separately and must be assembled prior to use. The components of bombs differ (depending on the particular type and model), but in general, they consist of: unfuzed bomb body containing the charge; fuze or fuzes; adapter boosters; fin assembly (assembled to small bombs as shipped); and arming wire assembly.

13-4. INSTALLATION. Bombs are installed in or on aircraft by means of suspension lugs. The lugs are either on the side of the bomb body as manufactured, or fastened to it by means of bands so arranged to provide for horizontal suspension. Smaller bombs may not have provisions for suspension because they are designed to fit into clusters or dispensers.

13-5. FUNCTIONING. Bomb functioning depends primarily on the fuze action, which may be instantaneous, delay, time, or proximity. The terms instantaneous and delay refer to the action at the instant of fuze impact with the target. The term time refers to the elapse of time from the release of the bomb from the aircraft until the instant of functioning of the fuze. Proximity refers to the characteristics of functioning upon approach to, but at some distance from, the target.

13-6. FUZE ARMING. Bomb fuzes, after being fitted to bombs, are prevented from arming and consequently from functioning by means of an arming wire. The wire is normally withdrawn from the fuze by the bomb's release from the aircraft. When it is necessary to remove the arming wire and defuze a bomb, the applicable seal wire or cotter pin will be replaced before removing the arming wire. Provisions are made in the aircraft for releasing a bomb safe by releasing the arming wire with the bomb at instant of separation. The wire falling with the bomb will not allow the fuze to arm and the bomb will impact unarmed and not function as designed.

13-7. CLASSIFICATION. Bombs are classified according to type of filler as explosive, chemical, incendiary, pyrotechnic, or inert. They are classified as to use as armor piercing (AP), semi armor piercing (SAP), general purpose (GP), fragmentation (FRAG), gas smoke, incendiary, miscellaneous, practice, and dummy.

13-8. HIGH EXPLOSIVE BOMBS.

13-9. High-explosive bombs are intended for the destruction of enemy buildings, bridges, military installations, and other target complexes. The destructive effect is produced by detonation (blast effect), by projection of fragments of the case (fragmentation), and by displacement of earth and structures (mining). A typical bomb explosive train is shown in figure 13-2.

13-10. GENERAL-PURPOSE BOMBS. General purpose bombs are divided into three distinct types: old series GP bombs (figures 13-3 and 13-4) which range in weight from 100 to 2,000 pounds, the streamlined new series GP bombs (figure 13-5), which range in weight from 750 to 3,000 pounds; and low-drag GP bombs (figure 13-6 and 13-7), which range from 250 to 2,000 pounds.

13-11. GP bombs will produce blast, fragmentation, and deep-mining effects. Their functions are determined by the action of the fuzes and fuze components with which they are armed. For example, when old series GP bombs are fuzed with long-delay tail fuzes, the chemical delay acts to detonate the bomb from 1 hour to 6 days from the time of release. Under these circumstances there is no nose fuze that can be used; therefore, the shipping plug may be retained in the bomb nose or a nose fuze may be installed for selectivity in functioning. Normally, GP bombs use a nose fuze (which produces instantaneous or short-delay action) and a tail fuze to increase functioning reliability. GP bombs gain their principal effect from their high explosive content.

13-12. The explosive filler of GP bombs represents approximately 50 percent of the total weight. The bomb cavity is completely filled with explosive filler except for thin pads of inert wax (called sealers) at

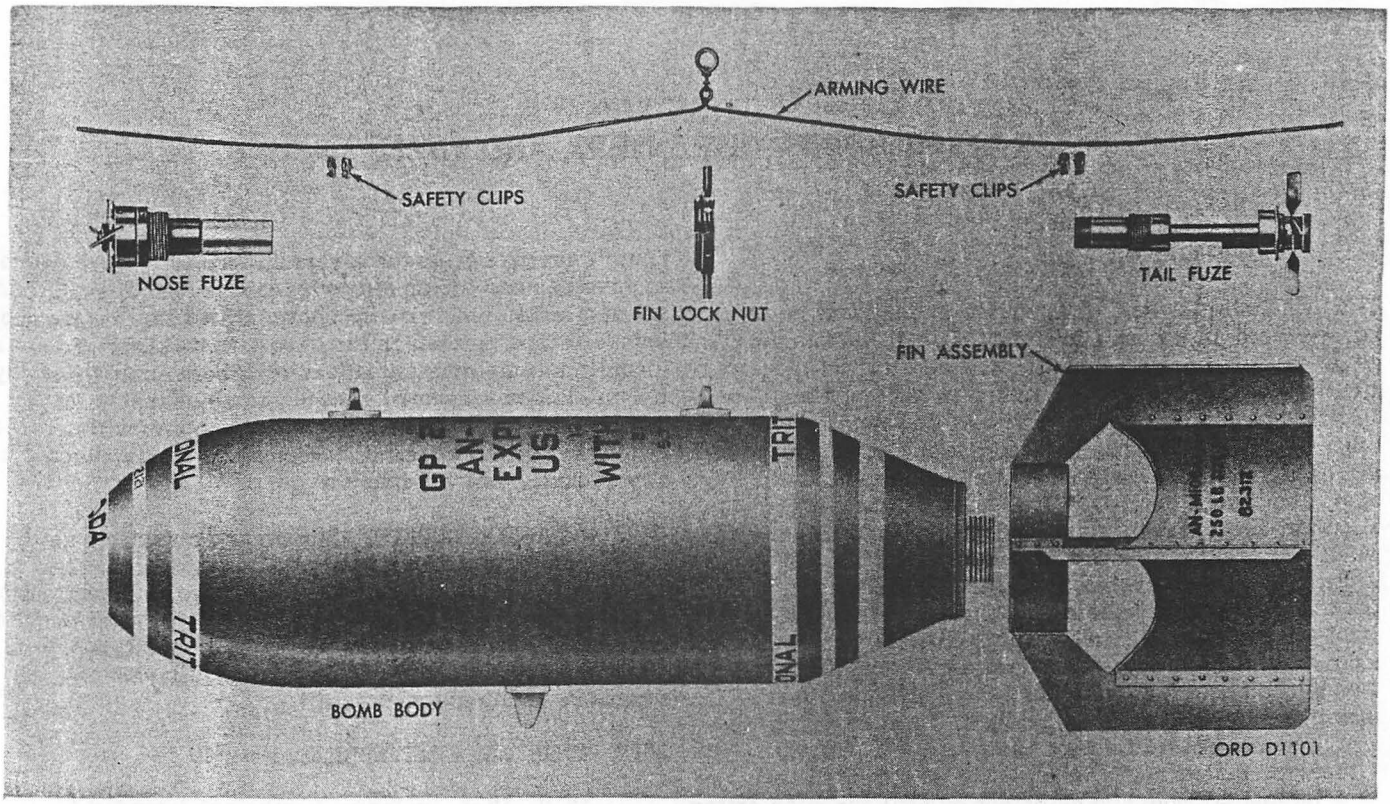


Figure 13-1. Components of Bomb Complete Round with Box Fin

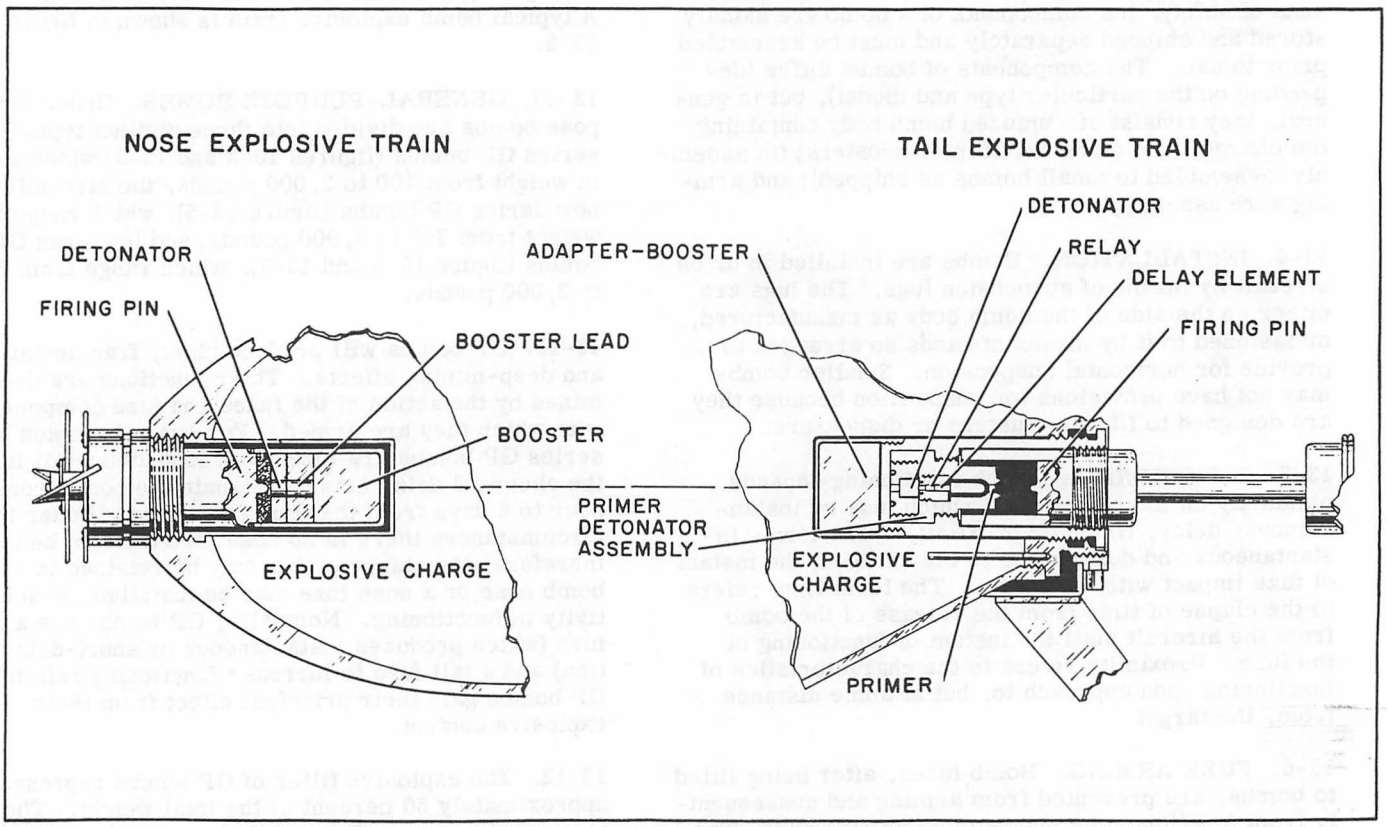


Figure 13-2. Typical Bomb Explosive Train

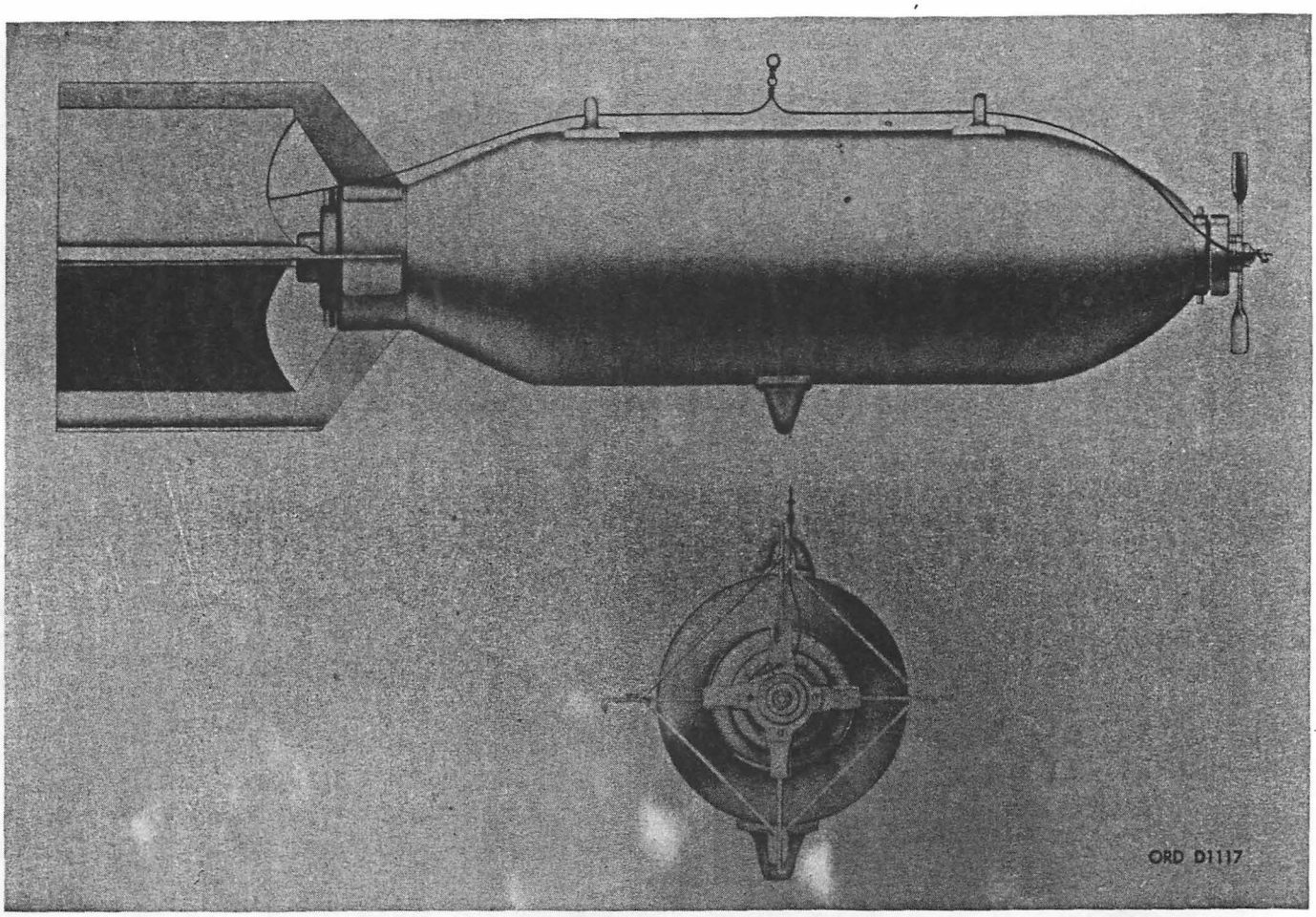


Figure 13-3. Old Series General Purpose Bomb with Box Fin Assembly

the nose and tail portions. The type of explosive filler used, as with fuzes, depends upon the use or function of the bomb. GP bombs can be loaded with tritonal, amatol, TNT, Comp B, H6 and, in some cases, HBX.

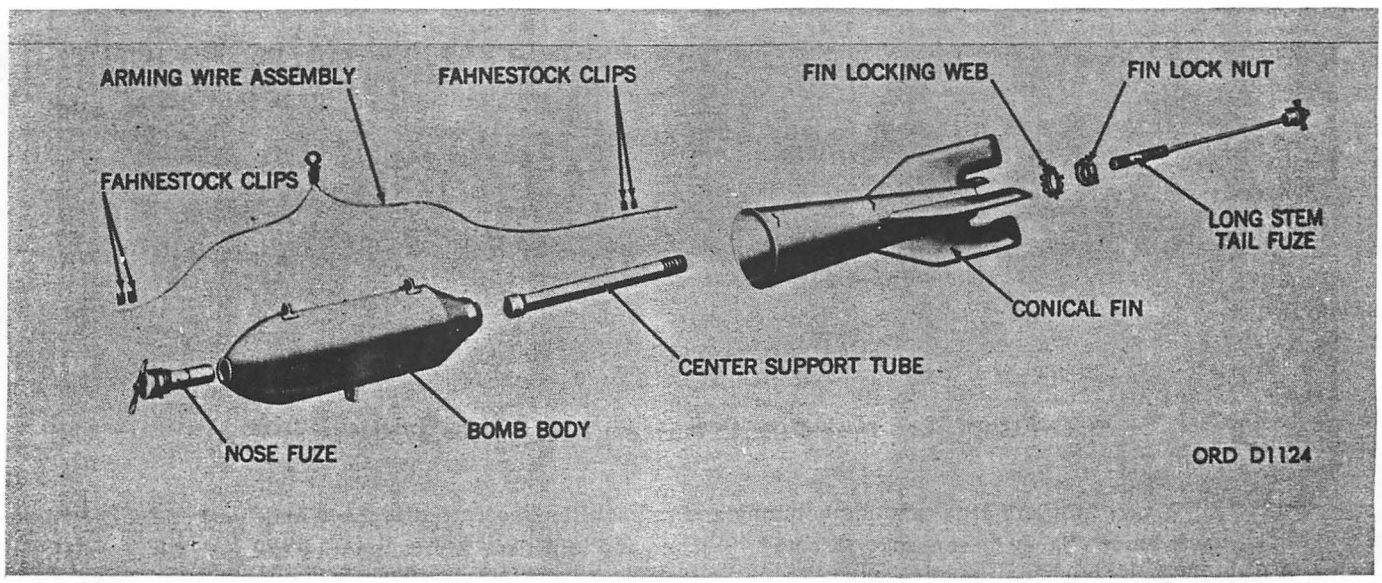


Figure 13-4. Old Series General Purpose Bomb With Conical Fin Assembly, Exploded View

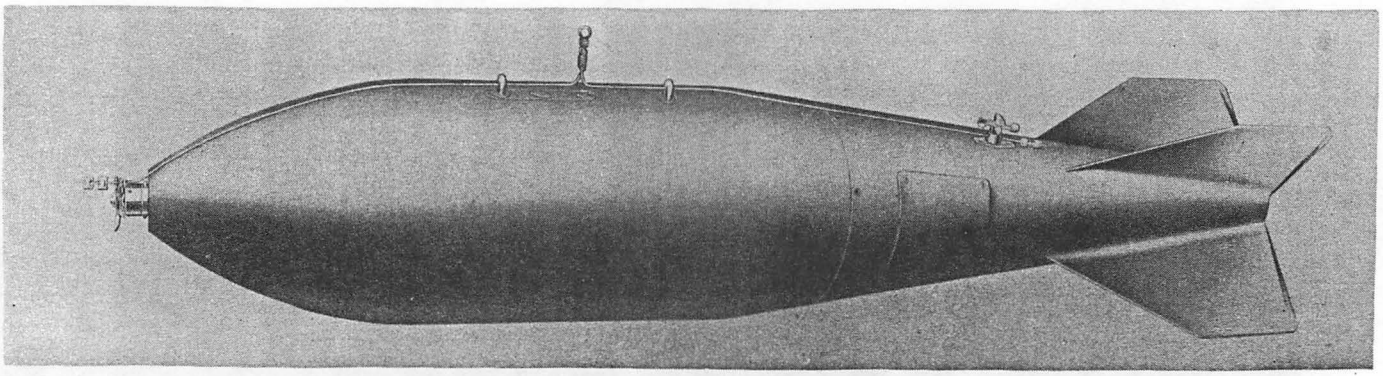


Figure 13-5. New Series General Purpose Bomb, Typical

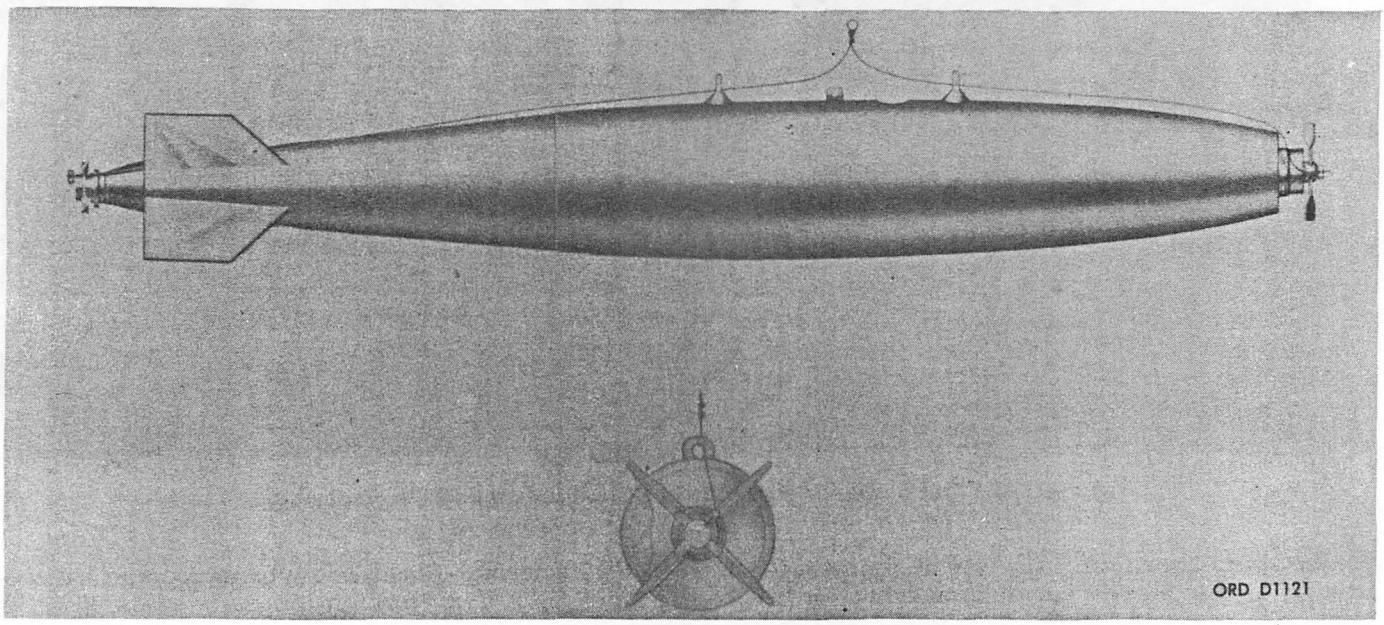


Figure 13-6. Low Drag General Purpose, Typical

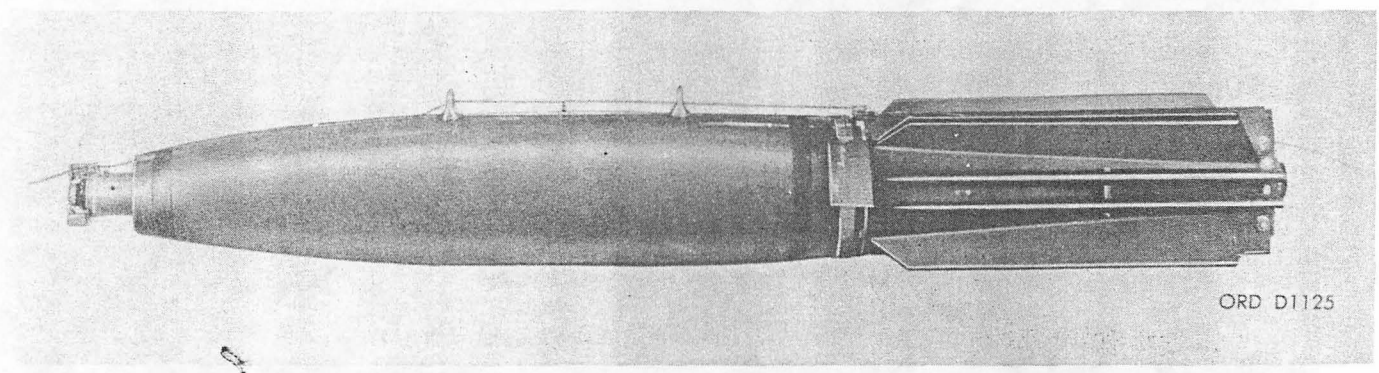


Figure 13-7. Low Drag General Purpose Snakeye I Series, Bomb

13-13. The development of high-altitude bombing and hign-speed aircraft made changes necessary in both external and internal design of GP bombs, plus the use of conical streamlined fin assemblies. The new-series and low-drag type bombs and the fin assemblies used, (figure 13-5 and figure 13-6) were designed to reduce air resistance and give better ballistic accuracy and aerodynamic performance in the transonic and supersonic ranges. A later model of the low-drag series (Snakeye I and Snakeye II)

(figure 13-7) incorporates a retarding fin assembly which provides a high-speed low-altitude bombing capability. Some new-series GP bombs are designed for electric fuzing. However, other nose and tail fuze combinations are also authorized. Old-series GP bombs are shipped with adapter-boosters installed. New-series and low-drag bombs are shipped without adapter-boosters.

13-14. The old-series GP bomb is a relatively thin-cased bomb (figure 13-8) with an ogival nose, parallel side walls, and a tapered aft section. Both nose and tail fuzes are used for a majority of operations. Approximately 50 percent of the complete weight of the round is its explosive filler of amatol 50--50, TNT, tritonal or Composition B. Two suspension lugs, 14 inches or 30 inches apart, are welded to one side of the bomb body, and a single lug is welded to the opposite side at the center-of-gravity. The old-series GP bomb uses both the box-type fin assembly and the conical-type fin assembly. The box-type fin assembly is secured to the aft end of the bomb body with a fin locknut, while the conical-type fin assembly is secured by means of a support tube, a locking web and a locknut. The base plug of the bomb is locked securely to the bomb body by two studs which extend from the base plug into the solidified explosive filler. The adapter-booster is locked to the base plug by a locking pin which is passed through a hole in the adapter-booster into a groove in the base plug. The above modifications were initiated to prevent removal of the base plug and adapter-booster when fuze anti-withdrawal devices are used. Bombs filled with amatol 50-50 include nose and tail surrounds of TNT, a body gasket, and an auxiliary booster. These features are not included with other explosive fillers.

13-15. The new-series general purpose bombs (previously called demolition bombs) (figure 13-9) are designed for a higher blast effect than smaller general purpose bombs. They are designed for improved aerodynamic performance and accuracy in flight when released from most altitudes and airspeeds. These bombs have a cigar-shaped body. A conical fin assembly is bolted to the rear. They are designed for either mechanical or electric fuzing. For electric fuzing they are equipped with two conduits (plumbing) for the fuze cable harness. These conduits connect the nose and tail fuze cavities with a charging receptacle located between the suspension lugs. These bombs are equipped for double suspension. Unlike the smaller (old-series) general purpose bombs, the new-series bombs have adapter-boosters capable of receiving tail fuzes with a 2-inch thread instead of the usual 1-1/2-inch thread. A fuze adapter is used on the inside of the adapter-booster to convert the fuze seal to accommodate fuzes with the smaller 1-1/2-inch threads. Bomb M117 has a 14-inch span between lugs, while bomb M118 has a 30-inch span. In the latter bomb, a single hoisting lug may be attached at the center of gravity.

13-16. Low-drag GP bombs have a slender body (figure 13-10) with a long, pointed nose. A streamlined fin is attached to the aft end of the bomb body by six or eight setscrews. These bombs use proximity (VT), mechanical or electrical fuzes. Mechanical and proximity fuzes require the installation of adapter-boosters to provide fuze seats of smaller diameters. Two conduits for the electric fuze cable harness connect the nose and tail fuze cavities with the charging receptacle cavity between the lugs of the outer surface of the bomb case. When electric fuzes are not used, a plug is threaded into the charging receptacle cavity. As shipped, the bomb body has a nose fuze plug, a support cup in the nose fuze cavity and a base fuze plug. When the bomb is mechanically fuzed, these three parts are removed and the adapter-boosters and fuzes are inserted. Adapter-boosters and arming wires are not used with electric fuzes. If the bomb is tail fuzed only, the support cup must be reinserted in the nose cavity to prevent collapse of the fuze cavity on heavy impact. The bomb body has a base plug containing locking pins which are imbedded in the solidified explosive filler. Two suspension lugs, spaced either 14 inches or 30 inches apart, and a hoisting lug at the center of gravity are threaded into lug inserts on the bomb body at time of use.

13-17. The Snakeye I- and Snakeye II-Series (Mk81 Mod 1 and Mk82 Mod 1 Low-Drag) bombs are characterized by a flight-retarding tail fin assembly (figure 13-11) attached by a quick-attachment mechanism. The retarding fin provides the aircraft with a high-speed, low-altitude bombing capability. It replaces the standard fin assembly and presents a low-drag configuration when closed. When the retarding-fin release-band assembly is activated, the assembly expands into four blades which open like an umbrella and decelerate the bomb so that it impacts almost perpendicular to the ground. The release mechanism is mechanical and is activated by the removal of the tail-release wire. The snakeye series bombs normally employ a nose fuze only. An option of releasing this bomb as a low drag configuration is available by not deploying the retarding fin assembly.

13-18. ARMOR-PIERCING. (See figure 13-12.) Armor-piercing bombs are used to pierce highly resistant targets, such as concrete bomb-proof construction and the heavy decking of armor plate on seagoing vessels. The various sizes range from 1,000 to 1,600 pounds. The case of the AP bomb is very thick, especially at the nose. The percentage of explosive is approximately 15 percent of the total weight. This type of bomb is loaded with explosive D, which is sufficiently insensitive to withstand the force of impact without exploding. The bomb is adapted for a tail fuze only, which is of the delay type to permit deep penetration of the target before detonation.

13-19. SEMI-ARMOR-PIERCING. (See figure 13-13.) Semi-armor-piercing bombs are used against reinforced concrete construction and lightly armored shipping. The various models range in size from 500 to 2,000 pounds. The percentage of explosive is approximately 30 percent of the total weight. This type of bomb is loaded with picratol. A delay tail fuze is used with this bomb. Although some of these bombs are adapted for a nose fuze, it is rarely used. The nose fuze well is ordinarily closed with an armor-piercing plug.

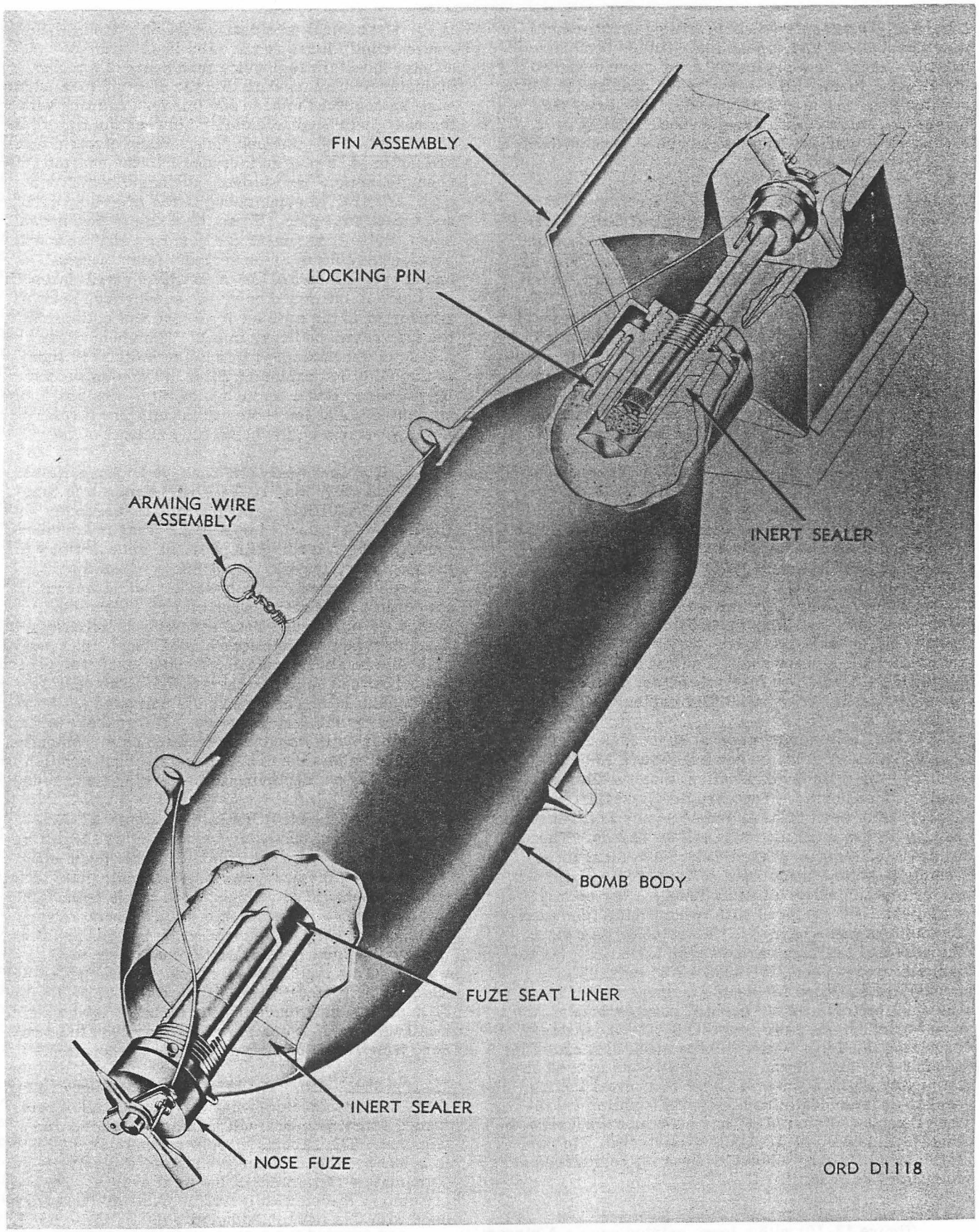


Figure 13-8. Old Series General Purpose Bomb, Cutaway View

13-20. FRAGMENTATION. (See figures 13-14 and 13-15.) Fragmentation bombs are designed for high-velocity projection of fragments. With the exception of the four-pound M83 fragmentation bomb, the body of a fragmentation bomb consists of a thin tabular sleeve closed at each end by a cast-steel cup. A body of heavy steel bar stock, spirally wound, is assembled to the outside of the steel sleeve and provides the principal source of fragments when the bomb is detonated. The nose piece is threaded to receive an impact fuze and the tail cap is threaded to provide attachment of the fin assembly. Fragmentation bombs which weigh 220 pounds or more and are effective against personnel or materiel are threaded to receive both nose and tail fuzes. The bombs are usually loaded with COMP B or TNT and the explosive charge averages 14 percent of the total weight. Fragmentation bombs range in size from 4 to 260 pounds. All small and medium sizes may be assembled in clusters by use of cluster adapters. The cluster is dropped from the aircraft as a unit. Withdrawal of the arming wire when the cluster is dropped acts to release the bombs from the cluster. This action is accomplished either by mechanical means directly or by arming a mechanical time fuze that opens the cluster after an interval. Fragmentation bombs are usually stabilized by one of the following methods:

a. Fin-stabilized. This type of fragmentation bomb is stabilized by fins. They are fitted with arming-vane type fuzes that function instantaneously on impact. Proximity nose fuzes may also be used to produce air burst. Bombs of the 220-pound size or larger are adapted for both nose and tail fuzes. The smaller bombs use a nose fuze only. Conical or box fins may be used on the 220 and 260 pound bombs.

b. Parachute-stabilized. This type of fragmentation bomb is fitted with a parachute unit to stabilize the bomb and retard its fall. It is used for low-altitude bombing, and the time interval between release of the bomb and its functioning on impact permits the aircraft to clear the danger area. The parachute fragmentation bomb uses an instantaneous impact type fuze. The fuze has a delay in arming after the arming wire is withdrawn by the opening of the parachute but functions instantaneously on impact.

c. Butterfly wing-stabilized. (See figure 13-16.) This type is the 4-pound Fragmentation Bomb M83 (Butterfly), which is a cylindrical bomb used only in clusters. Metal butterfly wings, which encase the body, are opened by spring action when the bomb is released from the cluster. The wings are forced to the top of a cable extension and caused to rotate by the airstream. The wings retard the fall of the bomb and, by turning the cable, withdraw the fuze arming stem, thus arming the fuze. The fuze is located transversely in the side of the cylindrical body. The action of the fuze may be air-burst, instantaneous on impact, delay after impact, or antidisturbance.

13-21. CHEMICAL (GAS) BOMBS.

13-22. Chemical bombs are generally made of a seamless tubing type construction with exacting methods to ensure no leakage of the filler. They may resemble the general purpose bomb construction or be quite different in size and shape. Some models are made of rather light metal construction to allow for easier case opening without destruction of the filler contents by the heat of a large amount of burster explosive. The bomb generally incorporates a burster well (tube) from the nose to the tail. Upon functioning of the burster explosive, the bomb case ruptures and disperses the chemical agent. The agent may be a persistent or non-persistent type. The bombs may be in the form of smaller bomblets for use in dispensers and clusters. Dispenser type bomblets may or may not have fin-stabilization. Examples of gas bombs are as follows:

a. Bomb, Gas, Nonpersistent, GB, 10-lb, M125A1: This bomb is a sheet-steel cylinder with a burster

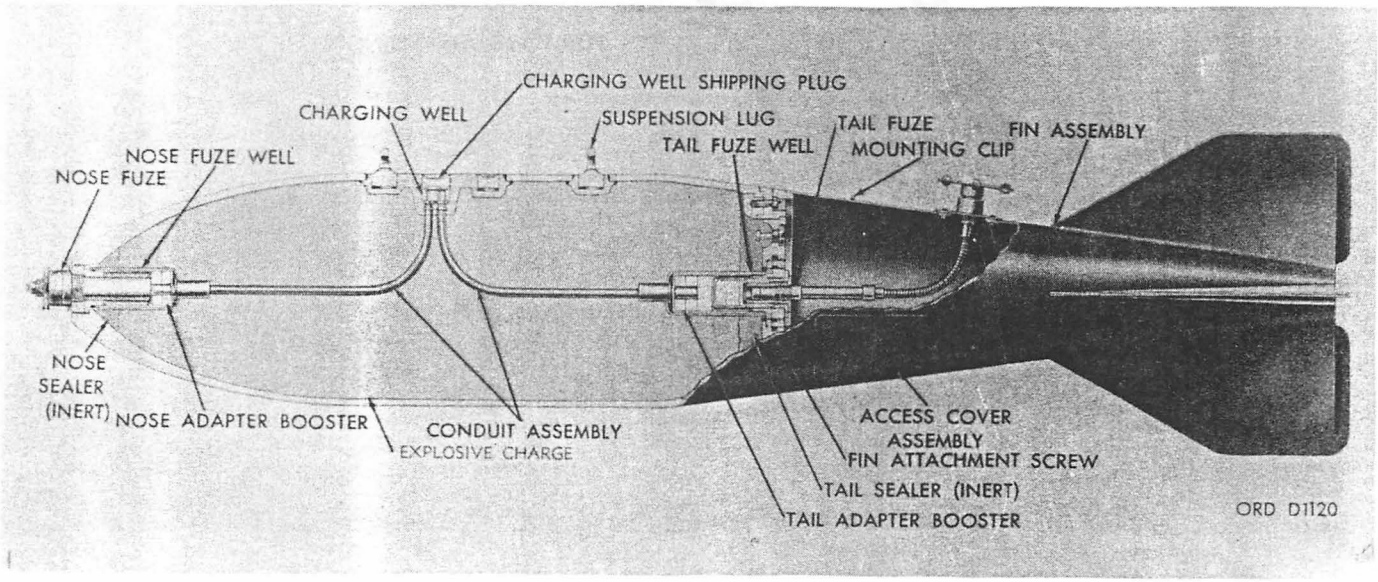


Figure 13-9. New Series General Purpose Bomb, Cutaway View

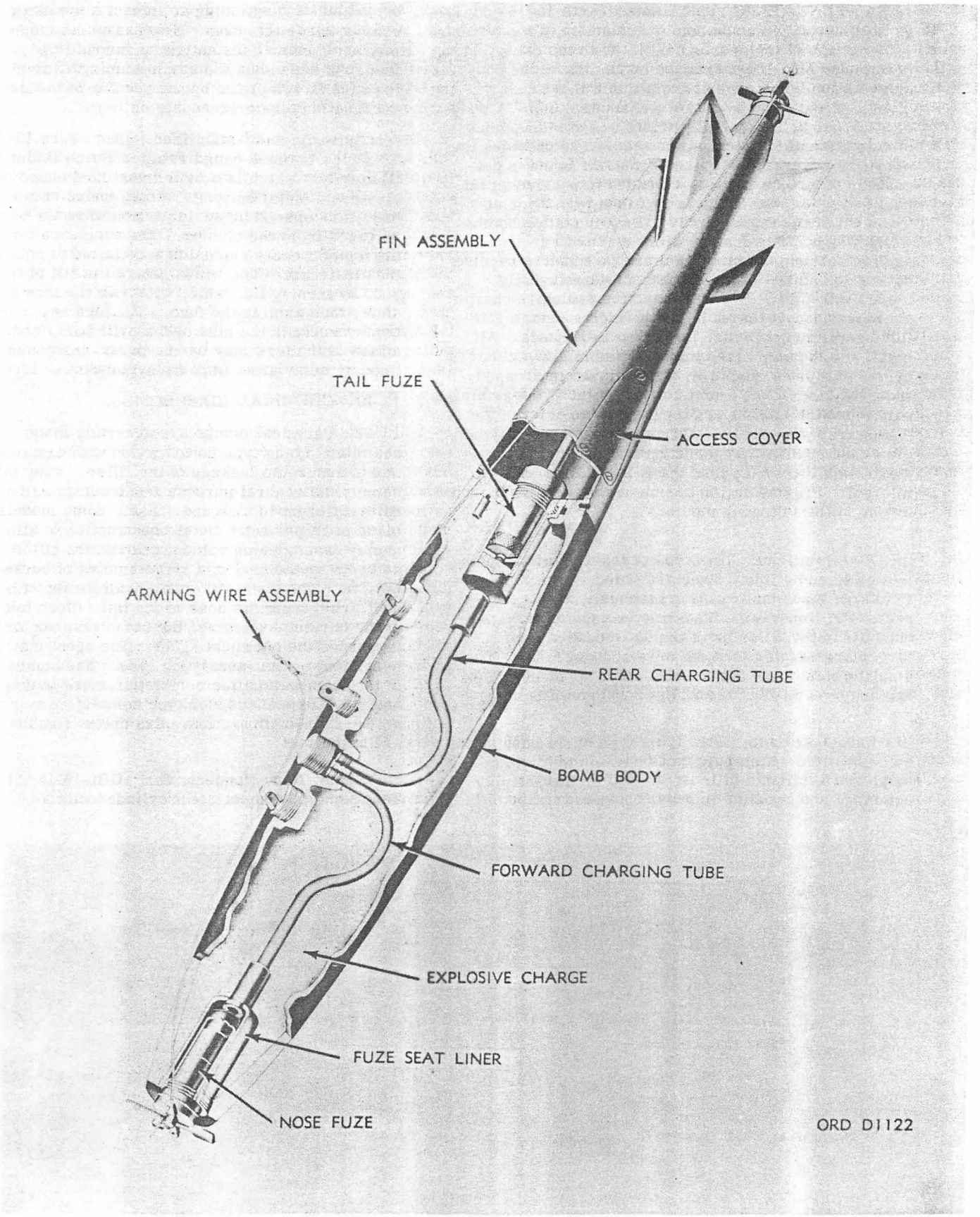


Figure 13-10. Low Drag General Purpose Bomb, Cutaway View

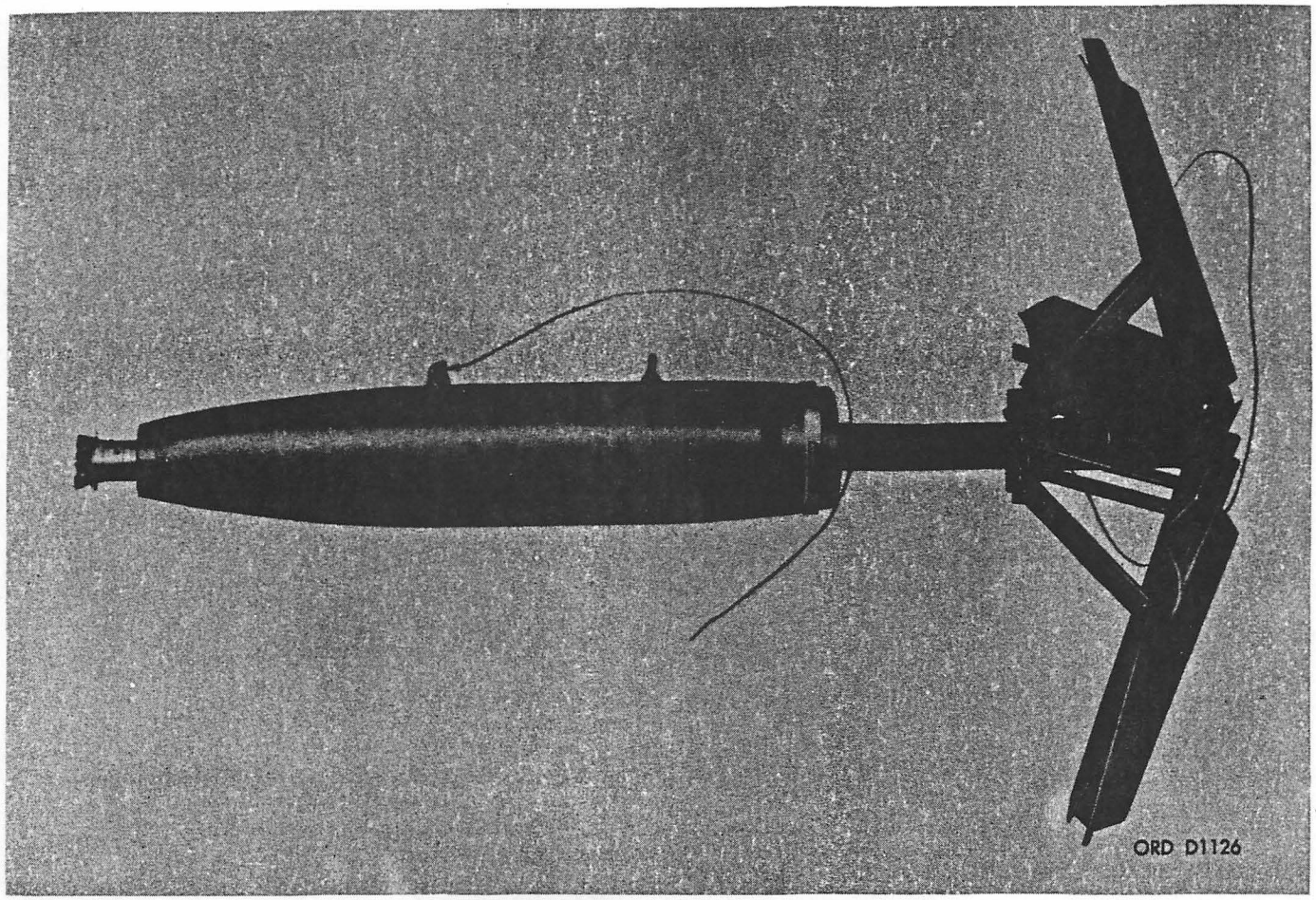


Figure 13-11. Low Drag, General Purpose, Snakeye I, Bomb with Fin Assembly Opened

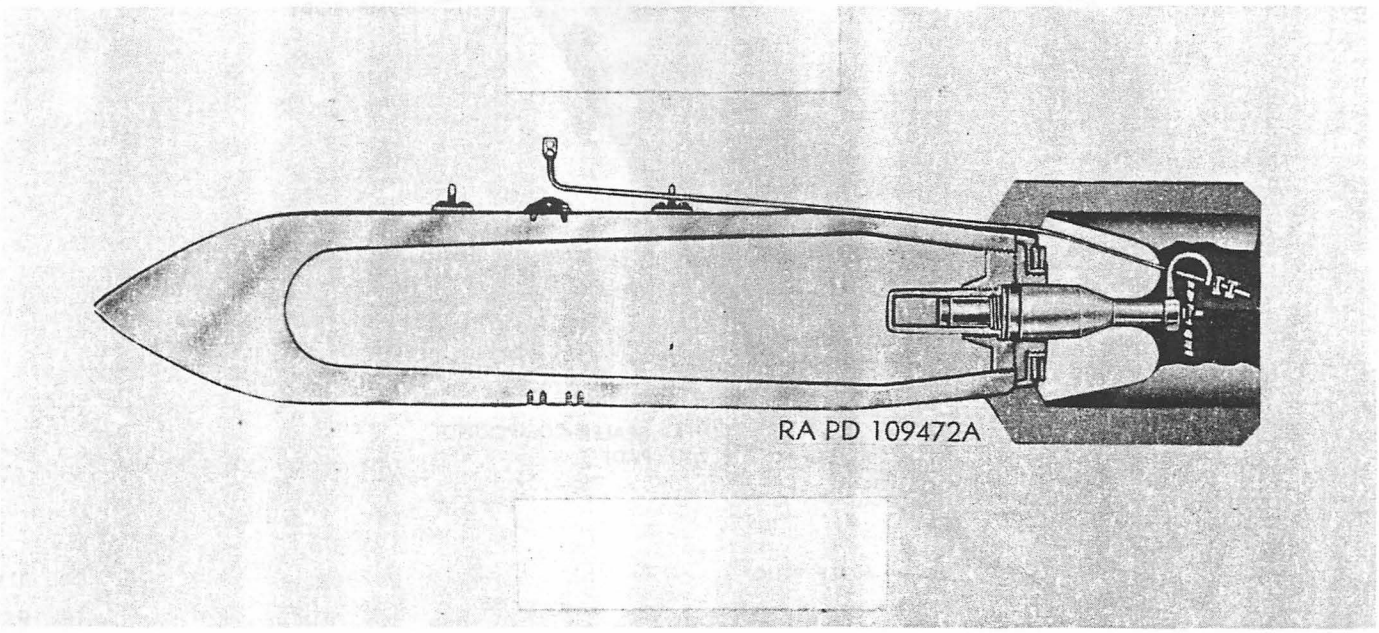


Figure 13-12. Armor-piercing Bomb, Cutaway View

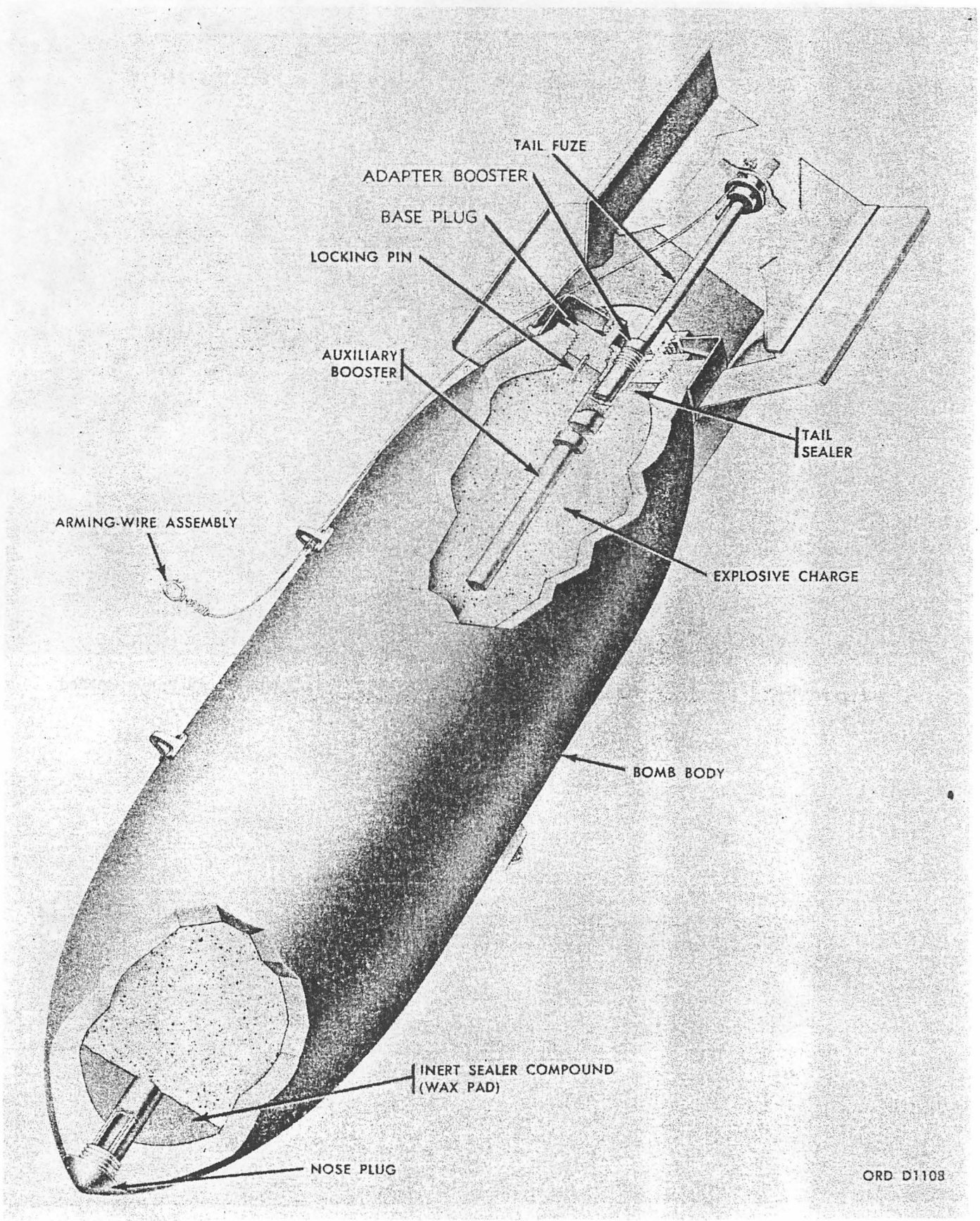


Figure 13-13. Semi-armor-piercing Bomb, Cutaway View

well and fuze at the front and a parachute at the rear ends. The bomb is used in ejection functioning clusters. This bomb is shown in figure 13-17.

b. Bomb, Gas, Nonpersistent, GB, 750-lb, MC-1. This bomb (figure 13-18) is designed for internal or external carriage on bomber and tactical-fighter aircraft utilizing single or double lug suspension for release at altitudes up to 60,000 feet, and air speeds up to 600 knots. MC-1 is essentially a new-series, general-purpose bomb M117 modified to accommodate a liquid chemical filler and a burster.

c. Bomb, Gas, MK94 Mod 0. Gas bomb MK94 Mod 0 (figure 13-19) is essentially a MK82 Mod 1 general-purpose, low-drag bomb which has been modified for GB filling. The modification consists largely in the elimination of the electric cable conduits from the low-drag bomb, and the addition of a burster and filler hole.

13-23. SMOKE BOMBS.

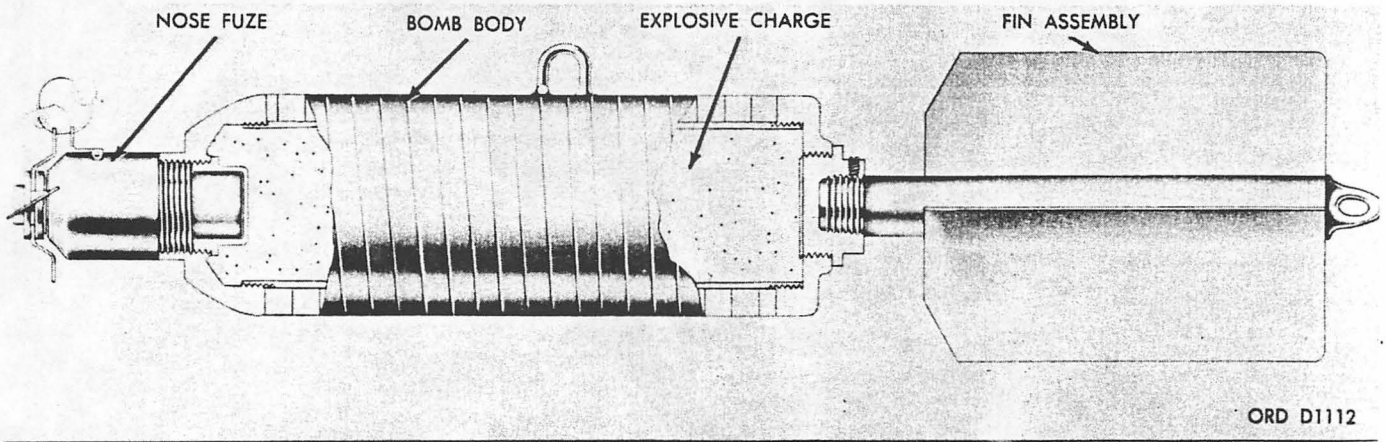
13-24. Smoke bombs such as the AN-M47A4, are generally used for screening purposes and for concealing troop movements. They may also be used for marking target areas. The bomb usually has a thin metal case containing a full length burster well (figure 13-20). The standard filling for these bombs is plasticized white phosphorus (PWP), which is a smoke-producing agent. Plasticized white phosphorus has a mild incendiary effect and will set fire to materials having a low kindling point, such as clothing, dry brush, paper, canvas, etc. Functioning of a fuze and a burster shatters the bomb on impact, dispersing the agent in burning particles over a wide area. The particles are ignited spontaneously by atmospheric oxygen and produce a dense white smoke.

13-25. INCENDIARY BOMBS.

13-26. Incendiary bombs are filled with burning agents such as thickened fuels and metallic fillings. A third type of incendiary material, not classified as a filling, is the magnesium from which the bodies of some incendiary bombs are made.

13-27. The incendiary bomb is designed for use against combustible land targets where large and numerous fires will cause serious damage and for use in igniting oil slicks on water.

13-28. THICKENED FUELS. Thickened fuels are composed of flammable liquids, such as gasoline, thickened to a jellylike consistency. PT1 and NP are examples of thickened fuels which are used to fill



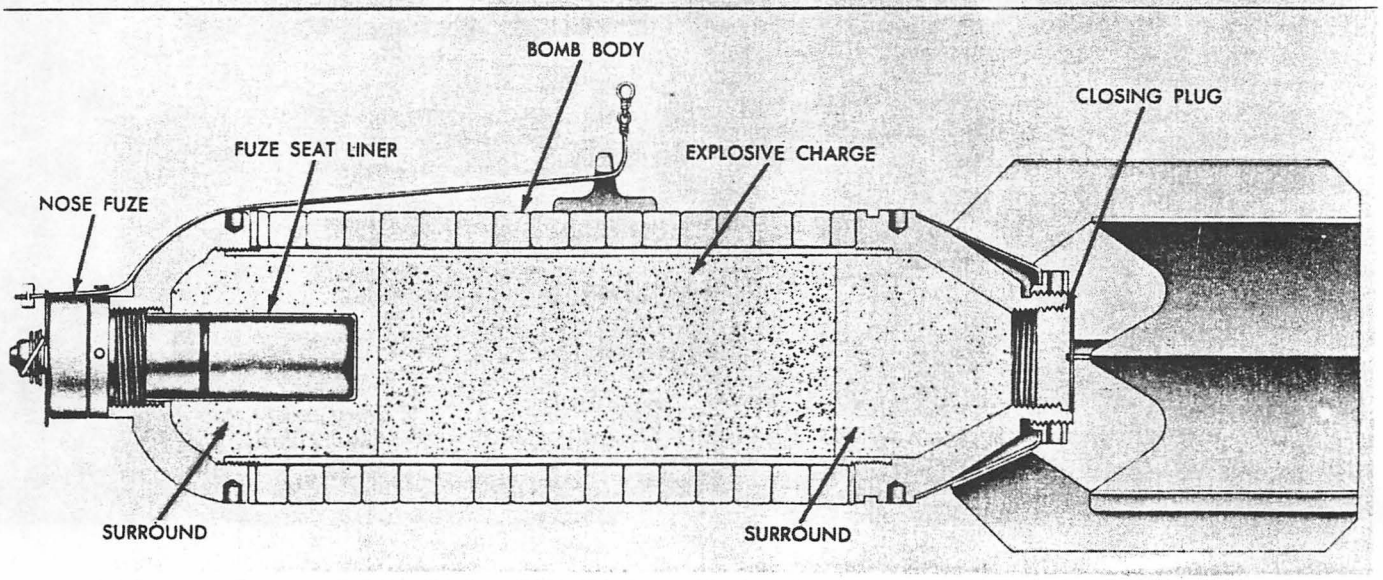


Figure 13-14. Fragmentation Bombs, M41A1 and M82, Cutaway View

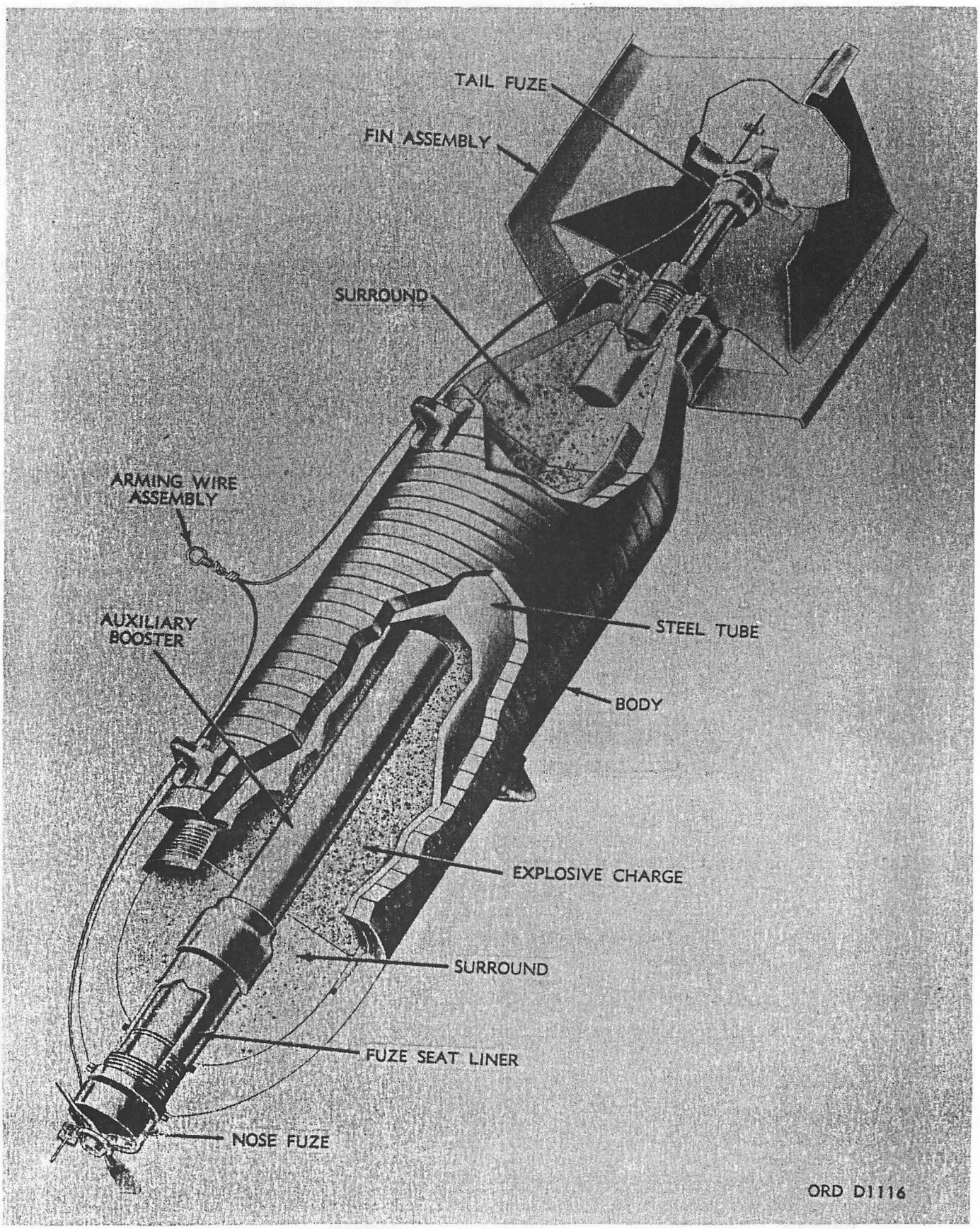


Figure 13-15. Fragmentation Bomb, Typical AN-M88 and AN-M81 Series, Cutaway View

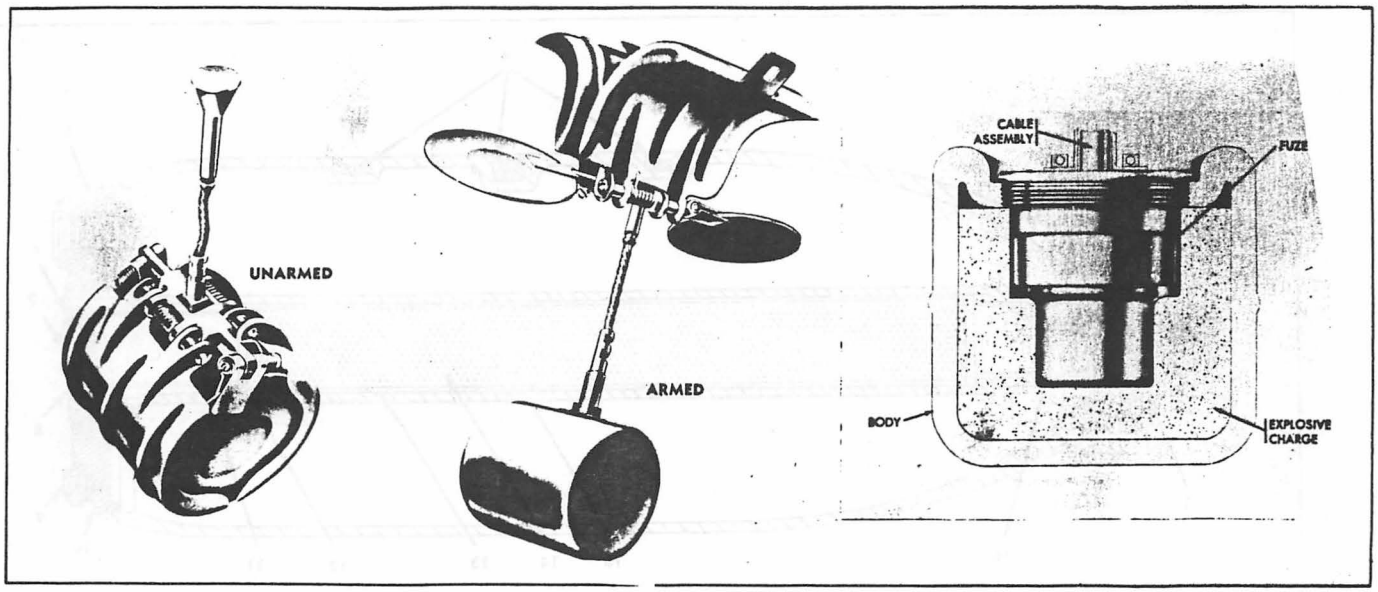


Figure 13-16. Fragmentation Bomb, M83 Butterfly Wing Stabilized, Cutaway View

incendiary bombs. PT1 is essentially a mixture of magnesium, petroleum products, and isobutyl methacrylate.

13-29. METALLIC FILLINGS. The basic ingredient of metallic incendiary filling is thermite. THERMITE is a mixture of powdered aluminum and powdered iron oxide, which, when ignited by an igniter (such as black powder), burns at a temperature of about 4,000 ° F. White-hot molten iron is released when thermite burns, and acts as a heat reservoir to prolong and spread the incendiary effect. When used as a filling

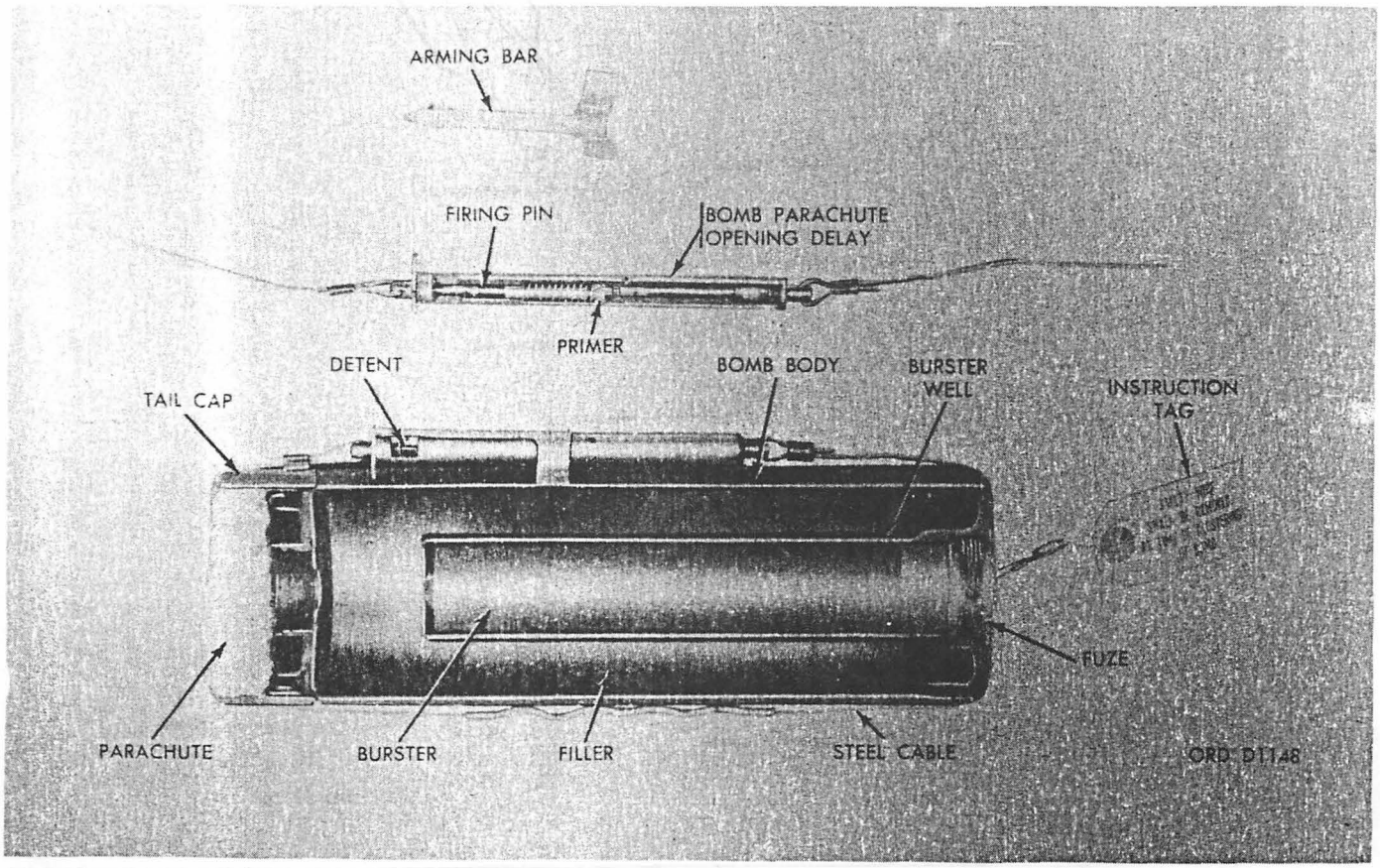


Figure 13-17. Gas Bomb, Nonpersistent, GB, M125A1, Cutaway View

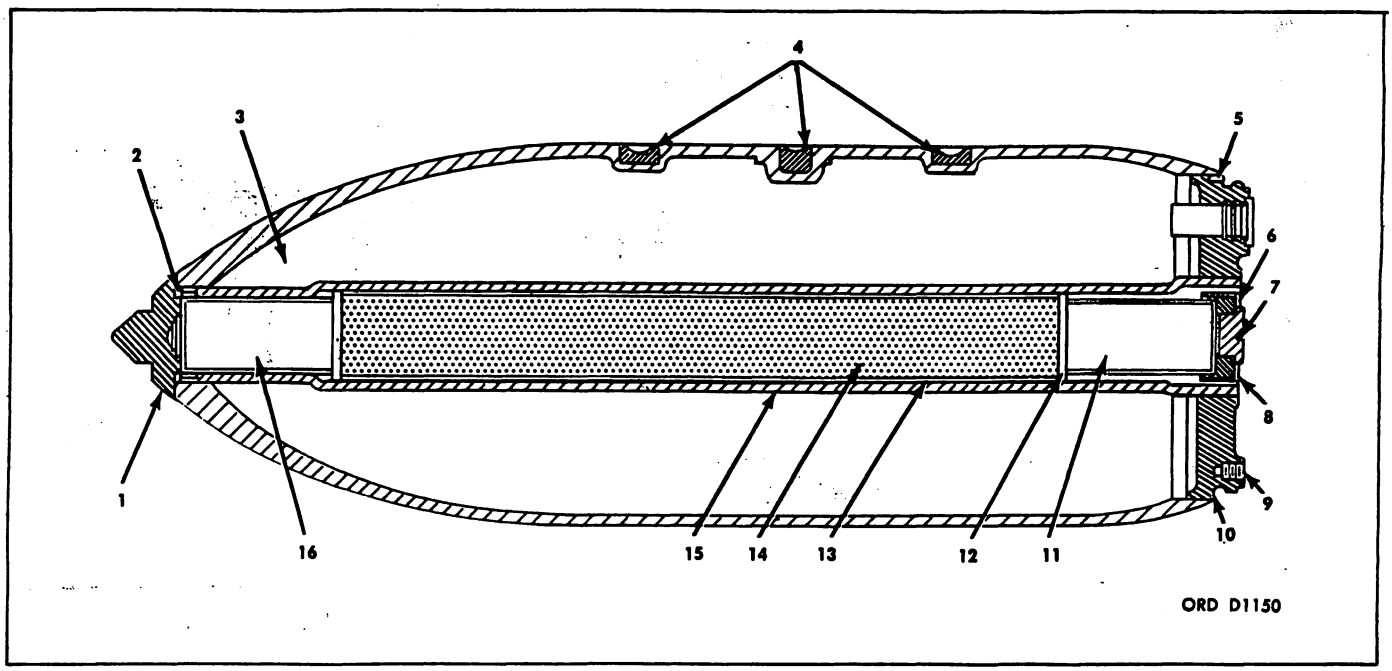


Figure 13-18. Gas Bomb, Nonpersistent, GB, MC-1, Cutaway View

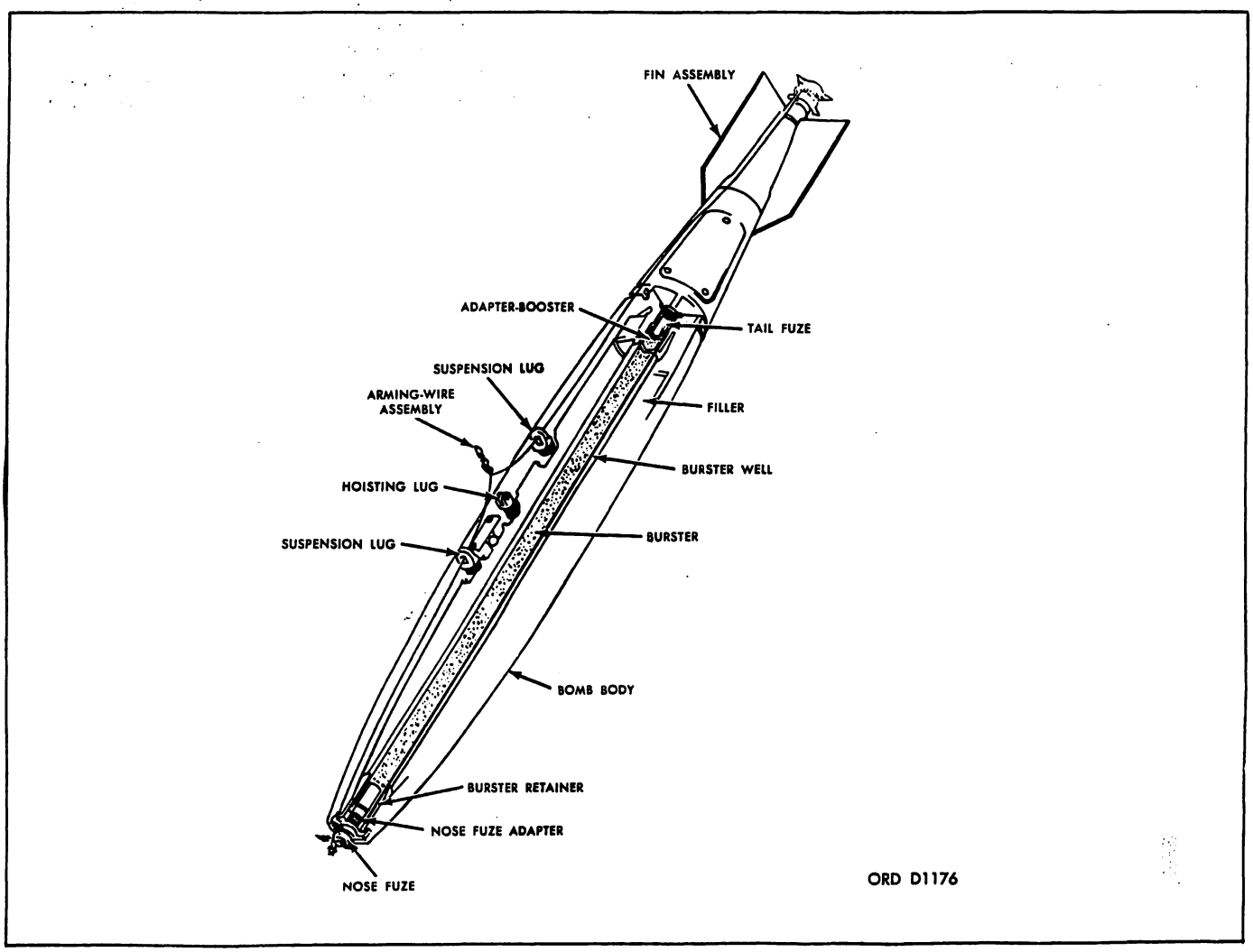


Figure 13-19. Gas Bomb, Nonpersistent GB, MK94 Mod 0, Cutaway View

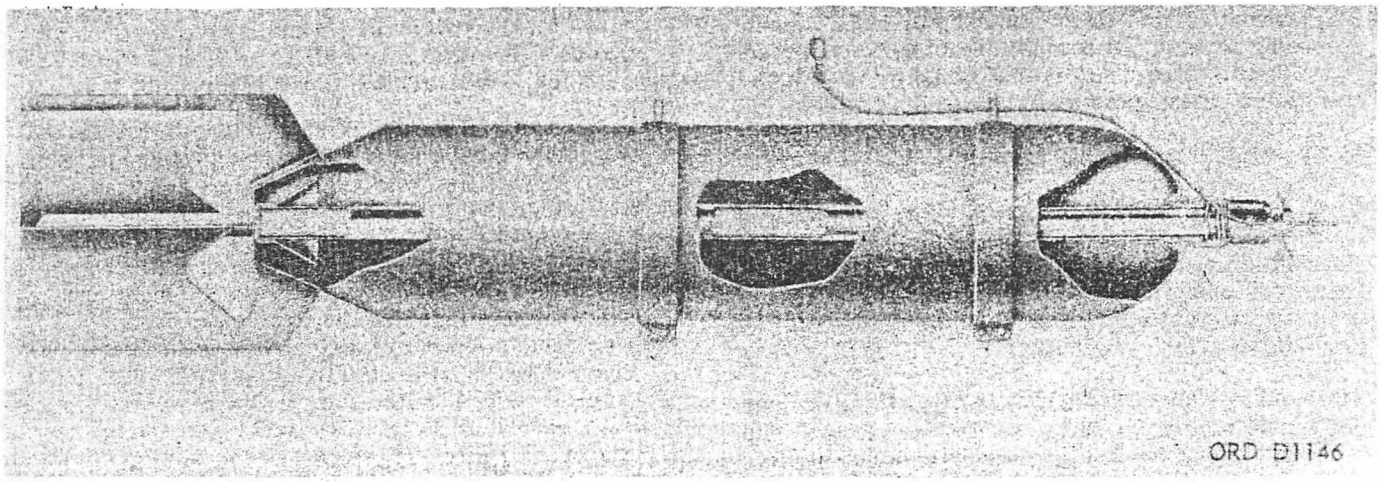


Figure 13-20. Smoke Bomb, PWP or WP, AN-M47A4, Cutaway View

for munitions, thermite is called TH1. THERMATE (TH3) is a mixture of TH1, barium nitrate, and sulfur in an oil binder. Thermate is the standard metallic filling used in incendiary bombs.

13-30. MAGNESIUM. Magnesium is a soft metal which, when heated sufficiently in the presence of oxygen, ignites and burns vigorously. Magnesium melts and flows as it burns, igniting all combustible material in its path. Bomb bodies made of magnesium comprise the bomb's main incendiary charge. The body of a magnesium bomb usually is made with an internal cavity containing a Thermate igniting filler. The 4-pound incendiary bomb AN-M50A3 is an example of a bomb with a magnesium body.

13-31. FIRE BOMBS. (See figure 13-21.) Fire bombs are usually thin-skinned containers of thickened fuel for use against such targets as dug-in troops, supply installations, wooden structures, and

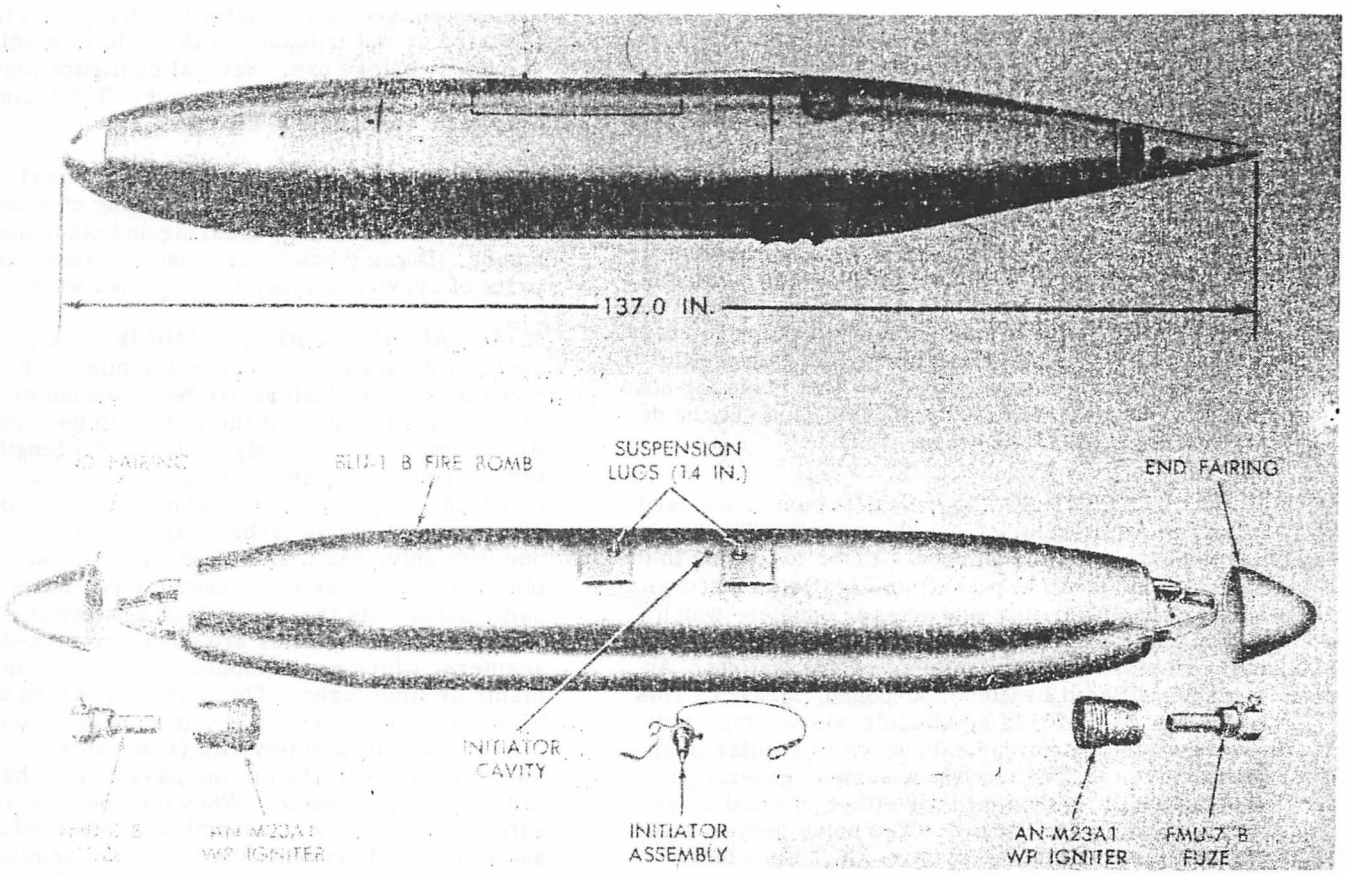


Figure 13-21. Fire Bombs, M116A2 and BLU Series, Cutaway View

land convoys. Most fire bombs rupture upon impact spreading burning, thickened fuel on surrounding objects. Impact fuze and AN-M23A1 igniter combinations are used to ignite the combustible filling.

13-32. MISCELLANEOUS BOMBS.

13-33. Missile cluster adapters, aircraft depth bombs, leaflet bombs, and photoflash bombs are classified as miscellaneous because of their physical and functional characteristics. The characteristics are such, that these items do not lend themselves to grouping in other catagories.

13-34. ADAPTER, CLUSTER, MISSILE. A missile cluster adapter is an antipersonnel or antimateriel munition, which physically resembles a 500-pound general purpose bomb. The body is a hollow shell with the entire upper half acting as a lid, which is hinged at the base of the conical tail fin assembly. The filler consists of a large quantity of small, solid, streamlined missiles having winged tail assemblies or hollow tubing construction tetrahedrons. The missiles are contained in paper sacks. A conical tail fin is welded to the lower half of the cluster. The suspension lugs are spaced 14-inches apart. This bomb is shipped and stored empty and is loaded with missiles as required. The functioning of the missile cluster adapter is effected by the use of a mechanical time fuze in the nose. After the cluster has been released and time delay has occurred, the fuze functions, causing the top half of the adapter to open, allowing the missiles to disperse immediately and drop to earth.

13-35. AIRCRAFT DEPTH BOMBS (ADB). (See figure 13-22.) The aircraft depth bomb, similar to a light-case bomb, is designed for use against underwater targets, submarines in particular. The bomb case contains a bursting charge of HBX, HBX-1, or TNT which represents approximately 70 percent of the total weight. The cylindrical case has a flat nose which reduces ricochet upon impact. The bomb functions at a predetermined depth dependent upon the setting of the hydrostatic fuze assembled to the bomb. Generally, depth bombs are fuzed with hydrostatic tail fuzes only, but provisions are also made for nose fuzing in the event that surface detonation may be desired for certain tactical conditions.

13-36. LEAFLET BOMBS. Leaflet bombs are used to distribute literature from an aircraft. The bombs are issued empty and unfuzed. Prior to loading in the aircraft, the bomb is packed with leaflets, fuzed with a mechanical time fuze and adapter booster, which will function a primacord charge and cause the bomb to open before impact and disperse the leaflets. An example is Bomb Leaflet, 750-pound, M129E1. This bomb (figure 13-23) is an aimable-cluster type and has an external configuration which is similar in appearance to the 750-pound new series, general purpose bomb. It is designed for either internal or external carriage on aircraft. The bomb body is made of fiberglass-reinforced plastic. It is split longitudinally into two sections, which are held together by four latches on each side. When joined, these halves form a cylindrical bomb body with an ogival-shaped nose. The fuze well is located in the nose of the bomb. No provision is made for a tail fuze.

13-37. PHOTOFLASH BOMBS. (See figure 13-24.) Photoflash bombs are essentially pyrotechnic items but are classified with explosive bombs because of their explosive nature and because they resemble explosive bombs in appearance and use. Photoflash bombs are thin-walled bombs designed to burst in air to produce a light of high intensity for night photography. Photoflash bombs have round cylindrical bodies and all use mechanical time nose fuzes. They range in weight from 100 to 150 pounds. The bomb cases are loaded with either a charge of photographic flash powder or metal alloy dust representing approximately 45 or 75 percent of the total bomb weight. The metal-dust type of bomb produces a greater candlepower and is more resistant to detonation by bullet or flak penetration. Photoflash bombs are fin-stabilized and may be equipped with a drag plate and spoiler ring (figure 13-25) or trail angles to provide a favorable trajectory.

13-38. PRACTICE AND DUMMY BOMBS.

13-39. PRACTICE BOMBS. Practice bombs are used for target practice and are available in sizes from 25 to 750 pounds. Practice bombs simulate the release characteristics of the larger bombs and are effective for training in bombing techniques and proficiency. Most practice bombs have a spotting charge and fuze, others are completely inert. Some models of practice bombs have a spotting charge and fuze, others are completely inert. Some models of practice bombs are sand or water loaded in the field to specific weight standards before use. Several configurations of service bombs are used for practice. The filling is sand or a reduced explosive charge.

13-40. DUMMY BOMBS. Completely inert bombs and components are used for training of ground crews in assembling, fuzing, unfuzing and other handling of bombs. Dummy bombs are made up from the metal parts of service bombs, inert-loaded when necessary.

13-41. ARMING WIRE ASSEMBLIES. Arming wire assemblies are used to prevent arming of fuzes while fuzed bombs or clusters are being loaded or carried in aircraft or to permit the rounds to be dropped safe. An arming wire assembly consists of a length of brass or stainless steel wire, to which a swivel loop is attached at one end and Fahnestock clips on the other end. A single (1-branch) assembly, used for one fuze only, has a swivel loop at one end. A double (2-branch) assembly, used for two fuzes on the same bomb, has the swivel loop between the ends. Multibranch assemblies are used for quick-opening adapters, which are equipped with release mechanisms or time fuzes. The wire is threaded through holes in the fuze arming pin or vane tab and usually held in place by a safety clip (Fahnestock). The swivel loop is attached to the pawl on the shackle or in the arming solenoid. When the round is dropped safe, the arming wire assembly is released at the same time and prevents the fuze from arming. The models of arming assemblies authorized for different rounds differ in number of branches and in the

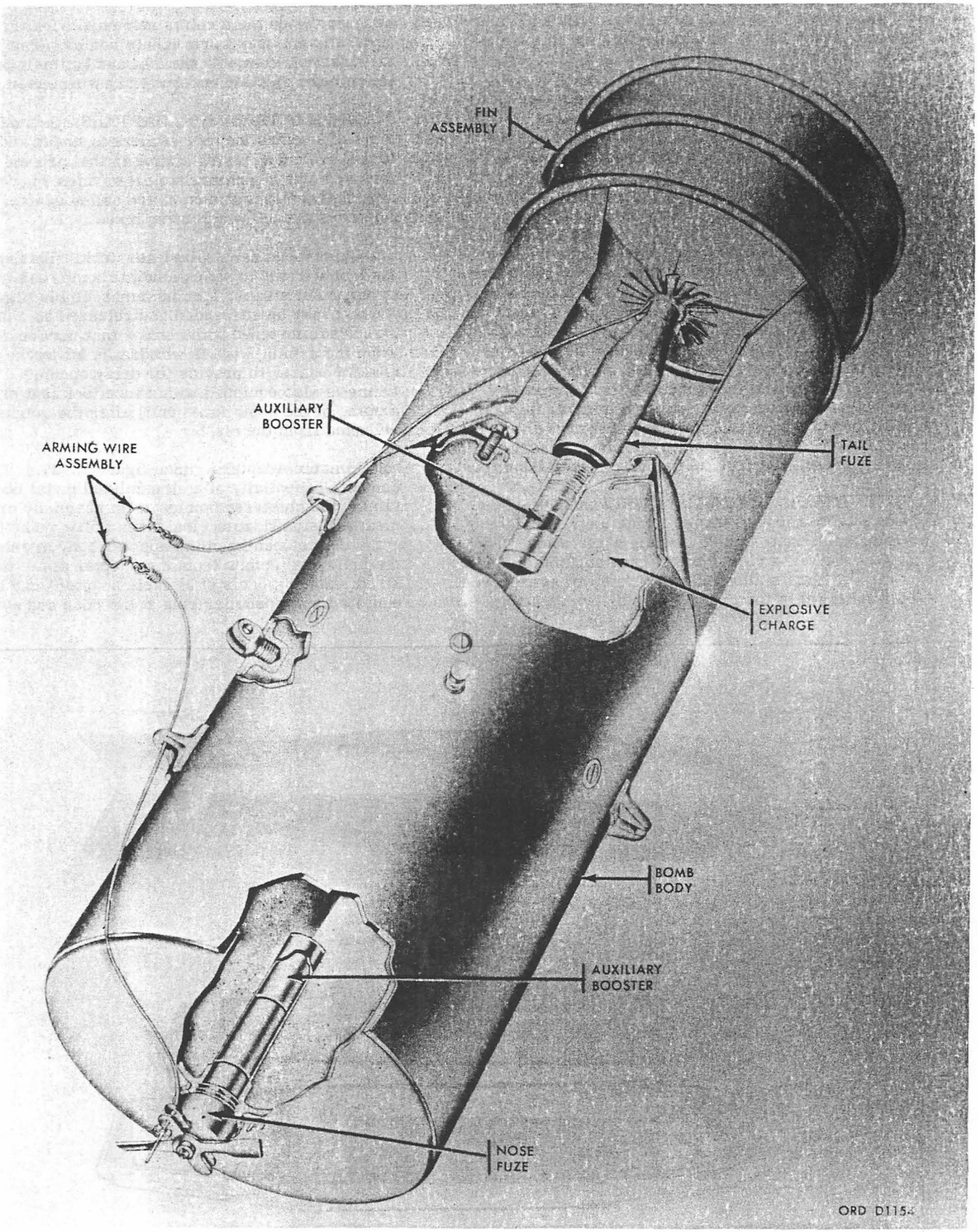


Figure 13-22. Depth Bomb, AN-MK54 Mod 1, Cutaway View

diameter and length of the branches. Bulk arming wire is available for fabrication of arming wire assemblies.

13-42. FINS. A fin assembly is usually used to stabilize a bomb or aimable cluster in flight. Fin assemblies are made of sheet metal. The box-type assembly consists of a fin sleeve that fits over the tail of the bomb and is secured by a fin locknut and fin blades fabricated to the sleeve forming a square box-like assembly. Although more recent designs require the use of heavier gage steel to strengthen the assembly, box-type fins are not strong enough for use on bombs dropped from high altitudes or carried externally on high-speed aircraft. For this use, conical fin assemblies have been developed. The conical fin assembly consists of an elongated fin cone (fin sleeve) and four streamlined blades assembled perpendicularly to the cone. In some cases, a coupling tube assembly and fin locknut is used to secure the assembly to the bomb. In other cases, the fin assemblies are attached to the bomb by means of radial screws or by bolts. For some 100-pound and all larger bombs, the fin assembly is packed and shipped separately from the bomb body.

13-43. OTHER MEANS OF STABILIZATION. Some bombs are equipped with parachute units, in place of fin assemblies, to retard the fall of the bomb. The unit consists of a closed metal case containing the parachute and its attachment. The cover is removed by withdrawal of the arming wire or by means of a hangwire when the bomb is released. Tail fuzes are generally not used in parachute bombs. The means of stabilization used with the 4-pound butterfly fragmentation bomb is the metal butterfly wing assembly.

13-44. CLUSTERS AND ADAPTERS. A cluster consists of several bombs that are suspended and released from a carrying station in the aircraft intended for one bomb. The mechanical devices required to accomplish this suspension are called adapters. Adapters are of the following three types:

a. Quick-opening (Frame) Adapters. This type consists of a frame to which several bombs are attached by means of straps, forming an assembly (figure 13-26) that may be suspended and released as a unit. The straps are fastened with clamps that may be released when the arming wire is withdrawn, or by the action of a time fuze, to provide for delay opening. The frame is also equipped with a fuze lock that prevents arming of the bomb fuzes until after the bombs are released from the cluster.

b. Aimable Adapters. (See figure 13-27.) This type consists essentially of a streamlined metal body containing the clustered bombs, a fin assembly or other means of stabilization, and a time fuze. The fuze actuates the opening of the adapter body to release the individual bombs from the adapter at the time desired. Some models of aimable adapters can be equipped with a spoiler ring at the nose and a drag

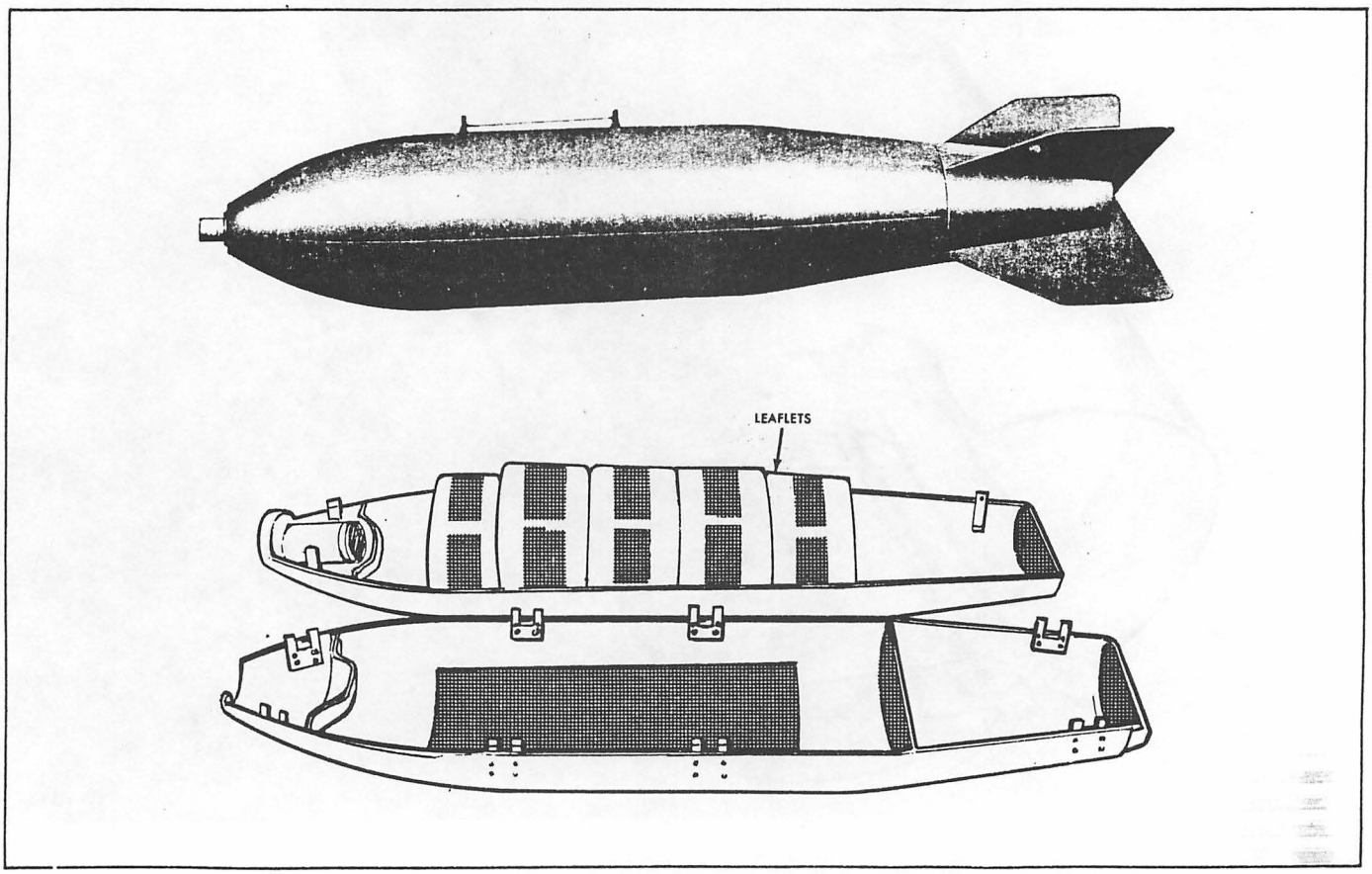


Figure 13-23. Leaflet Bomb, M129E1, Complete Round and With Lid Removed

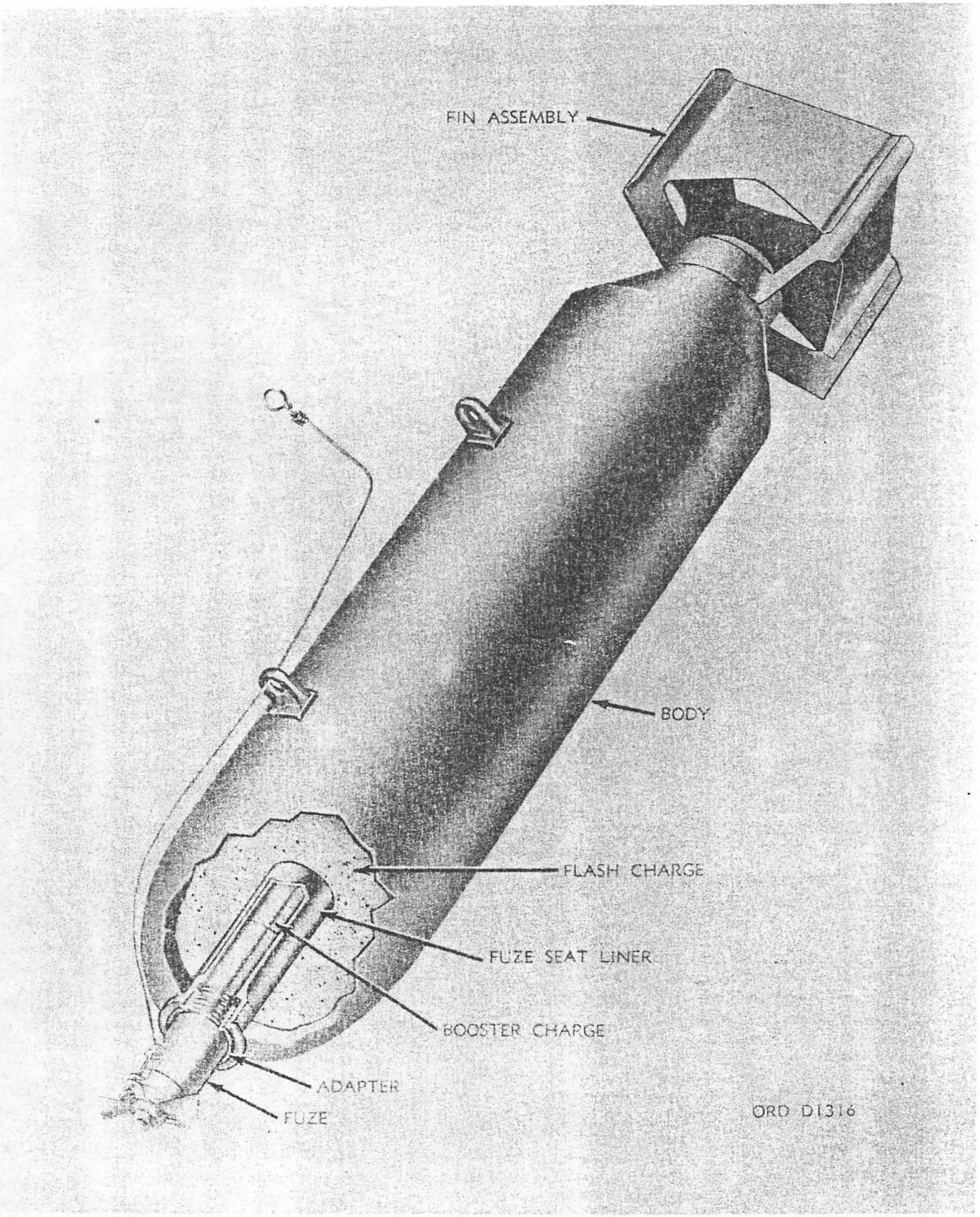


Figure 13-24. Photoflash Bomb, Typical, Cutaway View

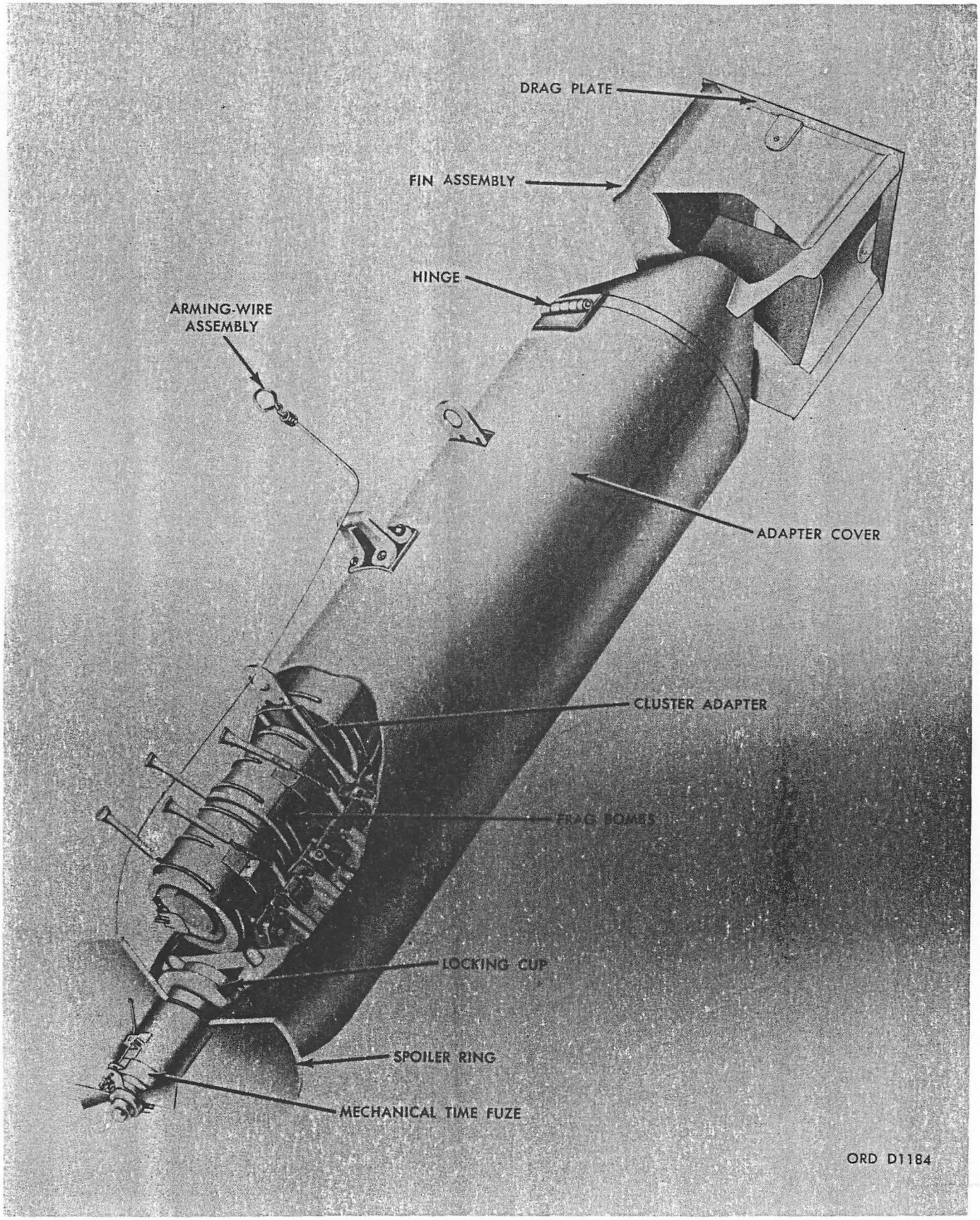


Figure 13-25. Cluster, Fragmentation Bomb, with Spoiler Ring and Drag Plate, Cutaway View

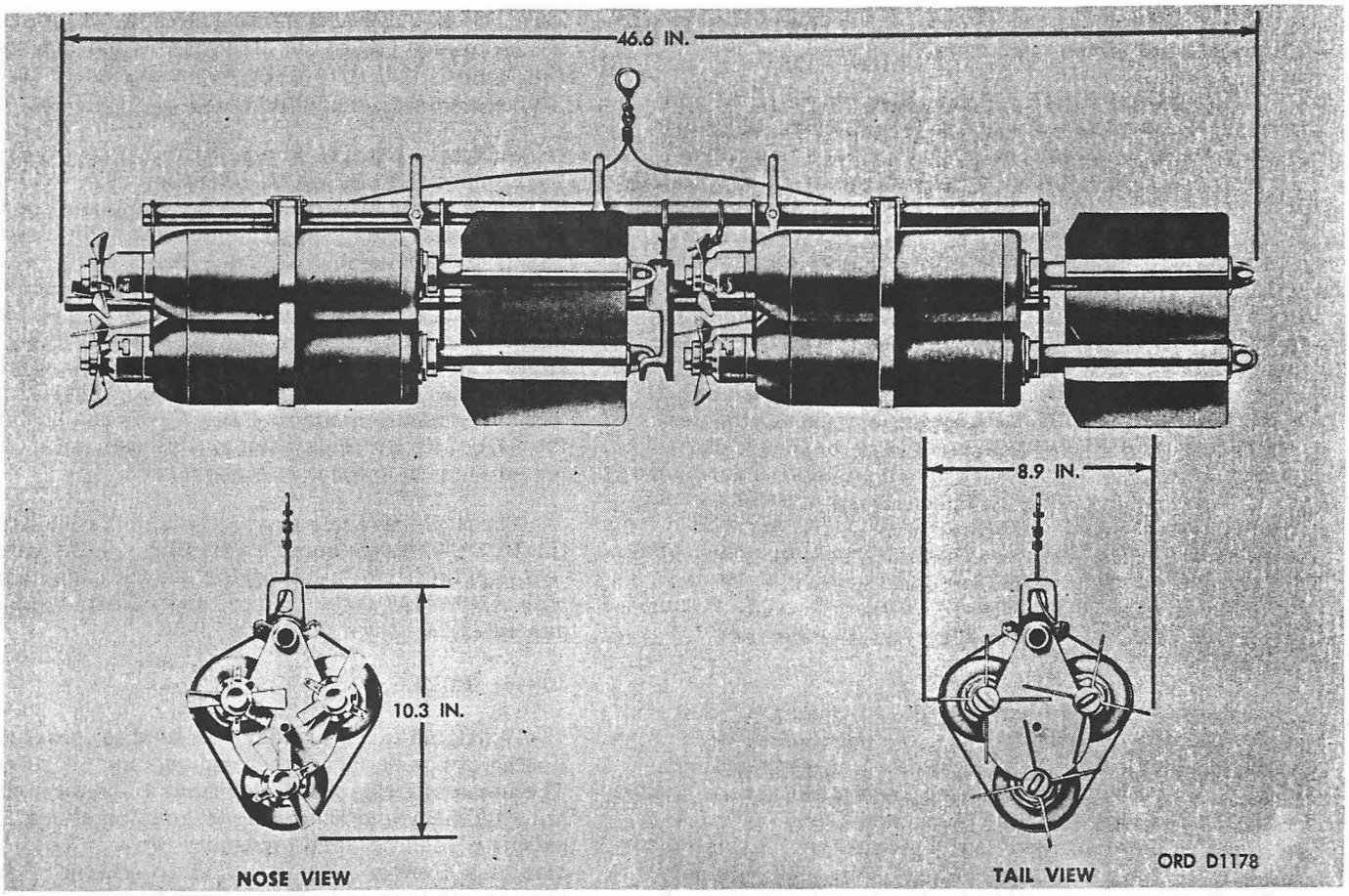


Figure 13-26. Cluster, Fragmentation Bomb, Quick-Opening Type

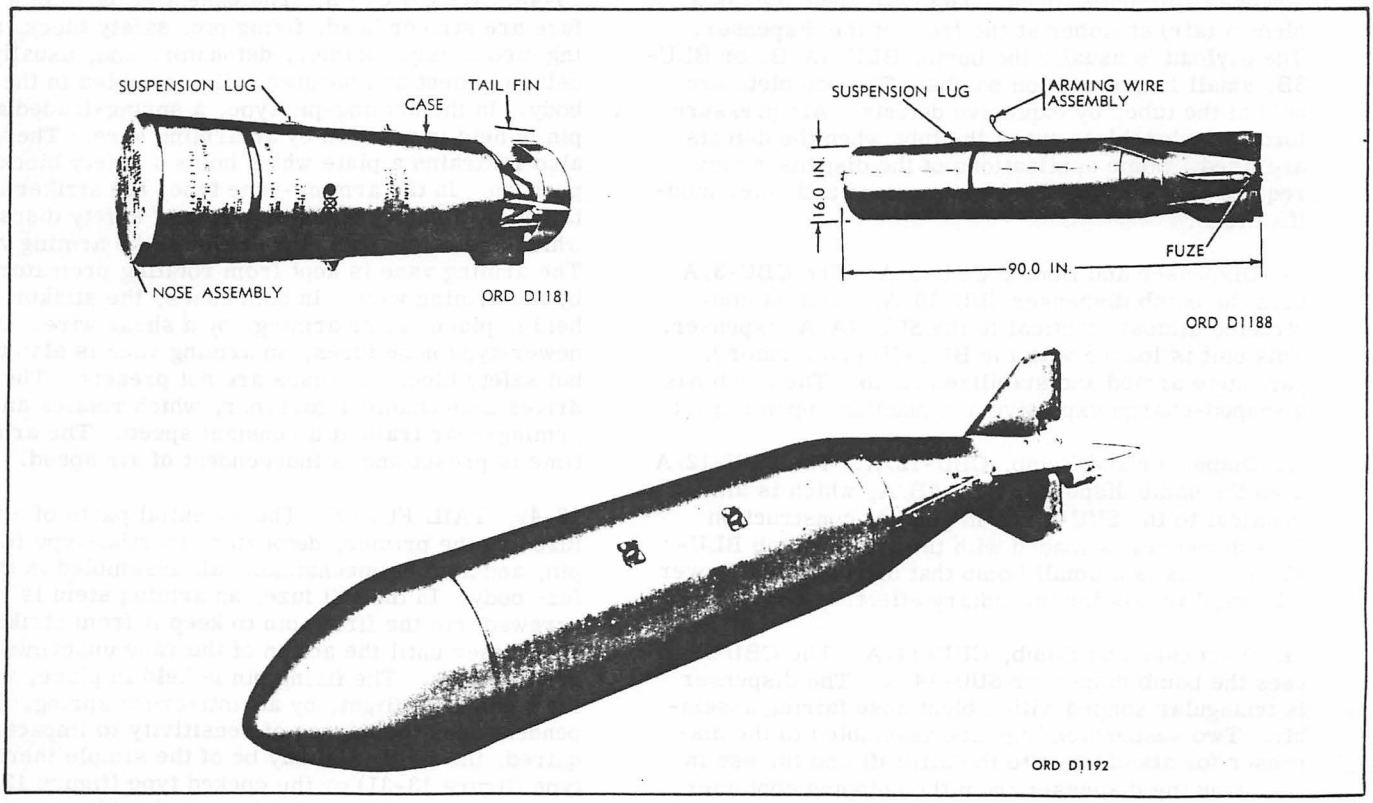


Figure 13-27. Aimable Clusters, Typical, M25, M35, and M34A1

plate on the rear end of the fin assembly (figure 13-25) to alter the trajectory.

13-45. BOMB DISPENSERS. (See figure 13-28 and 13-29.) The bomb dispenser is a mechanical device designed to dispense small bombs from aircraft in flight. It usually consists of a thin metal construction type container streamlined for external suspension or rectangular for internal carriage. The dispenser is electrically actuated by circuitry within the aircraft. The airmunitions dispensed are usually fragmentation, smoke, or incendiary type items, and are dispensed either from tubes or compartments. The bombs are equipped with safety devices that preclude the possibility of arming until after they have been ejected from the dispenser. Dispensers are usually issued completely loaded with the bombs. Dispensers are generally for external suspension on high performance aircraft, except where noted. The designations, ADU (Adapting Items, Special), BLU (Bombs, Aircraft Live, Special), CBU (Clusters, Bombs, Special), and SUU (Suspension and Release, Special), are established in accordance with Air Force - Navy Aeronautical Bulletin 440a. Examples of typical dispensers are as follows:

a. Dispenser and Bomb, CBU-1A/A and CBU-2/A. The CBU-1A/A and CBU-2/A use bomb dispenser SUU-7A/A (figure 13-28). The dispenser is cylindrical in shape with a round nose and a conical tail. Two suspension lugs are assembled to the dispenser for attaching the dispenser to the aircraft and for use in removing the dispenser from the shipping container. The dispenser is suitable for bomb rack ejection. It has a thin aluminum skin and contains 19 thin-walled anodized aluminum tubes. The nose cone acts as a plenum (air) chamber at the front of the dispenser. The payload is usually the bomb, BLU-4A/B, or BLU-3B, small fragmentation bombs. The bomblets are held in the tubes by explosive detents. Air pressure forces the bomblets out of the tube when the detents are fired. Some applications of the dispenser may require the addition of tube extensions and other modifications.

b. Dispenser and Bomb, CBU-3/A. The CBU-3/A uses the bomb dispenser SUU-10/A, which is constructed almost identical to the SUU-7A/A dispenser. This unit is loaded with the BLU-7B (antiarmor), parachute armed and stabilized bomb. The bomb has a shaped-charge explosive and functions upon impact.

c. Dispenser and Bomb, CBU-12/A. The CBU-12/A uses the bomb dispenser SUU-7B/A, which is almost identical to the SUU-7A/A in general construction. This dispenser is loaded with the smoke bomb BLU-17/B. This is a small bomb that discharges WP over a 35 yard radius for incendiary effect.

d. Dispenser and Bomb, CBU-14/A. The CBU-14/A uses the bomb dispenser SUU-14/A. The dispenser is triangular shaped with a blunt nose fairing assembly. Two suspension lugs are assembled to the dispenser for attaching it to the aircraft and for use in removing the dispenser from the shipping container. The dispenser is made up of six thin-walled alodined aluminum ejection tubes that are bound together by a strongback. The nose fairing assembly also serves as the breech end of the dispenser. The fragmentation bomb, BLU-3/B is the payload of the CBU-14/A. This dispenser was designed for low speed aircraft.

e. Adapter, Cluster Bomb, ADU-253/B. The ADU-253/B uses the SUU-24/A dispenser (figure 13-29). This dispenser is rectangular in shape and subdivided into 24 cells, each cell accommodates three ADU-253/B cluster bomb adapters. The cluster bomb adapter is an anodized greenish-gold aluminum container loaded with airmunitions. The adapter is cube-shaped and held together by a steel safety band. The timer can be set to release the restraining band at a predetermined time after release from the aircraft. The fragmentation bomb, BLU-3/B is the payload of the ADU-253/B. This adapter was designed for internal suspension in bomber aircraft.

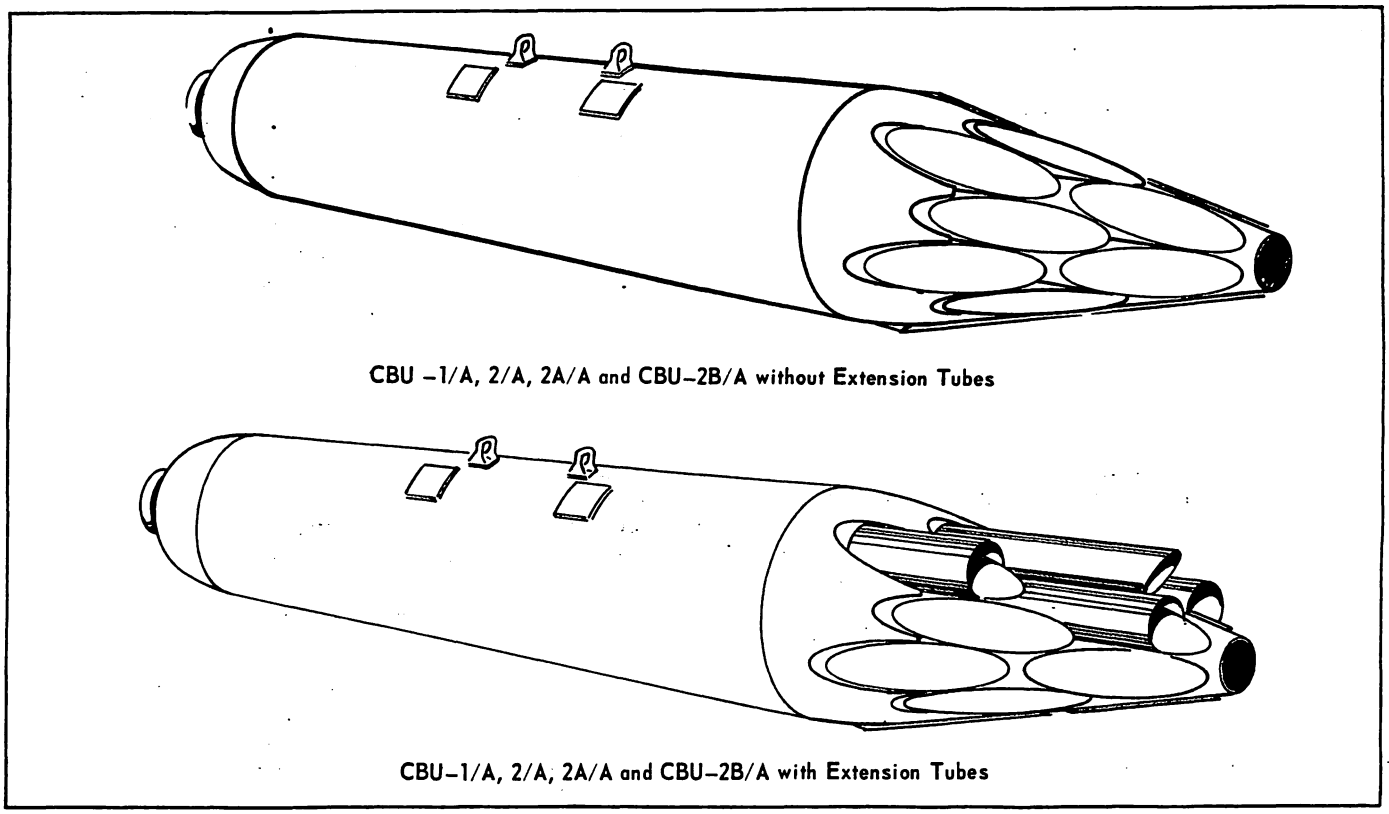
f. The SUU-24/A dispenser can also be loaded with the BLU-29/B fire bomb. The BLU-29/B fire bomb is a napalm filled, rectangular shaped case, complete with AN-M23A1 (WP) igniter, and a FMU-60/B fuze assembly as shown in figure 13-30.

13-46. FUZES.

13-47. Bomb fuzes are devices used to initiate functioning of bombs under the circumstances desired. The fuzes are classified according to position as nose, tail, and body and according to function as time, impact, hydrostatic, and proximity (VT). Fuzes are also classified according to method of arming as arming-pin type and arming-vane type.

13-48. NOSE FUZES. The essential parts of a nose fuze are striker head, firing pin, safety block, arming mechanism, primer, detonator, and, usually, a delay element and booster, all assembled in the fuze body. In the arming-pin type, a spring-loaded arming pin is held in position by an arming wire. The wire also restrains a plate which holds a safety block in position. In the arming-vane type, the striker is retained by a safety block or a ring of safety discs which are released by the action of the arming vane. The arming vane is kept from rotating prematurely by the arming wire. In both cases, the striker is held in place, after arming, by a shear wire. In the newer-type nose fuzes, an arming vane is also used, but safety blocks or discs are not present. The vane drives a mechanical governor, which rotates an arming-gear train at a constant speed. The arming time is preset and is independent of air speed.

13-49. TAIL FUZES. The essential parts of a tail fuze are the primer, detonator, inertial-type firing pin, and arming mechanism, all assembled in the fuze body. In the tail fuze, an arming stem is screwed into the firing pin to keep it from striking the primer until the action of the vane unscrews the arming stem. The firing pin is held in place, while the bomb is in flight, by an anti-creep spring. Dependent upon the degree of sensitivity to impact required, the firing pin may be of the simple inertial type (figure 13-31) or the cocked type (figure 13-32). In the newer tail fuzes, a drive and cable assembly for side mounting (figure 13-33) is used instead of a



CBU –1/A, 2/A, 2A/A and CBU–2B/A without Extension Tubes

CBU–1/A, 2/A, 2A/A and CBU–2B/A with Extension Tubes

Figure 13-28. Bomb Dispenser SUU-7A/A

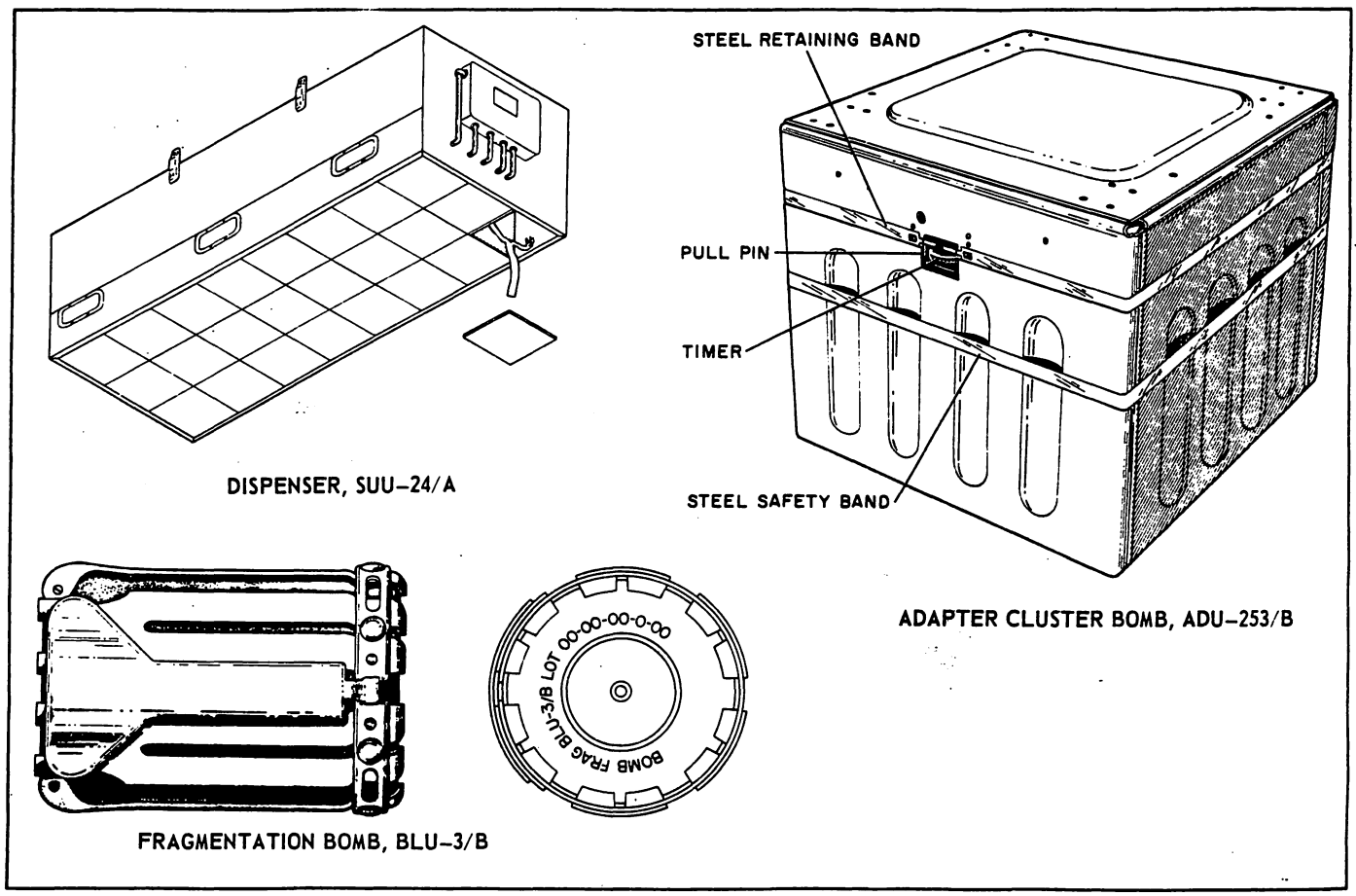


Figure 13-29. Bomb Dispenser SUU-24/A and Integral Components

direct-drive arming vane and stem. These fuzes also contain a mechanical governor which rotates an arming-gear train at a constant speed. The arming time is preset and is independent of air speed.

13-50. ARMING. Fuzes are so constructed that they cannot function while they are unarmed. A fuze is considered armed when the next normally expected event will initiate functioning of the fuze; that event may be impact (impact fuzes), time train running to completion (mechanical-time fuzes), or approach to the target (VT fuzes). As shipped, the fuzes are in a safe (unarmed) condition. In an unarmed fuze, the firing pin is mechanically restrained from initiating the explosive train of the fuze. In a detonator-safe fuze, the explosive train is interrupted, since the detonator is held out of line with the firing pin and booster lead until the fuze arms. Methods of arming are as follows:

a. Arming-vane Type Fuzes. (See figure 13-34.) When the arming wire is withdrawn on release of the bomb, the vane rotates in the airstream. The rotation is transmitted, generally through a reduction gear train, to a shaft or threaded stem in the fuze. In VT fuzes, a shaft runs a rotor, bringing the detonator into line and also connecting it in the electrical firing circuit. Mechanical arming delay devices can also be attached to certain fuzes to increase the arming delay. The device has its own vane and reduction gears. The device prevents rotation of the fuze vane until a preset amount of air travel has been accomplished. In other nose fuzes, the rotation of the vane unscrews an arming screw and releases an arming stem, causing the detonator to move into line in the detonator-safe type. Safety blocks are also ejected from between the striker and the fuze body, thus freeing the firing pin from restraint. In tail fuzes, the rotation unscrews an arming stem from an inertia-type firing pin or cocked (spring-loaded) firing pin, thus releasing the firing pin to function at a preset time (mechanical-time fuzes) or on impact. A definite number of turns of the vane is required to arm each model of fuze. The speed of rotation of the vane under like conditions depends on the angle of twist of the vane blades, hence different vane models may be used with the same fuze model to produce the desired arming time. Anemometer wind vanes (w/cup-shaped blades) are used to produce rotation of the vane in the airstream. Such vanes are required for sidearming tail fuzes that are used on some bombs.

b. Arming-Pin-Type Fuzes. (See figure 13-35.) When the arming wire is withdrawn on release of the bomb, the arming pin is ejected. The ejection of the arming pin may arm the fuze directly. Usually this ejection initiates a powder train or clockwork mechanism that arms the fuze after a predetermined time.

13-51. FUNCTIONAL TYPES OF FUZES.

13-52. MECHANICAL TIME. (See figure 13-36.) Nose and tail mechanical-time fuzes function to explode the bomb a certain number of seconds after release. Armed fuzes will also function on impact. The fuze contains an arming pin as well as an arming vane. Ejection of the arming pin on withdrawal of the arming wire (which actually takes place about 0.2 second after release) initiates the action of the mechanical-time (clockwork) mechanism. In addition to mechanical arming actuated by the arming vane, a time arming feature is incorporated in the time mechanism of most models. Time arming means that the fuze is unarmed (usually because the detonator is kept out of line) until the time mechanism has run for a fixed time interval. The running time of the

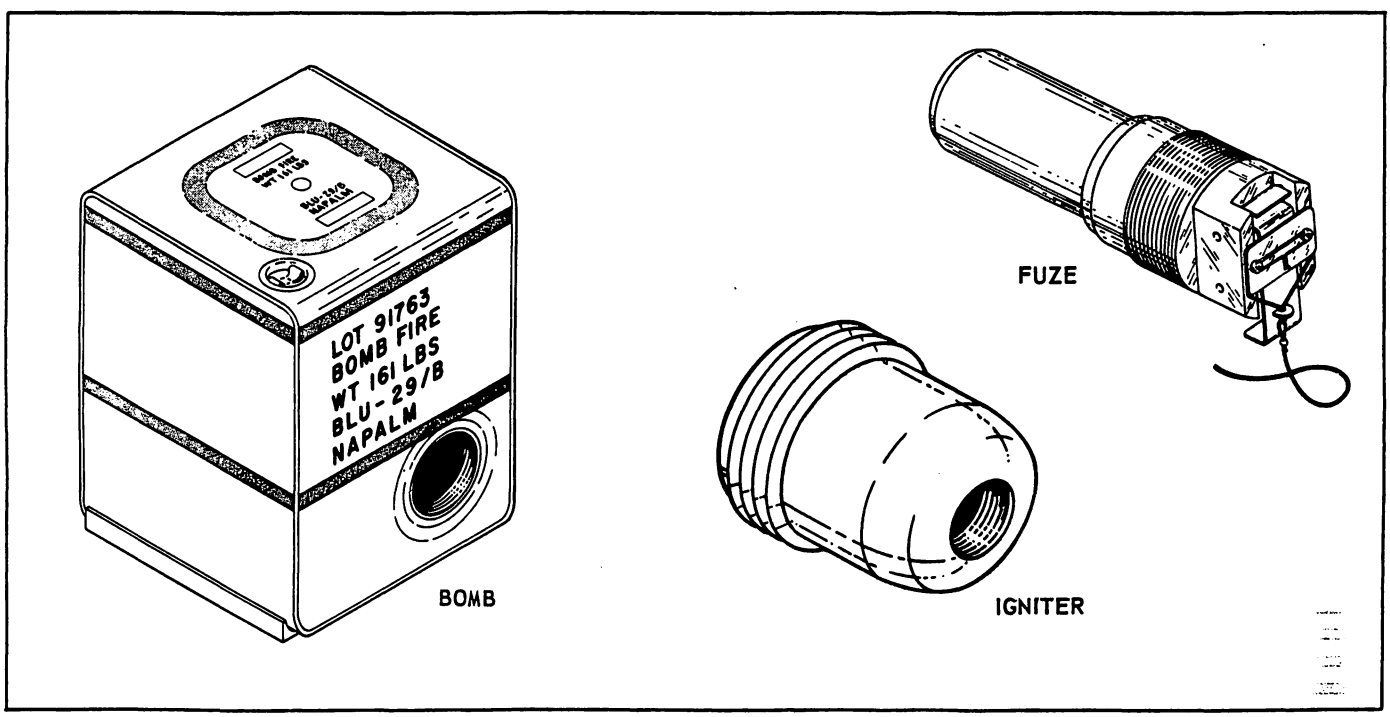


Figure 13-30. Fire Bomb BLU-29/B, Igniter AN-M23A1, and Fuze FMU-60/B

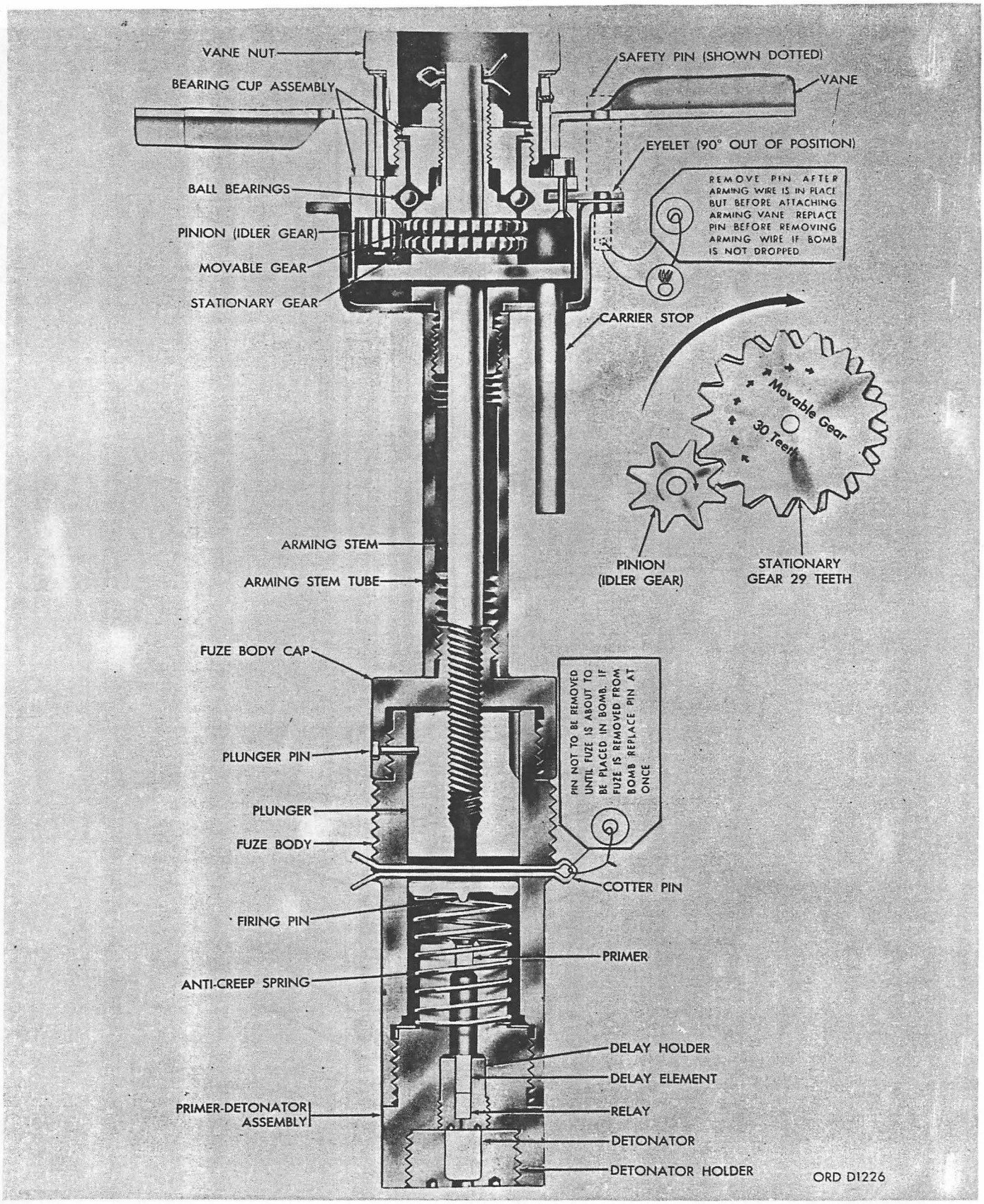


Figure 13-31. Tail Fuze AN-M100A2, Cross Section

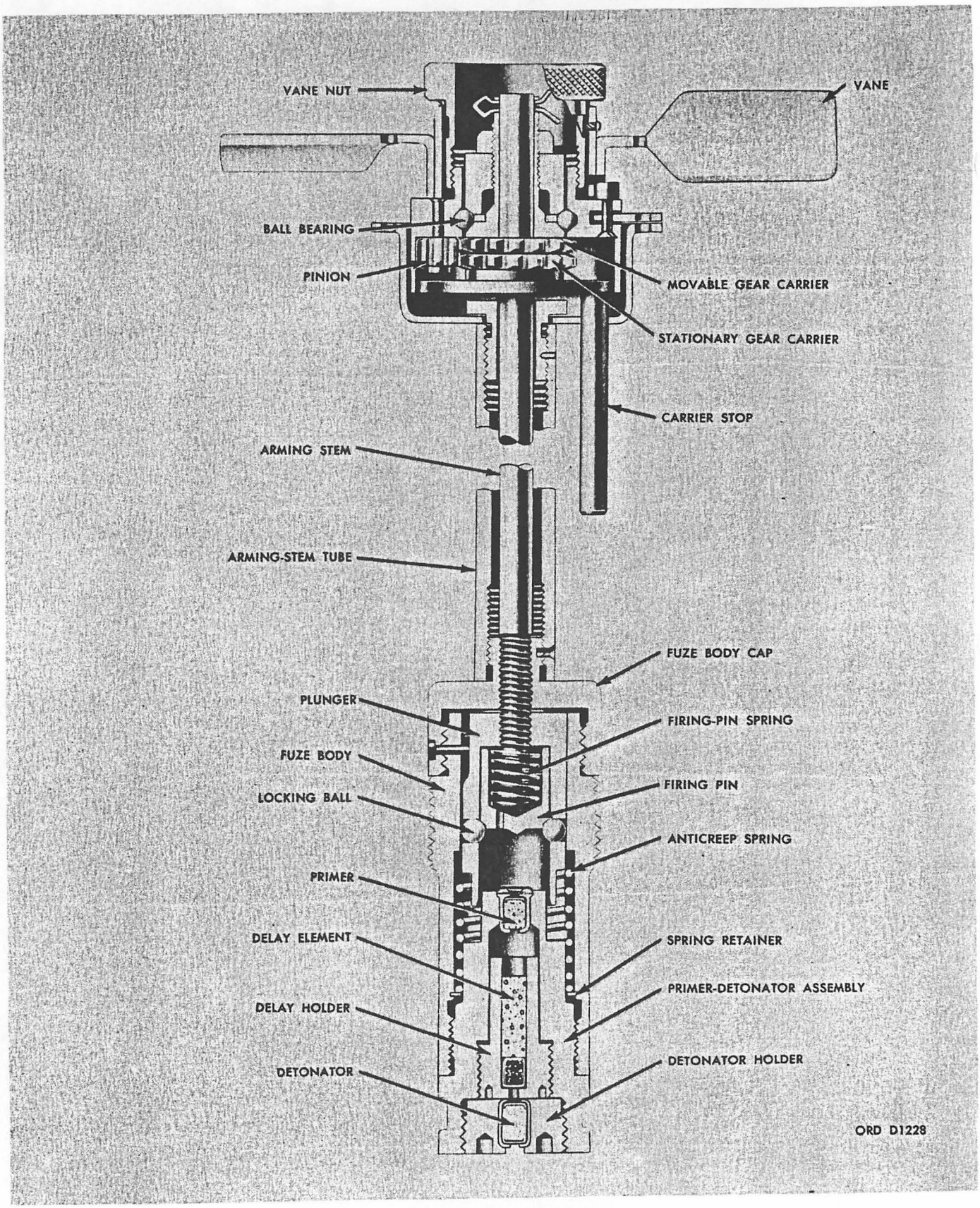


Figure 13-32. Tail Fuze M115, Cross Section

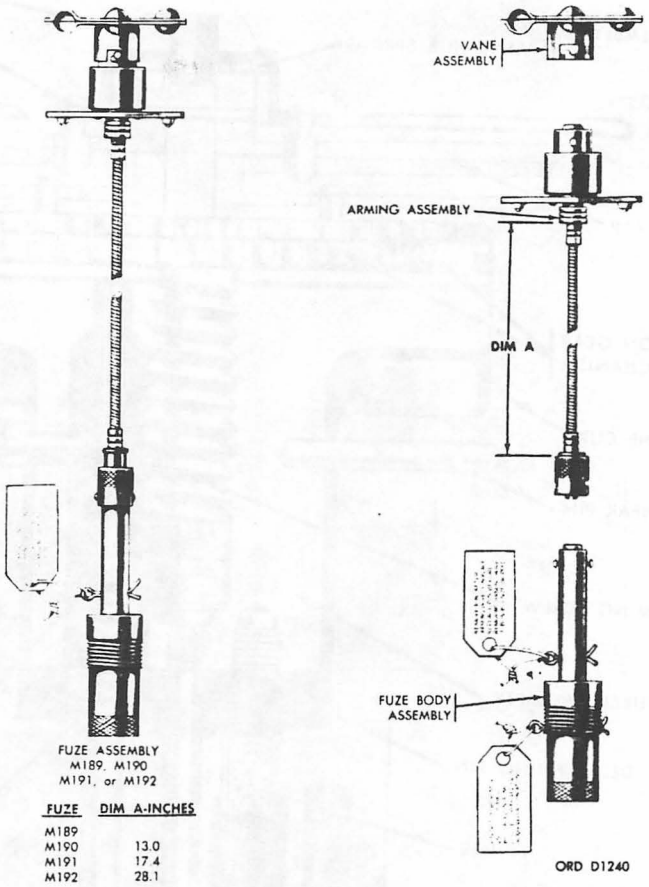


Figure 13-33. Tail Fuze M190

mechanism is usually adjustable and can be set when the complete round is assembled or as long as the fuze is accessible. A typical time range is 5 to 92 seconds.

13-53. IMPACT. Nose and tail impact fuzes begin their function when the bomb strikes a resistant material. Fuzes classed instantaneous (nose) or nondelay (tail) act to explode the bomb when the striker of the fuze hits the target or when the inertia plunger strikes the fuze primer, respectively. The inherent delay in functioning is about 0.0005 second for the instantaneous and for nondelay type. Impact fuzes classed as delay contain an element that delays the explosion of the bomb until a fixed time has elapsed after impact. The delay may be provided by a slow-burning delay charge a clockwork mechanism, or a chemical reaction. The slow-burning element is used in nose or tail fuzes to provide short delay times (less than 1 sec.) and in tail fuzes to provide medium delay times (4 to 14 sec.). A chemical reaction is used in tail fuzes to provide long delay times (10 minutes up to 144 hours) and usually incorporates an antiwithdrawal feature. Antidisturbance fuzes detonate the bomb if the fuze is disturbed after impact.

13-54. The always active impact and inertia-firing fuzes are fully armed by anemometer vanes after completing the required amount of air travel. The fuze is armed by air resistance in tumbling flight. Impact forces from any direction will cause instantaneous detonation. These fuzes are principally used in unstabilized munitions such as fire bombs.

13-55. HYDROSTATIC. (See figure 13-37.) Hydrostatic fuzes act under the influence of water pressure to explode a bomb at a predetermined depth below the surface. They are used in depth bomb for antisubmarine warfare. Hydrostatic fuzes are tail fuzes of the arming-vane type. They can be set for depth of 25, 50, 75, 100, or 125 feet.

13-56. PROXIMITY. (See figure 13-38.) Standard VT bomb fuzes are self-contained electronically operated fuzes that function as automatic time fuzes, without setting or adjustment, to detonate the bomb as it approaches the target. They produce air bursts at heights between 20 and 125 feet over average land. A VT fuze is a nose fuze with a vane that arms the fuze mechanically and electrically and also drives an electric generator. The generator furnishes power to charge a firing capacitor and to operate a radio transmitting and receiving unit. In flight, the fuze broadcasts a continuous radio signal. When this signal is reflected from the object to the armed fuze, the reflected signal interacts with the transmitted signal to produce beats. When the beat reaches a predetermined intensity, it trips an electronic switch

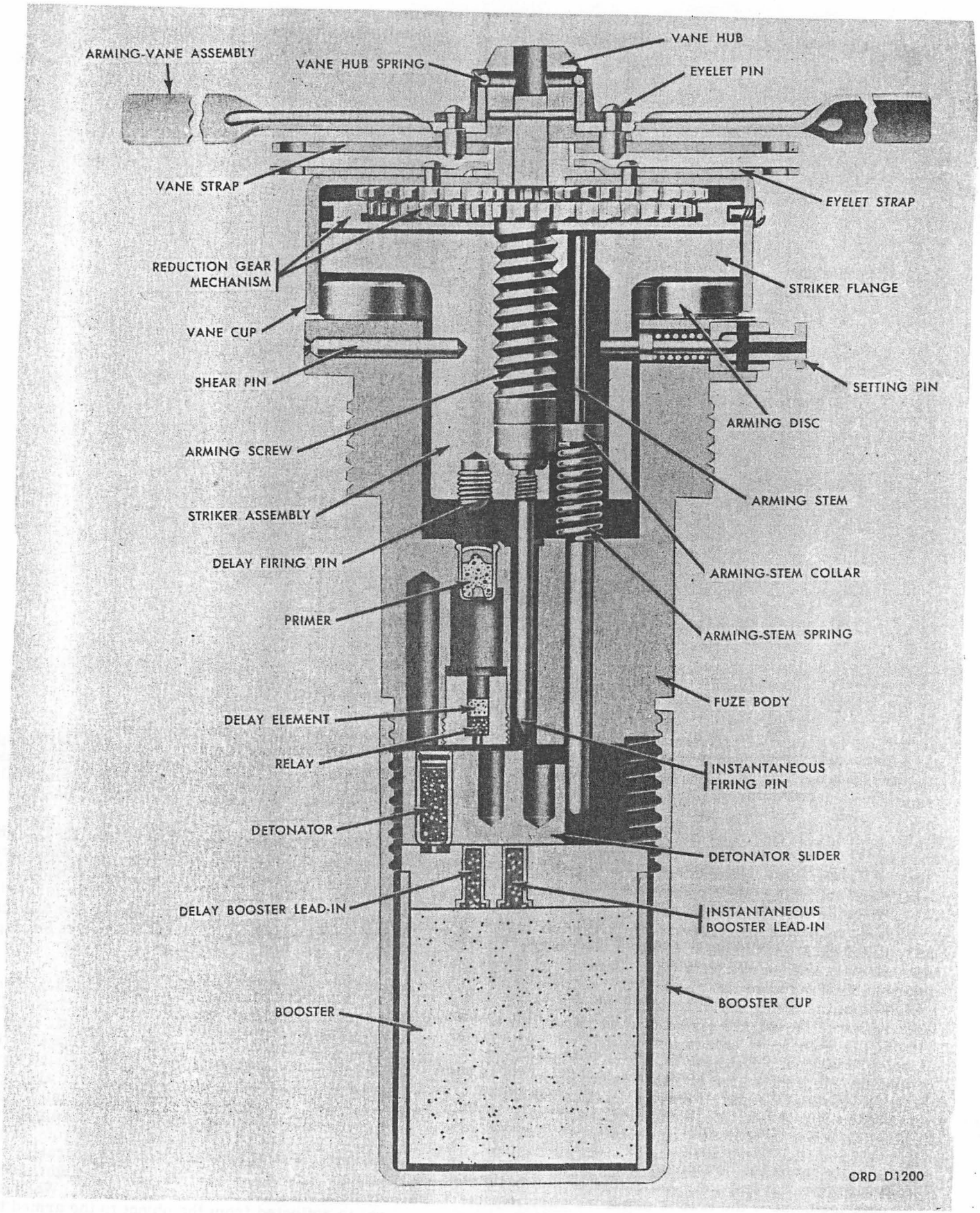


Figure 13-34. Nose Fuze AN-M103A1, Cross Section

that permits the firing capacitor to discharge through an electric detonator, thus exploding the bomb. There are two types of VT fuzes, the bar and the ring, which differ in behavior as well as appearance. Bar-type fuzes generally produce somewhat higher bursts than ring-type fuzes and are less apt to show a variation in burst height as the bomb type is varied. The bar-type fuzes give higher burst heights for steep angles of approach to the target where the ring-type fuzes produce higher burst heights for shallow angles of approach.

WARNING

Chemical long delay fuzes are very sensitive to impact and extremes in heat which may rupture the ampule. Once installed in a bomb these fuzes WILL NOT be removed.

13-57. LONG-DELAY TAIL FUZES. These fuzes require less than 100 feet of air travel to initiate the delayed action. They incorporate a booby-trap feature in that any attempt to remove these fuzes after installation will trigger an antiwithdrawal mechanism, causing instantaneous detonation of the bomb. Long-delay fuzes function in delay times ranging from minutes to days after impact, depending on which delay is used. The delay time is accomplished by chemical action. Completion of the chemical action causes the release of the firing mechanism. In addition, long delay and chemical-action fuzes contain a delay wad and a glass or thin metal ampule filled with solvent (figures 13-39 and 13-40). Delay time is shortened by heat and lengthened by cold.

13-58. ELECTRIC FUZES. The electric fuzes have an electric charging assembly that replaces the arming vanes used in other bomb fuzes. The development of electric fuzes has helped eliminate some of the problems created by increased speed and changed bombing tactics. When the bomb is released from the aircraft, the aircraft charging gear simultaneously energizes the arming and firing circuits. A series of delay elements prevents the fuze from arming or from detonating until the desired target or target area is reached. Some models of electric fuzes are completely self-contained units and do not rely on the aircraft electric system for energizing.

13-59. DIFFERENCES BETWEEN NOSE AND TAIL FUZES. In addition to the general methods by which nose and tail fuzes are held unarmed and the forces acting on the firing pin on impact, there are other differences between nose and tail fuzes, which are due to their relative positions on the bomb. The position of the vanes is reversed for the two types; to adapt a nose fuze for use as a tail fuze, as has been done for some mechanical-time fuzes, the pitch of the vane blades is reversed. Tail fuzes are more protected than nose fuzes in that they are not subjected to the striking force of the complete round on impact. The vane is separated from the fuze body by a long arming stem so that the airstream will act up on on it. Series (figure 13-41) of tail fuzes that differ only in the length of the arming stem are provided for use with bombs of different sizes. Tail fuzes with arming stems of special lengths are provided for use with conical fin assemblies that are longer than the corresponding box-type fin assemblies. In the case of fin-stabilized bombs, using side-arming tail fuzes, the arming vane is located near the forward end of the fin assembly.

13-60. INTERCHANGEABILITY OF FUZES. When it is desirable to use another model in place of the standard fuze because either the authorized fuze is

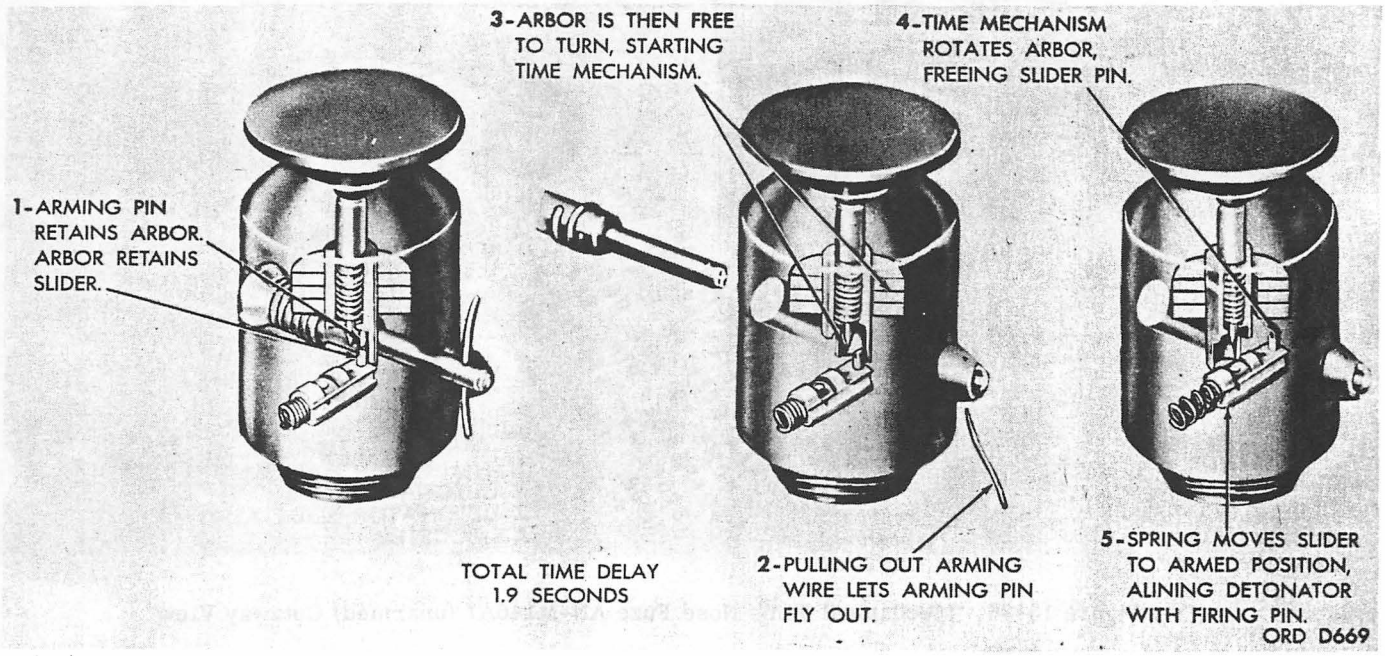


Figure 13-35. Arming-pin Type Fuze

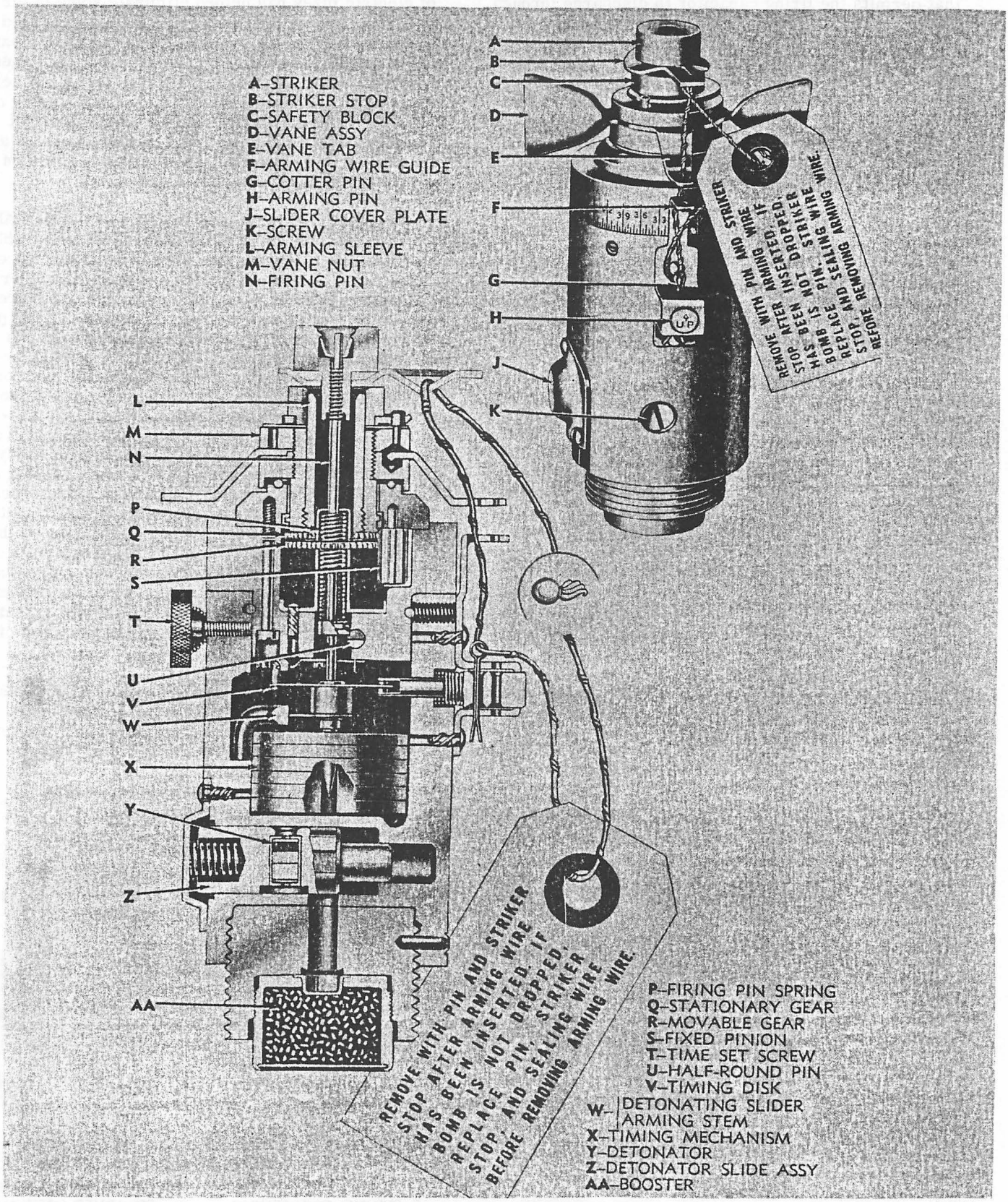


Figure 13-36. Mechanical Time Nose Fuze AN-M146A1 (unarmed) Cutaway View

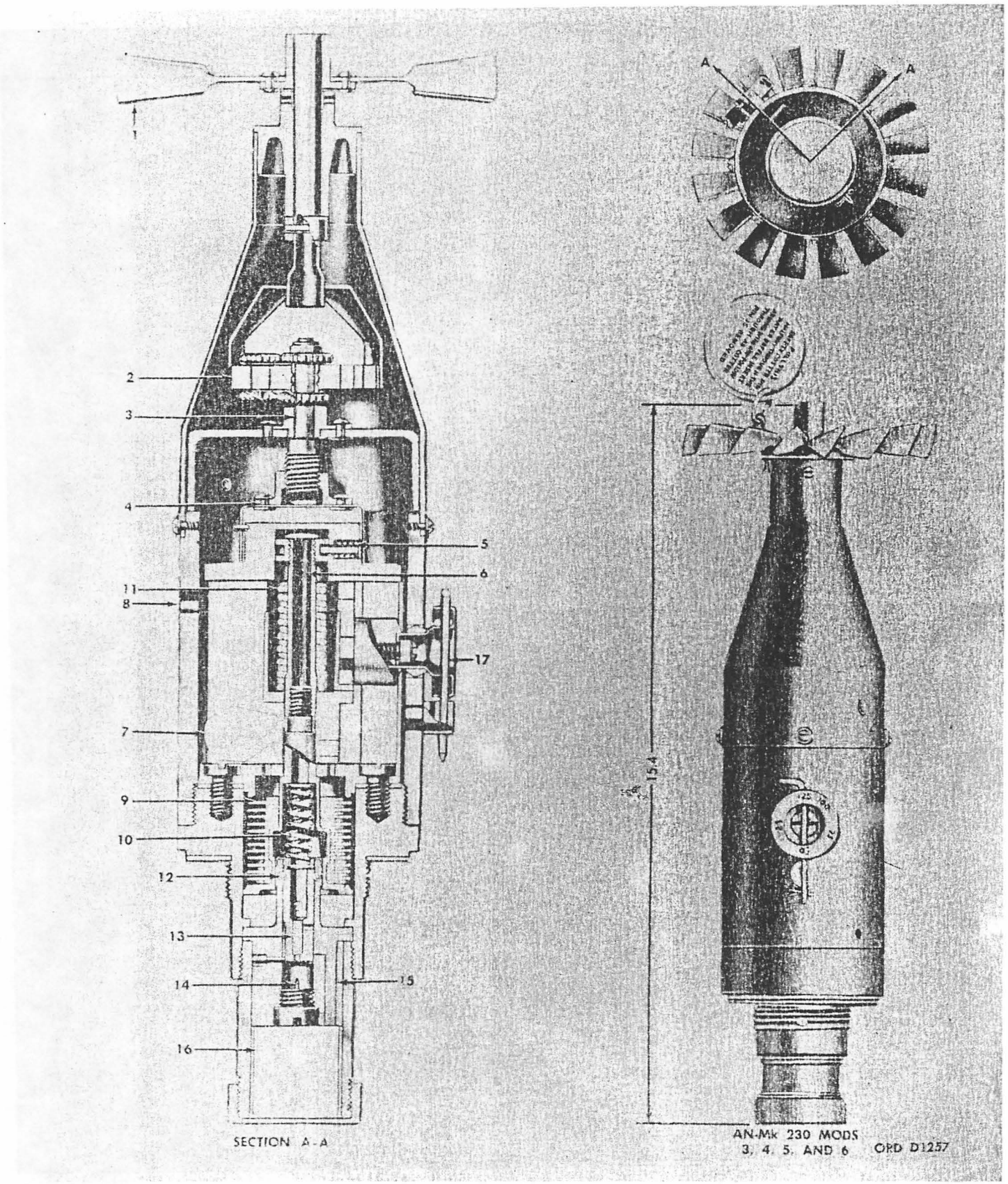


Figure 13-37. Hydrostatic Tail Fuze AN-MK230

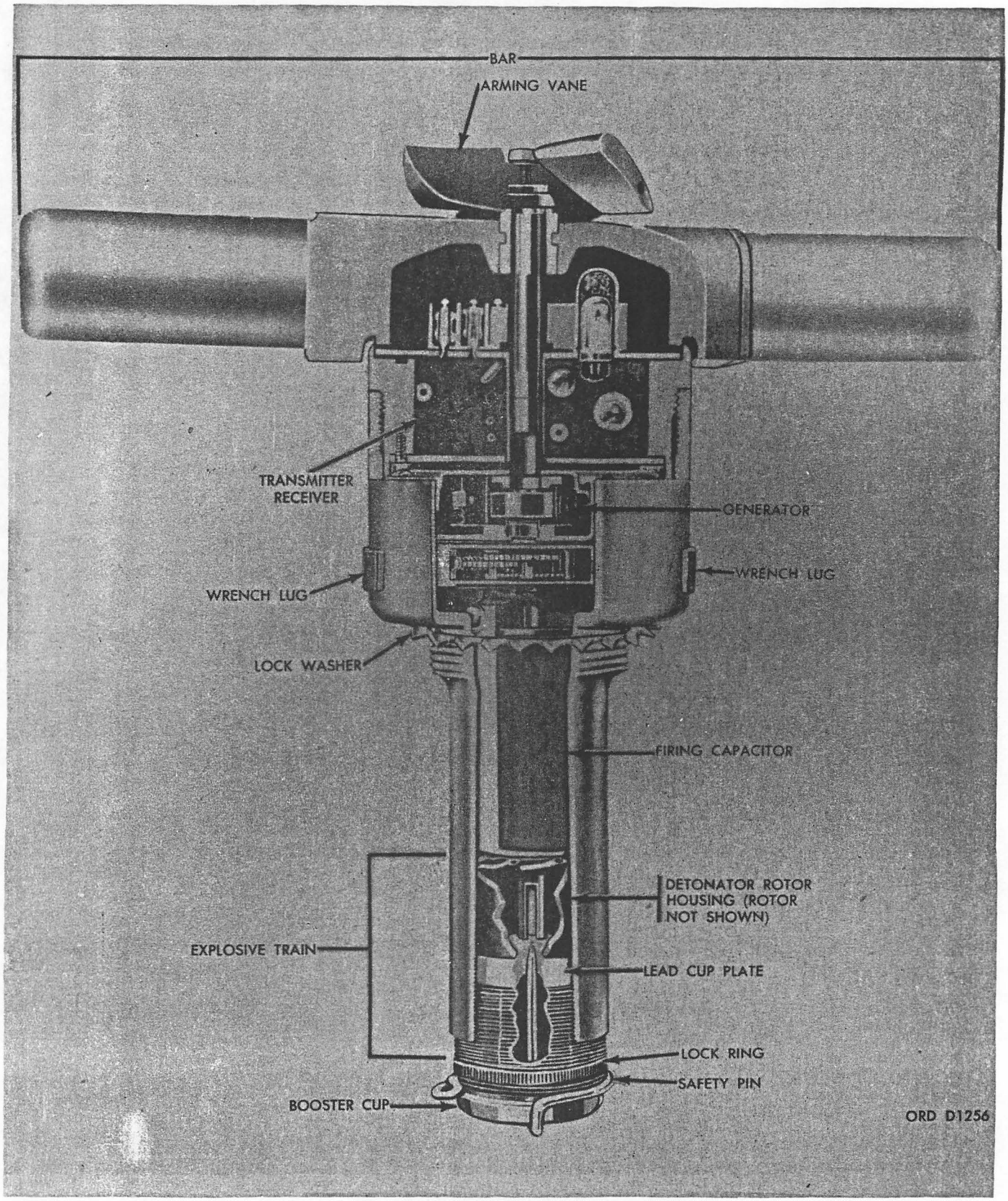


Figure 13-38. Proximity Nose Fuze M166, Cross Section

not available or the special action of another fuze is desired, the following conditions must be fulfilled:

a. The Fuze Must Fit Mechanically. The fuze must physically fit into the fuze seat of the bomb or an adapter must be furnished to achieve the proper fit.

b. The Fuze Must Fit Functionally. The fuze must be able to arm and operate properly under normal conditions of use. For example, short tail fuzes will not arm if used on large bombs. Also the arming time of the selected fuze must meet requirements.

c. The Explosive Train Must Be Completed By Combination of Bomb and Fuze. All elements, detonator, booster and main charge, must be present. Some fuzes contain a detonator only, and if these are used on a fuze-seat liner without a booster, low-order detonation or a dud may result. Other fuzes have a black-powder igniter in place of the booster element, and, if these are used in high-explosive bombs, the igniter will not reliably initiate the booster or charge.

d. The Components of the Explosive Train Must Be In Proximity. The detonator, booster and main charge must be sufficiently close so that the detonation wave is not weakened by passing from one element to the next. Some fuzes have short boosters, and if these are used in deep fuze seats, the space must be filled with an auxiliary booster or similar explosive charge, otherwise a low-order detonation or dud may result.

13-61. TACTICAL USE OF FUZES. There are various terms used to indicate the tactical use of fuzes. This terminology is as follows:

a. Air Travel. The amount of air travel required to arm the fuze is measured in feet along the trajectory. This measurement is referred to as value. The value for any particular fuze varies with the delivery attitude of the aircraft and with variations due to manufacturing tolerances.

b. Minimum-Safe Air Travel (MinSAT). Minimum-safe air travel is the distance of air travel within which no fuze arms. This is the minimum-safe value of air travel for any normal fuze of a particular type.

c. Arming Zone. The arming zone represents the tolerance in air travel to arm the fuze. It is the zone in which some fuzes are armed and other fuzes are not yet armed. The length of the arming zone added to minimum-safe air travel gives maximum air travel, after which all fuzes are armed.

d. Safe Vertical Drop. Safe vertical drop is the vertical distance below the release altitude at which no fuze is armed. It is the vertical component of minimum-safe air travel. It should be noted that the word safe refers to the condition of the unarmed fuzes and not to the security of the releasing aircraft. Safe vertical drop varies not only with the speed of the aircraft, but with altitude of release, size, shape and weight of the bomb, and other factors which affect shape and direction of the trajectory.

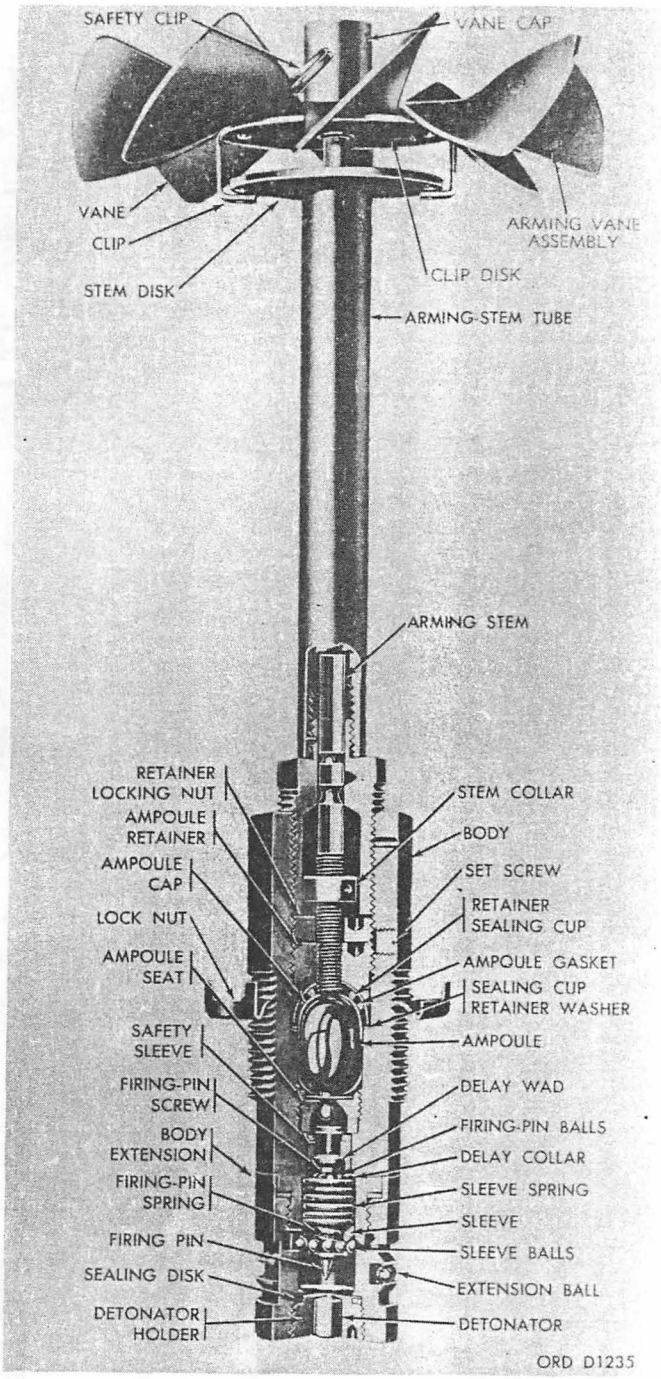


Figure 13-39. Tail Fuze M123A1, Cross Section

e. Maximum Drop to Arm. Maximum drop to arm is the vertical distance below release altitude at which all fuzes are armed. It has the same value as the minimum arming altitude, which is the lowest altitude at which bombs may be released with the possibility that the fuzes will become armed.

f. Safe Altitudes and Distances. Safe altitudes and distances are those at which the releasing aircraft incurs a specified minimum risk of damage from the bomb dropped.

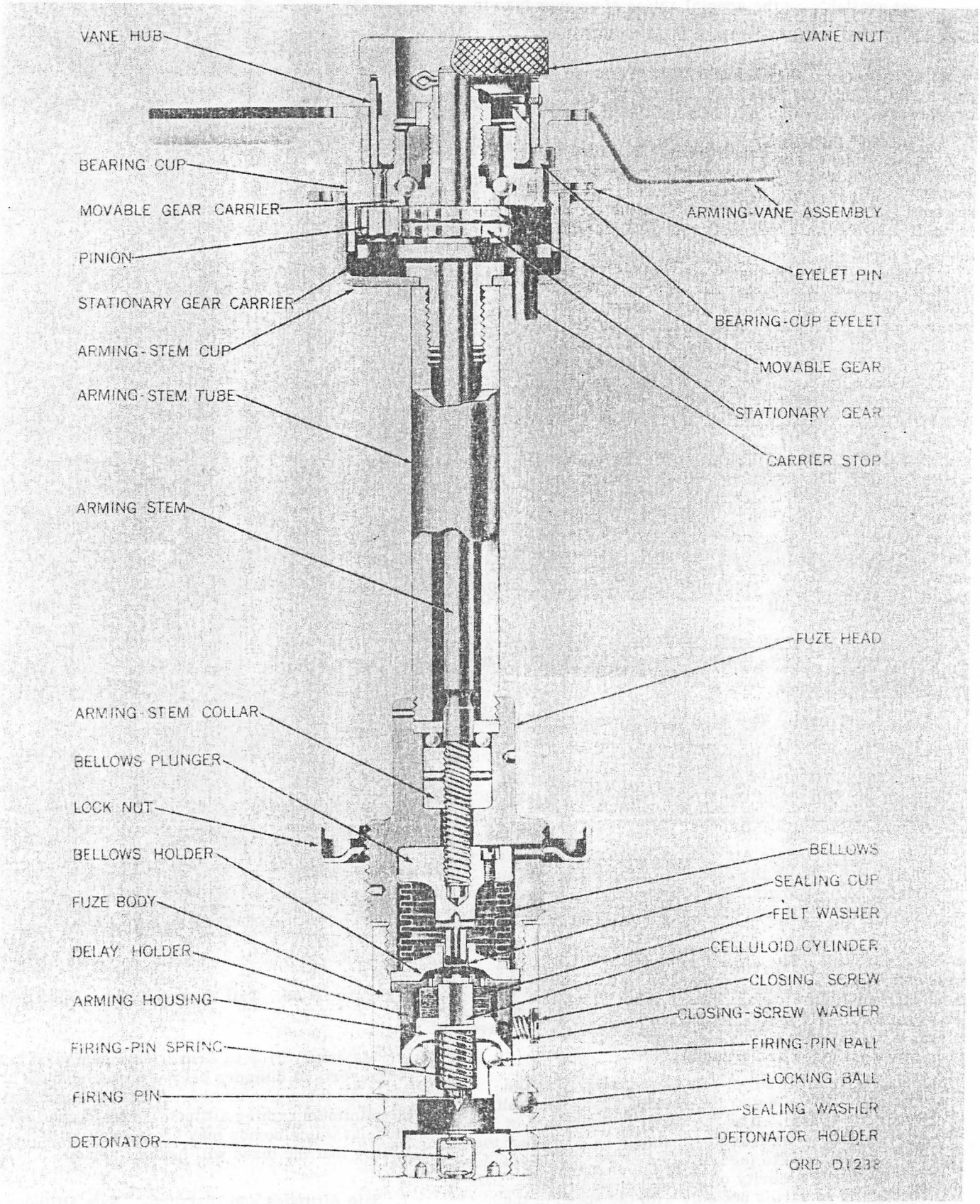


Figure 13-40. Tail Fuze M132, Cross Section

13-62. FUZE SAFETY FEATURES. Most fuzes incorporate one or more of the following types of safety features:

a. Detonator Safe. Fuzes that are detonator-safe have the elements of their firing train firmly fixed out of alignment in the fuze body while the fuze is unarmed. This increases safety during shipment, storage, and handling. The arming action of the fuze aligns the firing train.

b. Shear Safe. A shear-safe fuze will not become armed if its arming mechanism is damaged or completely severed from the fuze body. Shear-safe fuzes afford additional safety for externally-mounted bombs.

c. Delay Arming. This feature, whether it is mechanical or electrical, slows the arming of a fuze and keeps it in the safe condition until the bomb has fallen a sufficient distance away from the aircraft to minimize the effects of premature explosion. Delay arming helps to make low altitude bombing operations safer.

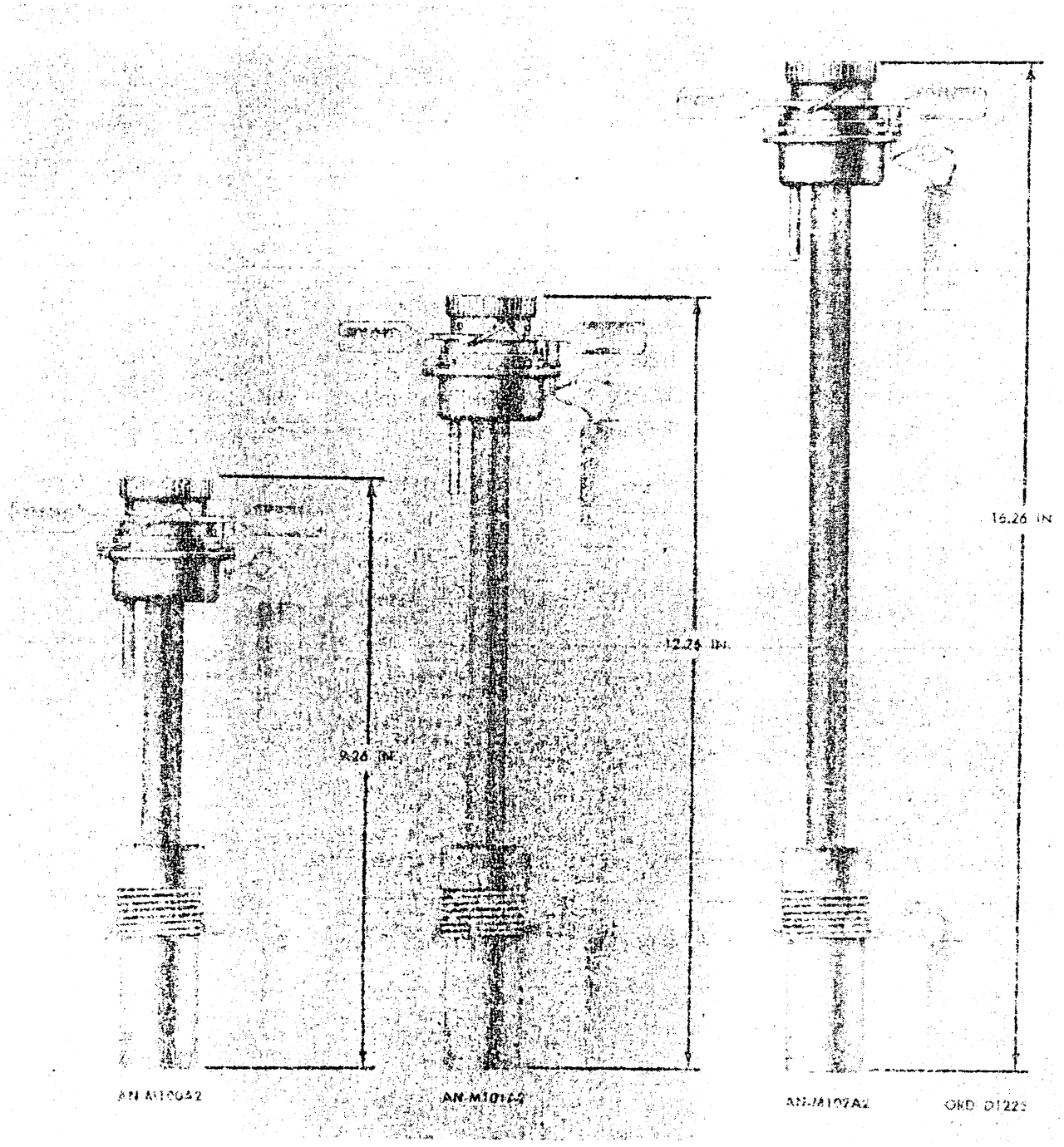


Figure 13-41. Tail Fuzes AN-M100A2 and AN-M102A2

13-63. PACKING AND MARKING.

13-64. PACKING. In general, bombs are shipped unfuzed with the fuze holes closed by metal shipping plugs. Large bombs are shipped uncrated with shipping bands that protect the suspension lugs. Some bombs, to which protruding suspension lugs are not assembled during shipment, are shipped without shipping bands. The very large bombs are shipped on skids or pallets. The fin assemblies of all large bombs are shipped separately in metal or wooden crates, cartons, or wooden boxes. Some smaller bombs are shipped finned in metal crates. Small fragmentation bombs may be packed in wooden boxes, sometimes with fuzes in the same box. Cluster type bombs are shipped fuzed in metal drums, wooden boxes (usually metal-lined), or sealed containers. Fuzes are shipped in individual sealed containers packed in quantity in wooden boxes. Miscellaneous components such as arming delays, primer-detonators, adapter-boosters, and vane assemblies are generally packed in wooden boxes.

13-65. MARKING. All information for identification and directions for shipping are marked on containers for bombs and components and on the bomb bodies when no container is used. Figure 13-42 provides information on the systems of color and markings of bombs. Military Standard 709 will guide future markings.

13-66. CARE AND PRECAUTIONS IN HANDLING. The general precautions in AFM 127-100 will be observed in handling bombs and components.

Bomb Type	Body Color	Band Color		Marking Color	
		Old	New	Old Stenciling	New Stenciling
SAP	Olive drab	Yellow	Yellow	Black	Yellow
GP	Olive drab	Yellow	Yellow	Black	Yellow
GP (LD)	Olive drab	Yellow	Yellow	Yellow	Yellow
Depth	Olive drab	Yellow	Yellow	Black	Yellow
Frag[1]	Olive drab	Yellow	Yellow	Black	Yellow
Chemical:					
Gas	Gray	Green	Red or Green [2,3]	Green	Red or Green[2]
Smoke	Gray	Yellow	Blue	Yellow	Blue
Incendiary	Olive drab	Purple	Light red	Purple	Purple
Fire	Olive drab [4,8]	Purple	(No Band)	Black [4]	Yellow
Practice	Black[5] (Old Issue) Orange (New Issue)	(No Band)[6]	(No Band)[7]		

1. Small fragmentation bombs (except M83) have yellow nose and tail.
2. Red for harassing; green for casualty.
3. One band for nonpersistent; two bands for persistent; three bands for G-series.
4. FB MK77 Mod 0 and 1 have unpainted body and red marking.
5. MPB MK5.
6. PB MK106, MK76 Mod 1, 2, and 4, and MK89 have white bands.
7. PB MK106 has white bands.
8. All models used by AF have unpainted bodies. After filling, red markings are added if the bomb is to be stored. No markings are added if the bomb is to be used immediately.

Figure 13-42. Bomb Color Coding

SECTION XIV
PYROTECHNICS

14-1. INTRODUCTION.

14-2. The term pyrotechnics as used herein refers only to pyrotechnic items used for military purposes to produce bright lights for illumination, colored lights or smokes for signaling, light or infrared for missile tracking, or simulated battle noises and effects for training. The art of pyrotechny is literally the art of fire. Pyrotechnic items are therefore those which produce their effect by burning, hence are consumed in the process. Mechanical or chemical smoke generators, electric signal lights, and like items are not classed as pyrotechnics. Illuminating projectiles, smoke projectiles, tracer items, and smoke grenades, are not classed as pyrotechnics. Photoflash bombs though pyrotechnic in nature, are classed as bombs because of their relatively greater hazard. Location markers and various other miscellaneous items, though not in strict conformance with the concept of pyrotechnics, are classed as pyrotechnic ammunition.

14-3. DESCRIPTION.

14-4. COMPLETE ROUND. Pyrotechnics are usually relatively small items and are issued in the form of complete rounds, that is, each item as issued is assembled with all the elements necessary for proper functioning. Large items, such as certain aircraft flares, are an exception to this general rule in that the fuzes are issued separately for assembly in the field.

14-5. IGNITION TRAIN. Pyrotechnics generally function by means of an ignition train (figure 14-1), which is somewhat similar to the propellant train of artillery ammunition. The train begins with an initiator, usually a primer which may be of the percussion, friction, or electric-type. The flame produced on initiation is transmitted successively to a propelling charge, delay element, expelling charge, and finally to the main charge of pyrotechnic composition (sometimes referred to as a candle). One or more of the intermediate elements between initiator and main charge may be absent, depending upon the requirements of the pyrotechnic. Typical elements and their basic functions are as follows:

a. Initiator. This element is usually a percussion, friction, or electric primer. The main purpose of the initiator is to produce a flame to start the sequence of ignition events.

b. Propelling Charge. This element may or may not be in the train depending upon the type of pyrotechnic. For example, when high burst ranging signals are fired from a rifle, a propelling charge is used to further project the signal to a predetermined distance. Normally the propellant will transmit flame to the delay or ignition element of the signal for subsequent ignition when the item is in flight.

c. Delay Element. When used in a particular pyrotechnic design, the delay element is used to delay ignition of the pyrotechnic composition until a specific time has elapsed, or to delay the expelling of an item from a container.

d. Expelling Charge. The expelling charge functions similar to the propelling charge, primarily to expel an item of pyrotechnic composition from a container, i.e., expel signals from the cartridge.

e. Pyrotechnic Composition. This composition is the main element of the munition, and the element to which the ignition train is subordinate.

14-6. EXPLOSIVES. Explosives used in the parts of the ignition train leading up to the main charge are especially selected primer compositions (mixtures) for the initiator, loose black powder for boosters, propelling charges and expelling charges, and compressed black powder for delay elements.

14-7. MAIN CHARGE PYROTECHNIC COMPOSITIONS. The earliest pyrotechnic compositions consisted of varying mixtures of the constituents of black powder, namely, charcoal, sulfur, and saltpeter (potassium or sodium nitrate). Other materials were added to produce special effects, such as, iron filings, coarse charcoal, and realgar (arsenic sulfide). Many other materials were added or substituted as the art of pyrotechnics progressed. Present day pyrotechnic compositions, in general, consist of physical mixtures of various combinations. In some cases, a single material may perform more than one of the following functions:

a. Oxidizers such as chlorates, perchlorates, peroxides, chromates, and nitrates provide some oxygen for burning, additional oxygen being obtained from the air. In pyrotechnic items such as barium chromate-boron mixtures, which have obturated components, the gaseous fuze powders do not require oxygen from the air.

b. Fuels, such as aluminum and magnesium powder, their alloys, sulfur, lactose, and other easily oxidizable materials provide brilliance.

c. Combustible binding and water-proofing agents, such as shellac, linseed oil, resins, resinates, and parafin ensure even burning.

d. Color intensifiers, such as polyvinyl chloride, hexachlorbenzene, or other organic chlorides mixed

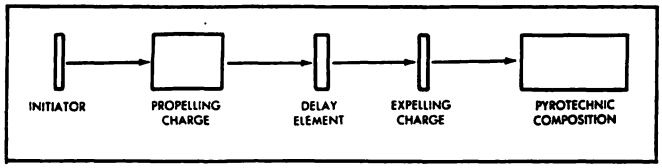


Figure 14-1. Representative Ignition Train for Pyrotechnics

with barium and copper salts are used to produce green or with strontium salts to produce red.

e. Dyes, such as methylamino-anthraquinone are used to produce red and auramine to produce yellow.

f. Magnesium carbonate and sodium bicarbonate are used as coolants.

14-8. Pyrotechnic smoke compositions are of the following two general types:

a. Those that burn with practically no flame but with the formation of a dense, colored smoke as a product of combustion.

b. Those that burn at a temperature so low that an organic dye will volatilize rather than burn and hence will color the smoke.

14-9. FRICTION IGNITER. A friction igniter consists of a primer cup containing a mixture of potassium chlorate, charcoal, and dextrin binder. A loop of wire coated with red phosphorus in shellac extends through this cup.

14-10. QUICK MATCH. The term quick match is applied to strands of cotton soaked in a mixture of black powder and gum Arabic and coated over with mealed powder. It is used as an initiator to transmit flame to igniting, priming, or pyrotechnic charges.

14-11. PRIMING CHARGE. The priming charge is a dried paste of black powder in intimate contact with the first-fire composition. Current newer pyrotechnic items use a priming paste composed of a special nonhygroscopic composition containing barium nitrate, zirconium hydride, silicon, tetranitrocarbazole, and a plastic binder.

14-12. FIRST FIRE. The first-fire composition is generally a mechanical mixture of illuminant charge and black powder. However, for certain items, it may be a special, nonhygroscopic easily ignitable composition, with high-burning temperature.

14-13. CLASSIFICATION.

14-14. Pyrotechnics are classified according to purpose as illuminants (photoflash cartridges and flares), signals, combination signaling and illuminating items, and simulators. Other types of ammunition modified to produce a pyrotechnic effect are classed with the parent types. The pyrotechnic effect produced generally falls into one of the following classes:

a. Photoflash Cartridges. These cartridges produce a single flash or light for photographic purposes.

b. Flares. A flare produces a single source of illumination which is generally of high candle-power and substantial duration. Flares may be parachute-supported, stationary, or attached to tow targets, rockets, drones or missiles. Their primary function is illumination, however, they may be used for identification, location of position, targets, or warning.

c. Signals. There are two types of effects obtained with signals; illumination and smoke. A particular model may produce any variety or combination of these effects. Light producing signals are much smaller and faster burning than flares and may consist of a single parachute-supported star or one to five freely falling stars, with or without colored tracers. Smoke signals are of the slow burning type, which produce a colored smoke.

d. Simulators. Simulators imitate actual battle sounds and flashes of light produced by service items of ammunition. They are designed for use in training.

e. Miscellaneous-Type. Pyrotechnics which have nomenclatures other than those listed have a variety of uses and are classed as miscellaneous.

14-15. VISIBILITY. The principal factors controlling the visibility of pyrotechnics are design, position, atmospheric conditions, and are clarified as follows:

a. Factors of design include candlepower and color.

b. Factors of position include height at which the flare or signal functions and relative position of flare, objective, and observer.

c. Atmospheric conditions are: degree of natural illumination, color and brightness of the sky, and clarity of the atmosphere as affected by the presence of haze, fog, dust, smoke, rain, or snow.

14-16. TYPES.

14-17. Types of pyrotechnics consist of flares, signals, photoflash cartridges, and items designed for various kinds of training in the use of pyrotechnics. Flares are designed to provide a strong light for an appreciable period to illuminate terrain for various air and ground tactical operations. Types of flares consist of aircraft flares (released from aircraft), ground flares (operated on, or projected from the ground), and guide or tracking flares. Signals are designed for both aircraft and ground use for various types of signaling in tactical and survival operations. Photoflash cartridges are designed for use in connection with aerial photography during reconnaissance missions. Pyrotechnic training items are designed to provide targets for air-to-air interception practice, and to provide devices that simulate ammunition items to accustom troops to combat conditions, and to track missiles in flight. Grenades using

pyrotechnic compositions are designed for illumination or signaling; for detailed information pertaining to these grenades, see Section XII.

14-18. AIRCRAFT FLARES. Flares for aircraft use furnish illumination for reconnaissance, observation, bombardment, and landing. These flares produce a white or yellow-white light of 60,000 to 2,000,000 candlepower for periods ranging from 1 to 3 minutes depending on the design of the particular model. They are generally parachute-supported to retard their speed of fall and thus provide a longer interval of illumination. The flares have some form of delayed ignition to ensure their clearing the aircraft as they descend to a specified altitude before starting to burn. A representative aircraft flare is the parachute flare MK24 Mod 3 (figure 14-2), which is used for reconnaissance and night operations. It is launched from tube dispensers mounted on 14-inch suspension bomb-racks and also can be launched from cargo type aircraft.

14-19. GROUND FLARES. Flares for ground use are designed for illumination for aircraft landings at emergency fields, for lighting airports in case of power failure or to warn of attempted infiltration by

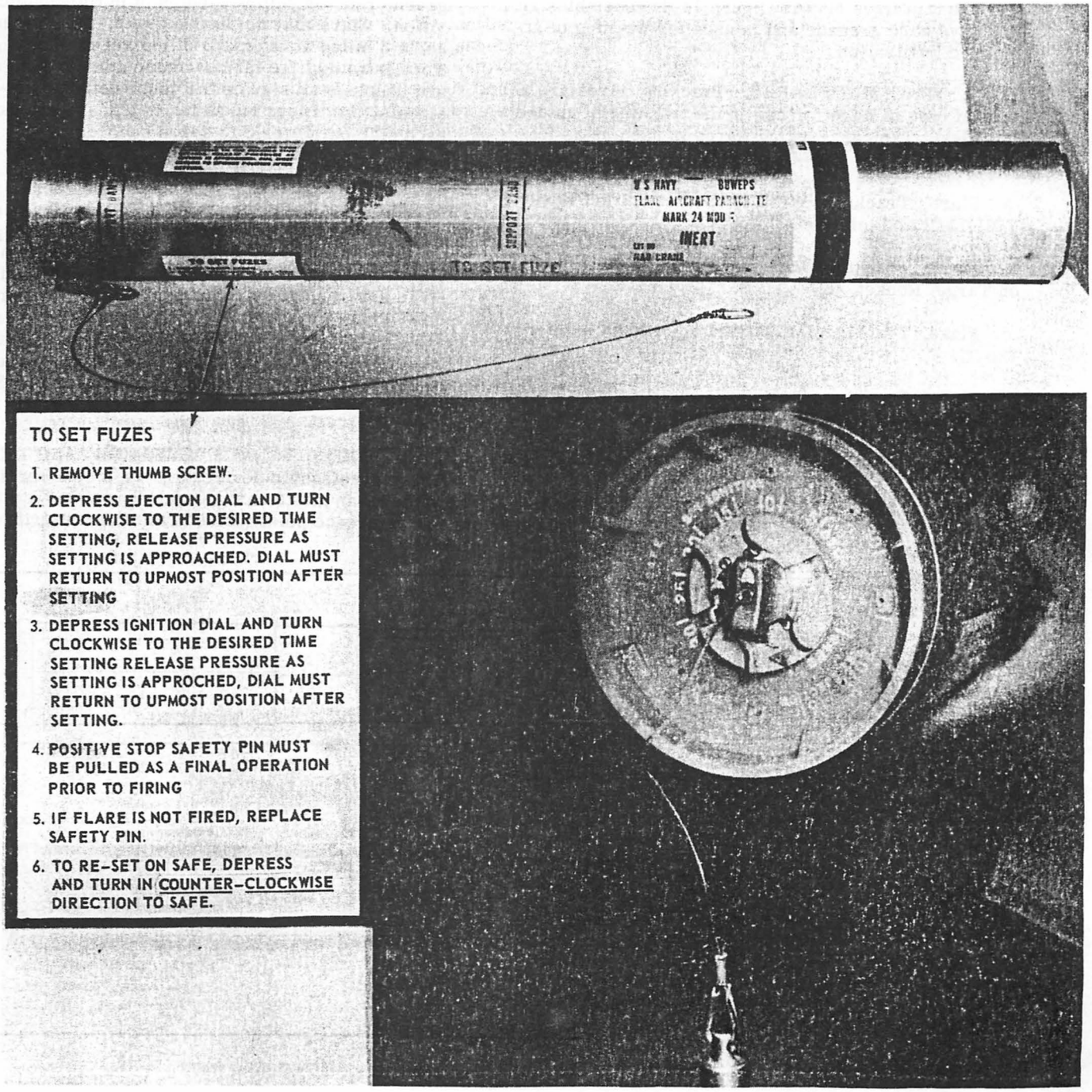


Figure 14-2. Aircraft Parachute Flare, MK24 Mod 3

enemy troops. Certain ground flares such as fusees may be used as recognition signals. Representative ground flares are as follows:

a. The airport flare M76, is a 20-pound cylindrical charge of illuminant (candle) encased in a zinc-sheathed box-board tube fitted with means of ignition, which burns with a yellow flame visible for 5 to 7 minutes at a distance of 20 to 30 miles depending upon atmospheric conditions.

b. The red fusee M72, is a 20-minute red-fire candle for multipurpose use. (See figure 14-3.)

c. The trip flare M49A2 (figure 14-4) resembles an offensive hand grenade and is used for warning of attempted infiltration.

14-20. TRACKING FLARES. Tracking flares are a special type of flare for use in the tracking of guided missiles. Typical tracking flares in use are as follows:

a. Flare, Tracking, W112B, used on Target Rocket, TDU-11/B and missile AIM-9/B.

b. Flare, Tracking, MK21 Mod 0 (figure 14-5), used on Target Rocket, TDU-11/B.

c. Flare, Tracking, MK27 Mod 0, used on AGM-12B/C.

d. Flare, Tracking, TAU-50/B, used on Tow Target, TDU-4/B.

e. Flare, Tracking, TAU-56/B, used on Q2C Drone.

14-21. SIGNALS. Pyrotechnic signals are designed to produce: light of various intensities, duration, and color; smoke of various colors and densities; or any combination of these. Signals may consist of a single parachute-supported star or a number of free-falling stars or clusters of various colors. Smoke signals are usually of the slow-burning type.

14-22. AIRCRAFT SIGNALS. Aircraft signals (figure 14-6) used directly in connection with combat operations were originally intended for signaling air-to-air or air-to-ground, but since the introduction of pyrotechnic pistol AN-M8 aircraft signals have also been used by ground troops for ground-to-ground and ground-to-air signaling. Single-star signals, double-star signals, and double-star tracer signals contain green, red, or yellow candles of pyrotechnic composition. Stars may be distinguished at distances up to about 5 miles at night and 2 to 3 miles in daylight. Total burning time is 7 to 13 seconds for both single- and double-star signals. For the double-star-tracer signals, the tracer burns for 2-1/2 to 4 seconds and each star burns for 3 to 4-1/2 seconds.

14-23. DISTRESS SIGNALS. Distress signals for daytime use produce smoke, those for night use produce a light or stars, and those for either day or night produce both smoke and light. Signals, flares, other pyrotechnics, or smoke grenades may also be used for distress signaling. Signals intended primarily for distress signaling are hand-held self-contained units. The distress signal AN-MK13 Mod 0 represents the day and night type. This signal contains smoke in one end and a red flare in the opposite end. (See figure 14-7.)

14-24. DRIFT SIGNALS, MARKERS, AND LIGHTS. These pyrotechnic devices are used by aircraft over water as an aid to navigation by providing a stationary reference point for determination of drift of an

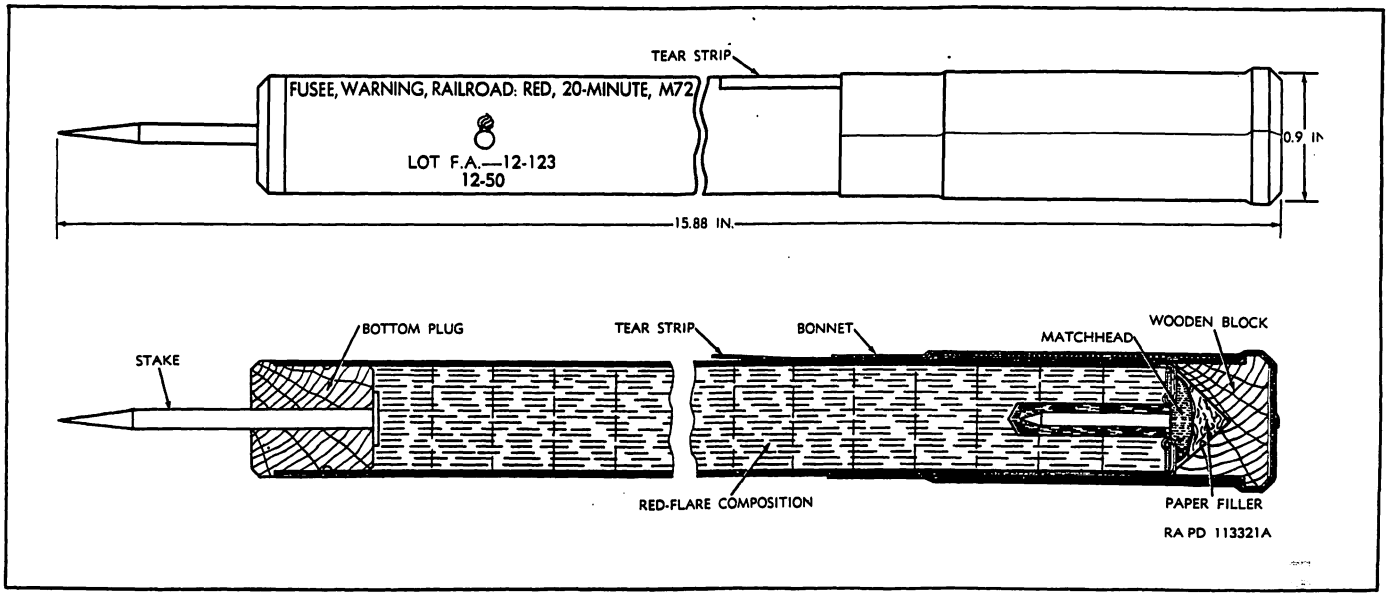


Figure 14-3. Fusee, Warning, Railroad: Red, 20 Minute, M72

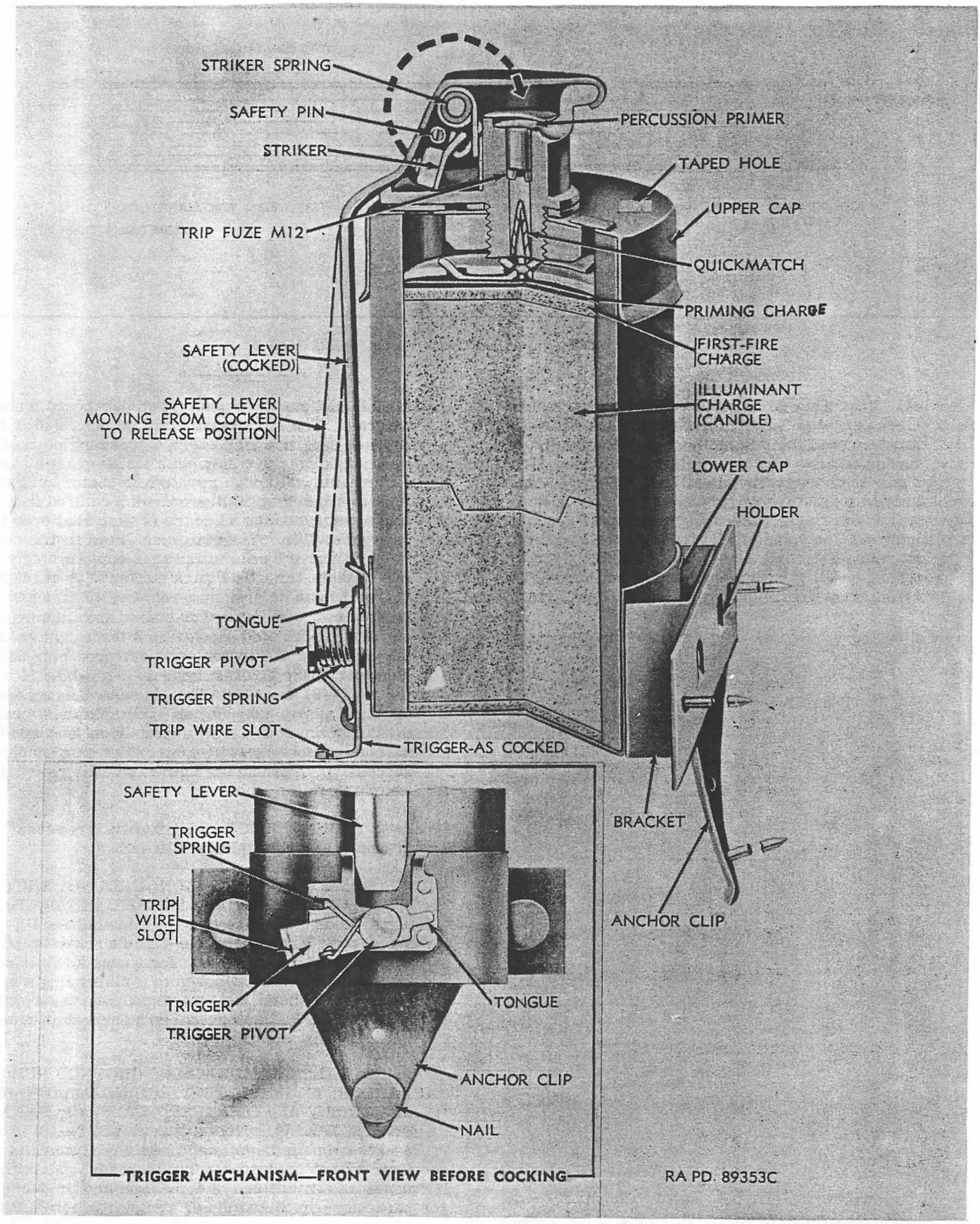


Figure 14-4. Flare, Trip, M49

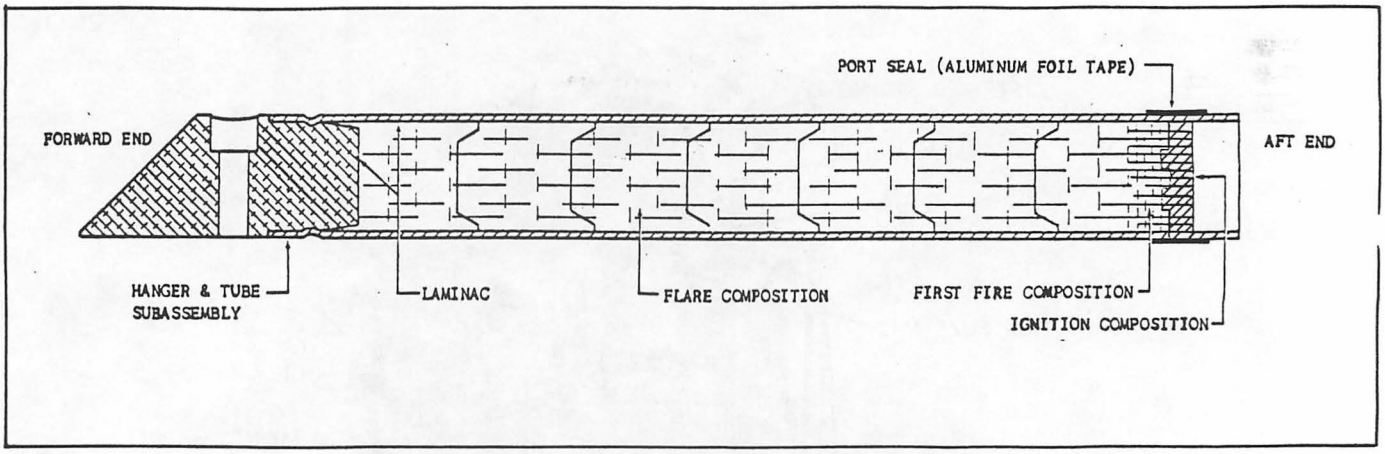


Figure 14-5. Tracking Flare, MK21 Mod 0

aircraft. They are also used to mark the location of a submarine or other object for the attention of surface vessels, for determining the wind direction before landing an aircraft, or to mark the location of the surface for emergency landing at night. The signals contain a pyrotechnic candle that ignites on impact with the surface of the water and floats, nose down, emitting flame and smoke from the tail. One type of marker produces a slick on the water surface. The other types, which produce smoke and flame, are called night drift signals or aircraft float lights. Drift signals and markers are thrown overboard from an aircraft. The slick marker AN-M59, which is for daytime use, contains a 2-1/4 pound cylinder of uramine, a soluble dye salt, in a brittle plastic case. The marker, although not a pyrotechnic has a somewhat similar effect. It produces a colored film or slick on the surface when the case is shattered by impact with water. The yellowish green flourescent slick produced by the uramine is approximately 20 feet in diameter. The slick persists for at least 2 hours and can be seen at a range of 10 miles from an altitude of 3,000 feet. The smoke and illumination signal AN-MK5 Mod 4 contains a three-unit candle that burns for 720 to 900 seconds, producing 650 candlepower. The aircraft float light AN-MK6 Mod 3 (figure 14-8) provides a long-burning surface marker for night or day use. A pull-type igniter is located in the tail of the body. The light may be launched from surface vessels as well as aircraft. The candles burn successively, producing flame and dense grayish-white smoke for 1 hour.

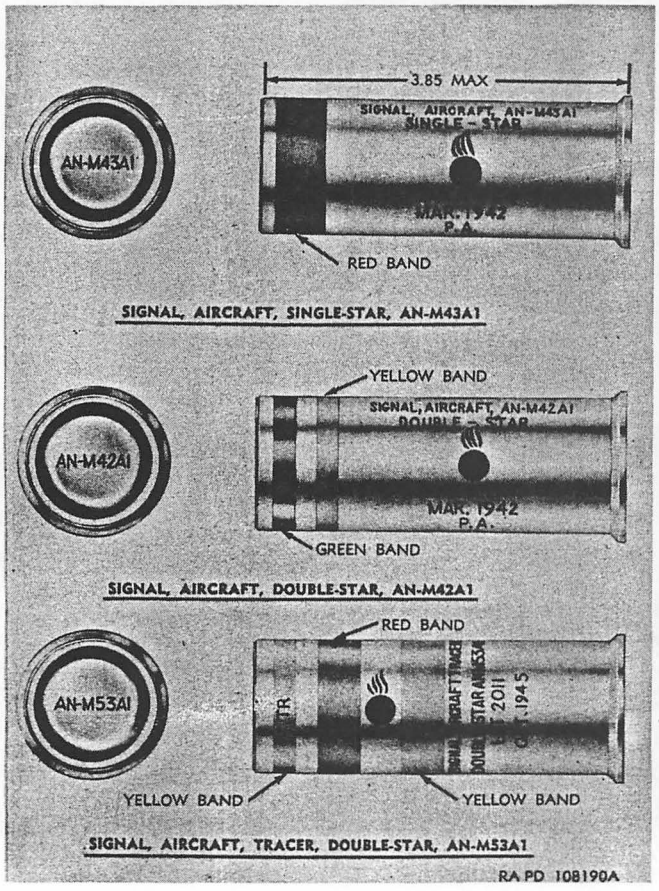


Figure 14-6. Aircraft Signals

14-25. GROUND SIGNALS. Signals fired from the ground are of several types as follows:

a. SIGNAL, ILLUMINATION, GROUND: WHITE STAR, PARACHUTE, M127(T73) (HAND HELD). This signal (figure 14-9) is rocket-propelled and fin-stabilized. The expendable-type launcher is integral with the signal and, hence, for firing does not require a grenade launcher attached to a rifle firing a special cartridge. When fired, the signal reaches an altitude of 650 to 700 feet and produces a parachute-supported white star.

b. SIGNAL, ILLUMINATION, GROUND: RED STAR, PARACHUTE, M131 (T66E1) (HAND HELD) (FORMERLY SIGNAL, DISTRESS, RED STAR, PARACHUTE, T66E1). This signal (figure 14-10) is a rocket-propelled spin stabilized signal which is fired from a hand-held expendable launcher. When fired, it reaches an altitude of 1,500 feet and produces a parachute-supported single red star which burns for 30 seconds and is identifiable up to 30 to 35 miles. It is intended to produce a distinctive red light above ground fog, haze, or overcast such as is commonly encountered in arctic regions, thereby enabling ground

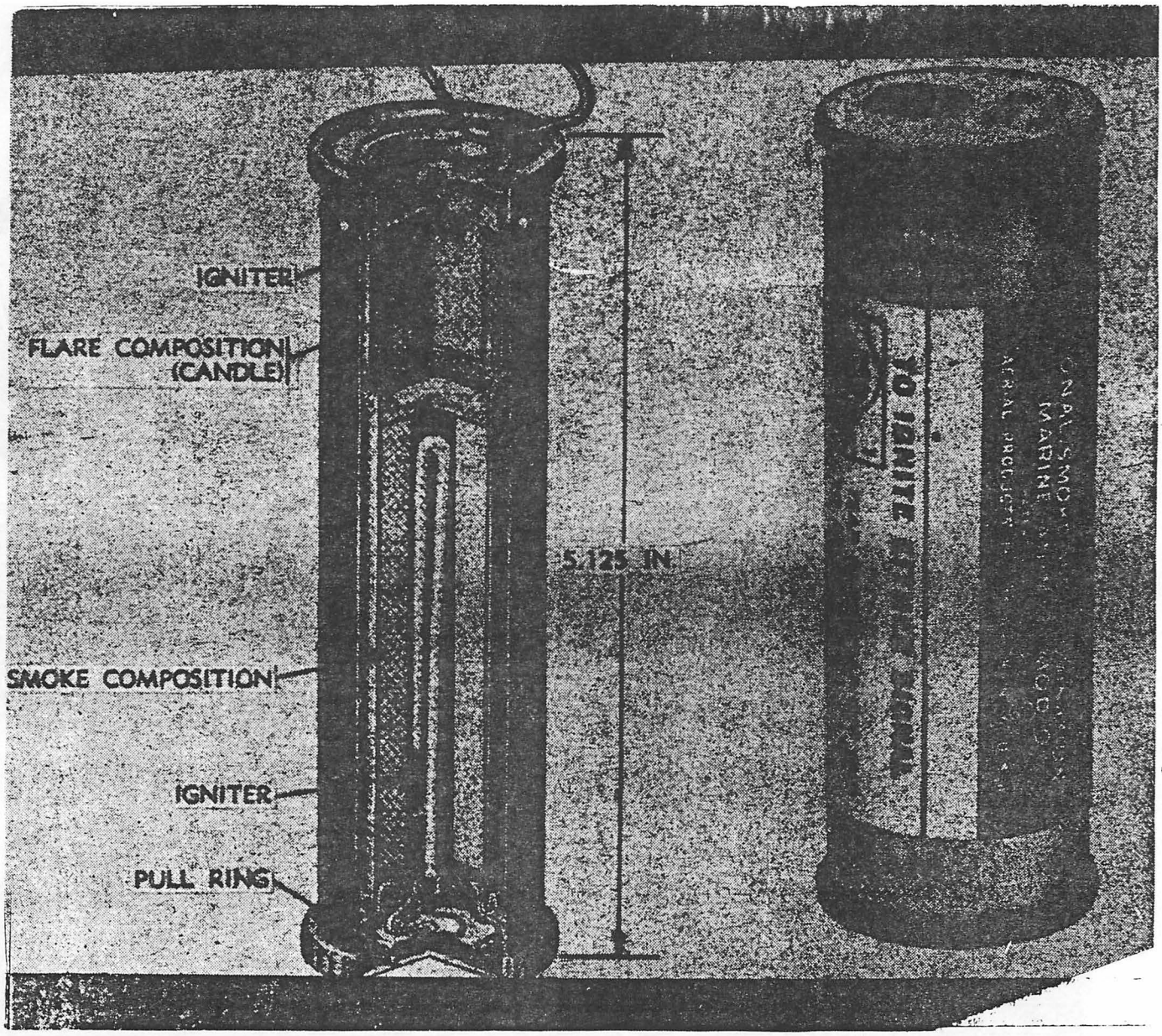


Figure 14-7. Signal, Smoke and Illumination, Marine: AN-MK13 Mod 0

personnel who are obscured by such conditions to signal to personnel in aircraft. As issued, the signal is assembled within two tubes. The outer tube is essentially a sealed waterproof container. The inner tube, after removal of the metal cap and outer tube, serves as an expendable launcher for firing.

14-26. PHOTOFLASH CARTRIDGES. These cartridges are used in connection with aerial photography during reconnaissance missions and are electrically initiated.

14-27. A service photoflash cartridge consists of a photoflash charge and delay fuze assembled in a case that, in turn, is assembled in an electrically primed cartridge case together with a small propelling charge. Examples are as follows:

a. Cartridge, photoflash, M112A1 (figure 14-11) contains 7 ounces of photoflash powder and has a peak light emission of 120 million candlepower. Cartridges with delays of 1, 2, or 4 seconds are provided.

b. Cartridge, photoflash, M123(T89) contains 1.75 pounds of photoflash powder and has a peak light emission of 260 million candlepower. A pyrotechnic delay fuze in the ignition train delays ignition of the photoflash powder. Cartridges with delays of 2, 4, and 6 seconds are provided.

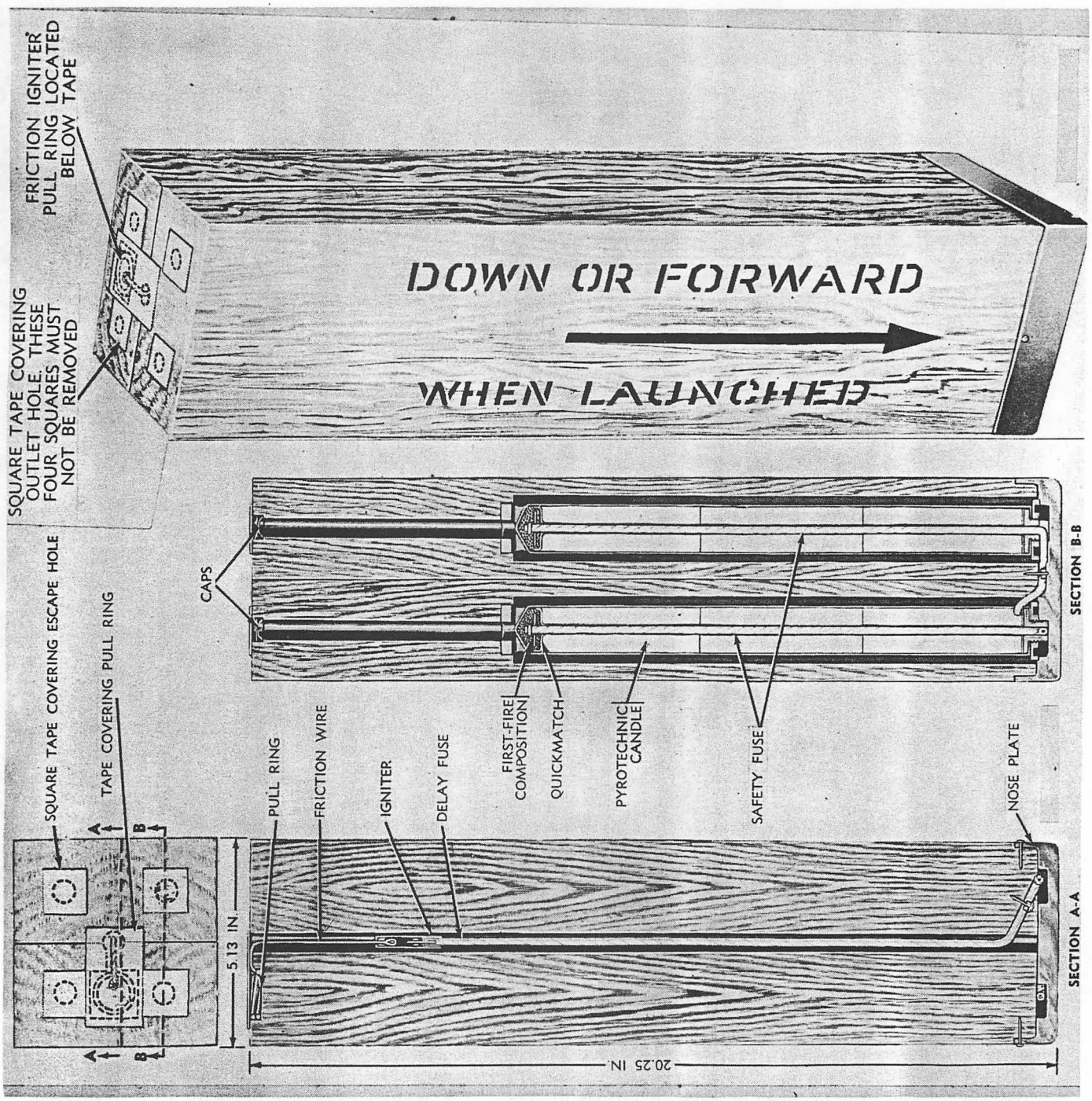


Figure 14-8. Light, Float, Aircraft, AN-MK6 Mod 2

14-28. A practice photoflash cartridge consists of an inert solid unit that is assembled in an electrically primed cartridge case together with a small propelling charge. The following are examples:

a. Cartridge, photoflash, practice, M121 simulates the M112A1 and is used as a practice round in the same projector.

b. Cartridge, photoflash, practice, M124 simulates the M123 and is used as a practice round for use in projectors for the cartridge M123.

14-29. TRAINING PYROTECHNICS.

14-30. Photoflash cartridges used for training purposes are Cartridge, photoflash, practice, M121 and M124.

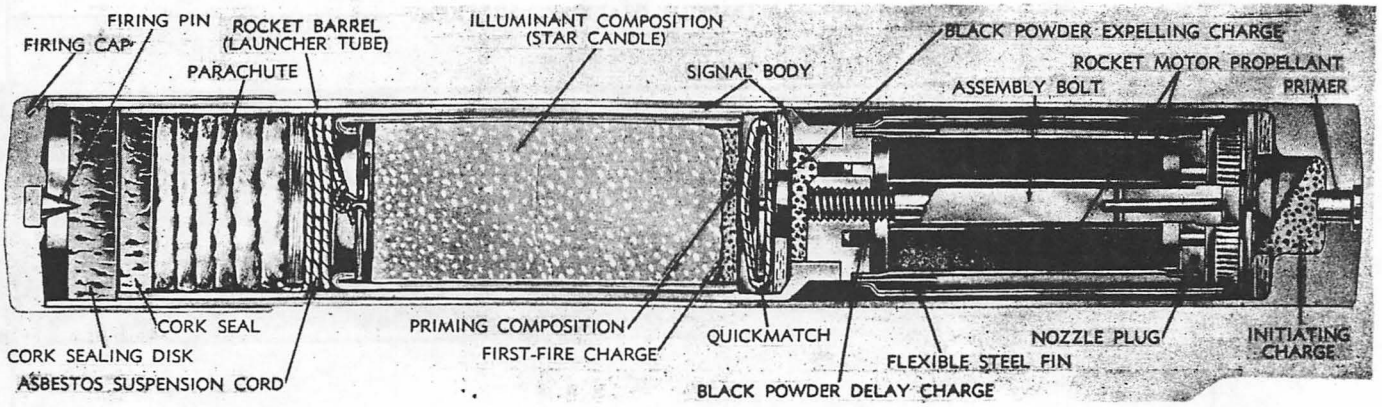


Figure 14-9. Signal, Illumination, Ground, White Star, Parachute, M127(T73) (Hand-held) - Section

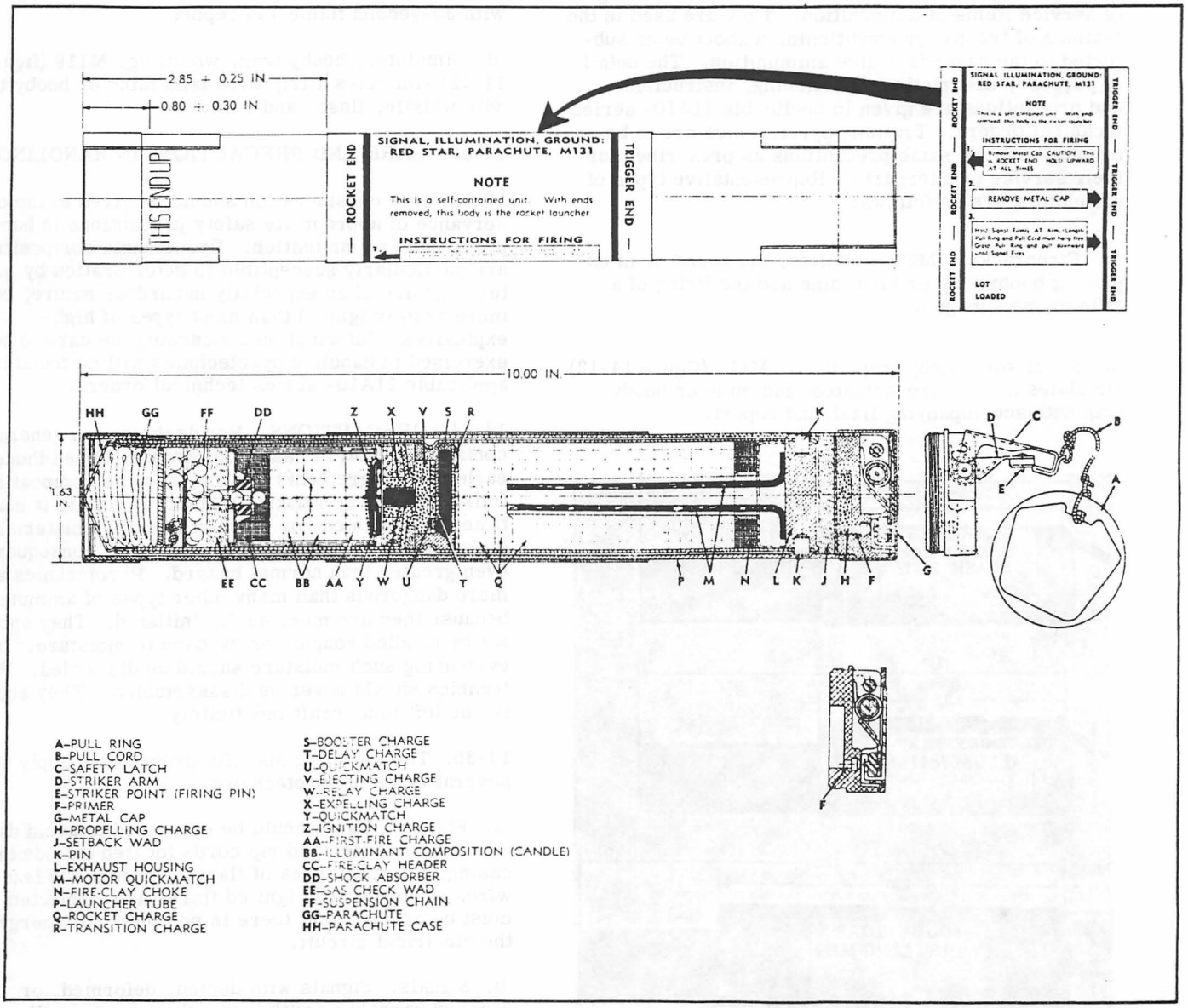


Figure 14-10. Signal, Illumination, Ground: Red Star, Parachute M127(T73) (Hand-held) - Section

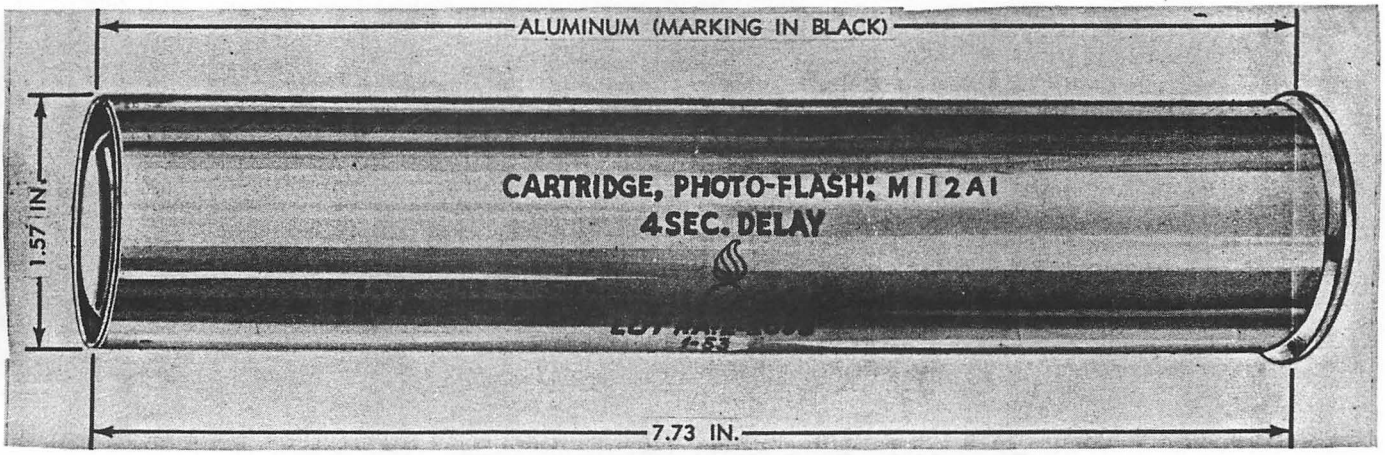


Figure 14-11. Cartridge, Photoflash, M112A1, 4-second Delay

14-31. Simulators are pyrotechnic devices designed to imitate the actual battle sounds, flashes, and lights of service items of ammunition. They are used in the training of troops for conditioning without being subjected to the hazards of live ammunition. The details of purpose, description, functioning, instructions, and precautions are given in applicable 11A10- series technical orders. Training pyrotechnics are to be handled with the same precautions as prescribed for their service counterparts. Representative types of simulators are as follows:

a. Firecracker, M80, simulates the sound of an exploding booby trap or land mine and the firing of a rifle or machinegun.

b. Simulator, booby trap, flash, M117 (figure 14-12) simulates a trip wire-actuated land mine or boody trap with accompanying flash and report.

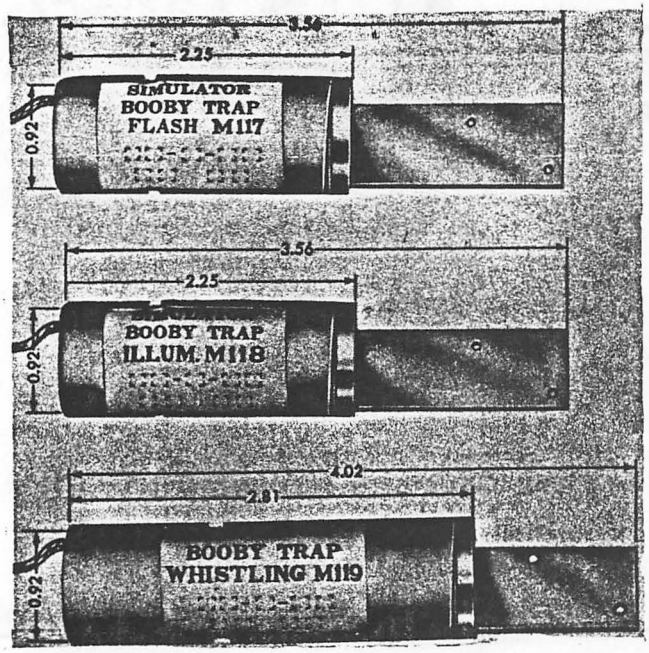


Figure 14-12. Simulator, Booby Trap, Flash, M117, Illuminating, M118 and Whistling, M119

c. Simulator, booby trap, illuminating, M118 (figure 14-12) simulates a trip wire land mine or booby trap with 30-second flame and report.

d. Simulator, booby trap, whistling, M119 (figure 14-12) simulates a trip wire land mine or booby trap with whistle, flash, and report.

14-32. CARE AND PRECAUTIONS IN HANDLING.

14-33. Due consideration should be given to the observance of appropriate safety precautions in handling pyrotechnics ammunition. Pyrotechnic compositions are particularly susceptible to deterioration by moisture and are of an especially hazardous nature, being more readily ignited than most types of high-explosives. Information concerning the care to be exercised in handling pyrotechnics will be found in applicable 11A10- series technical orders.

14-34. PRECAUTIONS. Pyrotechnics, in general, contain material of hazardous nature. Even though each of the ingredients in a pyrotechnic composition (mixture) may be relatively stable in itself, it may in time react with one or more of the other materials in the mixture to cause deterioration and, consequently, even greater than normal hazard. Pyrotechnics are more dangerous than many other types of ammunition because they are more easily initiated. They should not be handled roughly or exposed to moisture. Items evidencing such moisture should be discarded. Pyrotechnics should never be disassembled. They should not be left in aircraft indefinitely.

14-35. The following specific precautions apply to the several types of pyrotechnics.

a. Flares. Care should be exercised to avoid damage to fiber cases and rip cords located outside the casing of certain types of flares. Before the lead wires of electrically ignited flares are connected, it must be assured that there is no electrical energy in the electrical circuit.

b. Signals. Signals with dented, deformed, or cracked barrels or with loose closing caps will not be used. Signals will be guarded against a blow on the primer, because such a blow may ignite the signal.

c. Photoflash cartridge. The shunt cap must not be removed from the cartridge until just prior to loading the cartridge into the projector.

d. Simulators. Protective or safety devices should not be removed from simulators until just before use. The gunflash simulator contains an explosive filler similar to that of a photoflash bomb and requires the same care in handling. The electric squib used to fire the simulator requires the same care as an electric blasting cap.

14-36. HANDLING. Besides the hazardous pyrotechnic compositions, pyrotechnics are composed of sensitive elements, such as fuzes, friction compositions, and primers. Disassembly of pyrotechnics or components is prohibited. Pyrotechnics should be handled with care and protected against shock. Boxes containing pyrotechnics should not be dropped or thrown. Boxes containing signal cartridges, which are discharged by percussion primers, should be placed flat with top up. Protective or safety devices should not be removed until just before use. Care should be exercised to avoid damage to fiber cases and rip cords located outside the casing of Navy type flares. Pyrotechnics, especially the type which are projected, should be handled so as to avoid denting or deforming the barrel or case. Pyrotechnics which are seriously dented, deformed, cracked, broken, or having loose closing or shipping covers will be suspended from use and reported for disposition.

14-37. PRECAUTIONS IN FIRING.

14-38. Detailed information concerning safety precautions to be observed in firing pyrotechnics will be found in applicable 11A10- series technical orders. General safety precautions for firing pyrotechnics are as follows:

a. When firing pyrotechnics, extreme care should be taken to fire them in such a manner that burning material or burned signals will not fall on friendly personnel or into boxes of pyrotechnics or other ammunition or other flammable material. Care should also be exercised when firing through trees or other obstructions.

b. Projected pyrotechnics (especially rocket-propelled ground signals) may cause heavy recoil when fired.

c. The shell burst simulator projects burning paper fragments to a distance of 10 yards. It can ignite dry leaves and grass. The flash booby trap simulator is dangerous for personnel within 6 feet at time of functioning. The illuminating booby trap simulator produces a flame that will ignite wood or other combustible material or produce serious burns to personnel.

14-39. PACKING AND MARKING.

14-40. PACKING. The functioning of pyrotechnics is affected by moisture. Pyrotechnics are packed in moistureproof or hermetically sealed containers. The seals of such packings should not be broken until just before the item is to be used. If pyrotechnics are exposed to moisture, they should be separated from all other material until an examination has been made to make sure that they are serviceable and not dangerous. Although some pyrotechnic compositions (mixtures) may become more sensitive due to exposure to moisture, most pyrotechnic items become more difficult to ignite, hence less dependable.

14-41. MARKING. In addition to descriptive nomenclature, quantity, ammunition lot number, and month and year loaded, packages offered for shipment are marked with the Interstate Commerce Commission (ICC) shipping name or classification of the article volume and gross weights, and the Federal Stock Number (FSN).

SECTION XV
AIRCRAFT ROCKETS

15-1. INTRODUCTION.

15-2. Several types of Navy rockets have been used by the Air Force for forward firing from aircraft fitted with post (zero length) or rail launchers. The modifications and adaptations of World War II models with the newer aircraft have progressed to newer models in the rockets. At present the Air Force uses three basic types of rockets. The rockets are the 2.75-Inch Folding Fin Aircraft Rocket (FFAR), the 5.0-Inch Folding Fin Aircraft Rocket (FFAR) (ZUNI), and the 5.0-Inch High Velocity Aircraft Rocket (HVAR). The FFAR's are designed for use in tubular launchers. The HVAR is fired from retractable launchers, using suspension bands and lugs. The versatility use of these rockets is determined by the interchangeability of warheads and fuze combinations.

15-3. ROCKET TERMINOLOGY. A rocket is a missile which is propelled by the reaction caused by a discharging jet of gas from the burning of a charge of a propellant within the rocket motor. A military rocket consists essentially of a head, a motor, and means of stabilization during flight. The head comprises the element necessary to produce the desired effect at the target, usually an explosive filler and fuze. The motor comprises the elements necessary to propel the rocket, including the propellant charge, nozzle or nozzles, and means of igniting the propellant. Stabilization is accomplished either by fins attached to the motor (fin type) or, in the case of multiple nozzle rockets, by so locating the nozzles that the rocket is rotated in flight (spin type). In order that a rocket may be launched on a definite trajectory, a device called a launcher is required. Aside from providing means for initiating ignition of the rocket propellant, the launcher is required only to aim the rocket. Consequently, rocket launchers may be so light and portable that rockets can be fired from airplanes at ground target areas inaccessible to conventional artillery. The employment of rocketry is more economical than that of artillery against light and, in some instances, heavy targets at relatively short ranges. A further advantage of the use of rockets lies in the fact that the forces of setback are relatively small but spread over a comparatively long period of acceleration, thus permitting the use of light-case projectiles of higher capacity and less expensive construction than artillery shell of similar caliber, and the use of fuzes of less rugged construction. A rocket is relatively inexpensive, easily launched, and economical of personnel. The disadvantages of rockets, as compared with conventional artillery rounds, lies in the fact that operating personnel and inflammable material must be protected from the rearward blast of hot gas, that dispersion of rockets is considerably greater than that of comparable artillery shell, and that operation is limited to relatively short distances from the target.

15-4. THE ROCKET PRINCIPLE. The basic principle of rocket propulsion may be described and illustrated as follows:

a. When a gas is compressed in a closed vessel of any shape, pressure (as stated in Pascal's law) is equal and opposite in all directions; hence, the force in one direction counterbalanced by an equal force in the opposite direction with no resulting motion of the closed vessel. This is illustrated diagrammatically by arrows and shading in figure 15-1 representing a closed tube. Note that although the equal and opposite forces on the side walls of the tube are represented in figure 15-1, they are omitted in figures 15-2 and 15-3 because they cancel each other and therefore are not necessary in the further discussion of the rocket principle.

b. When an opening to the atmosphere is made in one end of the tube (figure 15-2), the pressure at the opening drops to near atmospheric while the pressure on the closed end remains momentarily greater than atmospheric; as a consequence, the tube tends to move in the direction of the closed end as a stream or jet of gas is ejected from the open end. If pressure is continually built up within the tube, as by the burning of a propellant, high pressure is maintained at the closed end until the propellant burns out, while near-atmospheric pressure prevails at the opening. Thus, the high pressure at the closed end, acting on an area equal to the area of the opening, results in a force or thrust in the direction of the closed end. Note that for a comparatively small opening, the pressure at the open end may be considered substantially the same as that at the closed end, except at the actual opening which is atmospheric. Thus it is that the forces at the closed and open ends are equal and opposite, except on an area equal to that of the opening; at the opening, this force is zero, whereas at the closed end the force which tends to produce motion is equal to the pressure times the area of the opening. The forces causing motion in the direction of the closed end while the propellant is burning are represented diagrammatically by the shading. The burning of a propellant in a tube, closed at one end and with an opening in the other end, results in pressure and heat energy which, by reaction, as the gas escapes through the opening or nozzle, tends to move the tube.

c. As the gas passes by the square corners near and at the opening (figure 15-2), there are substantial frictional losses due to turbulence which are represented by the curlicues in the shading near the opening. These losses are largely overcome by using the

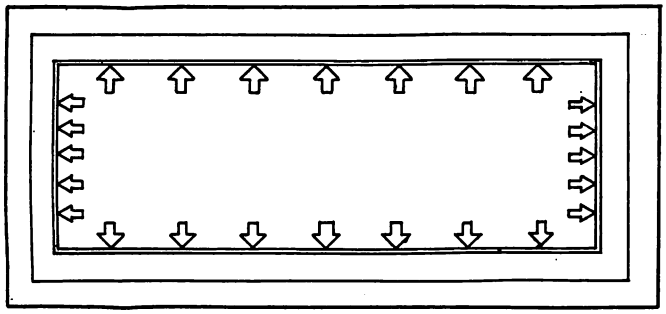


Figure 15-1. The Rocket Principle (Pressure in Closed Tube)

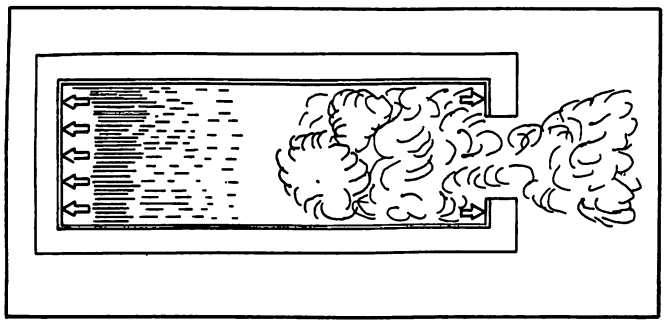


Figure 15-2. The Rocket Principle (Movement of the Tube-opening in one end)

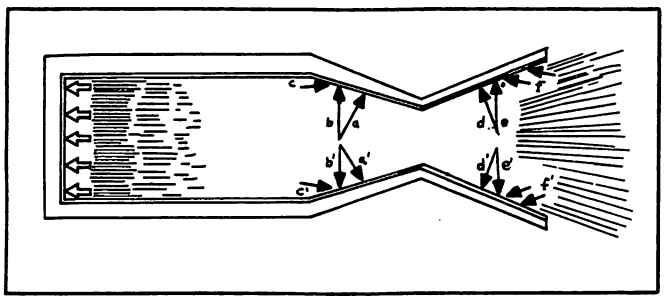


Figure 15-3. The Rocket Principle (Movement of the Tube-nozzle in one end)

shape shown in figure 15-3, forming a nozzle. This type of opening comprises a smooth contour which provides for a nonturbulent, hence relatively frictionless, flow of gas represented by the smoothness of the shading. The constricted opening, called the throat, limits the flow of gas and thereby maintains pressure within the tube while the propellant is burning. The gas, while flowing through the nozzle, is still under a pressure which decreases from the throat to the open end of the nozzle. Such pressures represented by (d) and (d') normal to the wall of the nozzle result in force components (f) and (f') in the direction of flight. Hence, energy which otherwise would be lost, if the gas were discharged through an opening such as that in figure 13-3, is converted to additional thrust by use of the nozzle. Forces, such as (c) and (c'), resulting from pressure on the approach side of the nozzle are of substantially the same magnitude as (may be slightly less due to somewhat lower pressure at the nozzle end) but in the opposite direction to those on an equivalent area at the closed end; hence, they balance each other. Since force components represented by (b) and (e) are equal and opposite to (b') and (e') they have no effect on motion. Thus, the principal forces producing motion of the tube consist of those resulting from the internal pressure acting at the closed end on an area equivalent to that of the throat plus the axial forces (f) and (f') resulting from the pressure within the nozzle.

15-5. 2.75-INCH FFAR.

15-6. The 2.75-inch fin stabilized aircraft rocket (figure 15-4) is for combat and rocket practice firing. It is a versatile weapon because it has several different types of warheads used for various types of targets. The body section comprises most of the length of the rocket and houses the rocket motor and integral igniter. The rocket is threaded internally at the forward end to receive the warhead and is composed of aluminum alloy. The aft motor section contains the nozzle and folded fins, which when retracted are the same diameter as the body section. A fin retainer holds the fins in position until the rocket is launched. A contact button connected to the igniter circuit is located on the aft end. There are several different models of rocket motors of the MK series. The motor uses an internal burning solid propellant grain, which upon firing, actuates the blast-operated folding fins to stabilize the rocket in flight.

15-7. WARHEADS, 2.75-INCH FFAR.

15-8. ROCKET HEAD HIGH EXPLOSIVE (HE), 2.75-INCH FFAR, MK1. This head (figure 15-5) is intended for air-to-air and soft ground targets. The delay element in the fuze permits the rocket to enter the aircraft structure before detonating. The filler is HBX-1, which consists of a mixture of TNT, RDX, aluminum and a desensitizer.

15-9. ROCKET HEAD, HIGH EXPLOSIVE, ANTI-TANK (HEAT), 2.75-INCH FFAR, MK5. This head has the same external configuration as the HE, MK1 except that it has a shaped explosive charge for armor penetration. The filler is Composition B.

15-10. ROCKET HEAD, 2.75-INCH, M151. This special head (figure 15-6) has been recently standardized. This warhead has a pearlite, malleable iron (PMI) case, threaded at the forward end for fuze attachment, and threaded externally at the aft end for attachment to the head closure of the motor assembly. This warhead is shipped with or without fuze. Composition B4 is the explosive filler in this head. This round has antiricochet capabilities. It has a graze sensitive and superquick action fuze. The length is 13 inches, without fuze.

15-11. ROCKET HEAD, SMOKE (WP), 3.5-INCH. This head (figure 15-7) has been adapted from the 3.5-inch Army ground launched rocket and fitted to a 2.75-inch rocket motor. This warhead is internally threaded at the aft end to receive a modified M404A1 Base Detonating Fuze. The warhead contains a 2.33 pound charge of white phosphorus. The M8 burster casing is press fitted into the union, and the steel

body is fitted over it. The steel ogive and the internal steel dome, which closes the forward end of the filler cavity, are attached to the body. It is used by propeller type observation aircraft to spot targets for jet aircraft. A special adapter made of aluminum alloy is required to mate this head to the 2.75-inch motor.

15-12. ADAPTER. The adapter is designed to adapt the 2.75-Inch Rocket Motor to the 3.5-Inch WP Rocket Head. It is made of aluminum alloy and has two external threads, one on each end of the adapter. One end of the adapter will fit the internal thread of the fuze and the other end will fit the internal thread of the rocket motor.

15-13. ROCKET HEAD, SMOKE (WP), 2.75-INCH, E13. This smoke head is used as a spotting head for the 2.75-inch FFAR. It contains approximately 2.4 pounds of WP, weighs approximately 9 pounds, and looks identical to the M151. Because of this feature the markings must be carefully observed and maintained. This warhead will replace the Rocket Head, Smoke (WP), 3.5-Inch.

15-14. ROCKET HEAD, PRACTICE, 2.75-INCH FFAR. This training item consists of an inert loaded MK1 or MK5 head with inert fuze and assembled to a live service motor.

15-15. FUZES, 2.75-INCH FFAR.

15-16. FUZE, MK176 (PD). The MK1, HE loaded head is received with the MK176 fuze installed. This fuze (figure 15-8) is a cone-shaped steel body containing the explosive train, which includes the firing mechanism, arming mechanism, primer, delay element, detonator, and booster. Arming is by sustained acceleration.

15-17. FUZE, MK181 (POINT INITIATING). This fuze is used with the MK5 Anti-tank (HEAT) warhead. The fuze (figure 15-9) contains a booster pellet at the base of the shaped charge warhead filler. The Shaped-charge Booster M122, has a concave shape at its after end to direct the explosion of the booster into a jet of high temperature gases. This jet travels to the base of the rocket head, through the cone and flash tube, to ignite the booster pellet and, in turn, the main charge. Arming of the fuze is by sustained acceleration.

15-18. FUZE, M427. This fuze is used with the M151 and E13 warheads. The fuze has a cylindrical body

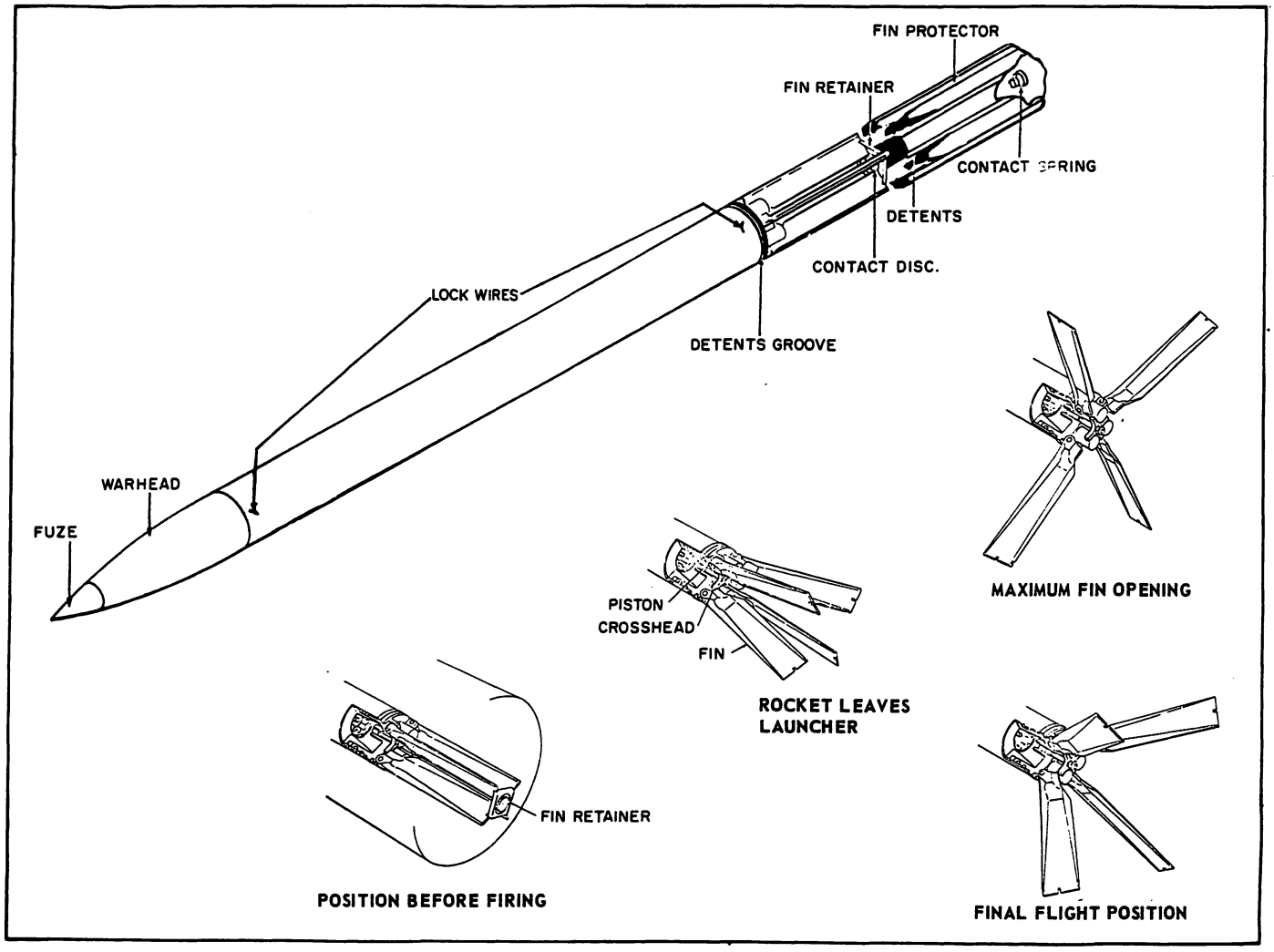


Figure 15-4. 2.75-Inch Folding Fin Aircraft Rocket (FFAR)

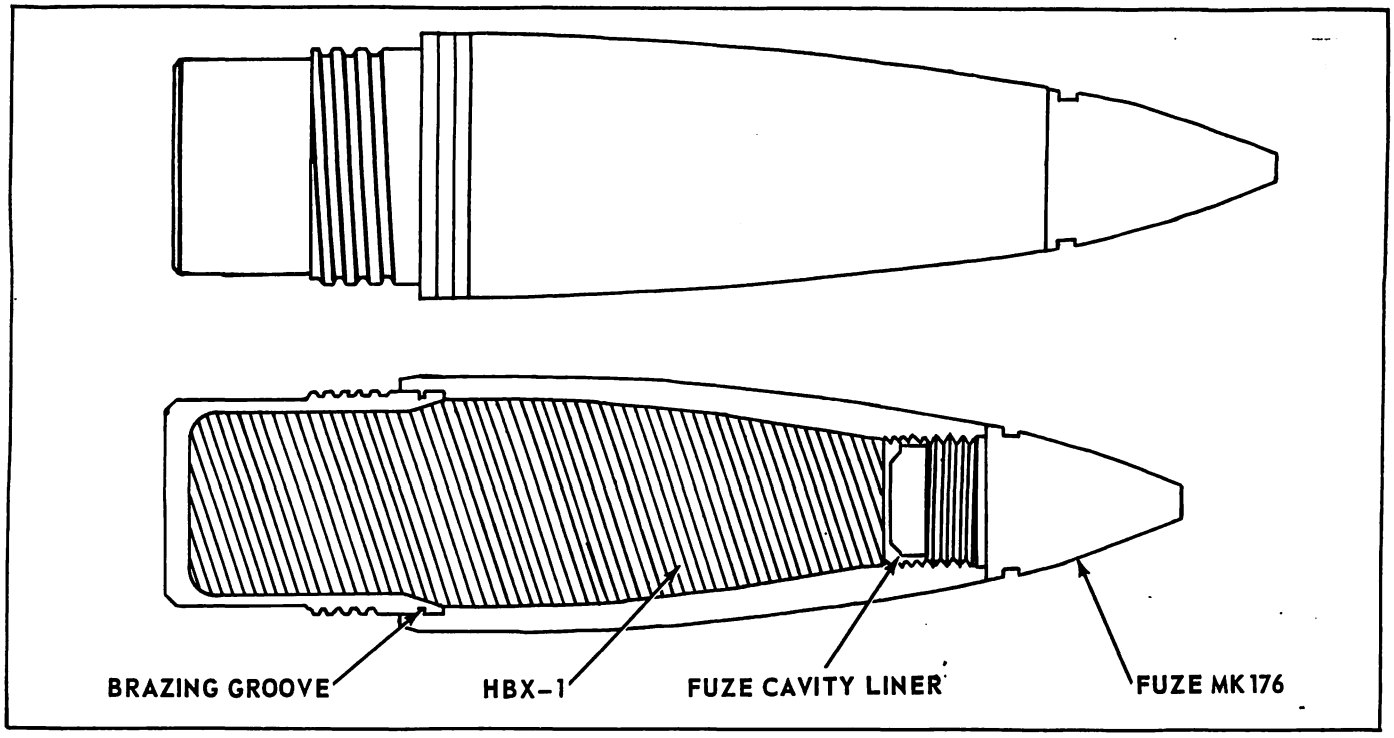


Figure 15-5. 2.75-Inch Rocket Warhead MK1 Mod 4 (HE)

with a conical nose section which arms by sustained acceleration and is graze sensitive with a superquick action.

15-19. FUZE, M404A1, BASE DETONATING. The M404A1 Base Detonating Fuze is used (figure 15-7), with the 3.5-Inch WP, Warhead. The fuze consists of a body which contains the functioning parts, a safety band, a detonator and a booster pellet. The fuze is externally threaded at the forward end and internally threaded at the aft end and serves as a coupling between the rocket head and the rocket motor.

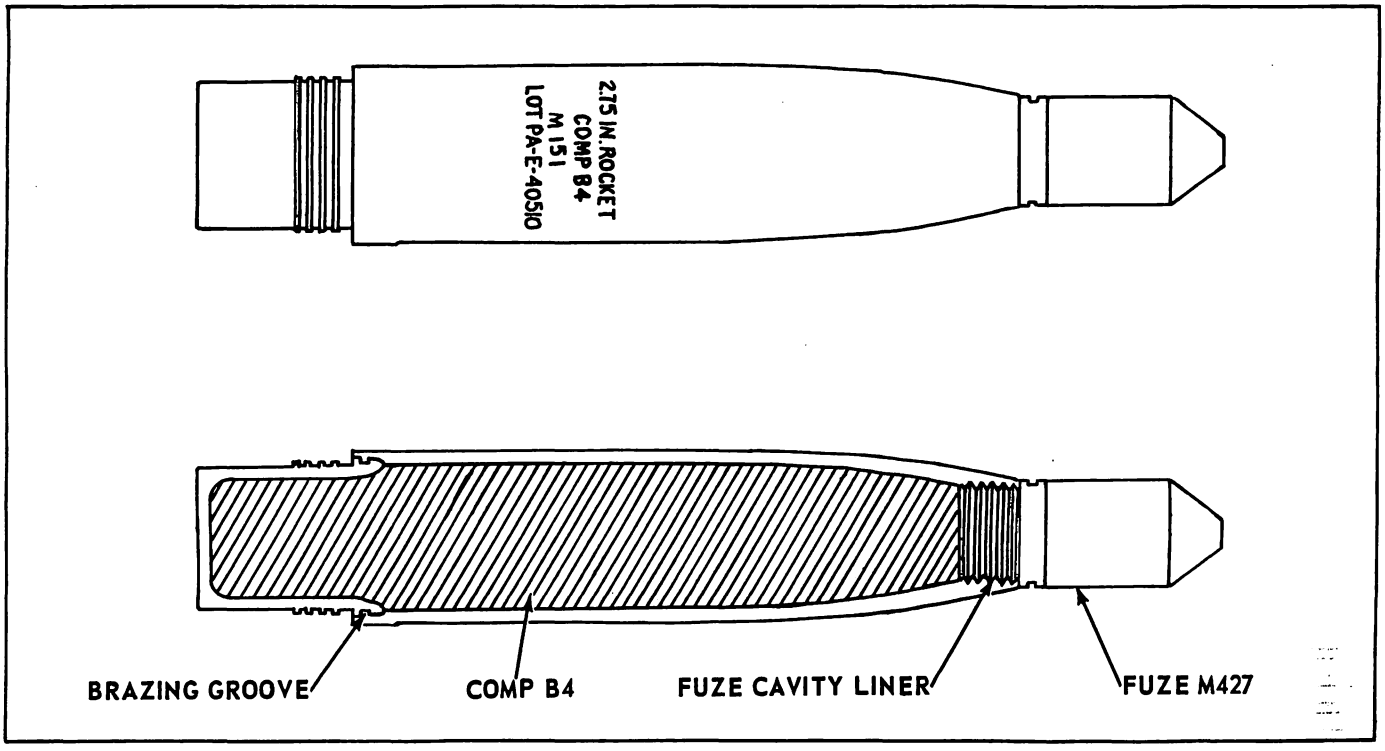


Figure 15-6. 2.75-Inch Rocket Warhead M151

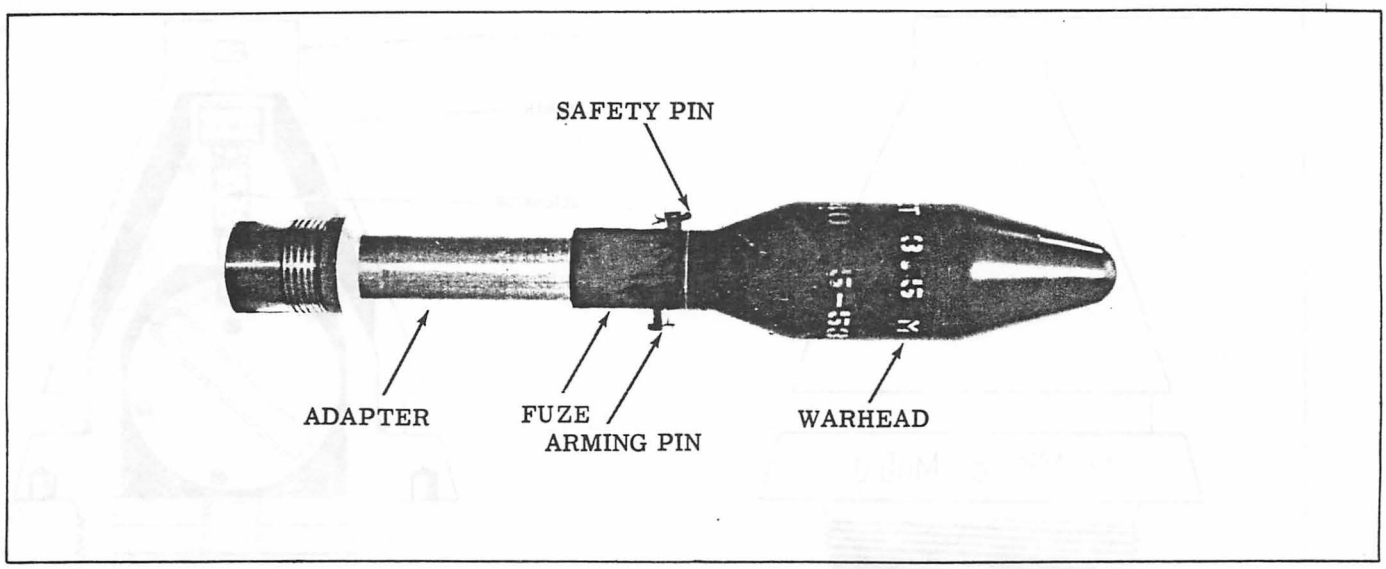


Figure 15-7. 3.5-Inch Smoke WP Warhead, Fuze, and Adapter, for 2.75-Inch Aircraft Rocket

The fuze has been adapted to work in the aircraft MA2 Airborne Rocket Launcher by doing away with the safety band; replacing the arming pin with a longer arming pin which extends through the fuze body and cutting a 1/16 inch wide slot through the fuze wall to allow the longer arming pin to be inserted completely through the fuze. The arming pin is then secured and made safe by inserting a cotter pin through the safety pin hole in the arming pin.

15-20. LAUNCHERS, 2.75-INCH FFAR.

15-21. The 2.75-inch FFAR's are launched from aircraft from tubular type launchers.

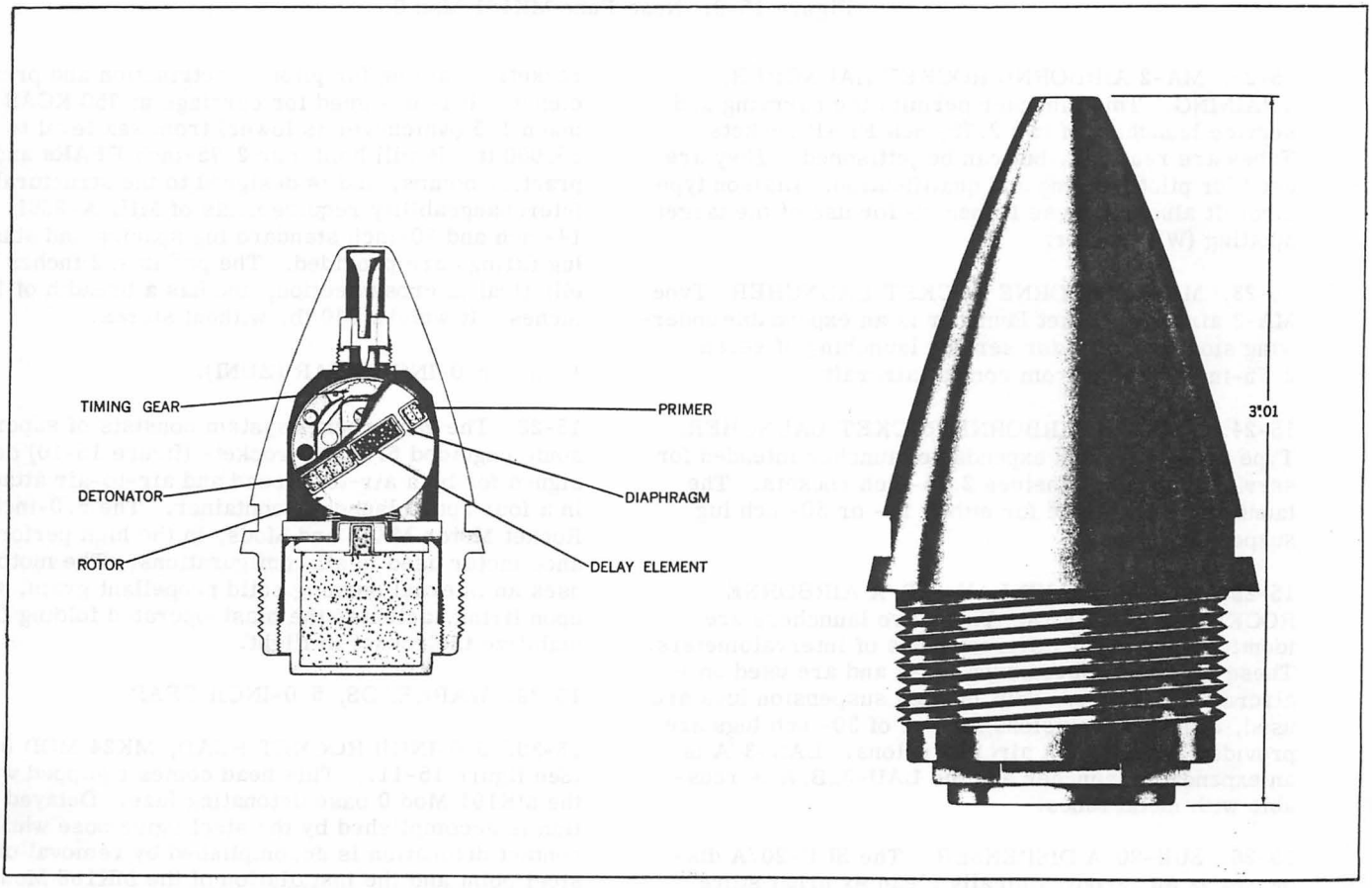


Figure 15-8. Nose Fuze MK176 Mod 1 (Acceleration Arming, Point-Detonating)

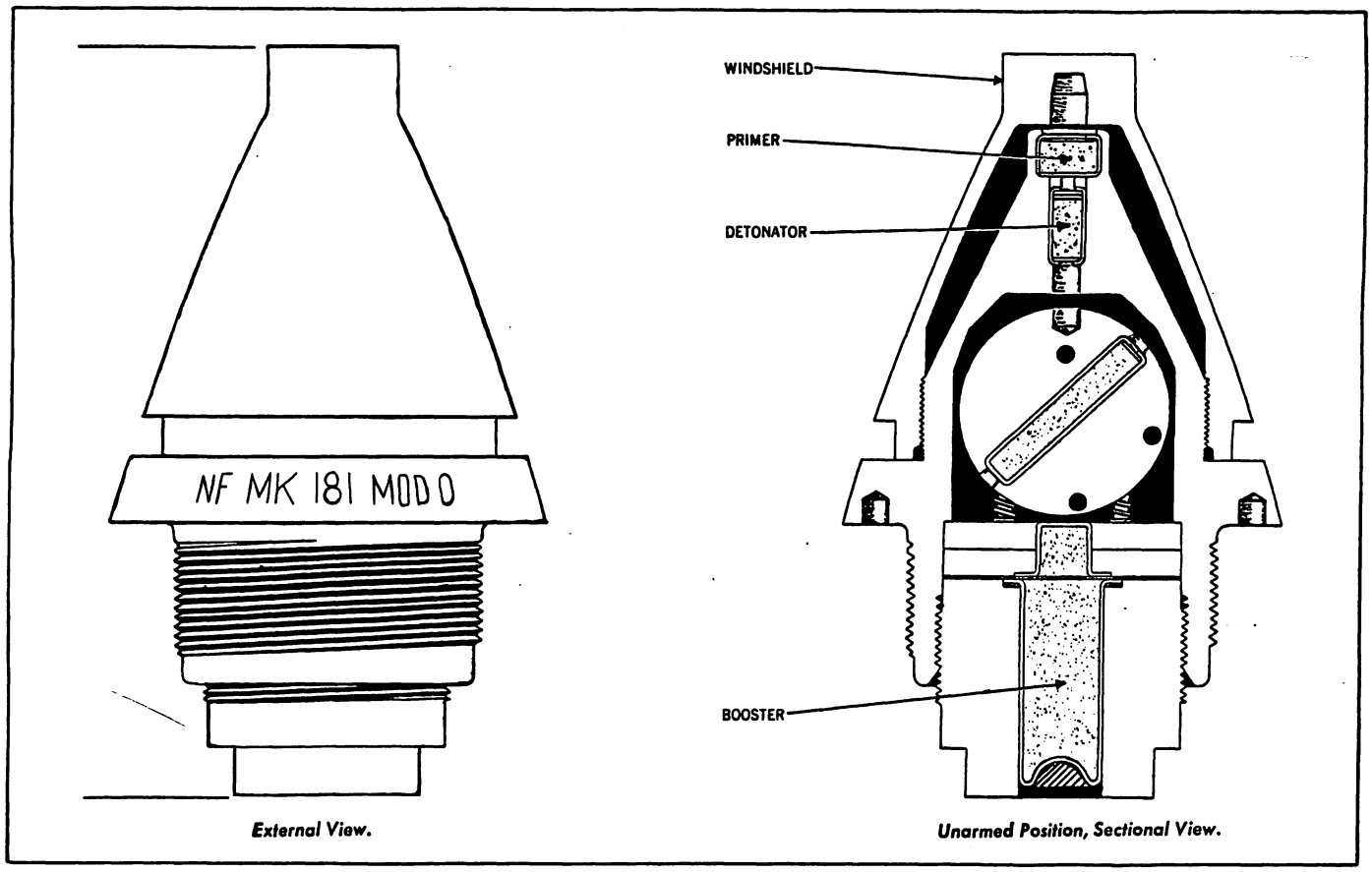


Figure 15-9. Nose Fuze MK181 Mod 0

15-22. MA-2 AIRBORNE ROCKET LAUNCHER, TRAINING. This launcher permits the carrying and service launching of two 2.75-inch FFAR rockets. Tubes are reusable, but can be jettisoned. They are used for pilot training and qualification. Liaison type aircraft also use these launchers for use of the target spotting (WP) rocket.

15-23. MA-3 AIRBORNE ROCKET LAUNCHER. Type MA-3 airborne rocket launcher is an expendable underwing store intended for service launching of seven 2.75-inch rockets from combat aircraft.

15-24. LAU-3/A AIRBORNE ROCKET LAUNCHER. Type LAU-3/A is an expendable launcher intended for service launching nineteen 2.75-inch rockets. The launcher is adaptable for either 14- or 30-inch lug suspension pylons.

15-25. LAU-32/A AND LAU-32B/A AIRBORNE ROCKET LAUNCHERS. These two launchers are identical except for different types of intervalometers. These launchers have seven tubes and are used on jet aircraft. Normally, only 14-inch suspension lugs are used, although provisions for use of 30-inch lugs are provided for different aircraft pylons. LAU-3/A is an expendable launcher and the LAU-32B/A is reusable with metal tubes.

15-26. SUU-20/A DISPENSER. The SUU-20/A dispenser is an aerodynamically clean external store developed to satisfy the requirements of bombing and rocketry training for pilot indoctrination and proficiency. It is designed for carriage at 750 KCAS or mach 1.5 (whichever is lower) from sea level to 35,000 ft. It will hold four 2.75-inch FFARs and six practice bombs, and is designed to the structural and interchangeability requirements of MIL-A-8591. Both 14-inch and 30-inch standard lug spacing and standard lug fittings are provided. The pod is 122 inches long, elliptical in cross section, and has a breadth of 19.3 inches. It weighs 240 lb. without stores.

15-27. 5.0-INCH FFAR (ZUNI).

15-28. The Zuni rocket system consists of supersonic unguided 5.0-inch rockets (figure 15-10) designed for both air-to-ground and air-to-air attack in a four round launcher container. The 5.0-inch Rocket Motor MK16 and Mods, in the high performance motor used in all configurations. The motor uses an internal burning solid propellant grain, which upon firing, actuates the blast-operated folding fins to stabilize the rocket in flight.

15-29. WARHEADS, 5.0-INCH FFAR.

15-30. 5.0-INCH ROCKET HEAD, MK24 MOD 0 (GP). (See figure 15-11.) This head comes equipped with the MK191 Mod 0 base detonating fuze. Delayed action is accomplished by the steel ogive nose while contact detonation is accomplished by removal of the steel point and the installation of the MK188 Mod 0 point detonating fuze.



Figure 15-10. 5.0-Inch Folding Fin Aircraft Rocket (FFAR) (ZUNI)

15-31. 5.0-INCH ROCKET HEAD, MK32 MOD 0 (ATAP). The MK32 Mod 0 antitank, antipersonnel (ATAP) head with a point detonating fuze effects shaped charge action. It is highly effective against heavy targets such as tanks or bunkers.

15-32. FUZES, 5.0-INCH FFAR.

15-33. FUZE, MK188 MOD 0 (PD). The MK188 Mod 0 point detonating fuze (figure 15-12) is used with the MK24 Mod 0 and MK32 Mod 0 warheads.

WARNING

Do not tamper with or remove the MK191 Mod 0 Base Fuze installed in the MK24 Mod 0 Warhead. Treat all warheads that have been dropped more than 10 feet as ARMED.

15-34. FUZE, MK191 MOD 0 (BD). Base Fuze MK191 Mod 0 (figure 15-12) is an electromechanical, acceleration arming, impact fuze designed for use with the Rocket Warhead MK24 for the 5.0-inch Folding Fin Aircraft Rocket (ZUNI). This fuze is distinguished by its electrical operation which does not require prelaunching charging but, instead, impact-energizes the primer initiating circuit.

15-35. LAUNCHER, 5.0-INCH FFAR.

15-36. LAU-10/A LAUNCHER. (See figure 15-13.) The launcher is a dual purpose unit for shipping and launching the rocket motors. The launcher is used in combat and as a reusable training device. The launcher when attached to the aircraft weighs approximately 105 pounds empty and 533 pounds loaded ready to fire four Zuni rockets.

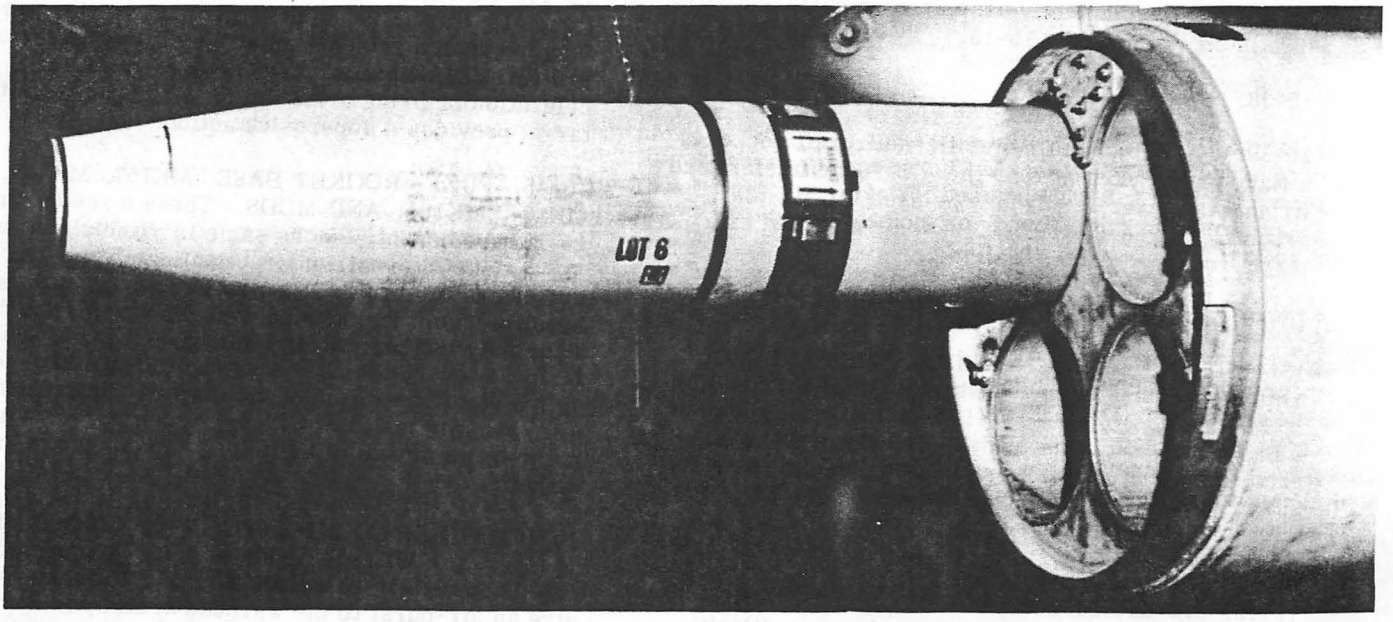
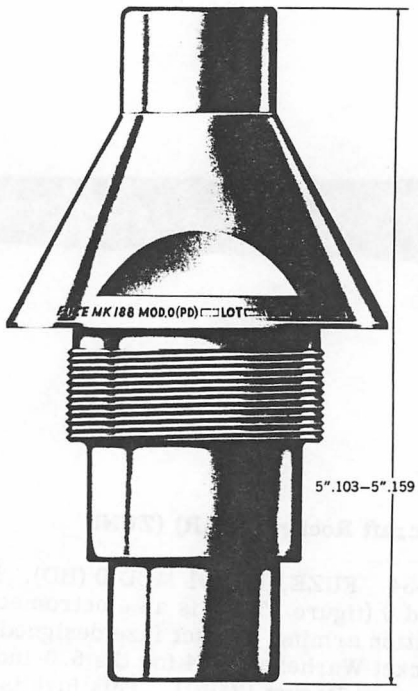
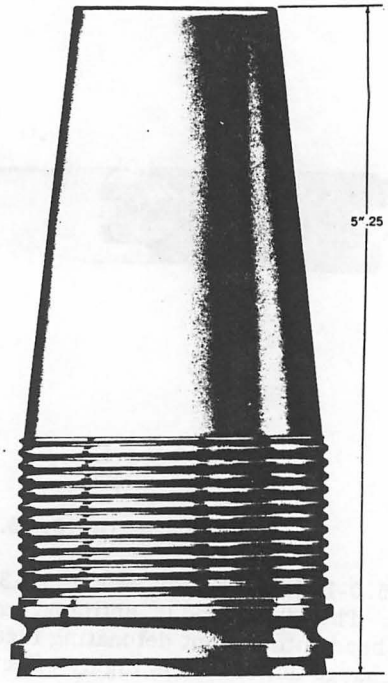


Figure 15-11. Rocket Head, 5.0-Inch, MK24 Mod 0, Installed in 5.0-Inch FFAR (ZUNI)



NOSE FUZE MK 188



BASE FUZE MK 191 MOD 0

Figure 15-12. Fuzes for 5.0-Inch FFAR (ZUNI) - Typical

15-37. FRANGIBLE FAIRINGS. The treated paper frangible fairings will shatter from rocket impact or blast. A metal band at the fairing base, equipped with lugs and a leaf spring, attaches the fairing to the launcher center section. The fairing fits flush with the outside surface of the launcher center section to form an aerodynamically smooth joint. A mounted launcher with completely assembled rockets and fairings is shown in figure 15-13.

15-38. 5.0-INCH HVAR.

15-39. The 5.0-inch fin stabilized aircraft rocket is a Navy type rocket used by the Air Force for forward firing from aircraft. It may be used for air-to-ground firing as a service round, or modified as a target rocket in AIM-9 training.

15-40. WARHEADS, 5.0-INCH HVAR.

15-41. 5.0-INCH ROCKET HEAD, MK6 AND MODS. This head comes equipped with the MK159 Mods 0 or 1, MK163 Mods 0 or 1, MK164 Mod 0 or MK165 Mod 0 Base Fuze installed. It is a general purpose high-explosive filled rocket head used for general blast and moderate fragmentation damage. The MK6 Mod 4 head has a deep fuze cavity provision for use of a VT fuze.

15-42. 5.0-INCH ROCKET HEAD, (HEAT) MK25-MOD 1. The MK25 Mod 1 high-explosive antitank warhead incorporates a shaped charge principle for the maximum penetration against armored targets. This head uses a built-in detonating cord to transmit the point-detonating fuze action to the base detonating element for maximum effect of the shaped charge.

15-43. FUZES, 5.0-INCH HVAR.

15-44. FUZE, ROCKET, NOSE, MK149 MOD 0. (See figure 15-14.) This is an airarming, impact operated fuze, designed for use in all standard MK series 5.0-inch HVAR heads. It is detonator safe until acceleration of firing arms the fuze. Impact with the target provides a superquick action.

15-45. FUZE, ROCKET BASE, MK157, MK163, MK164, MK165, AND MODS. These fuzes (figure 15-15) are essentially the same in principle except for various internal construction features. The fuzes are detonator safe until the build up of gas pressure resulting from the burning propellant arms the fuze. Primarily the base fuze is a back-up for the nose fuze, however, the base fuze could be used alone to gain slight penetration of the target. These fuzes are normally installed during manufacture and are not to be removed in the field except upon explicit direction.

15-46. FUZE, ROCKET, VT, M403. (See figure 15-16.) The VT fuze M403 is a ring type proximity fuze used for air-to-ground firing. It is designed to give an air-burst to the warhead at an optimum height for effect against exposed targets. The height of

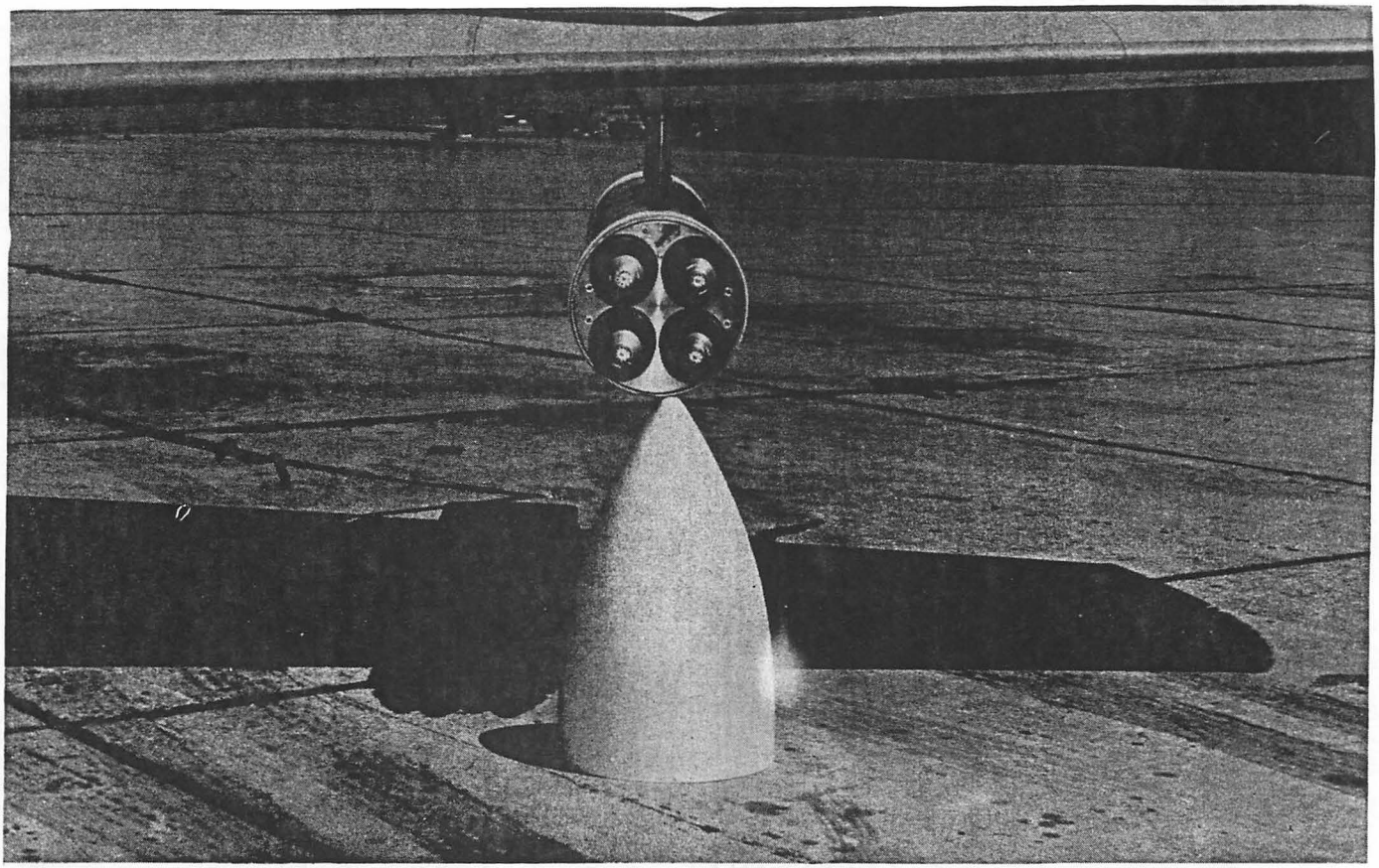


Figure 15-13. LAU-10/A Rocket Launcher, Loaded with 5.0-Inch (FFAR) (ZUNI) Rockets

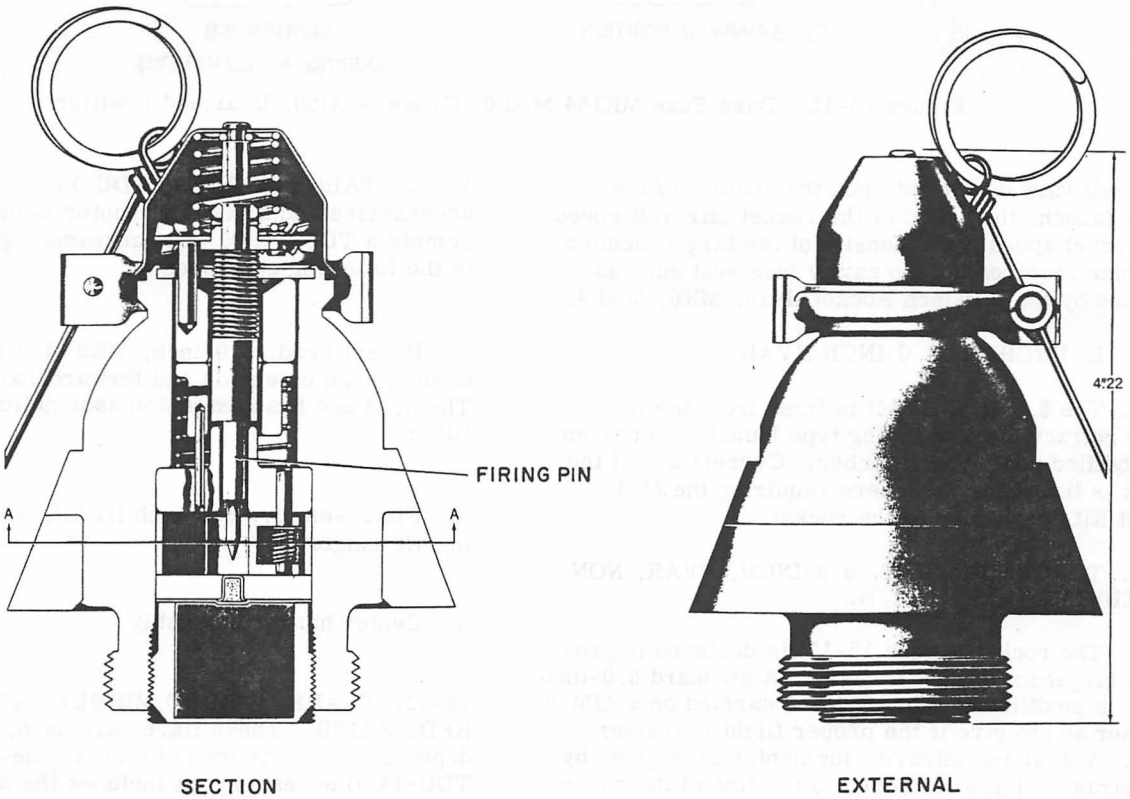


Figure 15-14. Fuze, Rocket, Nose, MK149 Mod 0

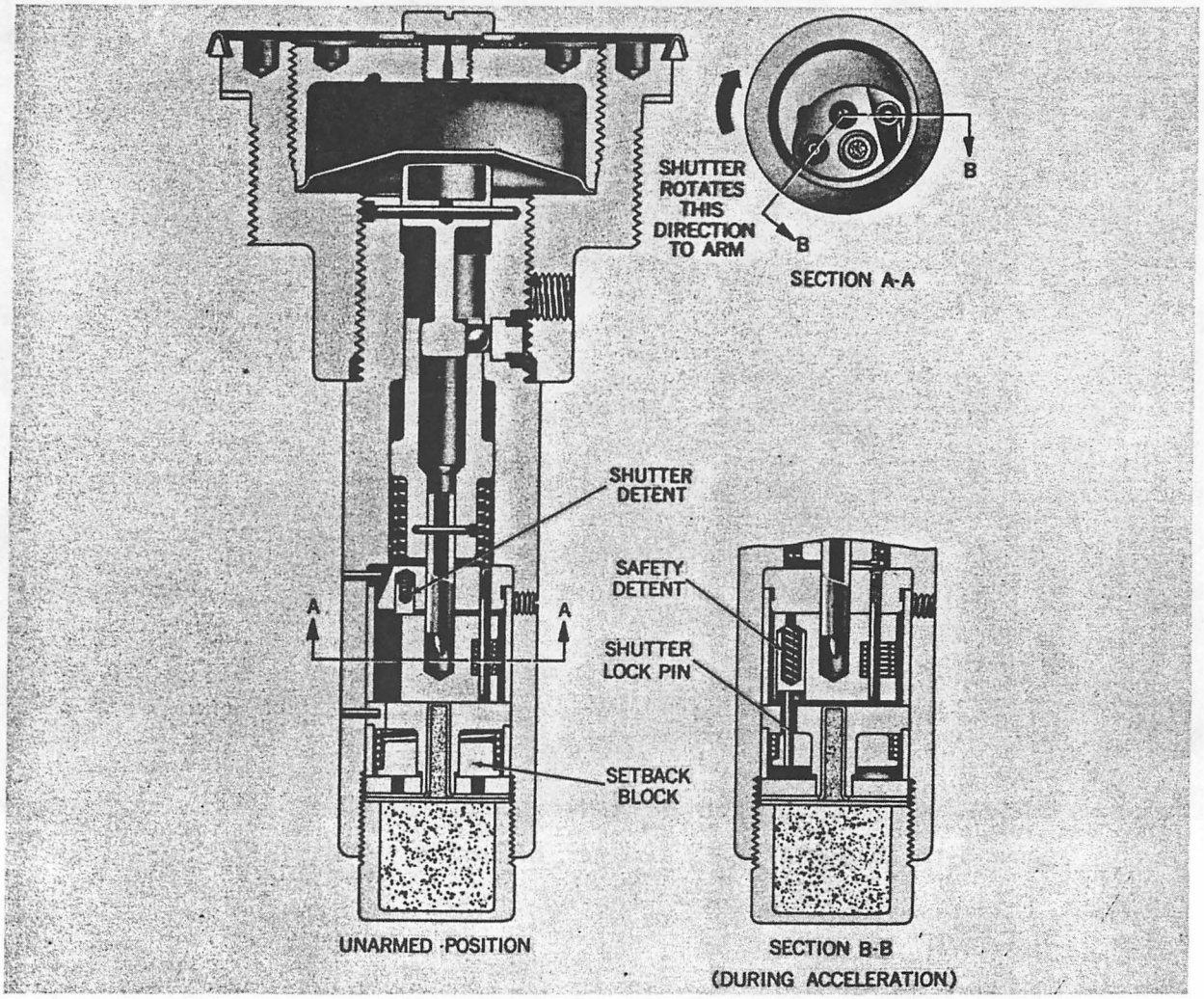


Figure 15-15. Base Fuze MK164 Mod 0, Cross Section, Unarmed Position

burst will vary dependent upon the attitude of the rocket launch, the speed of the rocket (aircraft speed plus rocket speed), and density of the target medium. This fuze requires a deep cavity fuze seat such as provided by the 5.0-inch Rocket Head, MK6, Mod 4.

15-47. LAUNCHER, 5.0-INCH HVAR.

15-48. The 5.0-inch HVAR is fired from the Air Force retractable jettisoning type launcher, or from the modified post-type launcher. Current use of the rocket is limited to launchers requiring the M34 Rocket Kit conversion of the rocket.

15-49. TARGET ROCKET, 5.0-INCH, HVAR, NON-MANEUVERING, TDU-11/B.

15-50. The rocket (figure 15-17) is designed to provide a target for AIM-9 training. A standard 5.0-inch HVAR is modified to allow it to be carried on a AIM-9 launcher and to give it the proper flight characteristics. Visual and infrared augmentation is given by four parasitic flares attached to the fins of the rocket. The complete target rocket is longer than the standard 5.0-inch HVAR and also heavier. It is 6-1/2 feet long and weighs approximately 215 pounds.

15-51. TARGET GROUP, TDU-14/B. This group of accessories and a 5.0-inch motor is necessary to assemble a TDU-11/B. The accessory group consists of the following components:

a. Rocket head, 5.0-inch, MK6 Mod 1, modified including head extension and forward-hanger assembly. The head and head extension assemblies are lead filled.

b. Fin assembly, 5.0-inch HVAR, modified including aft hanger.

c. Center hanger assembly.

15-52. FLARE, GUIDED MISSILE, AERIAL, INFRARED, W112B. These flares are used, in units of four, depending upon the type of tracking desired. The TDU-14/B accessory kit includes the necessary components for attaching these flares to the fin assembly. The flares are not in the modification kit and must be ordered separately.

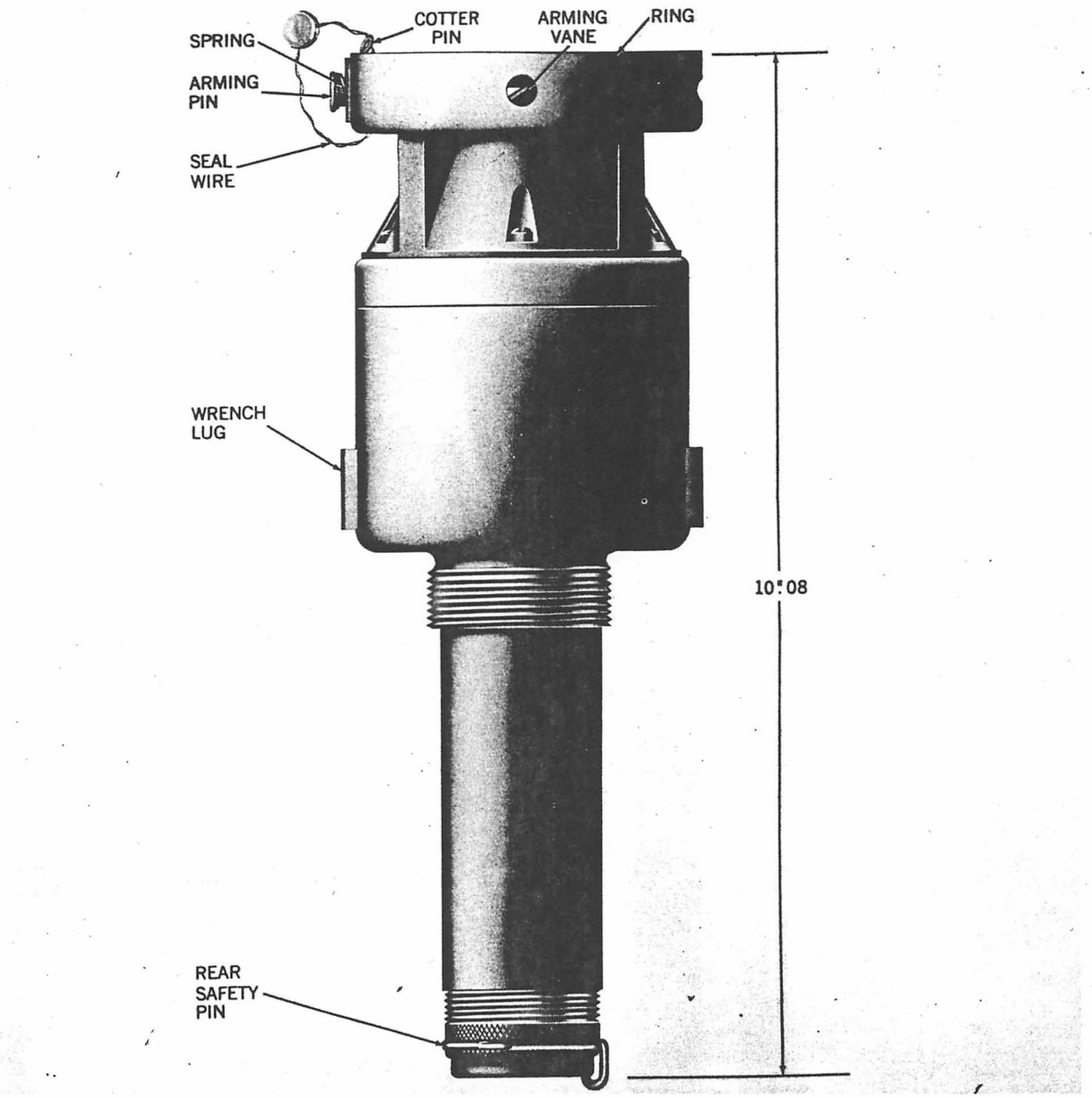


Figure 15-16. Fuze, Rocket VT, M403

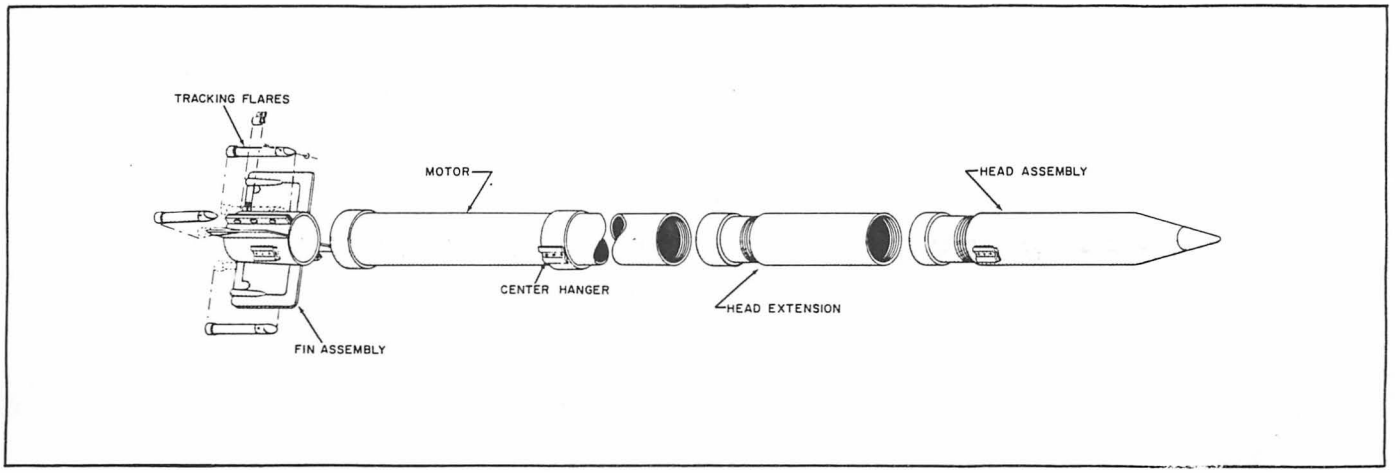


Figure 15-17. Target Rocket, 5.0-Inch, HVAR, Non-Maneuvering, TDU-11/B

SECTION XVI
JATOS

16-1. INTRODUCTION.

16-2. The term JATO is derived from the initial letters of the Jet Assisted Takeoff, indicating the first of several uses for which JATOs have been developed. A JATO, like a rocket, is a device that produces thrust. The basic manner in which thrust is obtained is also consistent with the rocket principle. JATO's are not designed to incorporate a warhead. JATO is also referred to as RATO and ATO.

16-3. DESCRIPTION.

16-4. The JATO motor is usually a solid propellant thrust unit containing no moving parts. It is used primarily for applying thrust in assisting the takeoff of aircraft. JATO units may be used for other applications requiring the same characteristics. The motor is completely identified by its nomenclature and ammunition lot number. Firing is restricted to the temperature ranges stenciled on each motor. The JATO unit is primarily a rocket motor operating as the nomenclature indicates. Figure 16-1 illustrates a typical JATO unit and the means of interpreting the nomenclature.

16-5. MAJOR COMPONENTS.

16-6. The JATO unit, as issued, is comprised of several major parts. The parts are normally completely assembled with the exception of the igniter, which is placed in the unit just prior to use. The major parts are as follows (figure 16-2):

a. Body assembly

b. Closure assembly

c. Igniter assembly

d. Propelling charge

e. Nozzle assembly

f. Blowout assembly

16-7. BODY ASSEMBLY. The body assembly is usually a deep-drawn steel case and may have a thicker ring welded to the rear of the case to provide a chamber for the propelling charge, or be so constructed that the aft cap assembly is of heavier metal (i.e., 15-KS-1,000). Mounting lug assemblies are usually welded to the main body assembly to facilitate installation on the aircraft. The mounting assemblies, of whatever configuration, serve to provide a ground to the electrical ignition system. The forward end of the body assembly has either a modified cone or dome contour to improve the propellant chamber characteristics. An igniter well is welded in the extreme forward end. If the unit uses a resonance rod, it is attached to the inner face of the igniter boss. Resonance rods aid in controlling the burning of some grains by dampening pressure waves resultant from rapid burning propellant. The shipping plug, in the igniter well during shipment and storage, has holes drilled through it and a plastic moisture cap affixed. The holes are for emergency exit of gases to neutralize thrust should accidental ignition occur. The rear (or aft) end incorporated a rounded or tapered end to minimize friction losses of the burning propellant gases.

16-8. CLOSURE ASSEMBLY. The closure assembly is steel forging that has been machined to fit the chamber and either has the nozzle machined into the assembly, or has a threaded provision for the insertion of the nozzle and pressure relief diaphram. The closure is held in place by a closure ring that is either threaded or secured by bolts. A synthetic rubber sealing ring is fitted in a groove to eliminate gas leak.

16-9. IGNITER ASSEMBLY. Various types of igniter assemblies are used for different models of JATO units and generally consist of a plastic case, which contains the igniter composition and two electric squibs, a flanged externally-threaded steel plug, and a connector wire. The igniter charge is ignited by the electric squibs connected in parallel. The igniter case is fastened to the steel plug by a screw and a nut on the terminal post. The screw and the terminal post serve as terminals for the connector wire and the two squibs. The screw makes contact with the steel plug, thereby providing a ground for the igniter system. The igniter assembly is usually shipped in a hermetically sealed container located in the shipping box of the JATO unit, and not assembled to the motor until preparation for use.

16-10. PROPELLING CHARGE.

16-11. The propelling charge may consist of several compositions. (See figure 16-1.) Most current JATO units use a solid physical state propellant and are of the KS, NS, or DS composition. The propellant charge may be held firm within the body chamber by means of plastic inhibitor strips, sponge rubber strips, or a close tolerance fit. To control burning rates of the various propellants used, inhibitors may be spaced in slots extending longitudinally in the grain, in specific locations within the grain, on certain burning surfaces, etc. Some propellant grains utilize a liner for shock protection and as an inhibitor combined.

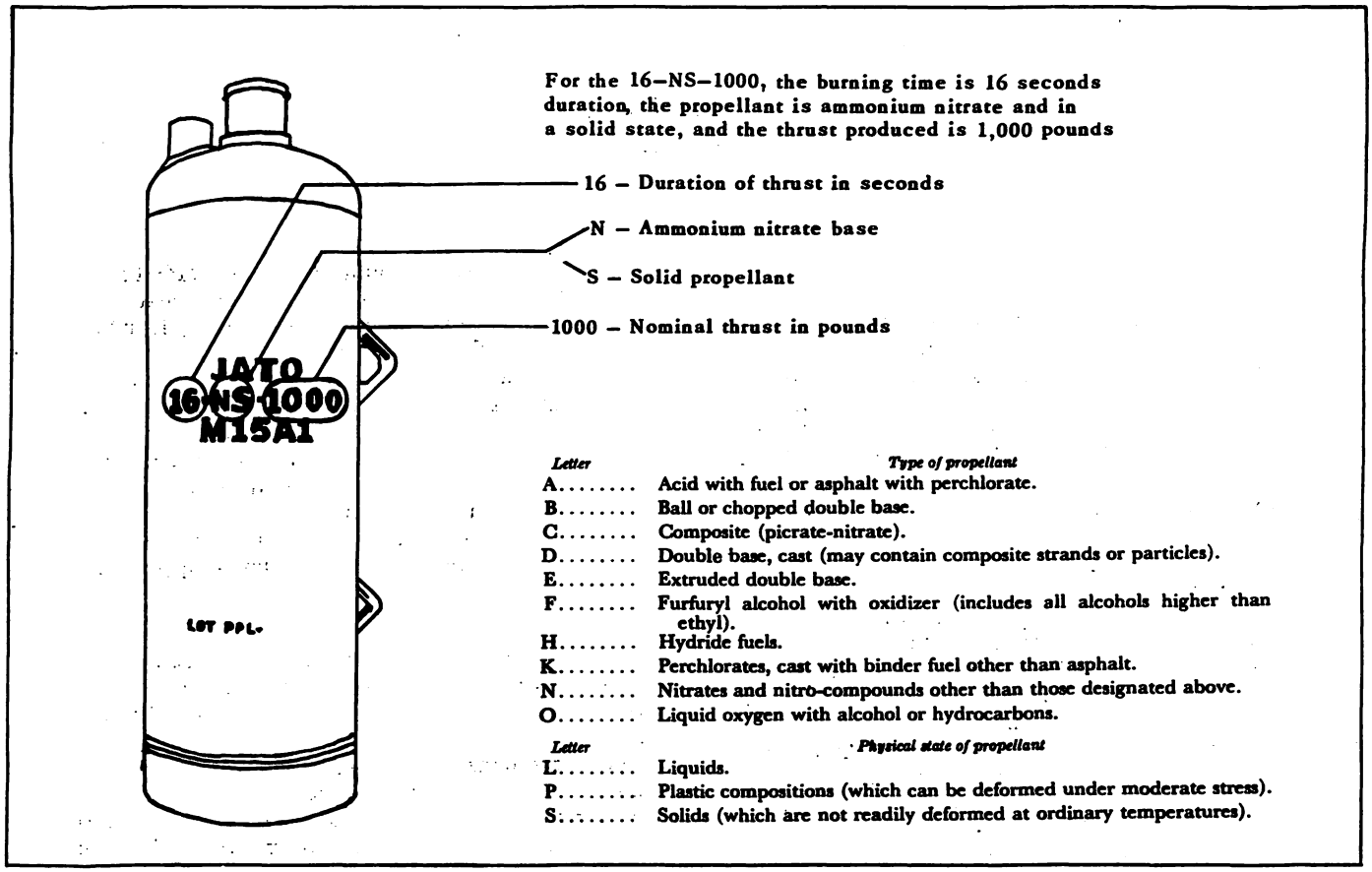


Figure 16-1. Typical JATO Identification System

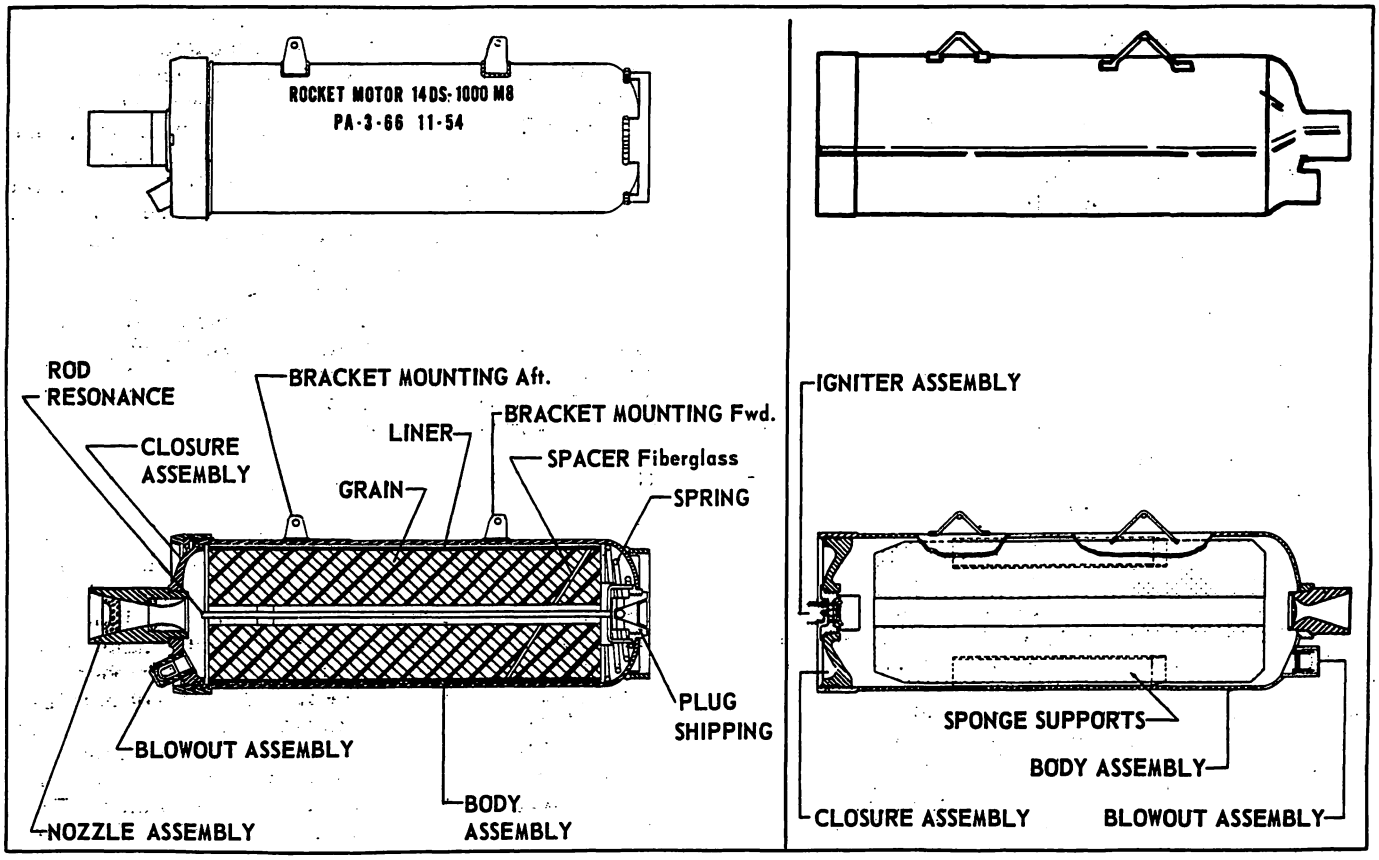


Figure 16-2. Major Parts of Typical JATO Rocket Motors

16-12. NOZZLE ASSEMBLY. The nozzle assembly is either a fitted unit that fits in a recess machined for it and retained by a lock ring, or screws into a threaded hole. The nozzle is fabricated of steel and is usually lined with a graphite material to reduce excessive corrosion from the hot gases. Corrosion results in enlarging the nozzle throat and the thrust obtained reduces accordingly. A molded plastic cup covers the nozzle and is blown out upon firing of the JATO. The plastic cup is cemented to the expansion cone to prevent the entrance of moisture into the motor.

16-13. BLOWOUT ASSEMBLY. All JATO units will incorporate some safety device of the blowout type to provide for sudden, excessive pressures from the burning propellant. Accidental cracking of the grain, for example, would result in an appreciable increase in the burning surface and result in substantially higher pressures. If a relief from the excess pressure were not provided, a mechanical rupture of the chamber could result, inflicting heavy damage to the aircraft.

16-14. FUNCTION.

16-15. JATO units are ignited by closing the electrical circuit firing switch located in the pilot's compartment. Current passes through the electric squibs, igniting the composition contained in the igniter cup. Flame produced ignites the propellant grain. Gas passed through the nozzle blows out the plastic nozzle closure and produces thrust.

SECTION XVII
GUIDED MISSILES

17-1. INTRODUCTION.

17-2. The term guided missile refers to an unmanned vehicle moving above the earth's surface or under water, the trajectory or flight path of which is capable of being altered by a mechanism within the vehicle. The missile usually carries a lethal or useful military load.

17-3. For reasons of safety and ease in handling and shipping, the components of a guided missile are usually stored and shipped separately and must be assembled prior to use. Assembly is performed at predesignated assembly areas. Refer to Air Force Technical Order 11 or 21-series for specific information about a particular missiles system, e.g. T.O. 21-AIM-4-1 pertains to the Falcon missile (AIM-4).

17-4. DEFINITIONS.

17-5. The components of the various guided missiles differ, depending upon the particular type and model. In general, a guided missile is composed of seven basic and distinct major components, defined as follows:

a. Aerodynamic structure. This refers to the design and fabrication of the missile body. The structure may be altered or partially fabricated by other major components.

b. Control system. The control system is that component that acts as a pilot to keep the missile in a stable flight attitude and make changes in course in response to signals from the guidance system. The control system operates the control surfaces and/or the propulsion unit.

c. Guidance system. The guidance system is that component that provides continued target intelligence (course data) that will take the missile to its target.

d. Propulsion system. The propulsion system is that component of a guided missile that supplies the power for the missile flight.

e. Warhead. The payload of a guided missile is its warhead. The warhead contains a useful military load. The mission of a guided missile is to deliver the warhead to a point where maximum effect will be inflicted on a specific target.

f. Fuze. The fuze is that component of a guided missile that causes the warhead to function at the time and under the circumstances desired.

g. Electrical power system. The electrical power system provides electricity for the operation of guidance, control, and fuzing systems of the missile.

17-6. CLASSIFICATION.

17-7. Guided missiles are classified according to the origin of the missile and its destination. They are designated by model number and modification letter, prefix letter, popular name, and other appropriate designations, in accordance with AFR66-20.

17-8. ELEMENTS OF THE DESIGNATION. Each designation consists of a combination of significant letters and numbers in the following sequence:

a. Status Prefix Symbol. A letter indicating that the vehicle is being used for experimentation or test. (Refer to figure 17-1.)

b. Launch Environment Symbol. A letter denoting the environment from which the vehicle is launched. (Refer to figure 17-2.)

c. Mission Symbol. A letter designating the primary mission of the vehicle. (Refer to figure 17-3.)

d. Type Symbol. A letter designating the kind of vehicle. (Refer to figure 17-4.)

e. Design Number. A number designating each vehicle type with the same basic design. Design numbers will be assigned consecutively, beginning with numeral 1 for each vehicle type.

f. Series Symbol. A letter used to denote major modifications to the vehicle that result in significant differences affecting the relationship of the vehicle to the nonexpendable portions of the related system components, or that result in significant changes to the logistic support. Series symbol letters will be assigned consecutively, beginning with A. To avoid confusion, the letters I and O will not be used as series letters.

17-9. The basic designation consists of the elements described; the manufacturer's code and serial number are normally used only for logistical and accounting purposes. When a status prefix symbol is applicable, use of a launch environment symbol is optional. The type symbol and design number will be separated by a dash. Basic designations of some Air Force guided missiles are listed in figure 17-5. The Air Force uses some Navy developed missile systems. Typical Air Intercept guided missiles in use by the Air Force are illustrated in figure 17-6.

17-10. IDENTIFICATION.

17-11. Guided missiles and their components may be identified by the painting and marking thereon. The markings include such data as name of the component,

LETTER	TITLE	DESCRIPTION
J	Special Test, Temporary	Vehicles on special test programs by authorized organizations and vehicles on bailment contract having a special configuration to accommodate the test. At completion of the test the vehicles will be either returned to their original configuration or returned to standard operational configuration.
N	Special Test, Permanent	Vehicles on special test programs by authorized activities and vehicles on bailment contract, whose configurations are so drastically changed that return of the vehicles to their original configurations or conversion to standard operational configurations is beyond practicable or economical limits.
X	Experimental	Vehicles in a developmental or experimental stage, but not established as standard vehicles for service use.
Y	Prototype	Preproduction vehicles procured for evaluation and test of a specific design.
Z	Planning	Vehicles in the planning or predevelopment stage.

Figure 17-1. Status Prefix Symbols (Classification letters)

its model designation, lot number and manufacturer, date of manufacture, type of warhead, and other appropriate identifying markings.

17-12. WARHEADS.

17-13. The useful military load of guided missiles is contained in the warhead. Dependent upon the target and the effect desired, the type of warheads that may be used are as follows:

a. High Explosive. The high-explosive warhead depends upon blast effect for destruction or demolition of the target.

b. High-Explosive Fragmentation. The effect of this warhead is produced primarily by the fragments of the warhead being projected at high velocity. The blast at the point of functioning will cause additional damage to the target or nearby objects.

LETTER	TITLE	DESCRIPTION
A	Air	Air Launched
B	Multiple	Capable of being launched from more than one environment.
C	Coffin	Horizontally stored in a protective enclosure and launched from the ground.
H	Silo Stored	Vertically stored below ground level and launched from the ground.
L	Silo Launched	Vertically stored and launched from below ground level.
M	Mobile	Launched from a ground vehicle or movable platform.
P	Soft Pad	Partially or nonprotected in storage and launched from the ground.
R	Ship	Launched from a surface vessel such as ship, barge, etc.
U	Underwater	Launched from a submarine or other underwater device.

Figure 17-2. Launch Environment Symbols

LETTER	TITLE	DESCRIPTION
D	Decoy	Vehicles designed or modified to confuse, deceive, or divert enemy defenses by simulating an attack vehicle.
E	Special Electronic	Vehicles designed or modified with electronic equipment for communications, countermeasures, electronic radiation sounding, or other electronic recording or relay missions.
G	Surface Attack	Vehicles designed to destroy enemy land or sea targets.
I	Intercept-Aerial	Vehicles designed to intercept aerial targets in defensive or offensive roles.
Q	Drone	Vehicles designed for target, reconnaissance, or surveillance purposes.
T	Training	Vehicles designed or permanently modified for training purposes.
U	Underwater Attack	Vehicles designed to destroy enemy submarines or other underwater targets or to detonate underwater.
W	Weather	Vehicles designed to observe, record, or relay data pertaining to meteorological phenomena.

Figure 17-3. Mission Symbols

c. Chemical. This type warhead may contain toxic chemical agents.

d. Nuclear. This type warhead may be designed to produce casualties (by thermal radiation, blast, and nuclear radiation), to cause destruction and damage to structures and equipment, and/or to deny the use of an area due to residual radioactive effects.

e. Practice. Practice warheads simulate service warheads and are provided for such purposes as training in handling, fuzing, and loading.

17-14. FUZES.

17-15. One or more fuzes may be used in conjunction with any of the warheads described in paragraph 17-13.

LETTER	TITLE	DESCRIPTION
M	Guided Missile	Unmanned, self-propelled vehicles designed to move in a trajectory or flight path all or partially above the earth's surface and whose trajectory or course, while the vehicle is in motion, is capable of being controlled remotely or by homing systems, or by inertial and/or programmed guidance from within. This term does not include space vehicles, space boosters, or naval torpedoes, but does include target and reconnaissance drones.
N	Probe	Non-orbital instrumented vehicles not involved in space missions that are used to penetrate the aerospace environment and transmit or report back information.
R	Rocket	Self-propelled vehicles without installed or remote control guidance mechanisms, whose trajectory or flight path cannot be altered after launch. Rocket systems designed for line-of-sight ground fire against ground targets are not included.

Figure 17-4. Vehicle Type Symbols

POPULAR (PROJECT) NAME	CURRENT DESIGNATION	CURRENT DESIGNATION	DESCRIPTION AND USE OF MISSILE
ATLAS F	HGM-16F (WS-1078)	SM-65F	Surface-to-surface ICBM; underground silo launch; inertial guidance; digital liquid propellant utilization system. Nuclear warhead. Speed 15,000 mph. Range: 6,300 miles. Weight 260,000 lb.
BOMARC B	CIM-10B	IM-99B	Surface-to-air supersonic ground controlled area defense missile with solid propellant booster and two ramjets for cruise with nuclear warhead. Range: 440 miles. Weight: 16,000 lb.
BULLPUP	AGM-12B/D (WS-321B)	ASM-N-7A/ GAM-83A	Air-to-surface radio guided tactical missile with conventional or nuclear warhead using solid or storable liquid propellant. Speed: near mach 2, Range: 3 miles. Weight: 571 lb.
BULLPUP B	AGM-12C	ASM-N-7B	Air-to-surface radio guided missile with 1,000 lb. warhead. Range: 5 miles
FALCON	AIM-26B	GAR-11A	Radar guided air-to-air missile with speed near mach 2. Range: 10 miles. Weight: 203 lb. Advanced version, Hughes Nuclear Falcon combines nuclear warhead capability of AIR-2A and AIM-4A's accuracy.
FALCON	AIM-4A	GAR-1D	Radar guided air-to-air missile. Speed: mach 2. Range: 5 miles. Weight: 120 lb.
FALCON	AIM-4B	GAR-2	Radar guided air-to-air missile, modified 4A.
FALCON	AIR-4C	GAR-2A	Infrared homing air-to-air missile, Speed: mach 2. Range: 5 miles
FALCON	AIM-4D	GAR-2B	Infrared guided air-to-air missile with speed near mach 3, Range: 6 miles, Weight: 120 lb.
FALCON	AIM-4E	GAR-3	Semiactive radar air-to-air missile. Speed: mach 3, Range: 5 miles. Weight: 150 lb.
FALCON	AIM-4F	GAR-3A	Infrared homing air-to-air missile. Speed: mach 3, Range and weight same as 4E.
FIREBEE	BQM-34C	KDA-4	Recoverable air and ground launched target drone. Speed: 625 mph, Range: max. 96 min., Weight: 2,500 lb.
HOUND DOG	AGM-28A/B (WS-131B)	GAM-77/77A	Air-to-surface inertially guided supersonic, jet propelled standoff strategic missile. Speed: 1,200 mph. Range: 500 miles. Nuclear warhead. Weight: 9,600 lb.
MACE	CGM-13C	TM-76A	Tactical surface-to-surface radar guided missile mounted on transport launcher and fired by rocket booster. Speed: 650 mph, Range: 700 miles, nuclear or conventional warhead. Weight: 18,000 lb.
MACE	CGM-13C	TM-76B	Tactical surface-to-surface inertially guided missile.
MINUTEMAN I	LGM-30B (WS-133A)	HSM-80B	Surface-to-surface; first solid-fuel, three-stage ICBM; inertial guidance. Range: 6,300 miles.
MINUTEMAN II	LGM-30F (WS-133A)	HSM-80F	Advanced Minuteman
QUAIL	ADM-20A/C	GAM-72/72B	Air-launched, air-breathing bomber decoy missile carried by B-52. Speed 600 mph. Range: 230 miles, Weight: 1,100 lb.

Figure 17-5. Department of Defense Missile Designation (Sheet 1 of 2)

POPULAR (PROJECT) NAME	CURRENT DESIGNATION	CURRENT DESIGNATION	DESCRIPTION AND USE OF MISSILE
SHRIKE	AGM-45	ASM-N-10	Antiradiation, solid fueled missile with homing capability against radar installations.
SIDEWINDER IB	AIM-9B	AAM-N-7	Air-to-air supersonic guided missile with conventional HE warhead using passive infrared guidance system and solid propellant. Speed: mach 2.5. Range: 3,500-11,000 ft. Weight: 155 lb.
SPARROW IIIB	AIM-7E	AAM-N-6B	Air-to-air; supersonic launch capability; semiactive homing radar.
SPARROW III	AIM-7D	AIM-101	Air-to-air electronically controlled homing missile using solid propellant with conventional warhead. Speed: 1,500 mph. Weight: 400 lb.
SUPER FALCON	AIM-4F, G	GAR-3A/4A	Air-to-air, infrared; range: 5 miles.
TITAN II	LGM-25C	XSM-68B	Strategic inertially guided liquid fuel ICBM with nuclear warhead. Speed: 15,000 mph. Range: 10,000 miles. Weight: 330,000 lb.
TITAN III	624A		Modified Titan II, plus two solid-propellant strap-on stages.

Figure 17-5. Department of Defense Missile Designation (Sheet 2 of 2)

Depending on the type of target and effect desired at the target, fuzes used with guided missiles may be of the impact, VT (proximity), or ground-controlled types.

17-16. IMPACT FUZE. An impact fuze is one that is actuated by striking the target. Functioning time after impact depends upon the design of the fuze and the nature of the target.

17-17. VT FUZE. VT fuzes function on approach to a target. Each type of VT fuze is actuated by some characteristic of, and at a predetermined distance from, the target. Five basic types of guided missile VT fuzes are as follows:

a. Radio-proximity.

b. Pressure-proximity.

c. Electrostatic-proximity.

d. Photoelectric-proximity.

e. Acoustic-proximity.

17-18. GROUND-CONTROLLED FUZING. In ground-controlled fuzing, the mechanism for determining target proximity is not housed in the fuze, but is on the ground. When the proper proximity relationship is reached between the missile and the target, a signal to detonate is sent to the missile.

17-19. ELECTRICAL POWER SYSTEM.

17-20. This system supplies electrical power for operation of the guidance and control mechanisms and for the fuzing of the warhead. The types of systems are as follows:

a. Battery supply, with or without electronic rectifier and transformer circuit. This type is suitable for small, short-range missiles.

b. An alternating-current generator using a turbine driven by wind, battery, engine, or compressed air. This type is suitable for longer range missiles.

17-21. PROPULSION SYSTEM.

17-22. The propulsion system used in guided missiles employs a jet-type engine, which is the only known type capable of propelling such missiles at the required speeds. A jet engine is one that operates on the reaction principle. It consists essentially of a combustion chamber and a nozzle. When a fuel is burned in the combustion chamber, a thrust is produced as a result of the products of combustion expanding and passing through the nozzle.

17-23. TYPES. Jet engines are of two general types, the air-breathing type, and the nonair-breathing type. The air-breathing type, of which the pulse jet, ram jet, and turbo jet engines are examples, uses liquid fuel and atmospheric oxygen as the oxidizer. The

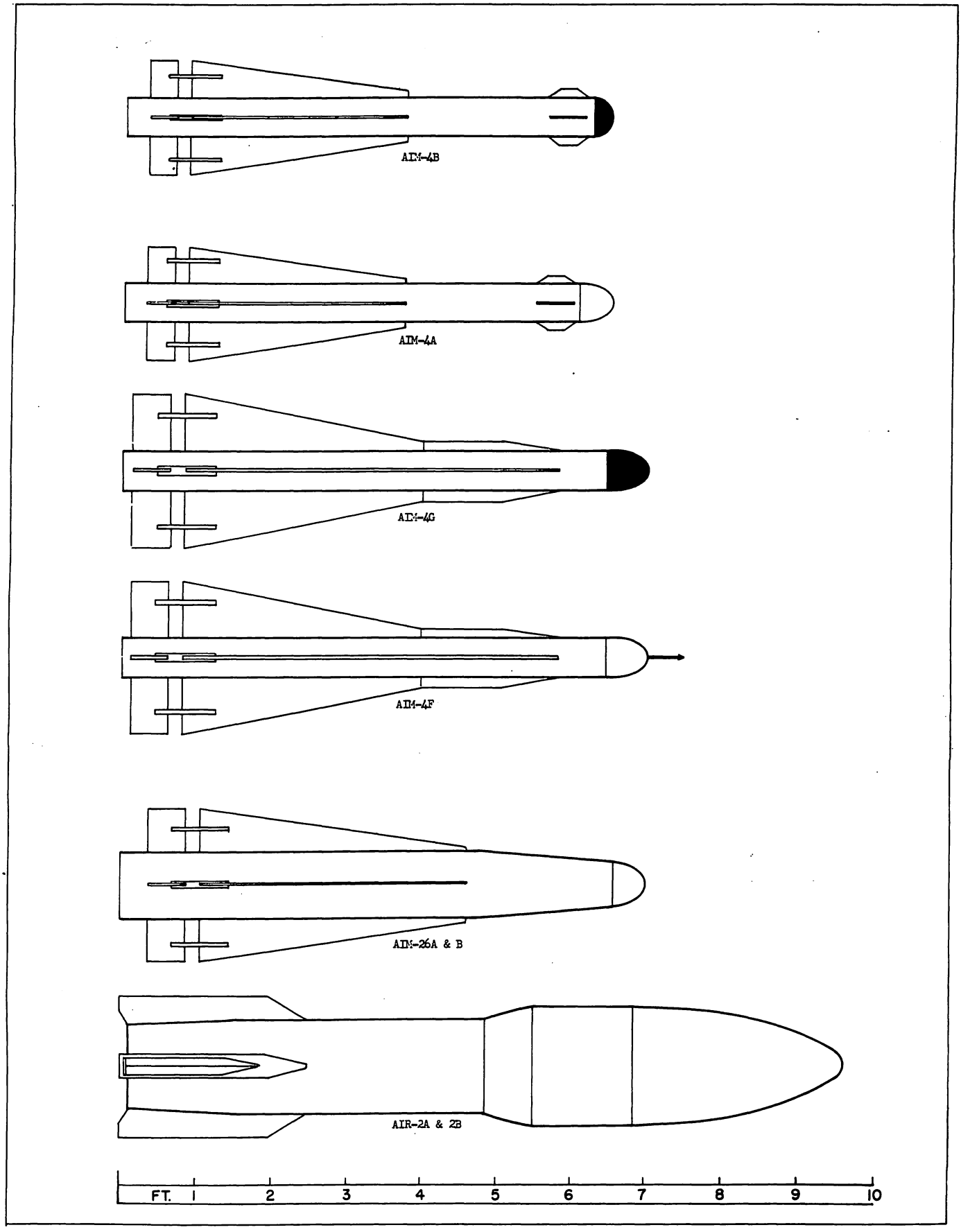


Figure 17-6. Air-to-Air Missiles, Typical

nonair-breathing type, of which rocket engines are ex-examples, uses solid propellant (fuel and oxidizer combined) or liquid fuel with an oxidizer.

17-24. FUELS AND PROPELLANTS. Fuels and propellants for jet engines are discussed in Section V.

17-25. PHASES OF OPERATION. The complete missile propulsion system generally operates in two phases: the launching phase, during which the missile is accelerated to the cruising speed by some means such as a catapult or a high-thrust jet engine sometimes called a booster unit or JATO; and the cruising phase, during which the missile is maintained at cruising speed by a relatively lower-thrust jet engine sometimes called a sustainer unit. In other cases, the missile propulsion system does not require a booster unit or catapult and operates in only one phase. The propulsion system may use a combination of liquid, jet engine or solid fuel units, e.g., the Bomarc missile is launched with a solid rocket booster unit, and cruises by means of a liquid fuel ram-jet sustainer engine.

17-26. CONTROL AND GUIDANCE SYSTEMS. The control and guidance are parts of an integrated system for automatically directing the flight of the missile.

17-27. CONTROL SYSTEM. The control system includes all the components necessary for complete automatic control of a missile in flight. The system receives intelligence from a radio signal or other electrical device and makes corrections for changes in yaw, pitch, and roll. The systems usually include gyroscopes, signal amplifiers, servomotors, and control-surfaces. The system may also receive internal or external guidance signals in order to adjust the path of a missile. Each control system component has a distinct function as follows:

a. Gyroscopes. The gyroscope is used in a missile to fix a reference direction.

b. Electric amplifiers. The amplifier increases the signal strength to a sufficient level to control the servomotors.

c. Servomotors. The servomotor supplies power to control surfaces to change the flight path of a missile.

d. Control surfaces. The control surface changes the missile path by application of some force in response to a directing signal. This change in path (steering) is accomplished by one or more of the following devices: air vanes, jet vanes, movable jet motor, or side jets.

17-28. GUIDANCE SYSTEM. The main functions performed by the guidance system are tracking, computing, and directing. Tracking is the process of determining the location of a missile and its target with respect to the launcher, and missile and target with respect to each other and some other reference. Computing is the process of calculating the directing signals for the missile by use of tracking information. Directing is the process of sending the computed signal to the missile. Directing may also be accomplished from within a missile. The directing signals are sent to the control system, thus giving control of missile flight. Some basic guidance systems are as follows:

a. Preset guidance system. A preset system is a guidance system wherein a predetermined path is set into the missile before launching and cannot be adjusted after launching.

b. Terrestrial reference guidance system. A terrestrial reference system is a guidance system for a predetermined path, wherein the path of the missile can be adjusted after launching, by devices within the missile that react to some phenomena of the earth.

c. Radio navigation guidance system. A radio navigation system is a guidance system for a predetermined path wherein the path of the missile can be adjusted by devices within the missile that are controlled by external radio signals.

d. Celestial navigation guidance system. A celestial navigation system is a guidance system for a predetermined path wherein the path of the missile can be adjusted by the use of continuous celestial observation.

e. Inertial guidance system. An inertial system is a guidance system for a predetermined path wherein the path of the missile can be adjusted after launching by devices wholly within the missile.

f. Command guidance system. A command system is a guidance system wherein the path of the missile can be changed after launching by directing signals from some agency outside the missile.

g. Beam climber guidance system. A beam climber system is a guidance system wherein the direction of the missile can be changed after launching by a device in the missile that keeps the missile in a beam of energy.

h. Homing guidance system. A homing system is a guidance system wherein the direction of the missile can be changed after launching by a device in the missile that reacts to some distinguishing characteristic of the target.

17-29. Guidance is not always maintained from launch to target. Some missiles are projected into a ballistic trajectory and guided until point of separation of the payload. Examples are intercontinental ballistic missile (ICBM) systems, where the ballistic path of the reentry vehicle is predicted from the trajectory, and guidance stops at time of separation of the reentry vehicle from the missile.

17-30. LAUNCHERS.

17-31. Launchers are mechanical structures that provide whatever control and acceleration are needed during the initial stages of flight to enable the missile control, guidance, and propulsion systems, to direct and carry it to the target.

17-32. TYPES OF LAUNCHERS. Some basic types of launching devices are trainable platform, vertical tower, vertical ramp, ramp or rail (other than vertical), zero length (a launcher on which there is negligible travel by the missile), gun type, catapult, and aircraft.

17-33. FIRING. Firing of guided missiles from a launcher is usually accomplished electrically by remote control.

17-34. BLAST PROTECTION. Due to the dangerous blast of flame emitted by guided missiles, the launching site must be cleared of all personnel and unnecessary equipment. All unprotected combustible material must also be removed from the launching area.

17-35. CARE, HANDLING, AND PRESERVATION. In general, the same regulations apply to guided missiles as to other types of ammunition. However, certain components of the missile require special handling. The control equipment, which includes such items as gyroscopes, homing devices, electronic equipment, and other precision instruments, must be protected from rough or careless handling. Special precautions must be taken with certain of the fuels and oxidizers due to fire, explosion, contact, and inhalation hazards. Protective clothing and masks must be used when handling certain of the fuels and oxidizers. Careful training in safety measures, procedures for handling, and precautions in use of guided missile explosive or flammable components is essential.

17-36. PACKING AND MARKING.

17-37. PACKING. The components of guided missiles are packed in appropriate types of containers. Fuzes and warheads are packed in wooden or metal containers. Propellants, which include fuel, oxidizer, reducer, and solid and liquid propellants, are packed in specially designed tanks, metal drums, glass bottles, or fiber containers in wooden boxes. Control and guidance equipment are packed in specially constructed packings since they are precision instruments. Propulsion systems are packed in metal crates or wooden boxes. Special equipment such as compressors, cable sets, storage batteries, firing panels, and similar items are also packed in suitable boxes, crates, and containers.

17-38. MARKING. The packing boxes, crates, drums, and containers in which guided missile components are packed are marked for easy identification. They may or may not be coded for a specific guided missile complete round. Packings of propellants and components of propellants, fuzes, and warheads are also marked to indicate the Interstate Commerce Commission shipping name and any important instructions in handling or storage.

SECTION XVIII
DEMOLITION MATERIALS

18-1. INTRODUCTION.

18-2. The term demolition materials refers to a variety of explosive charges of different sizes and shapes, explosive initiating devices designed for use with such charges, explosive and nonexplosive mechanical devices, and apparatus such as instruments, tools, and equipment used with the charges for performing various military demolition functions. These functions include such operations as destruction of earth works, fortifications, railroads, dams, bridges, and buildings, and excavation for construction projects and clearing obstacles and minefields. Certain demolition materials are grouped into lots and sets, for the convenience of especially designated military units in performing prescribed kinds of demolition work or missions and training therefor. Procedures for the use of demolition materials are provided in T.O. 11A-1-58.

18-3. DEMOLITION MATERIALS.

18-4. TNT (TRINITROTOLUENE) BLOCKS. TNT is packaged in 1/4-pound, 1/2-pound, and 1 pound blocks as follows (figure 18-1):

NOTE

Priming adapters and the standard base of firing devices fit all TNT blocks.

a. The 1/4-pound blocks are in an olive drab cardboard container with metal ends. One end has a threaded cap well.

b. The 1/2-pound blocks are in a yellow or olive drab cardboard container with metal ends. The yellow container has an unthreaded cap well and the olive drab container, a threaded cap well.

c. The 1-pound blocks are merely two 1/2-pound blocks in an olive drab cardboard container with metal ends. One end has a threaded cap well.

18-5. TNT is affected by intense cold, being less sensitive to shock.

18-6. TETRYTOL (M1 CHAIN DEMOLITION BLOCK). Demolition block M1 has all the desirable characteristics of TNT and is slightly more powerful, having a detonation rate of 23,000 feet per second. It is more effective as a cutting or breaching charge. It is slightly soluble in water, is brittle, and breaks easily when dropped.

18-7. Each block is 11 inches long by 2 inches square and weighs 2-1/2 pounds. A tetryl pellet is cast into the block near each end. Eight blocks spaced 8 inches apart, are cast lengthwise onto a single line of detonating cord, 2 feet of which is left free at each end of the chain. Each block is enclosed in an olive drab asphalt-impregnated paper wrapper. One chain (8 blocks) is packed in an olive drab cloth haversack with a carrying strap attached. The complete bag measures 4 by 8 by 11 inches and weighs about 22 pounds. It contains 20 pounds of explosive.

18-8. The M1 chain demolition block may be used in forward combat areas as an alternate for TNT. The complete chain, or any part of the chain, may be laid out in a line, wrapped around a target, or used in the haversack as it is packed. Entire chain will detonate even though the blocks may not be in contact with each other. If less than eight blocks are needed, the required number is cut from the chain. If blocks are separated by cutting, the detonating cord should be coated with waterproof grease to prevent penetration by moisture, which may cause misfire.

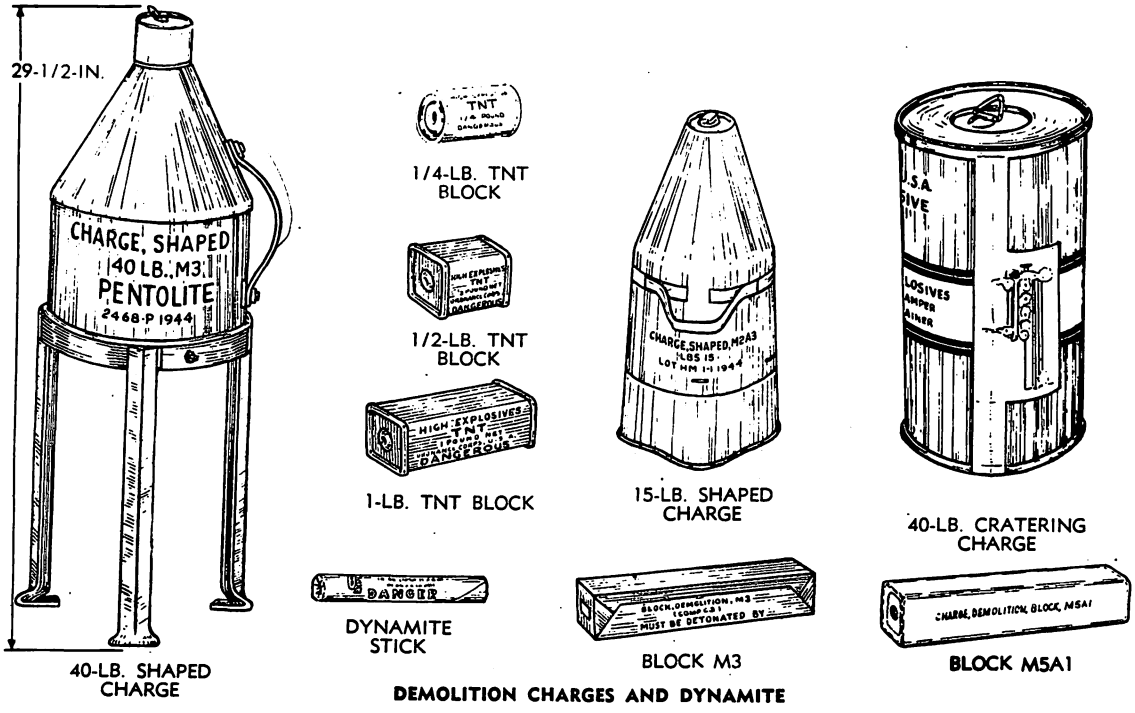
18-9. The sensitivity of this explosive is decreased by cold like that of TNT. A slight decrease in strength may result in extremely cold weather.

18-10. TETRYTOL (M2 DEMOLITION BLOCK). The M2 demolition block is similar to the M1 chain block, except that it has a threaded cap well in each end and has no core of detonating cord. The M2 demolition block measures 11 by 2 by 2 inches. A booster tetryl pellet, cast into block, surrounds each cap well. Eight blocks, 2-1/2 pounds each, are packed in a haversack. The M2 demolition block is used in same manner at the M1 block for cutting and breaching. Chains may be made by connecting blocks with detonating cord.

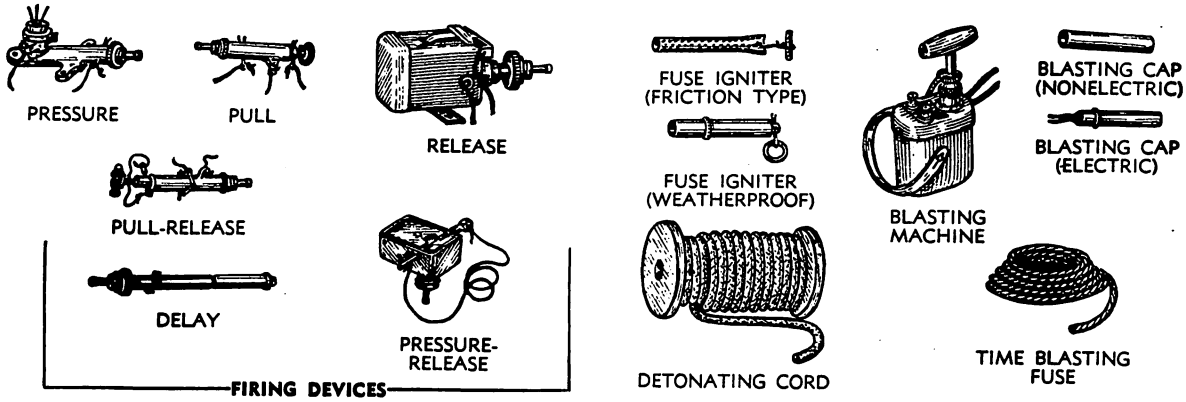
18-11. The M2 demolition block has slightly greater loss of strength at low temperature than the M1 and requires a minimum of six turns of the detonating cord instead of the usual four to obtain detonation. The M2 retains its sensitivity to shock, however, as it ignites or explodes under .50-caliber incendiary machinegun fire at subzero temperatures.

18-12. COMPOSITION C3 (M3 OR M5 DEMOLITION BLOCK). Composition C3 is packaged as the M3 or M5 demolition block. (See figure 18-1.) The M3 block is perforated around the middle to make it easy to break open. Each block measures 11 by 2 by 2 inches and weighs 2-1/4 pounds. The M5 demolition block has a plastic container with a threaded cap well.

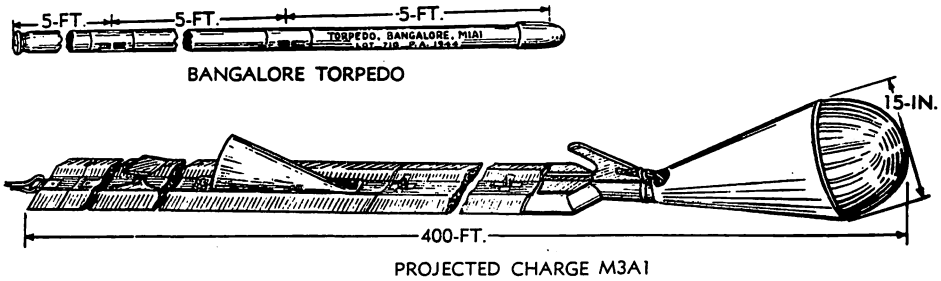
18-13. Because of its plasticity and high detonation velocity, Composition C3 is ideally suited to cutting steel structural members. It is easily molded in close contact to irregularly shaped objects and is an excellent underwater charge if enclosed in a container to prevent erosion.



DEMOLITION CHARGES AND DYNAMITE



INITIATING AND PRIMING MATERIALS



OBSTACLE AND MINE FIELD CLEARING DEVICES

Figure 18-1. Typical Demolition Material

18-14. When chilled, Composition C3 changes color from bright yellow to red, with no visible breakdown of material. Below -20°F., it becomes stiff and brittle; plasticity is restored only by reheating. Although at -20°F. the velocity is reduced, detonation is still of high order.

18-15. COMPOSITION C4 (M5A1 DEMOLITION BLOCK). Composition C4 is packaged as a block explosive measuring 11 by 2 by 2 inches and weighing 2-1/4 pounds. (See figure 18-1.) Each block is wrapped in a plastic covering with a threaded cap well at either end for use as a block explosive.

18-16. Because of its high detonation velocity (slightly higher than C3) and its plasticity, Composition C4 is well suited for cutting steel and timber and breaching concrete. It may be used as an underwater charge, if enclosed in the original or an improvised container to prevent erosion.

18-17. C4 remains pliable like putty at temperatures between -70°F. and +170°F. Below -70° it becomes hard and brittle.

18-18. MILITARY DYNAMITE. Military dynamite (M1) is a standard stick 1-1/4 by 8 inches and weighs approximately a half-pound. Because it detonates at a velocity of approximately 20,000 feet per second, it is very satisfactory for military construction, quarrying, and other demolition work.

18-19. COMMERCIAL DYNAMITES. These are used in certain military demolitions and construction where special explosives may be required. They include straight, ammonia, and gelatin dynamites. Commercial straight dynamites are named according to the percentage by weight of nitroglycerine they contain; for example, 40 percent straight dynamite contains 40 percent nitroglycerine. Ammonia dynamite is different, however, as 40 percent ammonia dynamite indicates that the dynamite is as strong as 40 percent straight dynamite but not that it contains 40 percent nitroglycerine by weight. Sixty percent straight dynamite, approximately equal in strength to TNT, has a variety of uses; gelatin dynamite is applicable to underwater demolitions and for land clearing, cratering, and quarrying. A gelatin dynamite of low heaving force and a high rate of detonation is used for blasting hard rock. Available dynamites and their characteristics are described in T.O. 11A-1-34.

18-20. Straight dynamite contains nitroglycerine and a nonexplosive filler. Its high velocity of detonation produces a shattering action. Although straight dynamite is water resistant only to a small degree, it may be used underwater if fired within 24 hours after submersion.

18-21. Ammonia dynamite contains ammonia nitrate and nitroglycerine, which is the explosive base. Because of its medium detonating velocity, it produces a heaving action. It is not satisfactory for use underwater.

18-22. Gelatin dynamite is a jelly made by disolving nitrocellulose in nitroglycerine. Because of its high resistance to water, it is satisfactory for underwater demolitions.

18-23. Commercial dynamite is not a standard military explosive because of its undesirable characteristics, but is acceptable in emergencies. It must be handled carefully as a flame, sparks, friction, and sharp blows may detonate it. Commercial dynamite deteriorates rapidly and requires special care in storage.

18-24. The sensitivity of dynamite decreases at diminishing temperatures until the dynamite freezes, after which it becomes extremely sensitive. Gelatin dynamite does not freeze as easily as straight dynamite. When straight dynamite is stored, the nitroglycerine tends to settle out of the sticks; accordingly, straight dynamite cases should be frequently and regularly turned to prevent settling.

18-25. AMMONIUM NITRATE CRATERING CHARGE. Ammonium nitrate cratering explosive is issued as a 40-pound charge in a cylindrical metal container 8-1/4 inches in diameter and 17 inches high. (See figure 18-1.) The container has a cap well and detonating cord tunnel for priming. An integral TNT booster is provided to ensure detonation. On top of the container is a ring for lowering the charge into a hole. The cleat placed above and to the side of the cap well is for attaching either electric or nonelectric priming assemblies.

18-26. Ammonium nitrate is used chiefly as a cratering charge because of its pushing or heaving characteristics. It is also effective in ditching and quarrying.

18-27. Except for the loss in strength at low temperatures, ammonium nitrate is satisfactory for use in the Arctic.

18-28. NITRAMON CRATERING CHARGE. Generally the nitramon cratering charge is issued in a cylindrical metal container 7 inches in diameter and 24 inches long. The charge and container weigh 43 pounds. The charge has two priming tunnels. The container has a ring on top for general handling and lowering into boreholes. The nitramon cratering charge, generally used in cratering, is also effective in ditching and quarrying. This is a blasting agent comparable with ammonium nitrate. It is not removed from its metal waterproof container for cratering operations because of its hygroscopic characteristics.

18-29. SHAPED CHARGES. A shaped charge is an explosive charge with its detonating action directed to increase its effectiveness in penetrating steel, armor, and concrete and other masonry. Charges as issued, are usually cylindrical in shape but may be linear like the charge included in the M157 demolition kit. Cylindrical shaped charges have a conical top, a conical recess in the base, and a conical liner that may be metal, glass, or some other inert material. Shaped charges, generally, are made from such explosives as Composition B, pentolite, and ednatol.

NOTE

The threaded cap well in the top is for priming with military electric or nonelectric blasting caps or any standard firing device with blasting cap attached.

18-30. The M2A3 shaped charge weighs 15 pounds and contains 11-1/2 pounds of pentolite (PETN and TNT) or Composition B (RDX and TNT). For protection, the explosive is issued in a water-resistant fiber container. (See figure 18-1.) A cardboard cylinder, fitted to the charge before use, provides the necessary standoff distance. Three M2A3 shaped charges are packed in a wooden box.

18-31. The M3 shaped charge consists of approximately 30 pounds of 50/50 pentolite, or Composition B, and a 50/50 pentolite booster in a metal container. (See figure 18-1.) The shaped charge has a metal cavity liner. A metal tripod provides the correct standoff distance. The M3 shaped charge is packed one each in a wooden box.

18-32. Shaped charges M2A3 and M3 are very useful for small arctic projects, especially for drilling holes, having the strength necessary to loosen perma-frost and ice. Shaped charges, however, should not be used as a cure-all demolition explosive as is the tendency to do so, for the logistical difficulties of supplying them in large quantities generally limits their use.

18-33. BANGALORE TORPEDO. The M1A2 bangalore torpedo consists of loading assemblies, connecting sleeves, and a nose sleeve. (See figure 18-2.) Each loading assembly, which may be used singly, is a 5-foot length of steel tubing 2-1/8 inches in diameter filled with 8-1/2 pounds of Composition B explosive and weighs 13 pounds. Four inches of length at both ends is filled with a Composition A-3 booster. All sections have a threaded cap well at each end so that they may be assembled in any order. The connecting sleeves make rigid joints. A nose sleeve is placed on the front of the torpedo to assist in pushing it through entanglements and over the ground. It is also desirable to attach an improvised leading section without explosive on the end to forestall premature detonation by mine when the torpedo is shoved into place. In the assembly of two or more tubes, the nose sleeve is pressed onto one end of one tube, and the other end is connected to a second tube by a connecting sleeve. A bangalore torpedo or torpedo section may be improvised by the use of 2-inch diameter pipe with a 24-gage wall thickness with approximately 2 pounds of explosive per foot of length. Successive pipe lengths, however, must be closely connected.

18-34. The bangalore torpedo clears a path 10 to 15 feet wide through barbed wire entanglements. In minefield breaching, it will explode all antipersonnel mines and most of the antitank mines in a narrow foot path. It should be used for this purpose only in an emergency, as many of the mines at the sides may be shocked into a sensitive state, which makes extreme care necessary in any further mine clearing. Bangalore torpedoes are also useful as expedient individual charges.

18-35. ROCKET-PROPELLED TRAIN BANGALORE TORPEDO. The train consists of 20 sections of

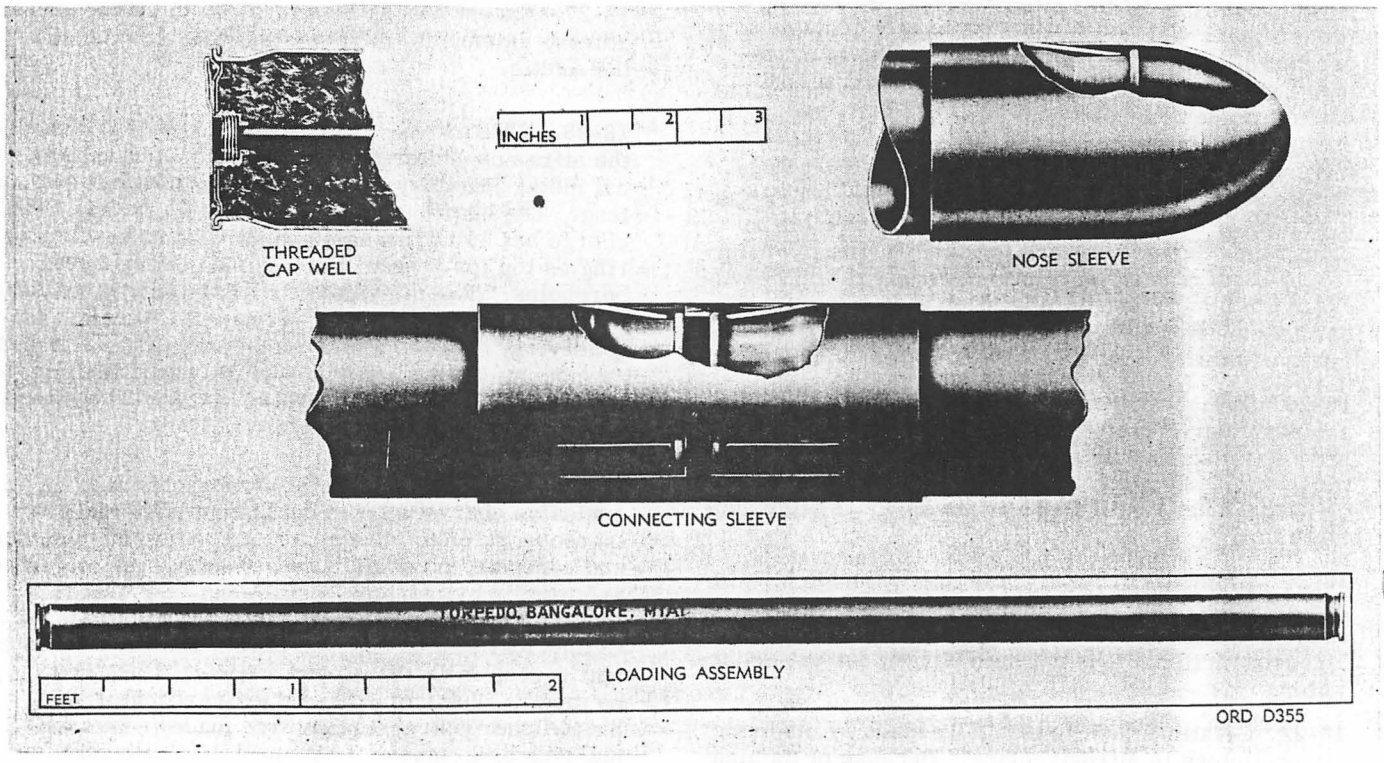


Figure 18-2. Torpedo, Bangalore, M1A2

bangalore torpedo fitted together by special connecting sleeves to form a 100-foot train. A kit contains the rocket motor, tail assemblies, and couplings for 20 sections. The motor is fitted to the front of the train to provide propulsion. Detonation occurs at the tail assembly by means of a pull fuze, a nonelectric blasting cap, and a reel of cable.

18-36. The rocket-propelled bangalore torpedo is used against barbed wire entanglements, antipersonnel mines, and similar small obstacles. The rocket propulsion enables deeper penetration of small obstacles with less chance of exposure of personnel to enemy observation and fire.

18-37. M37 DEMOLITION CHARGE ASSEMBLY. The M37 charge assembly (figure 18-3) consists of eight M5A1 demolition blocks (Composition C4), eight demolition block hook assemblies, and two M15 priming assemblies. The demolition blocks are packed in two bags, four blocks per bag and placed in an M85 carrying case. The M15 priming assembly is a 5-foot length of detonating cord with two plastic adapters and two RDX boosters attached. The adapters are threaded to fit the standard cap well in the demolition block. The priming assembly has two detonating cord clips for fixing the M37 charge assembly to the main line.

18-38. This assembly is applicable for use by assault demolition teams in the reduction of small obstacles. It is a versatile demolition kit and may be used for emergency destruction plans.

18-39. IMPROVISED CHARGES. Demolition teams operating in the field frequently find targets to which standard methods and charges may not apply and improvisions are required. Frequently the success of the mission depends upon the ingenuity of the team. The package and pole charges are such improvisations. By skillful modifications, they may be applied successfully in many situations.

18-40. The M10 Universal High-Explosive Destructor (figure 18-4) is a high-explosive charge in an assembled metal device initiated by means of blasting caps or land mine activators with standard firing devices. The destructor has booster cups containing tetryl pellets. The chief function of the destructor is in the conversion of loaded projectiles and bombs to improvised demolition charges and in the destruction of abandoned ammunition.

18-41. FOREIGN EXPLOSIVES. Explosives used by foreign countries include TNT, picric acid, and guncotton. Picric acid has characteristics like TNT except that it corrodes metals and thus forms extremely sensitive compounds. A picric acid explosive in a rusted or corroded container will not be used; in fact, it should not be handled in any way, except to move it very carefully to a safe area for disposal.

18-42. Explosives of allied nations and those captured from the enemy may be used to supplement standard supplies. Such explosives, however, should be used only by experienced personnel. Captured bombs, propellants, and other devices may be used

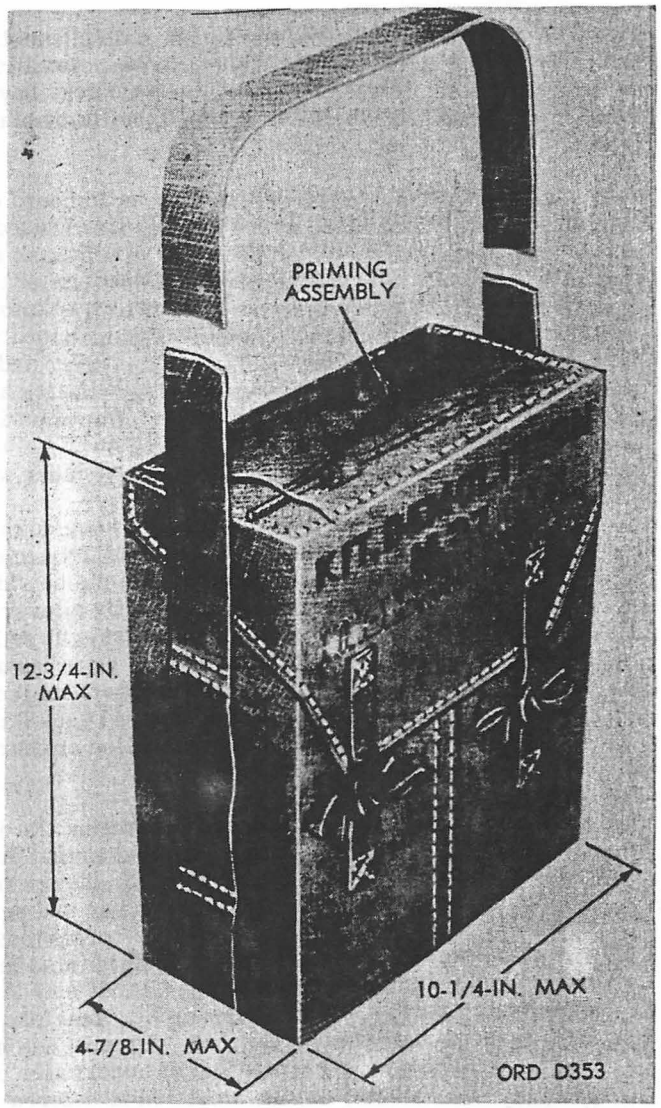


Figure 18-3. Kit, Demolition, M37

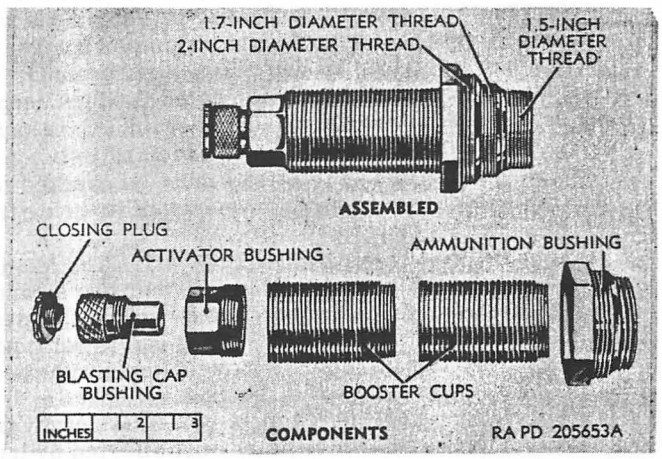


Figure 18-4. Destructor, High-Explosive, Universal, M10

with U.S. military explosives for larger demolition projects, such as pier, bridge, tunnel, and airfield destruction. Most foreign explosive blocks have cap wells large enough to receive U.S. military blasting caps.

18-43. DETONATING CORD. Detonating cord consists of a flexible tube filled with PETN encased in a white, yellow, or yellow-and-black waterproof covering. Watersoaked detonating cord will detonate if initiated from a dry end. Like other high-explosives, it is subject to sympathetic detonation. Detonating cord is issued in spools in 50-, 100-, 500-, and 1,000-foot lengths. Detonating cord detonates at approximately four miles per second. The following three types of detonating cord - I, II, and IV - are used in military demolitions on land and under water.

a. Types I and II Detonating Cord. These detonating cords consist of an explosive core of PETN enclosed in a braided seamless cotton tube. On the outside of this tube is a layer of asphalt covered by a layer of rayon with a wax gum composition finish. Type II has a slightly larger diameter than type I, as it has an extra layer of cotton covering that increases its tensile strength to approximately 150 pounds. Types I and II detonating cord are used in the detonation of charges from single point initiaters.

b. Type IV, Plastic-Reinforced Detonating Cord. (See figure 18-5.) This cord is similar to that described in paragraph 18-43a, except for the special plastic covering designed for vigorous use and severe weather. This covering increases the cord's tensile strength from 150 pounds to 250 pounds; it also makes the cord more stable in high temperatures and decreases the possibility that the wrapper may lose its waterproof qualities when handled. Type IV detonating cord is used in the detonation of underwater or underground charges, where initiation is desired on the surface.

18-44. Detonating cord does not lose its explosive properties by exposure to long periods of cold. Even during severe drops in temperature, it fires all standard military explosives. The only variation in method is the use of six instead of the normal four turns when detonating the M2 (tetrytol) demolition block. The outer covering of chilled detonating cord becomes stiff and cracks when bent. Repeated flexings deepen the cracks and break the explosive train. Care must be taken to ensure a minimum of cracking in tying detonating cord; and connections must be checked for tightness, as the cord tends to loosen after being tied.

18-45. DETONATING CORD CLIP, M1. The M1 detonating cord clip is used to hold together two strands of detonating cord, either parallel or at right angles to each other, or to fasten a blasting cap to detonating cord. Connections are made more quickly with these clips than with knots. Also, knots may loosen and fail to function properly if left in place any length of time. Joints made with clips are not affected by long exposure.

WARNING

Each roll of blasting time fuze must be tested shortly before use. The rate of burning will vary for the same or different roll under different atmospheric and/or climatic conditions, from a burning time of 30 seconds or less per foot to 45 seconds or more per foot. Particular precautions must be taken when used under water as the rate of burning is increased significantly.

18-46. BLASTING TIME FUZE (FABRIC COVERED). This consists of black powder tightly wrapped with several layers of fabric and waterproofing materials. It may be any color, orange being the most common. This fuze burns slowly at a uniform rate, allowing personnel firing the charge to reach safety before the explosion. Each roll must be tested immediately prior to using under actual conditions in the area where the charge is to be placed.

18-47. BLASTING TIME FUZE (PLASTIC COVERED). (See figure 18-6.) This fuze is in the form of a 0.20-inch diameter cord consisting of a black powder core tightly wrapped with waterproofing materials and a plastic cover. The dark green cover is smooth with single painted bands at either 1-foot or 18-inch intervals and double painted bands at either 5-foot or 90-inch intervals, depending on old or new manufacture. These markings are used to estimate the approximate lengths of fuze required for tactical situations.

18-48. Blasting time fuze is issued in 50-foot rolls; two rolls, one nested inside the other, are packed together. One can contains 500 feet of fuze.

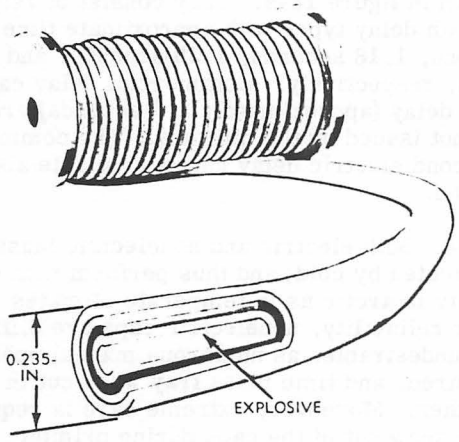
18-49. When ignited by a match or a fuze igniter, the fuze transmits a flame to a nonelectric blasting cap. This fuze is for use in demolitions both on land or underwater. The burning rate of the fuze is approximately 40 seconds per foot.

18-50. Although the powder train of the time fuze does not break down or deteriorate during long periods of cold, the outside covering becomes brittle and cracks easily. It is necessary to handle time fuze carefully during priming to prevent cracking and breaking of the powder train. The burning rate is determined in the same manner as when it is used in a moderate climate--a measured length is cut off and burned in the area and at the temperature in which it will be used. A good procedure is to cut time fuze in a warm shelter and keep it next to the body until time for priming. Nonelectric firing, however, is undesirable in arctic/subarctic temperatures.

18-51. FUZE LIGHTERS. The M2 waterproof fuze lighter was designed as a positive method of lighting time fuze (figure 18-7) and safety fuze. It operates effectively under all weather conditions, even underwater if it is properly waterproofed. A pull on the

striker retaining-pin causes the striker to hit the percussion cap, igniting the fuze. A sealing compound is generally used to waterproof the joint between the fuze and the lighter. Although the plastic sealing compound is applied and the nonelectric firing assembly is properly prepared, any slight disturbance of the lighter on the time fuze allows water to enter at the union when installed underwater.

18-52. The M2 weatherproof fuze lighter is unsatisfactory for arctic use, as the percentage of failures is too high. The warming of the lighter and fuze, just before using them, reduces failures to a marked degree. Because of the tendency of the fuze end to fray, repeated cuts may have to be made before it can be inserted deeply enough into the M2 lighter to be ignited.



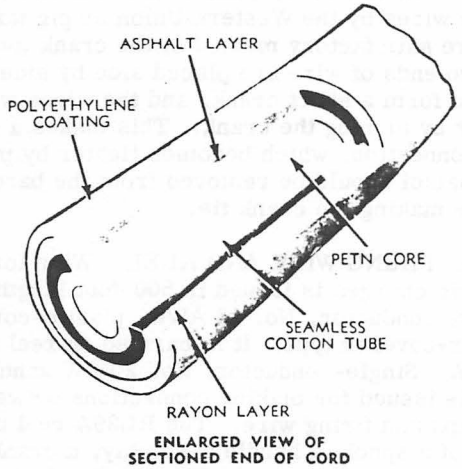


Figure 18-5. Cord, Detonating, Waterproof, Plastic-reinforced

18-53. The M60 weatherproof fuze lighter is designed to ignite time fuzes under all weather conditions and underwater. The fuze is inserted into a fuze retainer and sealed and waterproofed by means of two rubber seals. A pull on the pull ring releases the striker assembly, allowing the firing pin to drive against the primer, which ignites and initiates the fuze.

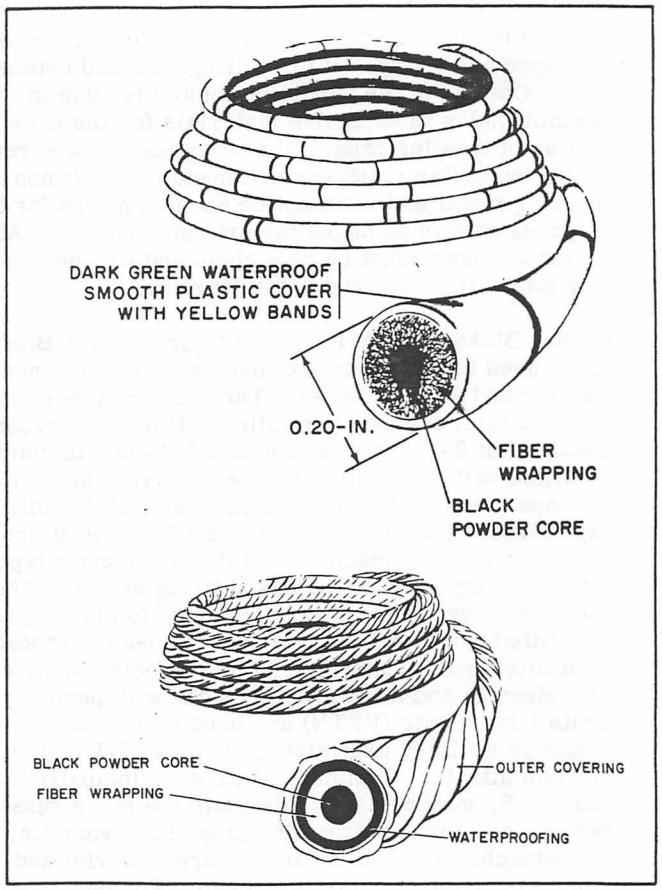


Figure 18-6. Fuze, Blasting, Time, Fabric-covered and Plastic-covered

18-54. The M60 fuze lighter has been tested under extreme cold conditions and found satisfactory. It functions without failure at temperatures as low as -25°F.

18-55. CAP CRIMPER. The M2 cap crimper is used to squeeze the shell of a nonelectric blasting cap around a time fuze, firing device, or detonating cord securely enough to keep it from being pulled off. The crimper forms a water resistant groove completely

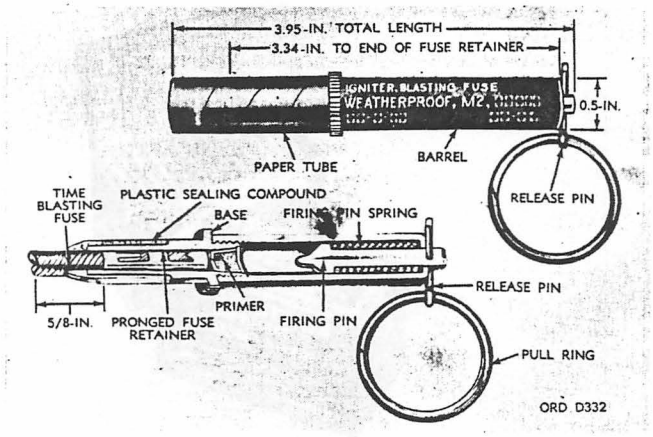


Figure 18-7. Lighter, Fuze, Weatherproof, M2

around the blasting cap. The rear portion of the jaws is shaped and sharpened for cutting fuze and detonating cord. One leg of the handle is pointed for use in punching holes in explosive materials for the easy insertion of blasting caps. The other leg has a screwdriver end. Cap crimpers are made of a soft nonsparking metal and must not be used as pliers for any purpose, as this damages the crimping surface. Also the cutting jaws must be kept clean and will be used only for cutting fuze and detonating cord.

18-56. BLASTING CAPS. (See figure 18-8.) Blasting caps, used for initiating explosives, are of the nonelectric and electric types. The military types consist of a thin, tabular, metallic shell of noncorrosive metal about 2-1/2 inches long and 1/4-inch in diameter filled with a sensitive high-explosive. In priming, the caps are inserted into the cap wells of demolition explosives. The electric type has wires for attachment to a blasting machine and the nonelectric type may be crimped to any standard firing device. The nonelectric caps may also be crimped to blasting time fuze fitted with a fuze lighter or crimped to detonating cord fitted with a delay detonator. Special Army caps, both electric and nonelectric, loaded with pentaerythrite tetranitrate (PETN) are used to detonate less sensitive military explosives, such as TNT and ammonium nitrate. Commercial caps, principally No. 6 and No. 8, may be used to detonate the more sensitive explosives, such as dynamite, a gelatin dynamite, or nitrostarch. The No. 8 cap is more powerful and more expensive than the No. 6 cap. For description of wiring and electric wiring circuits, refer to T.O. 11A-1-58.



Figure 18-8. Blasting Caps, Non-electric and Electric

18-57. The two types of electric blasting caps used are:

a. Instantaneous. The military instantaneous electric blasting caps are type II (J 2 PETN) and M-6 (RDX). These have 12-foot electric leads for attaching to a firing wire and then to a blasting machine or other source of power for detonation. Commercial electric blasting caps No. 6 and No. 8 have three lengths of leads: short (4-10 feet), medium (12-40 feet), and long (50-100 feet). The lead wires of the commercial blasting cap enter through a seal made either of sulphur, rubber, or plastic. A short-circuit tab or shunt fastens the loose ends of the wires together, preventing accidental firing.

b. Delay. Military electric delay blasting caps are shown in figure 18-9. They consist of 1st, 2d, 3d, and 4th delay types with approximate time delays of 1 second, 1.18 seconds, 1.35 seconds, and 1.53 seconds, respectively. Commercial delay caps up to 10th delay (approximately 2.5 seconds) are available but not issued by the military. The commercial millisecond electric delay cap is available also, but not issued.

18-58. Both electric and nonelectric blasting caps are unaffected by cold; and thus perform with equal reliability in arctic as in temperate climates. Despite their reliability, nonelectric caps are difficult to use and undesirable, as numerous manual operations are required, and time fuzes fray when cut in cold weather. Moreover, extreme care is required to keep snow out of the caps during priming. Electric caps are easier than nonelectric caps to prepare. It is difficult, however, when wearing arctic mittens to splice wires by the Western Union or pig tail twists. A more satisfactory method is the crank tie, wherein the two ends of wire are placed side by side, the ends bent to form a short crank, and the wires wound together by turning the crank. This makes a quick, taut connection, which becomes tighter by pulling. All the enamel should be removed from the bare wires before making the crank tie.

18-59. FIRING WIRE AND REEL. Wire for firing electric charges is issued in 500-foot lengths. It is the two conductor, No. 18 AWG, plastic-covered or rubber-covered type. It is carried on reel unit RL39A. Single-conductor, No. 20 AW annunciator wire is issued for making connections between blasting caps and firing wire. The RL39A reel unit consists of a spool, a handle assembly, a crank, an axle, and two carrying straps. The fixed end of the wire is extended from the spool through a hole in the side of the drum and fastened to brass thumbnut terminals. The handles are made of two U-shaped steel rods. A loop at each end encircles a bearing assembly, which is a brass housing with a steel center to accommodate the axle. The crank is riveted to one end of the axle and a cotter pin is placed in the hole at the other end to hold the axle in place.

18-60. BLASTING MACHINE. (See figure 18-10.) Blasting machines are classified by the number of caps which can be fired in a series circuit. They may be used to fire parallel and series-parallel

circuits if only a few blasting caps are in the circuit. The standard blasting machines used are as follows:

a. The 10-cap blasting machine is a small electric, impulse-type generator that produces adequate current to fire 10 electric caps connected in series.

b. The 30-cap blasting machine fires 30 electric caps connected in series. It weighs about 20 pounds.

c. The 50-cap and 100-cap blasting machines are similar to the 30-cap machines except for size and weight and are operated in the same manner. They are adequate for firing their rated capacity of electric blasting caps connected in series.

18-61. Both the 10-cap and 30-cap blasting machines fire satisfactorily their rated number of electric caps after prolonged exposure to arctic conditions. Although low temperatures retard the mechanical operation of the armature, normal rotation may be obtained by vigorous operation of the handle at least 10 times before firing. The handle of the 10-cap blasting machine is inclined to break at the connecting slot, especially after prolonged chilling. Thus the device should be carefully loosened before operation. The lead wires are difficult to attach by operators wearing heavy mittens.

18-62. GALVANOMETER. The galvanometer (figure 18-10) is an instrument used in testing the electric firing system to check the continuity of the various parts, such as blasting cap, firing wire, wire connections, splices, and circuits in order to reduce the possibility of misfires. The components include an electromagnet, a small special silver-chloride dry cell, a scale, and an indicator needle. When the two external terminals are connected in a closed circuit, the flow of current from the dry cell moves the needle across the scale. The extent of the needle deflection depends on the amount of resistance in the closed circuit and on the strength of the cell. The galvanometer must be handled carefully and kept dry.

18-63. The standard silver chloride dry cell installed in all galvanometers is unsatisfactory in demolitions in the arctic. The cell freezes and ruptures, completely ceasing operation, at temperatures below 0° F. If, however, the galvanometer is warmed by heating and then placed next to the body until use, it gives a partial scale reading that is usable.

18-64. FIRING DEVICES. Firing devices (figure 18-11) are of two general types: the tubular type and the box type. The coupling base, fitted to all types, has the standard thread and nipple and always contains a percussion cap primer. The coupling base, may be used interchangeably as appropriate for the particular task to be accomplished. Firing devices may be used with explosive charges and primed blasting caps. When used directly with demolition blocks, a firing device requires a crimped-on blasting cap.

18-65. The tubular type firing devices, consisting generally of head, case, coupling base, and percussion cap primer, are arranged for actuation by pressure, pull or release of pull, or chemical action,

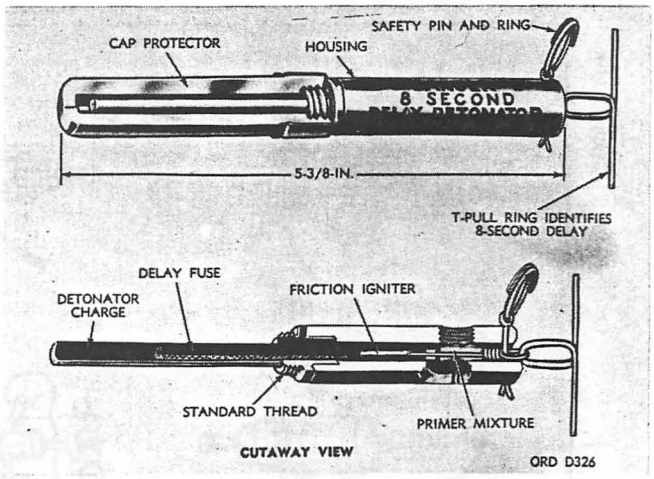


Figure 18-9. Detonator, 8-second Delay, M2

according to the design of the particular model. Typical devices are as follows:

a. The delay type firing device (M1) is a chemical device used for firing a delay-action mine or demolition block. Delay action is initiated by crushing a glass capsule, filled with corrosive liquid, contained in a thin-walled portion of the case. An identification and safety strip, colored to indicate the delay time of the device, is visible through an inspection hole in the coupling base. The nominal delay time (at 75° F.) and corresponding colors are: 9 minutes, black; 15 minutes, red; 1 hour, white; 2-1/2 hours, green; 5-1/2 hours, yellow; and 11-1/2 hours, blue. The nominal delay time is subject to temperature correction in accordance with a table furnished with the firing device.

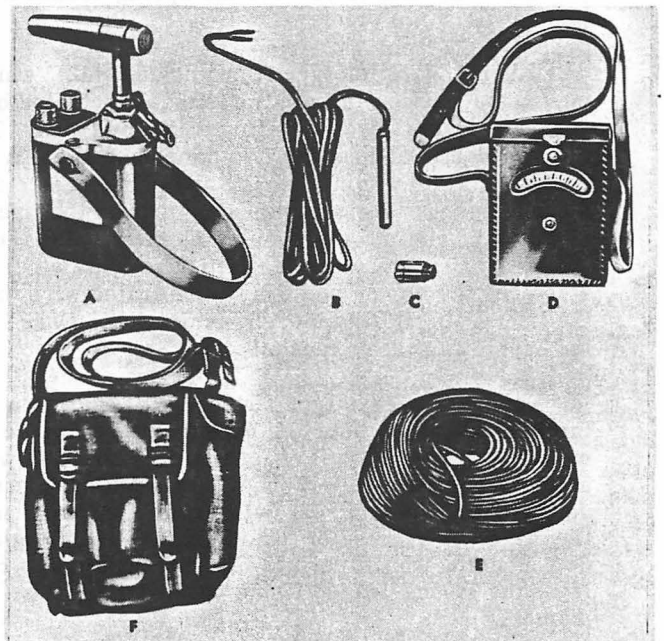


Figure 18-10. Demolition Equipment

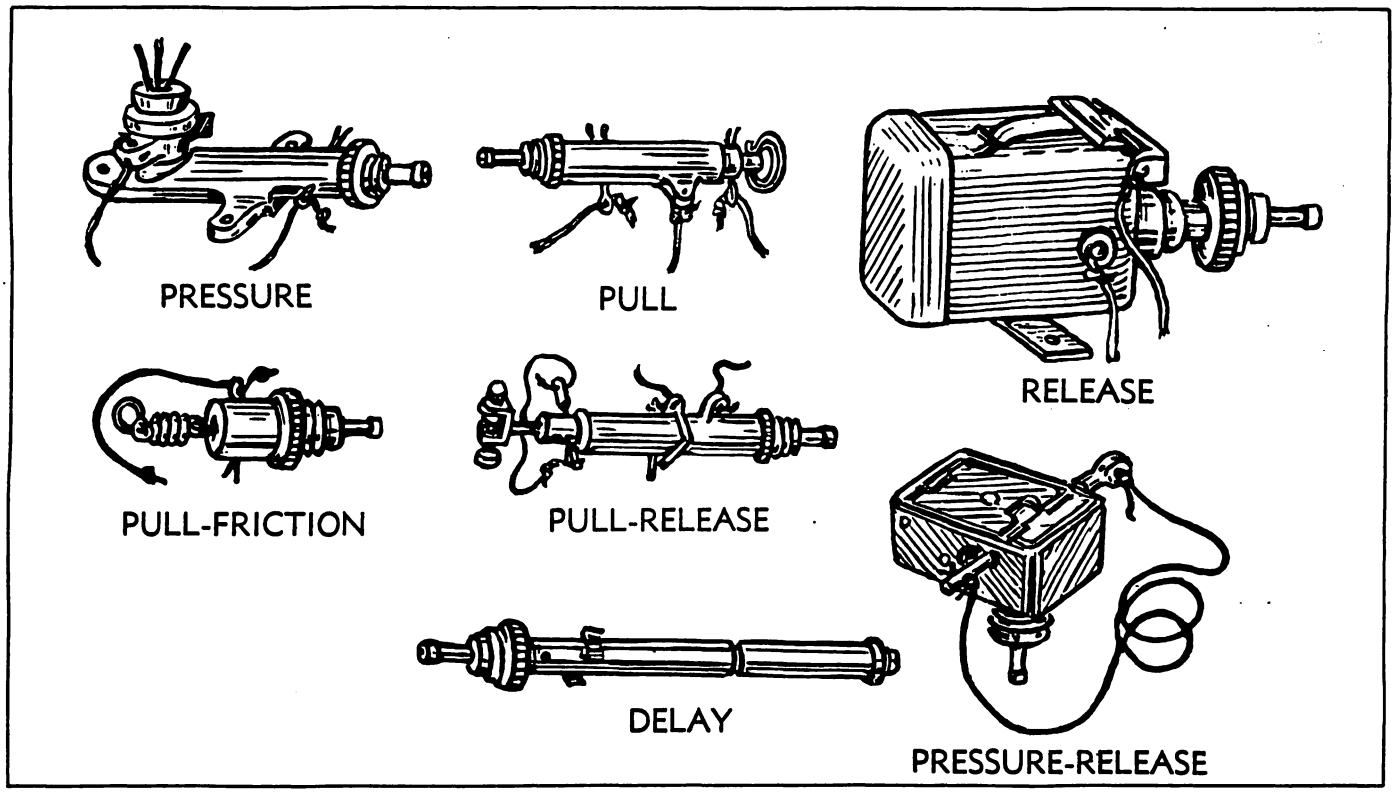


Figure 18-11. Firing Devices

b. The pressure type firing device (M1A1) is actuated by pressure and is used in setting up booby traps. When a safety pin between the firing pin and primer has been removed, a pressure of 20 pounds on the pressure cap acts to release the spring-loaded firing pin that fires the primer.

c. The pull-friction type firing device (M2), which contains a friction initiated primer, is actuated by a pull wire and is used in setting up booby traps. The body is plastic and the base is nonremovable. A coated wire, to which a spring and pull ring are attached, passes through the body, through the friction compound, and into a nipple on the base. A direct pull of 3 to 11 pounds on the trip wire (pull wire) stretches the spring and draws the coated wire through the friction compound thereby igniting it. Once fired, the device cannot be reused.

d. The pull-release type firing device (M3) is a mechanical device actuated by either an increase (pull) or a decrease (release) of tension in a taut trip wire and is used with antipersonnel mines M3 or in setting up booby traps. A direct pull of 6 to 10 pounds on the trip wire, or release of tension, such as cutting or detaching the trip wire, act in different ways to release the spring-loaded firing pin that fires the primer.

e. The pull type firing device (M1) is a mechanical device actuated by a pull on a trip wire and is used with antipersonnel mines M3, for activation of antitank mines and in setting up booby traps. A direct pull of 3 to 5 pounds on the trip wire releases the spring-loaded pin that fires the primer.

18-66. The box type firing devices, consisting of a rectangular steel body and primed coupling base, are actuated by release of pressure. Examples of this type are as follows:

a. The pressure-release type firing device (M5) is a mechanical device used to activate antitank mines equipped with supplementary fuze wells (cap well) and for general booby-trap installations with charges having a threaded well. A release plate will release the spring-loaded firing pin, which fires the primer, when a restraining load of at least 5 pounds is displaced more than five-eighths of an inch. This firing device may be reused.

b. The release type firing device (M1) is actuated when a restraining weight is removed from it and is used in setting up booby traps. A restraining weight of at least 2 pounds is applied on the top face of the latch at the time of installation. After the safety pin has been removed, displacement of the restraining weight releases the latch, allowing a spring lever to actuate the firing pin that strikes the primer.

18-67. Inert firing devices used for training purposes are to be employed in exactly the same manner and with the same care and precautions as are the explosive items comprising the firing devices simulated.

18-68. M1 CONCUSSION DETONATOR. The M1 concussion detonator is a mechanical firing device activated by the concussion wave of a nearby blast. (See figure 18-12.) It fires several charges simultaneously. A single charge fired in any way in water or air will detonate all charges primed with concussion

detonators within range of the main charge or of each other. These detonators should not be used in surf at depths greater than 15 feet, as they function by hydrostatic pressure at a depth of 25 feet. Methods of use are outlined in T.O. 11A9-1-101.

18-69. MINE AND BOOBY TRAP FIRING DEVICES. Standard mine and booby trap fuzes and firing devices include the following general types:

a. Pull. The M1 pull firing device is initiated by a pull on a tripwire.

b. Pressure. The M1A1 pressure firing device functions by pressure.

c. Pressure-release. The M5 pressure-release functions when pressure is released from it.

d. Combination. The M3 pull-release firing device functions when a taut tripwire is either pulled or cut. Also, two or more devices may be installed in a single charge so that firing may result in any combination of the above actions.

18-70. DEMOLITION SETS. Demolition sets are an assembly of demolition explosive items, accessories, and tools for various demolition jobs.

18-71. ELECTRIC AND NONELECTRIC DEMOLITION SET. The electric and nonelectric demolition equipment set consists of TNT and M5A1 (Composition C4) demolition blocks and accessories for electric and nonelectric priming and firing. The set is carried in the engineer platoon demolition chest.

18-72. NONELECTRIC DEMOLITION SET. The nonelectric demolition equipment set consists of M5A1 (Composition C4) demolition blocks and accessories for nonelectric priming. The set is carried in a canvas haversack.

18-73. All equipment in demolition sets 1 and 5 (figures 18-13 and -14) performs satisfactorily under arctic winter conditions except the following items:

a. Cap sealing compound. Because of its high viscosity and the difficulty of thawing and keeping warm, cap-sealing compound is unsatisfactory for use in the Arctic.

b. Engineer pocket knife. The engineer pocket knife is not sturdy enough for arctic use. The blades do not hold their sharp edges at subzero temperatures.

c. Firing wire and reel. This equipment must be kept free of ice and snow. All snow must be removed during rewinding.

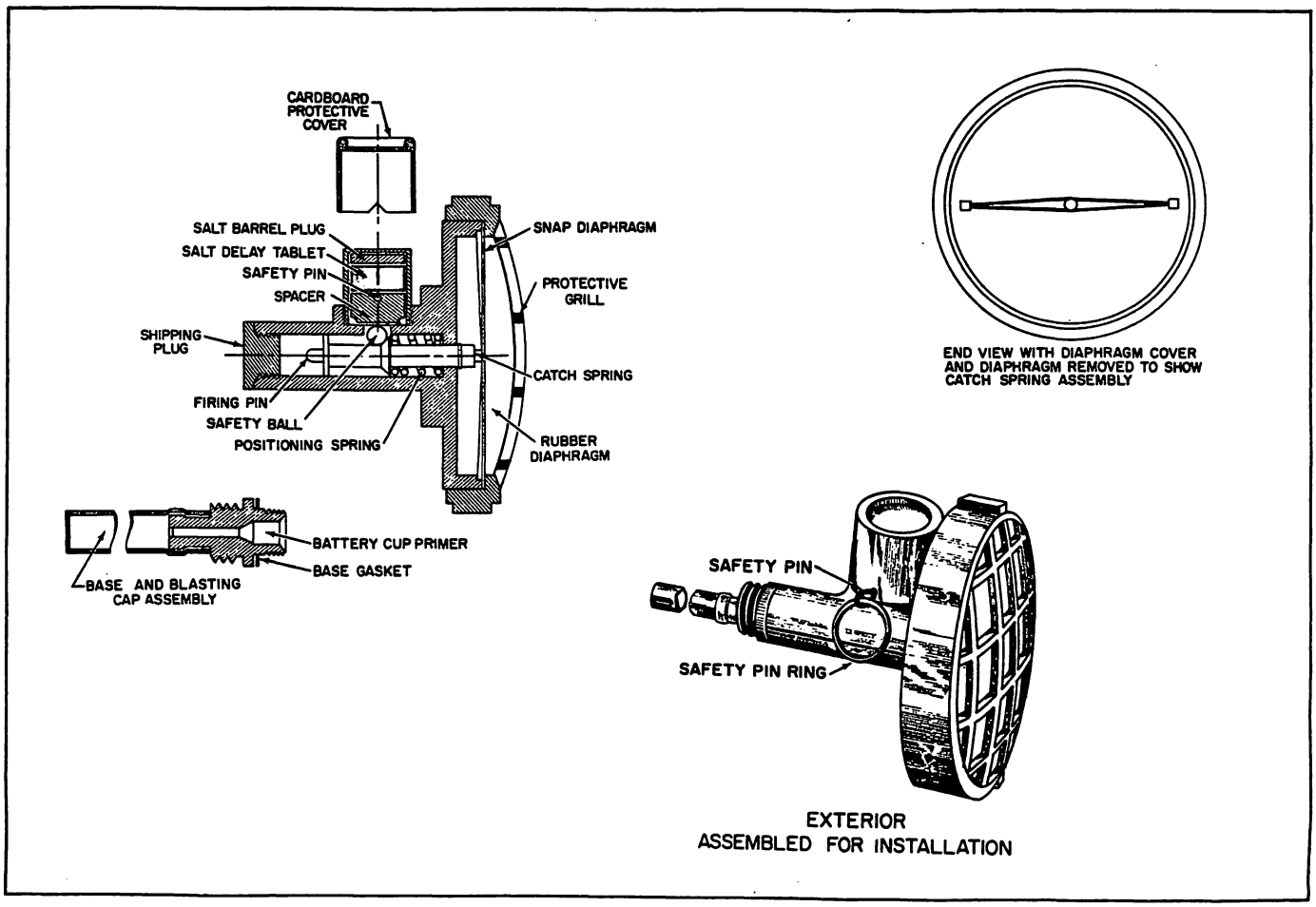


Figure 18-12. Detonator, Concussion Type, M1

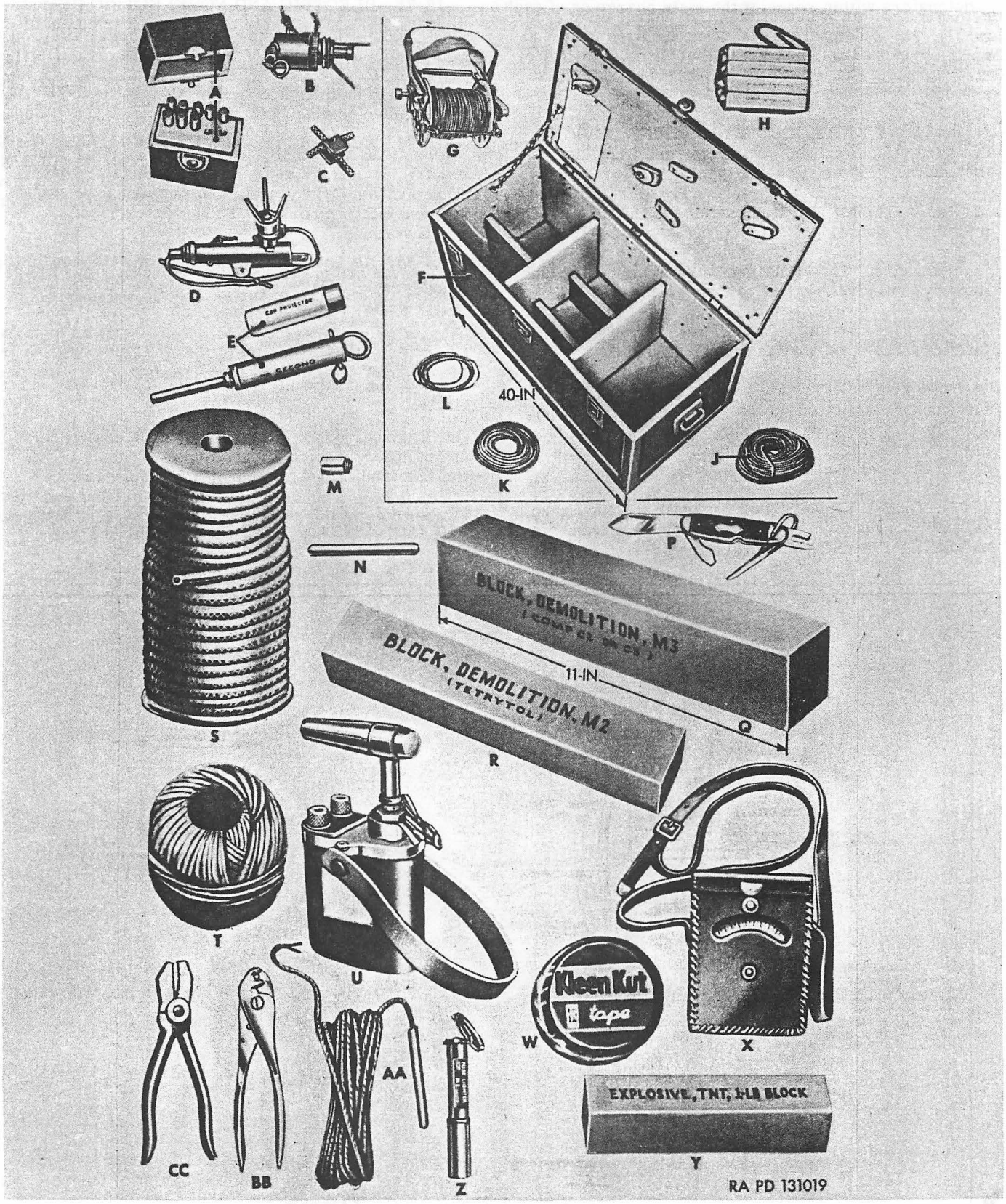


Figure 18-13. Demolition Equipment Set Number 1

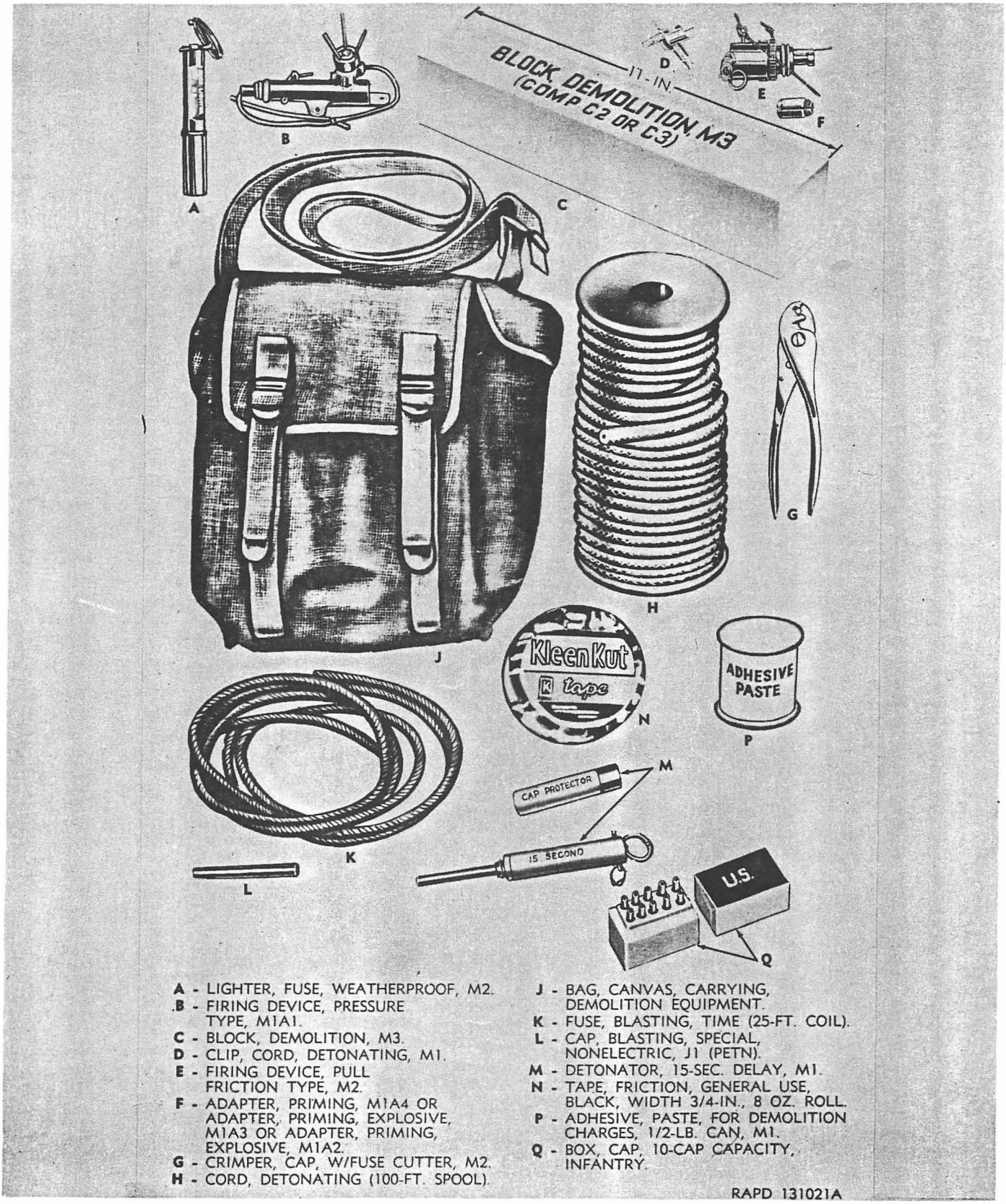


Figure 18-14. Demolition Equipment Set Number 5

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Numerical Index of Departmental Forms	AFR 0-9
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Report of Damaged or Improper Shipment	AFR 71-4
Preservation, Packaging, Packing, and Marking Policy	AFR 71-6
Responsibilities for USAF Aerospace Accident Prevention Programs	AFR 127-1
Investigating and Reporting USAF Accidents/Incidental	AFR 127-4
Ammunition and Explosive Materiel Quality Assurance	AFR 136-6
Safeguarding Classified Information	AFR 205-1
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Air Force Manual of Abbreviations	AFM 11-2
Maintenance Management	AFM 66-1
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Packaging and Handling of Dangerous Materials for Transportation on Military Aircraft	AFM 71-4
Explosives Safety Manual	AFM 127-100
Numerical Index and Requirements Table - Armament, Fire Control Guidance, Hazard Detecting, Personnel Ejection Systems, and Associated Equipment	T. O. 0-1-11
Materiel Deficiency Reporting on Air Force Equipment and Materiel	T. O. 00-35D-54
Military Explosives	T. O. 11A-1-34
General Instructions for Disposal of Ammunition	T. O. 11A-1-42
Ammunition and Explosive Materiel Serviceability and Location Record	AFTO Form 15
Routine Unsatisfactory Report	AFTO Form 29
Ammunition Disposition Report	AF Form 91
Report of Damaged or Improper Shipment	DD Form 6
Inspection Reports, Motor Vehicles Transporting Class A and B Ammunition and Explosives over Public Highways	DD Form 626
USAF Stock List - Ammunition and Explosives	FSC 1300
USAF Stock List of End Items -- FSC Group 81 Containers, Packaging, and Packing Supplies, Class 8140 Ammunition Boxes, Packages, and Special Containers	FSC 8140

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Index of Blank Forms	DA Pam 310-2
Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7, 8, and 9), Supply Bulletins, Lubrication Orders and Modification Work Orders.	DA Pam 310-4

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Index of Supply Catalogs and Supply Manuals	DA Pam 310-6
Explosives: Responsibilities and Procedures for Explosive Ordnance Disposal	AR 75-15
Military Security: Safeguarding Defense Information	AR 380-5
Fire Report	AR 385-12
Safety: Accident Reporting and Records	AR 385-40
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Storage and Shipment and Handling of Chemical Agents and Hazardous Chemicals	TM 3-250
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The Army Equipment Record System and Procedure: Protection and Storage of Army Equipment Log Book Assembly	TM 38-750
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Conversion Set External Cluster Storage M16	TB 3-400-1
Bomb, Fire: 750-lb, M116A2	TB 3-400-9
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Ammunition: Restricted or Suspended	TB 9-AMM-2

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Operational Procedure for Use in Storage, Handling, Movement, Decontamination, and Disposal of GB-Filled Shell	CML C MATCOM INSTRUCTIONS NO. 9.2-14(B)
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Ammunition Condition Report	DA Form 2415

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