MMS SUBCOURSE NUMBER **621**

AMMUNITION MATERIEL

JULY 197[illegible]

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U. S. ARMY

MISSILE AND MUNITIONS CENTER AND SCHOOL

REDSTONE ARSENAL, ALABAMA

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GENERAL INFORMATION

This subcourse consists of one or more lessons and an examination. Each of the lessons is divided into two parts; the text and the lesson exercises. For one lesson subcourses the lesson exercises serve as the examination. A heading at the beginning of each lesson gives the title, the hours of credit, and the objectives of the lesson. The final examination consists of questions covering the entire subcourse.

If a change sheet is included, be sure to post the changes before starting the subcourse.

THE TEXT

All the text material required for this subcourse is provided in the packet. The text is the information you must study. Read this very carefully. You may keep the text; however, any unused answer cards and envelopes should be returned.

THE LESSON EXERCISES

Following the text of each lesson are the lesson exercises. After you have studied the text of each lesson, answer the lesson exercises. After you have answered all the questions, go back to the text and check your answers. Remember your answers should be based on what is in the text and not on your own experience or opinions. If there is a conflict, use the text in answering the question.

With each subcourse you are provided lesson answer cards. After you have answered the questions and have checked them against the text, carefully punch your answers on the card. Be sure to include your social security number and the subcourse number. If your mailing address or THROUGH address has changed note the new address on your answer card.

There are two ways you may handle the grading of the lesson answer cards. You may mail them to us as you complete each lesson or you may wait until you complete all lessons. Your answer cards will be graded and promptly returned to you. You must average 75 percent on the lesson exercises to be eligible to take the examination.

THE EXAMINATION

After you have completed all the lessons and mailed in your answer card for the last lesson, the final examination will be mailed to you with the examination answer card and the approved solutions for the lesson exercises. Prepare the examination the same way you did the lesson exercises. Answer each question in the examination. Your final grade for the subcourse will be the same as your examination grade.

ASSISTANCE

If you require clarification of anything in this subcourse write to us. Also, if you see any information in the text which is incorrect or obsolete, your recommendations will be welcome. Be sure your recommendations are explained in detail, and, if possible, include a reference which gives the correct information. Include your name and social security number. Address all correspondence to:

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CORRESPONDENCE COURSE
OF THE
U. S. ARMY MISSILE AND MUNITIONS
CENTER AND SCHOOL

MMS SUBCOURSE NUMBER 621, AMMUNITION MATERIEL
(22 Credit Hours)

INTRODUCTION

Any military force that is successful in a tactical operation must have many significant advantages over its adversary. The areas which affect materially the outcome of an action are quality and quantity of both manpower and materiel. Conflicts are generally won by the forces which inflict the greatest damage and number of casualties on the enemy.

This destructive power, then, is proportional to the quantity, quality, and timeliness of the overall logistical effort with special emphasis on ammunition support. One reason the U.S. Army has been successful in both defense and offense is because our ammunition is of superior quality and our logistical support is second to none.

Since the end of WW II, the U.S. has been engaged in a series of widely separated deterrent police actions resulting from cold war aggressor nation tactics. Concurrently all forces involved have expended tremendous effort in the research and development of new types of ordnance materiel.

However, regardless of weapon superiority and technically trained personnel, the logistical effort would be ineffectual unless specific types of munitions, in adequate quantities, were made available at the proper place and time.

In order to assure the proper supply, storage, and delivery of serviceable ammunition, the support personnel must know ammunition. This knowledge must be comprehensive. It involves the identification, storage, inspection, transportation, maintenance, and supply of all types of ammunition. The student taking this subcourse may have a general knowledge of ammunition, but a review and refresher will be helpful, because previous experiences may have been limited to certain types.

This subcourse will give you a general knowledge of the types, characteristics, and identification of ammunition. It consists of nine lessons and an examination as follows:

Lesson 1	Military Explosives	2 Hours
Lesson 2	Small Arms Ammunition	1 Hour
Lesson 3	Artillery Ammunition	3 Hours

Lesson 4	Fuzes, Boosters, Bursters, and Primers	1 Hour
Lesson 5	Mines and Grenades	2 Hours
Lesson 6	Military Pyrotechnics	1 Hour
Lesson 7	Bombs and Bomb Fuzes	3 Hours
Lesson 8	Rockets and Guided Missiles	4 Hours
Lesson 9	Demolition Materials	3 Hours
Examination		2 Hours

LESSON 1. MILITARY EXPLOSIVES

MMS Subcourse No 621	Ammunition Materiel
Lesson Objective	To give the student a general knowledge of the history, use, types, characteristics, identification, classification and packing and marking of military explosives.
Credit Hours	Two

TEXT

1. INTRODUCTION

a. Military explosives are essential elements of ammunition. Personnel engaged in the handling and storage of ammunition do not always have the knowledge of explosives that their importance requires. Personnel responsible for ammunition handling and storage should have a general knowledge of explosives to understand the potentially destructive characteristics of ammunition.

b. When you know the type of material being handled you will exercise safety precautions consistent with handling material of that type. In addition, you should have a knowledge of the history, classification and uses of military explosives. This lesson will provide you with a knowledge of explosives which will enable you to assume responsibilities and perform duties with more confidence, efficiency and safety mindedness.

2. DEFINITIONS

a. Explosive

(1) An explosion, a violent bursting or expansion as a result of great pressure, may be caused by an explosive or the sudden release of pressure, as in the bursting of a steam boiler. An explosive produces an explosion because of the very rapid change of the material into more stable substances; always with the liberation of heat and almost always with the formation of gas.

(2) An explosive may be a chemical compound such as trinitrotoluene (TNT) or nitroglycerin, a mixture of compounds such as TNT and ammonium nitrate to form amatol, or a mixture of one or more elements such as potassium nitrate, sulfur, and carbon to form black powder.

(3) An explosive may be solid, liquid, or gaseous. Military explosives are mainly solids or mixtures prepared so as to be solid at normal temperature of use.

(4) The rates of change of explosives, upon initiation, have been found to vary greatly. One group which includes black and smokeless powders, undergoes combustion at rates that vary from a few centimeters per minute to approximately 400 meters per second. These are known as low explosives. A second group, which includes TNT and nitroglycerin, has been found to undergo detonation velocities from 1000 to 8500 meters per second. Such materials are known as high explosives.

b. Propellant. A propellant is an explosive that is suitable for effecting the controlled propulsion of a solid body such as a projectile or a rocket. As rupture of the weapon must not take place and as flight of the projectile or rocket must be controlled closely with respect to range as well as direction, the explosive process must be subject to correspondingly close control. Because of these requirements, only few low explosives have been found suitable for use as propellants. Many propellants, because of certain ingredients, can be caused to undergo detonation as well as combustion, but acceleration to a point where detonation takes place must be prevented. This is accomplished by control of the size and the form of each grain of propellant.

3. HISTORY OF EXPLOSIVES AND PROPELLANTS.

a. Black powder has been known to the western world for an uncertain number of centuries having its probable origin in the addition of potassium nitrate to form Greek fire. It was not until the middle of the 13th century that Bacon described the material which until that time had been used for pyrotechnic, incendiary and demolition effects only. Early in the 14th century Schwarz is credited with having invented a gun and using black powder to propel stones from it. This discovery of the usefulness to accomplish mechanical work may be considered the real beginning of the history of explosives. For the next 500 years black powder was the universal explosive. It was not until 1425 that the granulation of black powder was accomplished and 1525 that the control of grain size by screening was reported by the French. Black powder, despite other developments was used as a major military explosive throughout most of the 19th century.

b. The modern era of the history of explosives began in 1838 with the preparation of nitrocellulose by Pelouze by nitrating paper. In 1846 Schonbein and Bottger independently discovered its explosive properties. In 1846 or 1847 Sobrero prepared nitroglycerin and described its explosive properties. Disastrous explosions retarded the development of nitrocellulose for a number of years and the possibility of using nitroglycerin as an explosive attracted very little attention for some time after its discovery.

c. In 1836 Nobel began the commercial production of nitroglycerin, and in 1864 Schultze made the first successful smokeless powder. In 1865 Abel purified nitrocellulose to make a stable material. Nobel invented dynamite and the mercury fulminate blasting cap in 1867. Simultaneously, Ohlsson and Norrbin discovered the usefulness of ammonium nitrate in what was essentially a dynamite. In 1868 E. A. Brown discovered that dry compressed guncotton could be detonated by means of blasting cap. Shortly afterwards he found that wet guncotton could be detonated by the explosion of a small quantity of dry guncotton. This established the principle of the booster charge. In 1875 Nobel invented the nitroglycerin- nitrocellulose mixtures known as blasting gelatin and gelatin dynamite. In 1886 Turpin patented the use of picric acid as a bursting charge for shell, and it was used by the French under the name of melinite.

d. Up to this time, the development of explosives had been chiefly in the direction of blasting explosives, and black powder remained the major military propellant. Schultze and E C powders were used in shotgun ammunition but were unsatisfactory because of too great a rate of burning. During this period Vieille invented Poudre B, the first smokeless powder suitable for use in rifled guns and this was adopted immediately for use by the French Army and Navy. In 1888 Nobel invented the double-base propellant powder ballistite. In the following year Kellner and Abel developed the propellant used by the British under the name of cordite. In the Spanish-American

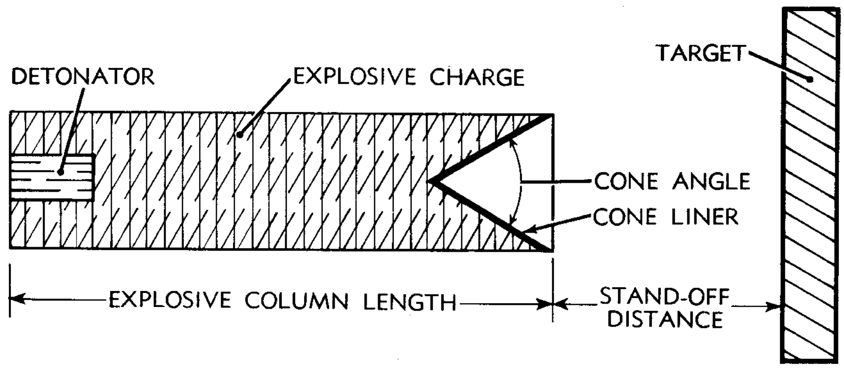

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Figure 1-1. Shaped charge and target.

War, the United States forces still used black powder as a propellant for artillery, although the U. S. Navy Powder Factory at Indian Head, Maryland had started at the period to manufacture single-based powder. The Army, however, was slower to accept it and did not start manufacture of it until about 1900. In 1909 the use of centralite as a stabilizer was introduced in Germany and ammonium picrate was standardized in the United States as a bursting charge for armor-piercing shell.

e. The use of picric acid as a bursting charge for shell was considered unduly hazardous and soon it began to be replaced by TNT, first by Germany and then by others. TNT was officially adopted in 1912 as a standard bursting charge for HE shell for the mobile artillery of the U. S. Army. World War I saw the introduction of lead azide as an initiator by the Germans, the use of amatols as substitutes for TNT by all warring nations, and the introduction of tetryl as a booster explosive for shell charges.

f. During the next two decades, RDX, PETN, lead styphnate, DEGN and lead azide were developed as military explosives. The development in the United States of processes for producing toluene from petroleum removed limitations on the availability of TNT and permitted the development of the powerful and castable composition B and pentolite. Flashless propellants were developed in the United States and low-erosion DEGN propellants were developed in Germany and Italy.

g. World War II saw the development of rocket propellants. Haleite, a new explosive, was developed in the United States as were tetrytol and picratol, special purpose explosives used in demolition work and in semi-armor-piercing bombs, respectively. A number of plastic explosives were developed in Great Britain and the United States, the most important being the C-3 composition based on RDX. The discovery and great value of the blast effect of explosives led to the development of tritonal, torpex and minol, which contain powdered aluminum and have powerful blast effects, Finally, the application of the shaped charge principle (figure 1-1) resulted in the use of special explosives of the pentolite or composition B type.

h. The expanding techniques of modern warfare led to more and more specialized requirements for explosives and propellants. Future developments may be expected to take the direction chiefly of mixtures of currently known explosives and other materials. But in some cases, the requirements can be satisfied only by new and more powerful explosives, which presently are being sought.

4. CHARACTERISTICS OF MILITARY EXPLOSIVES AND PROPELLANTS

a. High Explosives

(1) General. During the past 100 years, many explosives have been studied for possible suitability for military use, yet less than a score have been found acceptable for such use and some of these have certain characteristics that are considered to be serious disadvantages. Required military characteristics are such that but few explosives can meet most of them and be acceptable for standardization.

(2) Availability and cost. In view of the enormous quantity demands of modern warfare, explosives must be produced from cheap raw materials that are nonstrategic and available in great quantity. In addition, manufacturing operations must be reasonably simple, cheap, and safe.

(3) Sensitivity. All explosives are sensitive to some degree, but can be too sensitive for handling and use or too insensitive for use. It may be considered that the present standard explosives represent a range of sensitivity within which a new explosive must fall.

(4) Brisance and power. A military explosive must have shattering effect (brisance) and potential energy that make it comparable with or superior to other high explosives used as bursting charges; or it must have the ability to initiate the detonation of other explosives and be sensitive enough itself to be initiated by practicable means such as percussion, friction, flame, or electric current.

(5) Stability. In view of the long periods of storage to which they are subjected during peace and because of the adverse conditions of storage to which they may be exposed, military explosives must be as stable as possible. Global warfare has increased the variety of adverse conditions to which ammunition is exposed and this has resulted in an increase in the requirements designed to prevent the harmful chemical and physical effects of such adverse conditions.

(6) Density. Loading density is an important characteristic of a military explosive, a maximum density being desirable because of the fixed volume of the space available for explosives in a round of ammunition. The greater the loading density at which a fixed weight of a given explosive is pressed or cast, the greater is its effect when detonated. However, the standard explosives having the greatest density values, mercury fulminate and lead azide, are not the most powerful standard explosives, and the selection of an explosive for a specific use cannot be based primarily upon its density.

(7) Hygroscopicity. Hygroscopicity, the property of absorbing moisture, can have an adverse effect on the sensitivity, stability, or reactivity of some explosives and must be negligible, if the explosive is to be considered satisfactory for military use. An exception is the very hygroscopic ammonium nitrate, which can be used in the manufacture of amatols, if kept under conditions that preclude the absorption of moisture.

(8) Volatility. Volatility (pass off in vapor) of military explosives is an undesirable characteristic, and they must not be more than very slightly volatile at the temperature at which they are loaded or at their highest storage temperature. Loss by evaporation, the development of pressure in rounds of ammunition, and separation of constituents of mixtures are sometimes the result of undue volatility.

(9) Reactivity and compatibility. Minimum reactivity and consequent maximum compatibility with other explosives and nonexplosive materials are necessary properties of a military explosive. As the explosive must be loaded in contact with metal or coated metal and may be mixed with the other ingredients of a propellant, the explosive must be non-reactive therewith. Reaction, particularly in the presence of moisture, may produce sensitive metallic salts, cause deterioration and loss of power or sensitivity, or may result in the liberation of gaseous products of reaction. Compatibility is particularly important, if the explosive is to be mixed with liquid TNT to make an explosive mixture suitable for loading by casting.

(10) Toxicity. Many explosives, because of their chemical structures, are somewhat toxic. To be acceptable, a military explosive must be of minimum toxicity. Careful attention must be paid to this feature, because the effects of toxicity may vary from a mild dermatitis or a headache to serious damage to internal organs.

b. Propellants

(1) Availability and cost. Like high explosives, military propellants must be manufactured from relatively cheap, nonstrategic materials that are available in large quantity. While nitrocellulose is not considered entirely satisfactory because of some inherent instability, it has retained its position as a general ingredient of propellants, because of the nonavailability in quantity of a more stable material having the same advantageous characteristics.

(2) Sensitivity. Military propellants, as used, are not unduly sensitive to shock or friction. They must be sufficiently sensitive to ignition by flame that initiation may be positive and burning uniform.

(3) Stability. Stability is even more important in the case of propellants than high explosives, since practically all propellants contain nitrocellulose, which is less stable, particularly in the presence of moisture, than any of the standard high explosives, except mercury fulminate. In order to insure the maximum stability of a given propellant composition, a stabilizer is included.

(4) Potential. The ballistic effect of a propellant, sometimes termed its ballistic potential, is an important characteristic for which it is designed. The ballistic effect is a function of the absolute value of the quantity of heat produced and the absolute value of the quantity of gas produced.

(5) Density. Absolute density is seldom critical in small arms and artillery propellants, since they are seldom used at maximum density. However, this characteristic sometimes is of importance in propellants used for jet propulsion.

(6) Hygroscopicity. As nitrocellulose is distinctly hygroscopic, propellant compositions containing this material tend to be hygroscopic. This is an undesirable characteristic, since changes in moisture content cause changes in ballistic effect. Furthermore, the rate of deterioration of a propellant is proportional to the amount of moisture it contains.

(7) Volatility. Unduly volatile ingredients are not used in the manufacture of propellant compositions, but when propellants are manufactured by a volatile solvent process, the solvent can not be removed completely by drying. This residue of volatile matter is an undesirable feature of the propellant and must be kept constant, if ballistic effects are to remain unchanged. Compositions containing nitroglycerin and made without a volatile solvent are considered to be undesirably volatile under certain conditions. In such cases, the effects on the rate of burning and its acceleration are very marked.

5. CLASSIFICATION OF MILITARY EXPLOSIVES AND PROPELLANTS.

a. From the viewpoint of functioning characteristics as used, explosives and propellants are classified as follows:

(1) Burning explosives, which undergo combustion, such as black powder, pyrotechnic compositions and colloided nitrocellulose.

(2) High explosives which undergo detonation.

(a) Initiating explosives, detonated by spark, friction or impact, can initiate the detonation of relatively insensitive explosives. Examples are lead azide and mercury fulminate.

(b) Noninitiating explosives that must be detonated by an initiating explosive. These are comprised as described below:

1. Booster explosives, such as tetryl and PETN, that are easily initiated and detonate at high rates, but are not suitable for loading in large masses.

2. Bursting charge explosives, such as TNT and explosive D, that must be initiated, usually by means of a booster explosive, and which can be loaded en masse.

3. Substances that can be used only as ingredients of mixtures. These include explosives that are too sensitive to be used alone, such as nitroglycerin, and substances which are too insensitive to explode when used alone, such as ammonium nitrate.

b. It is by utilizing the special characteristics of explosive in each of these classes that it is practicable to establish the explosive train in ammunition.

6. PRECAUTIONS IN HANDLING

a. Although explosives are considered hazardous materials, they can be handled and transported with safety provided personnel, engaged in such activities, are trained in accordance with stringent safety regulations.

b. In addition to the explosive hazard, explosives also represent varying degrees of toxicity hazard when enhaled, ingested or absorbed through the skin. Because of this and the fact that dust-air mixtures present additional explosion hazard, explosives should be handled under conditions of good ventilation so that dust-air mixtures cannot be formed. Prevention of the spark discharge of static charges of electricity should also be insured by proper grounding devices.

c. The inhalation of vapors of nitroglycerin or the nitrated glycols can cause severe headache, and some individuals are sensitive to very small amounts of such materials. The inhalation of the dusts or vapors of nitro compounds such as TNT and picric acid has been known to have fatal effects. Accordingly, if practicable, explosives should always be handled in well ventilated places.

d. Effects of contact of the skin with explosives vary from simple discoloration to dermatitis and from headache to poisoning, because of absorption through the skin. The hands should be dry when handling explosives, as moisture increases the absorption through the skin. After handling small quantities of explosives, the hands should be washed thoroughly, preferably with a dilute solution of sodium sulfite and then with water. If exposed to contact with explosives throughout the day, the worker should bathe and change clothes.

e. Since they represent explosion hazards because of their characteristic of sensitivity, explosives must be handled with care proportional to their relative sensitivity. For this reason, the degree of sensitivity of a new or unknown explosive should be determined before anything else is done with it. The outcome of sensitivity tests will determine in what quantity and under what conditions the material should be handled. The more sensitive the explosive, the smaller the quantity that should be handled at one time and the greater the precautions to be taken to prevent injury and damage in case of accidental explosion. It should be borne in mind that sensitivity is a characteristic involving initiation by any form of applied energy, regardless of whether by friction, compression, shock, mechanical, thermal, chemical, or electrical sources.

f. Because of the very real danger from fragments, the more sensitive explosives should not be handled in glass vessels when dry and only behind a barricade when this is necessary. Metal vessels are dangerous, if the explosive can react with the metal to form a sensitive compound. Metal spatulas, scoops, etc, should not be used for handling explosives, rubber articles being preferable.

g. The nervous reaction of the individual working with explosives is of great importance. The extremely nervous individual is not compatible with sensitive explosives, nor is the hurried worker. You, as an ammunition storage supervisor, should always be on the alert to detect unsafe working conditions, careless work practices or unsafe acts on the part of personnel under your supervision which could result in accidents. When such conditions are found, immediate corrective action should be taken.

7. **BLACK POWDER.** General. Black powder is the name originally applied to a mixture of charcoal, sulfur, and potassium nitrate and now applied also to a compositions containing bituminous coal instead of charcoal, and sodium nitrate instead of potassium nitrate. In appearance it varies from a black, very fine powder to dense pellets which may be black or have a grayish-black color because of a graphite-glazed surface. While no longer used as a military propellant, black powder is used in the ignition of smokeless powder, time fuzes, saluting charges, squibs, smoke puff charges, and catapult charges. Other uses are in igniters of rocket and missile propulsion units by means of black powder and black powder compositions used in rockets, jatos, missile boosters, and sustainer motors.

8. **INITIATING EXPLOSIVES.**

a. General. Initiating explosives are high explosives used in military ammunition and include priming compositions and initial detonating explosives.

b. Priming compositions are physical mixtures of materials that are very sensitive to impact or percussion and, when so exploded, undergo very rapid combustion. Priming compositions are used for the ignition of black powder igniter charges, propellants in small arms and artillery ammunition.

c. Initial detonating explosives are high explosives that are so sensitive to heat, impact or friction that they undergo detonation when subjected to flame or percussion. They are used to initiate detonation of the less sensitive high explosives comprising booster charges, demolition high explosives and dynamites. Most initial detonating explosives have distinctly lower rates of detonation and brisance values than those of the explosives they are used to initiate. Examples of initial detonating explosives are lead azide, mercury fulminate, diazodinitrophenol (DDNP), lead styphnate, and tetracene.

d. Most military priming compositions consist of mixtures of one or more initial detonating agents with oxidizing agents, fuels, sensitizers, and binding agents.

9. NONINITIATING HIGH EXPLOSIVES.

a. Noninitiating high explosives comprise explosives that require initiation to detonation by another explosive and are used as booster and bursting charges and for blasting and demolition purposes. They may be divided into the following types:

(1) Single compound - include compounds with ammonium as the only important inorganic high explosive.

(2) Binary explosives - consist of mixtures of TNT with another explosive. For example: Tetrytol is a mixture of TNT and TETRYL.

(3) Plastic explosives - consist of a highly brisant explosive, such as RDX, and a binding agent that forms a putty-like mass.

(4) Dynamites - blasting explosives made of nitroglycerin absorbed in a porous material. This is known as straight dynamite. A blasting explosive that contains RDX and TNT is known as military dynamite.

b. Examples of noninitiating high explosives are:

(1) Ammonium nitrate - white

(2) Nitroglycerin - colorless liquid

(3) Nitrocellulose - light green

(4) PETN - white or light buff

(5) Nitrostarch - gray

(6) TNT - light yellow to buff

(7) Tetryl - light yellow

(8) Picric acid - white to yellow

(9) Explosive D - yellow to orange

(10)Nitroguanidine - white

(11)Halite - white to buff

(12)RDX - white

(13)HMX - white

(14)Amatol - yellow to brown

(15)Ammonal - gray

(16)Tritonal - silver

(17)Pentolite - light buff

(18)Tetrytol - yellow

(19)Picratol - brown yellow

(20)Ednatol - yellow

(21)Composition B - yellow brown

(22)Torpex - silver white

(23)Composition A-3 - white to buff

(24)Composition C-3 - reddish yellow

(25)Composition C-4 - dirty white

(26)Dynamite - buff

(27)Octol - pale yellow to brown

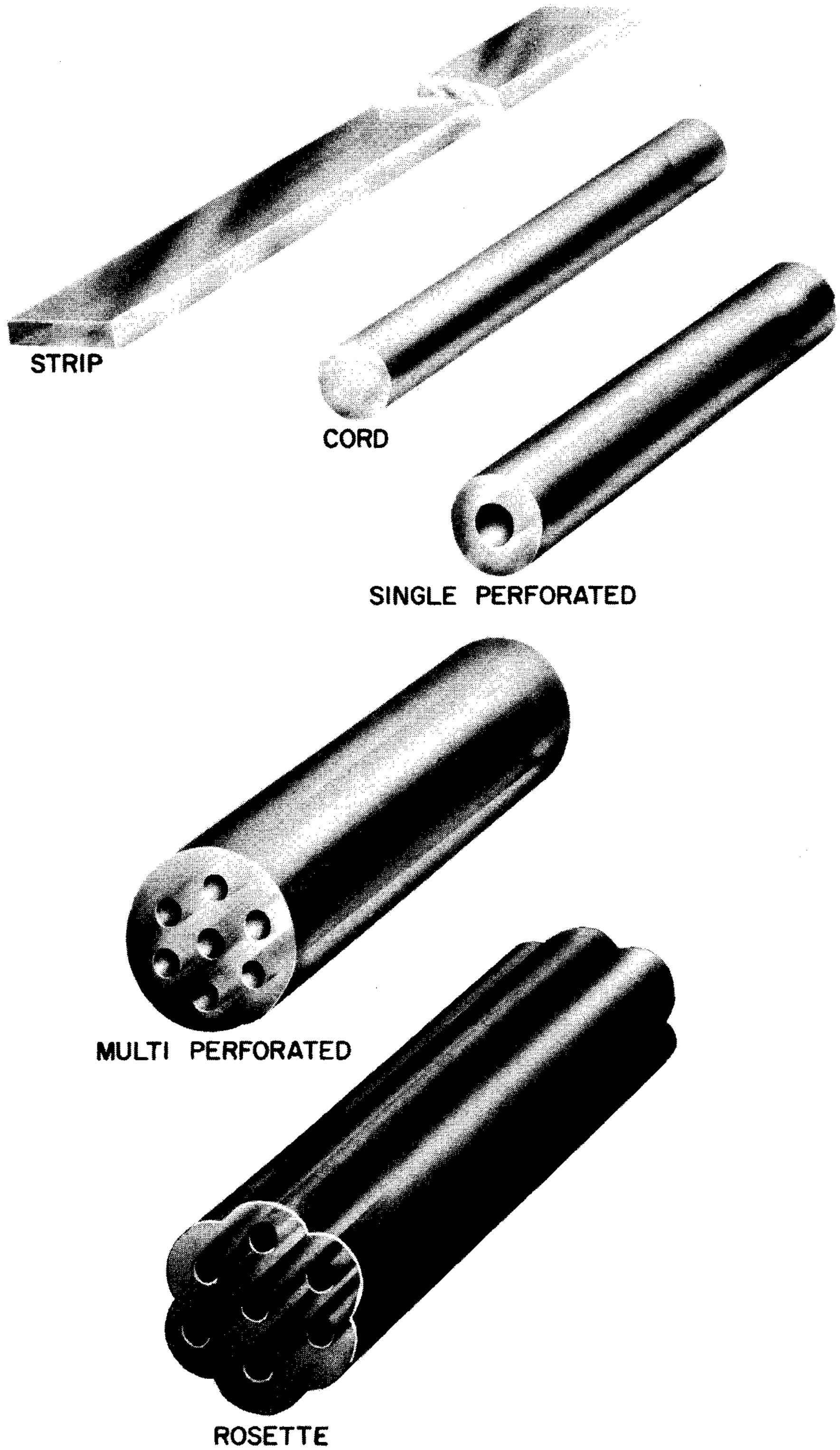

Figure 1-2. Forms of propellant grains

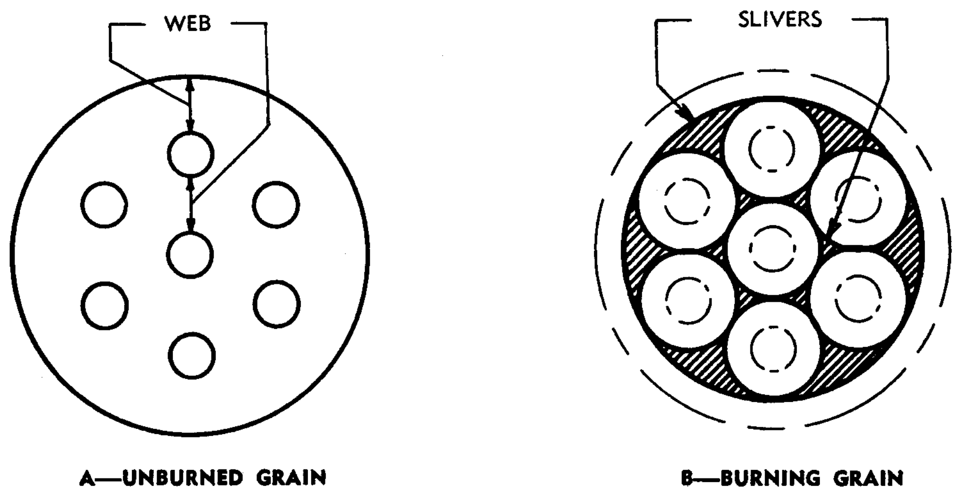

Figure 1-3 - Webs and Slivers of Propellant Grains.

10. PROPELLANTS

a. Propellant compositions, generally referred to as smokeless powders, invariably contain nitrocellulose. As these propellants are not used in the form of powder and liberate varying amounts of smoke when burned, the term is a misnomer.

b. From the viewpoint of compositions, modern propellants are divided into four classes:

(1) Single-base propellant includes compositions that are principally gelatinized nitrocellulose and contain no high explosive ingredient such as nitroglycerin.

(2) Double-base propellant includes compositions that are predominately nitrocellulose and nitroglycerin.

(3) Triple-base propellant includes compositions which consist of some nitrocellulose and nitroglycerin and are principally nitroguanidine.

(4) Composite propellant includes compositions that do not contain significant amounts of nitroglycerin or nitrocellulose and are mechanical mixtures of a fuel with an oxidant.

c. Single base propellants are used in artillery and small arms ammunition. Double base propellants are used in artillery, small arms, mortars, rocket assemblies and jet propulsion units. Composite propellants are used in rocket assemblies and jet propulsion units. As a given propellant may be suitable for use in several different applications, it is not practicable to classify propellants on the basis of use.

d. Numerous forms of powder grains have been utilized, the most important of which are shown in figure 1-2. The most important dimension of these grains is the web thickness or minimum distance between any two adjacent surfaces of the grain. (figure 1-3). As propellant grains burn, the burning surface decreases continuously until the grain is consumed. Propellant grains are said to burn progressively, degressively, or neutral depending on type and number of perforations. Figure 1-4 illustrates these burning characteristics.

e. The wide variety of weapons requires that powder grains be used with a wide variation in size as well as form. Figure 1-5 shows the relative grain sizes used in artillery weapons. Grains used in rockets are larger than those for artillery. Forms of rocket propellants are shown in figure 1-6.

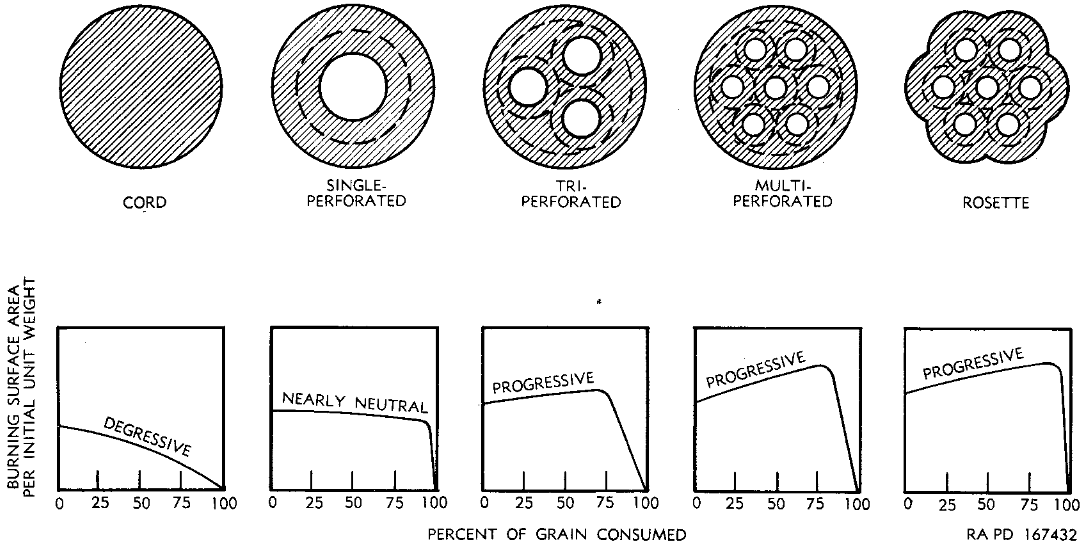

Figure 1-4 Burning of Grains of Propellant.

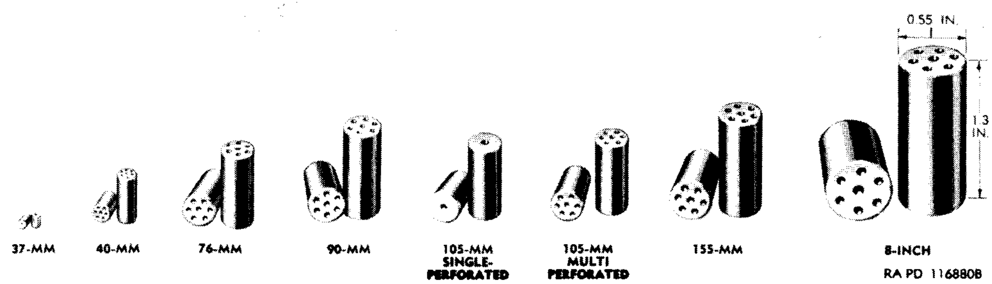

Figure 1-5 Relative Grain Sizes of Propellants

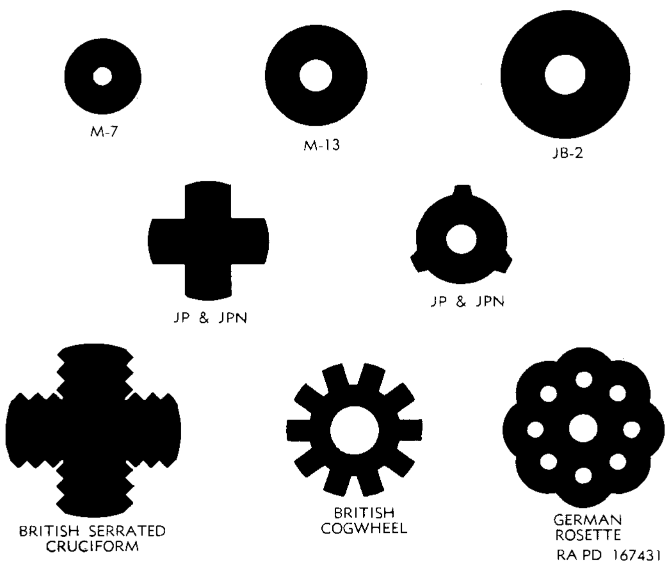

Figure 1-6 Forms of rocket propellants.

11. PYROTECHNIC, SMOKE TRACER AND INCENDIARY COMPOSITIONS

a. Pyrotechnic compositions are low-explosives. They produce considerable light, heat, smoke and sound. Therefore, tracer, smoke, delay fuze powder, igniter and incendiary compositions could well be considered pyrotechnics.

b. Important functioning characteristics of a pyrotechnic compositions are:

(1) luminous intensity

(2) burning rate

(3) color

(4) color value

(5) efficiency in light production

(6) sensitivity

(7) ignitibility

(8) stability

(9) hygroscopicity

c. Smoke compositions are mixtures of materials that undergo combustion with a marked amount of smoke but no visible light. They are used for signalling and screening.

d. Tracer compositions are used for both small arms and artillery ammunition in determining range and directing fire.

e. Delay compositions are used in delay elements and provide the predetermined time delay between the initiation and the ultimate detonation of the main charge.

f. Simulator compositions are used in a variety of pyrotechnic devices designed to simulate the effect produced by service items of ammunition typical of which are the following:

(1) Air burst simulators - simulate an artillery burst by producing a puff of white smoke.

(2) Boobytrap simulators - function with a loud report and flash to teach troops a proper respect for real boobytraps.

(3) Ground burst simulators - provide battle noises and effects during troop maneuvers producing a whistle, a flash and a loud report.

(4) Gun flash simulator - provides a flash resembling that of the 90mm gun and the 155mm howitzer.

(5) Hand grenade simulator - provides battle noises and effects during troop maneuvers. It is thrown like a hand grenade and produces a flash and a loud report.

g. Incendiary compositions - loaded in projectiles, bullets and bombs are used to start fires.

12. PACKING AND MARKING.

a. General.

(1) The wide range in the sensitivity, stability, and hygroscopicity characteristics of explosives and propellants has required the development of appropriately varied types of packing. The sensitivity of initiating explosives to shock and friction, that of black powder to spark and flame, the decreased stability of some propellants in the presence of moisture, and the hygoscopicity of many propellants and black powder have necessitated such extremes as packing in a wet condition and the use of airtight containers that must withstand a prescribed internal pressure. On the other hand the nonhygroscopicity and relative insensitivity of some high explosives permit the use of cartons which are collapsible and can be reused when these explosives are packed for interplant shipment or short term storage.

(2) Bulk priming, pyrotechnic, smoke, tracer, and incendiary compositions are not subjected to shipment or storage, being manufactured and loaded at the same plant. Special packing containers, therefore, are not prescribed for these compositions.

(3) The marking of containers for explosives and propellants is prescribed by drawings and U. S. Army and U. S. Navy general specifications and comply with regulations of the Department of Transportation (formerly ICC Reg), Tariff No. 23 The name of the material, lot number, manufacturer's initials or symbol, contract number, date of manufacture, gross weight, cubical displacement, and the dangerous commodity designation required by the Department of Transportation regulations are the most general markings. Markings may also include grade and/or class, plant where manufactured, and a box number. Initiating explosives are marked to indicate their nature and a prohibition against storing or loading with other explosives.

b. Initiating explosives

(1) Initiating explosives, because of their sensitivity to shock and friction, necessitates that these be packed in a wet condition. Because of the low solubility of lead azide, mercury fulminate, diazodinitrophenol, and lead styphnate, water can be used as the wetting agent. However, if shipment or storage under low temperature conditions is anticipated, a mixture of equal weights of water and ethanol is permitted.

(2) Approximately 25 pounds of the explosive, wet with not less than 20 percent of liquid, is placed in a duck or rubberized cloth bag and covered with a cap of the same material. The bag is tied securely so as to prevent leakage. Not more than six such bags are placed in a larger bag of the same material. The larger bag is tied securely and placed in the center of a watertight metal or wooden barrel, drum or keg lined with a heavy, close fitting, jute bag. The large bag containing the explosive is surrounded with well-packed sawdust that has been saturated with water or water-ethanol mixture. The bag forming a liner is closed by sewing before the barrel, drum or keg is closed. Not more than 150 pounds (dry weight) of explosive is permitted in a single container.

c. Noninitiating explosives

(1) Nitroglycerin, as such, may not be shipped by freight or express and almost invariably is manufactured at the plant where it is to be used.

(2) Nitrocellulose, because of its sensitivity to spark, is wet with at least 20 percent of water and packed in watertight drums.

(3) Because of sensitivity to shock, RDX and PETN are wet with water or ethanol-water

mixture, so that the paste or slurry contains not less than 40 percent of liquid. This paste or slurry is placed in duck, rubber, or rubberized cloth bags holding not more than 50 pounds (dry weight) of explosive. These bags are placed in the larger bag of the same material. The small bags are surrounded with water and the large bag is closed securely. This bag is then placed in a watertight barrel, keg or drum. The dry weight of explosive in one container must not exceed 300 pounds.

(4) Ammonium nitrate, because of its great hygroscopicity, is packed in moistureproof metal drums or paper bags. The metal drums are lined with paper and may be of the single-trip type. Single-trip drums and burlap-covered paper bags for packing ammonium nitrate have a maximum capacity of 100 pounds.

(5) TNT, tetryl, explosive D, picric acid, haleite and nitroguanidine are almost nonhygroscopic. For lengthy storage or oversea shipment, they are packed in wooden boxes lined with waterproof paper and holding 50 or 100 pounds of explosive (figure 1-7). For interplant shipment or temporary storage, such explosives can be packed in fiber cartons which are lined with a waterproof bag and hold approximately 50 pounds of explosive (figure 1-8). Such cartons are **collapsible and can be reused, the paper bag being destroyed after emptying.**

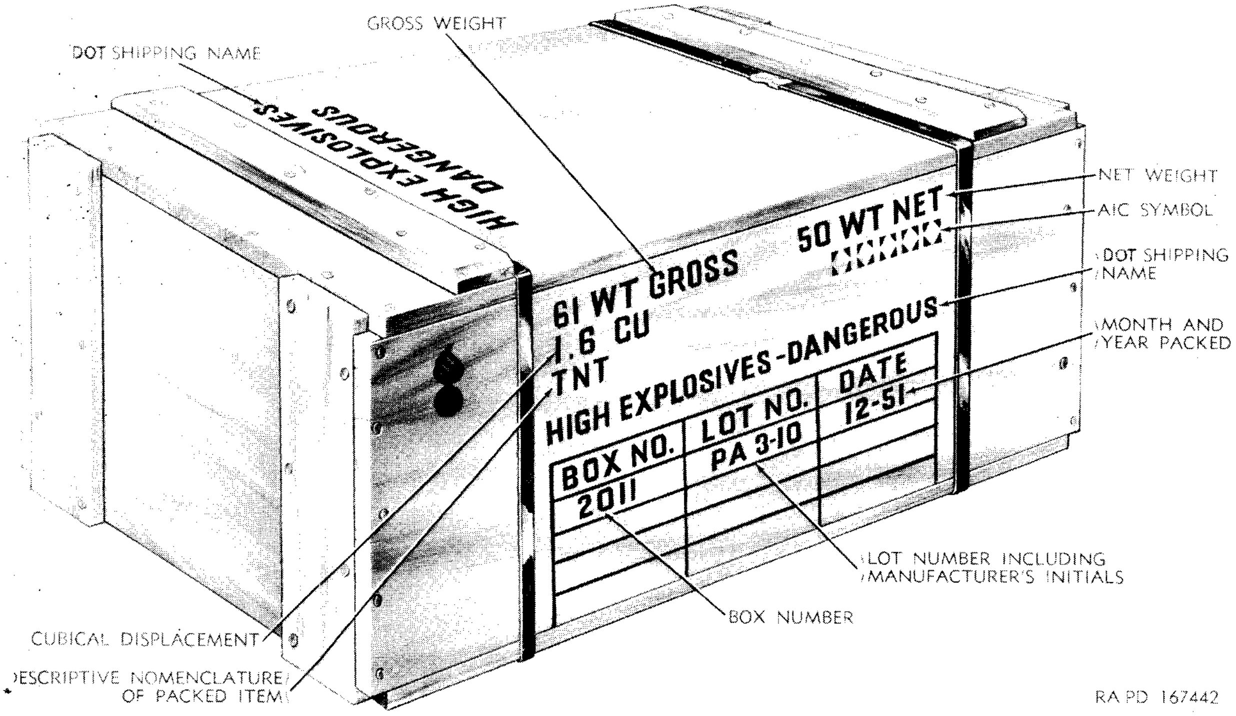

Figure 1-7. Wooden Box for Packing High Explosives

(6) Explosives such as amatol, tetrytol, picratol, torpex, and tritonal generally are manufactured at the loading plants where they are to be used and are not subjected to packing. Composition C-3, when shipped in bulk, is packed in wooden boxes holding 58 pounds and lined with oilproof and moistureproof paper bags.

(7) Military dynamites and demolition explosives such as the C-3 composition, like their commercial counterparts, are wrapped in moisture proof paper in 1 pound sticks or blocks; and these are packed in paperlined boxes holding 50 pounds of explosive. The paper used for packaging and packing generally is required to be oilproof as well as moistureproof.

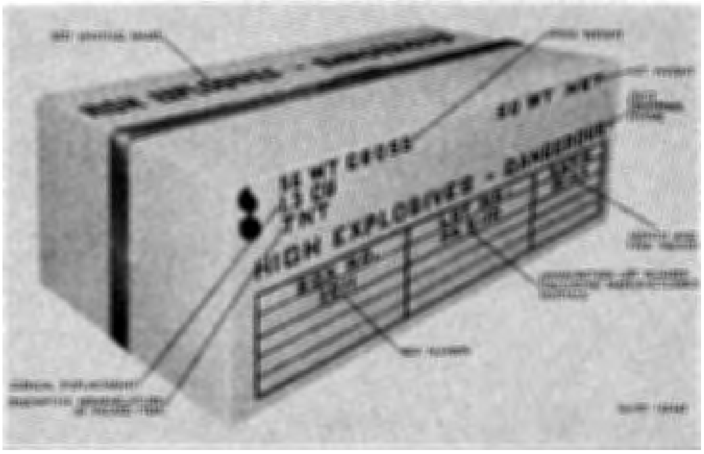

Figure 1-8. Fibercarton for Packing High Explosives

d. Black powder. Because of its extreme sensitivity to spark and its great hygroscopicity, black powder is packed in airtight steel drums, which hold 25 pounds of powder. These, sometimes, have small, slide-type gasketed closures.

e. Propellants. The hygroscopicity of nitrocellulose propellants in general and the adverse effect of moisture absorption on stability and ballistic value render necessary the packing of propellants in airtight containers. Copper-lined wooden boxes, tested for resistance to air pressure of 5 psi, were used formerly for all types of propellants and are still standard (figure 1-9). These vary in size, holding as much as 150 pounds of powder. More recently, there have been standardized

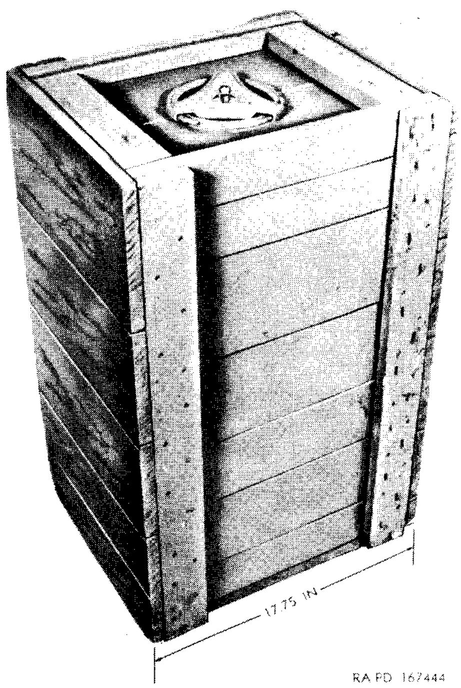

Figure 1-9. Wooden Box for Packing Propellant

containers of stainless steel with a bonded outer layer of plywood and containers made of heavier, galvanized steel (figure 1-10).

Containers for propellants have relatively large, rubber-gasketed closures of the clamping type, with pressure applied by means of a screw. It has been found that propellants stored in such containers do not undergo change in moisture content even under the adverse conditions of tropical storage.

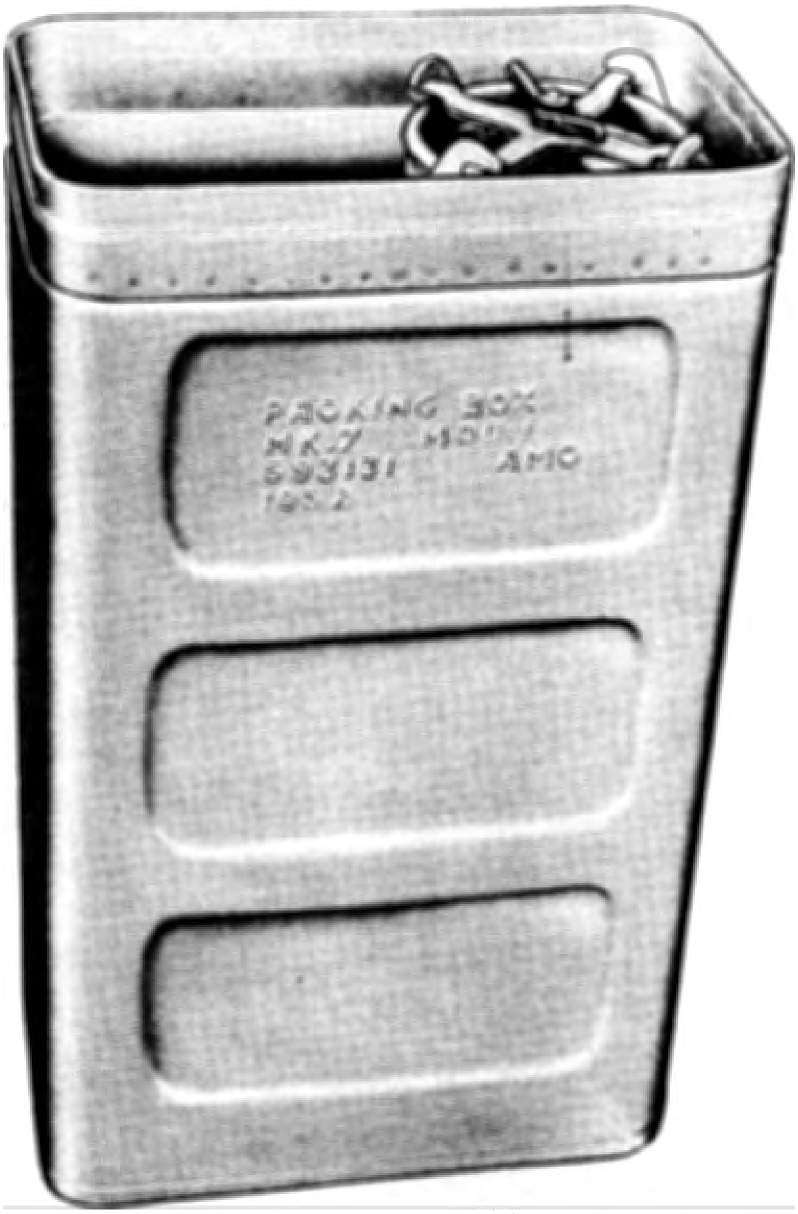

Figure 1-10. Steel Box for Packing Propellant

SUMMARY. The lesson you have just completed has provided a comprehensive coverage of military explosives to include history, use, types, characteristics, identification, classification and packing and marking. You are encouraged to use the knowledge gained to advantage, while performing your duties involving ammunition and explosives operations. In addition, it is recommended that you review this lesson at frequent intervals to refresh your memory in the various areas covered. To do so will improve your effectiveness as an ammunition storage supervisor.

EXERCISES FOR LESSON 1

1. Which is a low explosive?

   A. RDX
   B. Amatol
   C. Black Powder
   D. Dynamite

2. Which explosive must be packed in a wet condition?

   A. Initiating
   B. Bursting Charge
   C. Propellant
   D. Noninitiating

3. In what year was dynamite invented?

   A. 1846
   B. 1863
   C. 1886
   D. 1867

4. Which explosive is used in the ignition of propelling charges?

   A. Torpex
   B. Black Powder
   C. Picric Acid
   D. Tetryl

5. What is the most important dimension of a propellant grain?

   A. Width
   B. Length
   C. Diameter
   D. Web Thickness

6. Which composition upon combustion produces no visible light?

   A. Simulator
   B Smoke
   C. Incendiary
   D. Tracer

7. What is the first action that should be taken before handling a new or unknown explosive?

   A. Write an SOP
   B. Train Personnel
   C. Determine degree of sensitivity
   D. Request handling equipment

8. Which characteristic of a high explosive may cause serious damage to internal organs?

   A. Toxicity
   B. Hygroscopicity
   C. Volatility
   D. Stability

9. Which explosive is usually detonated by a booster explosive?

   A. Lead azide
   B. Tetryl
   C. TNT
   D. Black Powder

10. Which is an example of an initial detonating explosive?

   A. Amatol
   B. Lead Azide
   C. PETN
   D. Composition B

11. Which propellant grain burns degressively?

   A. Rosette
   B. Single-Perforated
   C. Multi-Perforated
   D. Cord

12. What is the distinguishing color of composition B?

   A. Silver White
   B. Yellow Brown
   C. Gray
   D. Colorless

13. What type of scoop should be used when required to handle sensitive explosives?

   A. Steel
   B. Iron
   C. Tin
   D. Rubber

14. A mixture of what two explosives forms amatol?

   A. Pricratol and nitrostarch
   B. Ammonal and picric acid
   C. TNT and ammonium nitrate
   D. Ammonal and tetryl

15. What is the composition of a double base propellant?

   A. Black powder and lead azide
   B. Nitrocellulose and nitroglycerin
   C. Nitrocellulose and ballistite
   D. Cordite and potassium nitrate

LESSON 2. SMALL ARMS AMMUNITION

MMS Subcourse No 621	Ammunition Materiel
Lesson Objective	To give the student a general knowledge of the types, identification, characteristics, and color code of small arms ammunition.
Credit Hours	One

TEXT

1. INTRODUCTION.

a. This lesson is intended for instruction and distribution of such general and technical information concerning small arms ammunition (through 30mm) as may be necessary for proper care, handling and use. The information in this lesson is applicable to all members of the armed forces and especially to supervisory personnel since this type ammunition is in his area of responsibility. A knowledge of small arms ammunition is essential for maximum efficiency and safety in all areas of responsibility of the ammunition storage supervisor.

b. General.

(1) This type of ammunition consists of cartridges of various types and sizes used in rifles (except recoilless type), carbines, revolvers, machine guns, submachineguns and shotguns. Small arms cartridges are similar in general shape and construction. They may be identified as to caliber, model and type by their size, shape, color (table 2-1) and by marking on packing boxes and cartons. In most types of small arms ammunition, a cartridge (figure 2-1) consists of a cartridge case, primer, propellant and bullet. A shotgun cartridge differs in that it contains shot, pellets, flechettes or a single slug in a metal or paper body. Cartridge cases are composed of brass (brass and copper or gilding metal) or steel and have 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. The cartridge case also expands and seals the weapon chamber against the escape of gases to the rear when the weapon is fired. This process of sealing by expansion is known as obturation.

NOTE: Small arms ammunition is no longer graded in accordance with TB 9 AMM4 which has been rescinded and is superseded by SB 700-1300-1 which assigns functional condition codes. For example, lots formerly assigned grade R, R and AC are to be converted to functional code A unless otherwise restricted or suspended. All current production of small arms ammunition should be assigned functional code A.

(2) Bullet. Bullets for service use have a metal core, slug or steel container covered by an outside jacket of gilding-metal or gilding-metal-clad steel, which makes possible higher velocities as compared to lead bullets. Ball and tracer cartridges have a lead alloy or common steel core. Armor piercing bullets have a hardened steel alloy core which may be made of tungsten-chromium or manganese-molybdenum steel. A cannelure may be cut or rolled into the jacket to provide a recess into which the mouth of the cartridge case is crimped at assembly and also serves to hold the jacket and core together more firmly. An extra cannelure may be added to identify the bullets prior to assembly (e.g. Caliber .50, incendiary M1 and M23, (figure 2-4).

(3) Primer. The primer assembly of center fire cartridges consist of a brass or gilding metal cup that contains a primer composition pellet of initiating explosive, a paper disk (foil) and a brass anvil. A blow from the firing pin of the 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 permit the flames to pass through the primer vent in the cartridge case thereby igniting the propellant charge.

(4) Propellant. There are two types of small arms propellant generally used, the single-base (nitrocellulose) type and the double-base (nitrocellulose-nitroglycerine) type. The difference between the two types is that the double-base type burns more rapidly than the single-base and is used in shotgun cartridges, some caliber .45 cartridges and carbine ammunition. Small arms propellants are manufactured in the form of small flakes, pellets, sheets, spherical (ball) grains or perforated tubular grains. The weight of the propellant charge is not constant and is adjusted for each propellant lot to give the required muzzle velocity and chamber pressure as prescribed for the weapon in which fired. This charge is assembled loosely in the cartridge case.

2. TYPES.

a. Small arms ammunition is classified according to type as combat service and noncombatant (special) and listed as follows:

Combat (Service)	**Noncombat (Special)**
Armor-piercing	Blank
Armor-piercing-incendiary	Dummy
Armor-piercing-incendiary, tracer	Frangible
Ball	High-pressure test
Grenade cartridges	Line-throwing
Incendiary	Match
Shotgun cartridge	
Spotter-tracer	
Tracer	
Hornet Cartridge Cal .22	

b. Characteristics, Color Code and Identification.

(1) The characteristics of small arms ammunition vary according to needed requirements. An example of this is armor-piercing (AP). This type of bullet (fig. 2-2) has a hardened steel-alloy

Table 2-1. Color Identification of Small-Arms Cartridges

Color of tip of bullet	Type of cartridge
Black	Armor-piercing, cal. .50, M2, cal. .30, M2, and 7.62-mm, M61.
Aluminum color	Armor-piercing-incendiary, cal. .50, M8 and cal. .30, M14.
Red with aluminum color annulus to the rear	Armor-piercing-incendiary-tracer, cal. .50, M20.
None	Ball, cal. .50, M2, and M33; cal. .45, M1911; cal. .30, M2, carbine, M1; 7.62-mm, M59 and M80; cal. .22, M65; and cal. .38, M41.
None (4 holes in cartridge case)	Dummy, cal. .50, M2.
None (fluted case)	Dummy, cal. .30, M40 and 7.62-mm, M63.
Green with white annulus to the rear (bullet has mottled appearance)	Frangible, cal. .30, M22.
None (tinned cartridge case)	High-pressure test, cal. .50, M1; cal. .45, M1; cal. .30, M1; carbine, M18 and 7.62-mm, M60.
Light Blue	Incendiary, cal. .50, M1, and cal. .30, M1.
Blue with light blue annulus to the rear	Incendiary, cal. .50, M23.
Yellow with a red annulus to the rear	Spotter-tracer, cal. .50, M48 and M48A1.
Red	Tracer, cal. .50, M1, headlight, M21, cal. .45, M26, cal. .30, M1, and carbine, M16.
Orange	Tracer, cal. .50, M10, cal. .30, M25, carbine, M27, and 7.62-mm, M62.
Brown or maroon	Tracer, cal. .50, M17.

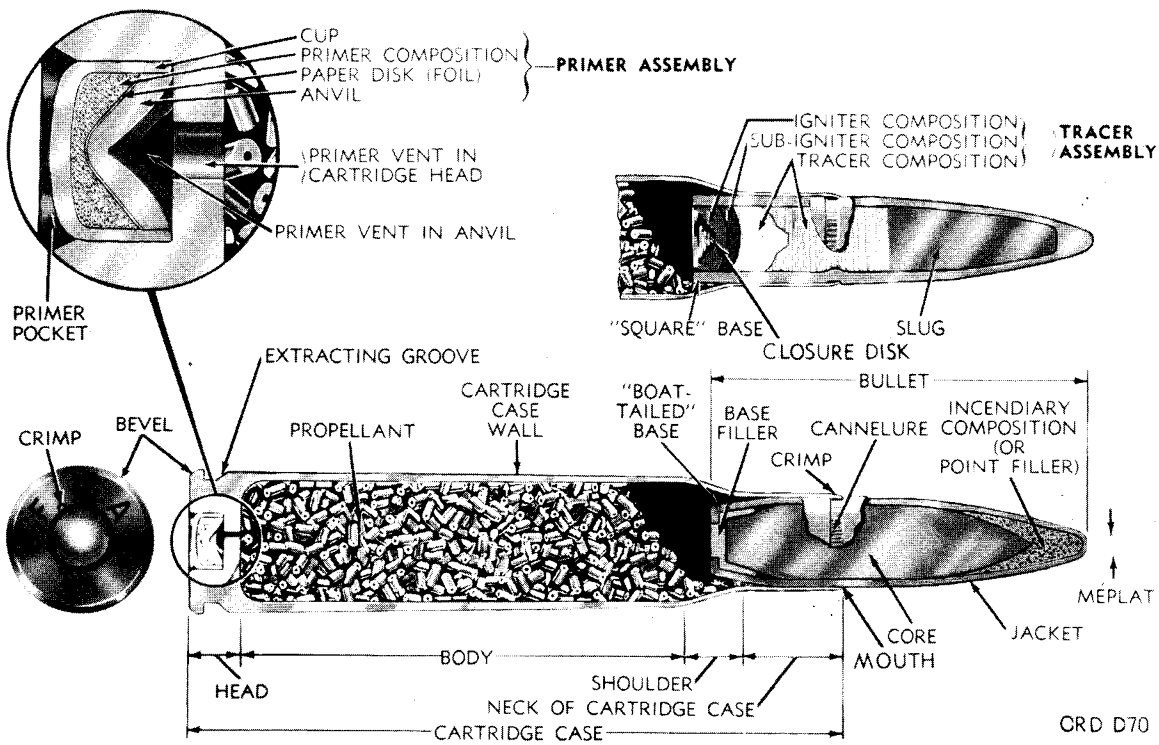

Figure 2-1. Cartridge terminology.

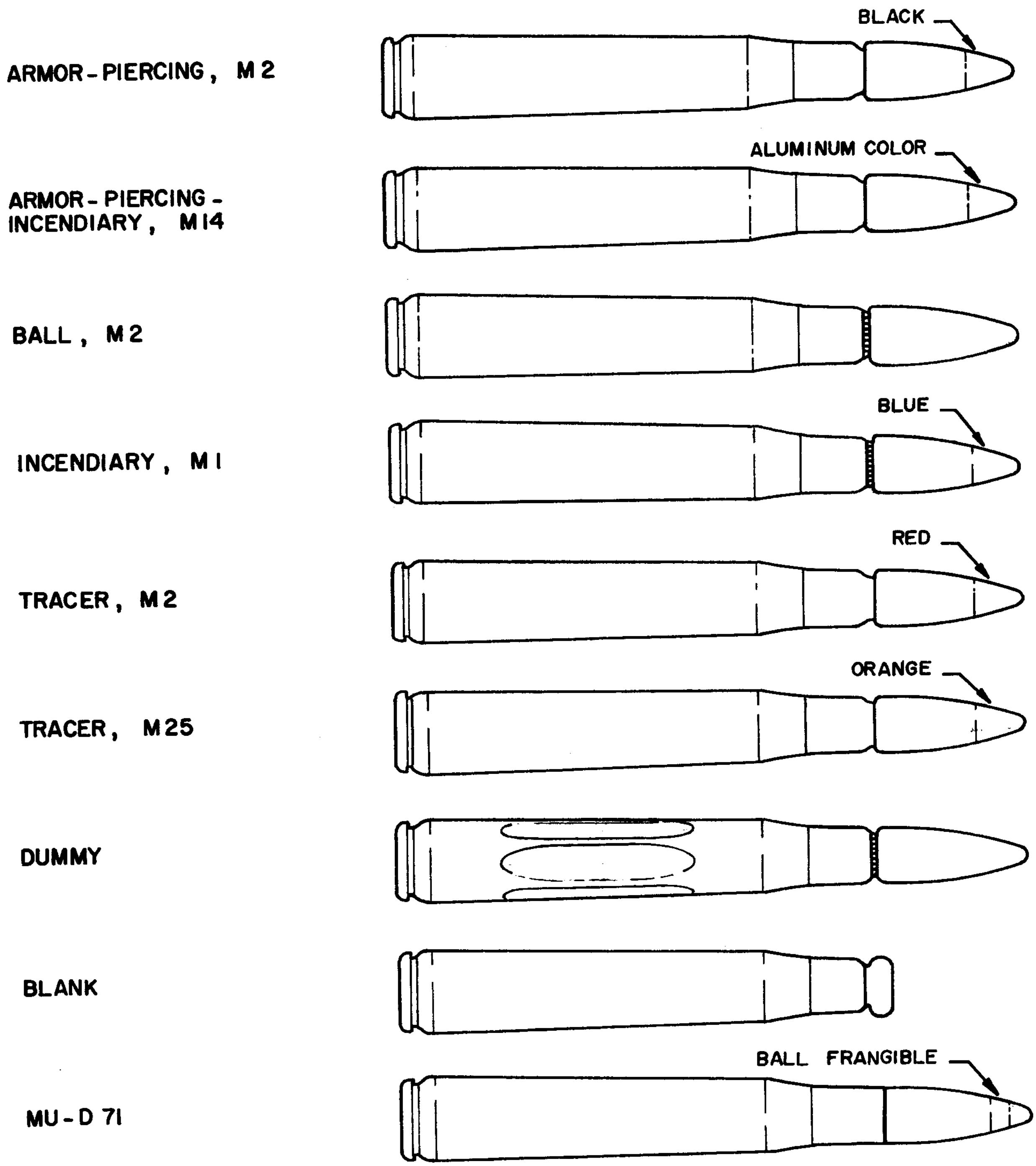

Figure 2-2. Caliber .30 cartridges.

core. In addition, it may have a base filler and a point filler of a softer metal. This type of cartridge is intended for use against armored aircraft and vehicles, concrete shelters, and similar bullet-resisting targets. This cartridge can be identified by the black bullet tip and is used in caliber .30, .50, and 7.62mm cartridges.

(2) A ball type cartridge (figures 2-2, 2-3, 2-4 and 2-5) is intended for use against personnel and light materiel targets, and is the oldest service type. It has been replaced for combat purposes,

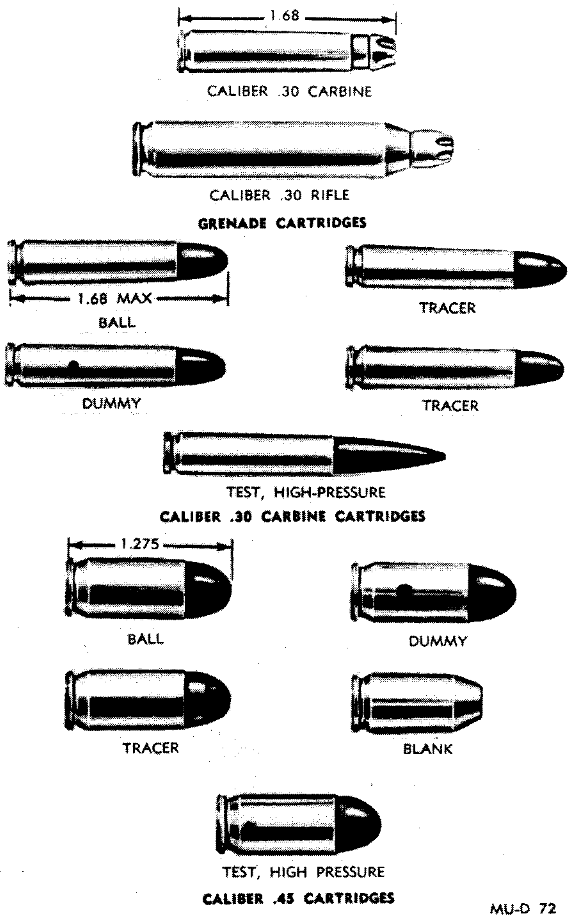

Figure 2-3. Grenade, carbine, and caliber .45 cartridges.

however, by armor-piercing and other types. Ball type cartridges are applicable to all small arms. This cartridge can be identified by the natural jacket finish.

(3) The incendiary type cartridge (figures 2-2 and 2-4) is similar to ball or armor-piercing ammunition in outward appearance. It is used for incendiary purposes against aircraft. It contains an incendiary composition in the bullet core or as a point filler, that ignites on impact with the target. It is used in caliber .30, .50, and 7.62mm machine guns. This cartridge can be identified by a blue bullet tip.

(4) Tracer ammunition (figures 2-2, 2-3, 2-4 and 2-5) is used in caliber .30, .45, .50 and 7.62mm weapons to aid gunners in correcting aim, for incendiary and signal purposes. The caliber .30 cartridge is identified by a red bullet tip for the M1 cartridge, and an orange bullet tip to identify both dim and bright trace for the M25 and M27 cartridges. Caliber .50 tracer, M17 has a brown painted bullet tip if manufactured since 1952, or a maroon bullet tip if manufactured prior to 1952. The caliber .45 tracer cartridge is identified by a red painted bullet tip and the 7.62mm tracer cartridge by an orange painted bullet tip.

(5) The armor-piercing-incendiary (API) type of cartridge (figure 2-2) combines the features of armor-piercing and incendiary cartridges. It is used in caliber .30 and .50 weapons. This cartridge can be identified by the aluminum colored bullet tip.

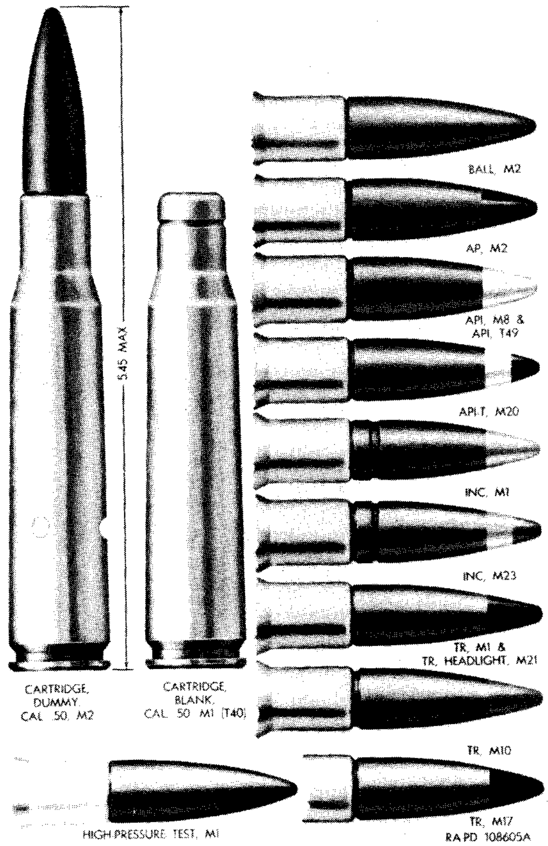

Figure 2-4. Caliber .50 cartridges.

(6) An armor-piercing-incendiary-tracer (API-T) cartridge (figure 2-4) combines the features of armor-piercing, incendiary, and tracer cartridges and is intended to replace these items. This cartridge is for use in caliber .50 machine guns. It is identified by the tip of its bullet being painted red with an aluminum annulus to the rear.

(7) Grenade cartridges (figure 2-3) are special blank cartridges used to project antitank, high explosive, fragmentation, illuminating, smoke and chemical grenades. The grenade cartridges can be identified by the characteristic rosette crimp on the mouth of the case and the absence of a bullet.

(8) Shotgun cartridges (figure 2-7) are procured commercially for use in shotguns of various gages. These cartridges are used for combat, guard, and survival purposes. They are of the same general appearance, and may be identified by the stamping on the head, body, and closing wad. Additional identification is provided by markings on the packing containers and boxes.

(9) The ball hornet cartridge (figure 2-8) is authorized for use in the caliber .22 survival rifle M4 and in the upper barrel of the caliber .22/.410 gage survival rifle-shotgun M6, and is designed for shooting game for food purposes. This cartridge can be identified by the natural jacket finish.

(10)Blank cartridges (figures 2-2, 2-3, 2-4 and 2-5) are used for signal purposes, firing salutes and for instruction. These cartridges are manufactured in caliber .30, .45, .50, also 7.62mm and 10 gage. This cartridge can be identified by having no bullet.

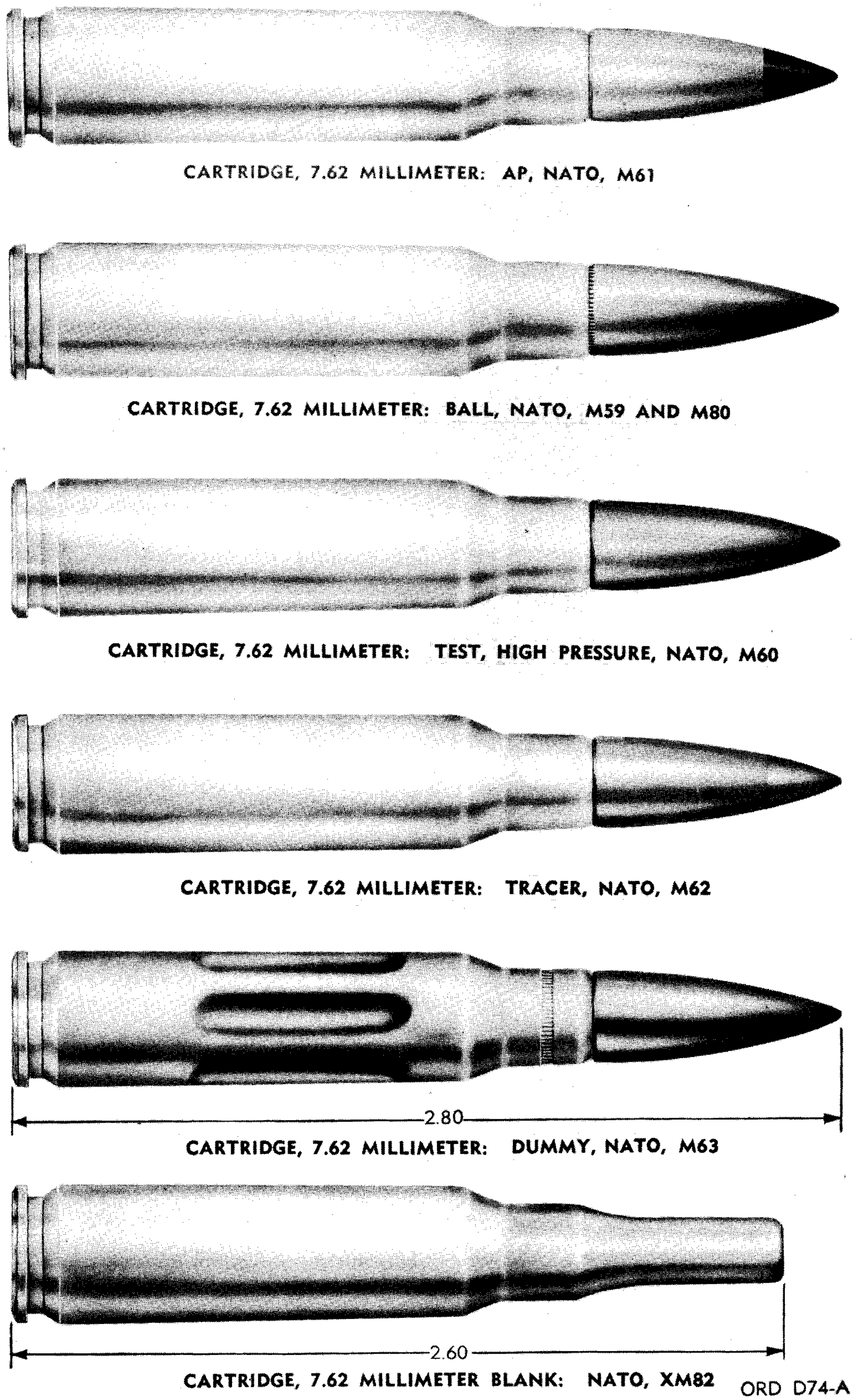

Figure 2-5. 7.62 Millimeter cartridges.

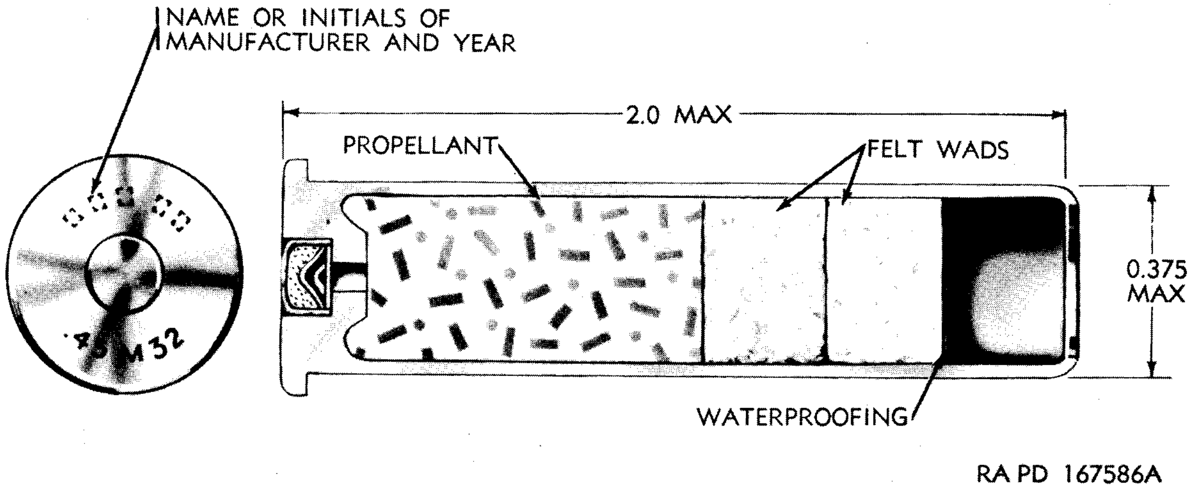

Figure 2-6. Cartridge, caliber .45, line-throwing: blank, M32.

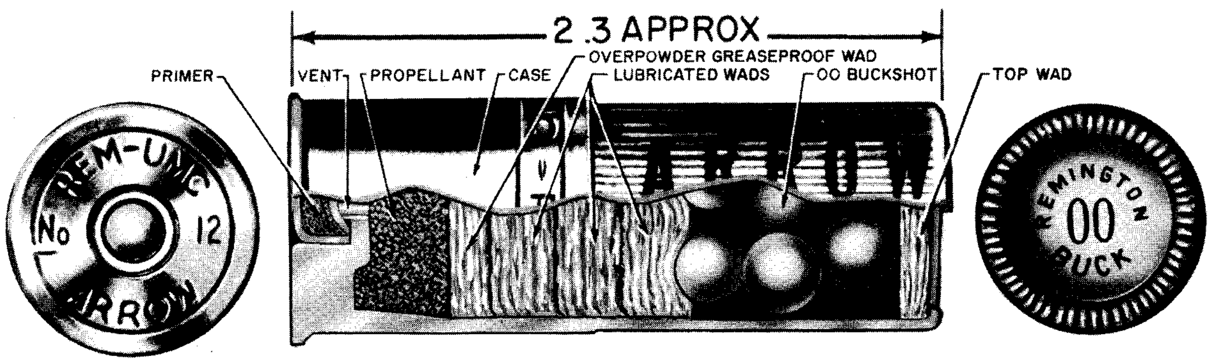

Figure 2-7. 12-Gage shotgun cartridges-sectioned.

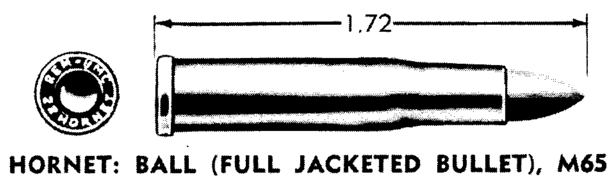

Figure 2-8. Hornet: Ball (Full Jacketed Bullet), M65.

NOTE: *Precautions in firing blank ammunition: It is dangerous to fire blank cartridges at personnel at distances less than 20 feet as the wad or paper cup may fail to break up and the propellant may not be completely consumed.*

(11)Dummy cartridges (figures 2-2, 2-3, 2-4 and 2-5) are used for personnel training in caliber .30, .45, .50 and 7.62mm. The caliber .30, .45, and .50 cartridges are identified by a hole in the primer pocket and by drilled holes in the side of the cartridge case. The 7.62mm cartridge case has six longitudinal corrugations approximately one third of the length of the case.

(12)Frangible ammunition (figure 2-2) is used in tank gunnery training. Frangible ammunition is caliber .30 and is identified by a green bullet tip with a white annulus to the rear. The bullet is composed of 50 percent powdered lead bonded with 50 percent bakelite and will break up completely on normal contact with 3/16 inch aluminum alloy sheet at 100 yards normal impact.

(13)High pressure test ammunition (figures 2-2, 2-3, 2-4 and 2-5) produces pressures in excess of specification. It is used for proof-firing weapons at place of manufacture, test, and repair. Cartridges come in the following sizes and identifications: caliber .30, tinned case; caliber .38, mottled brownish black coating; caliber .45, brass case stannic, steel case, zinc coated; caliber .50, tinned case; 7.62mm tinned case.

(14)The line throwing cartridge (figure 2-6) is caliber .45 blank, designed to fire a standard navy line for a minimum of 75 yards at 30 degree elevation. The cartridge is identified by a slight roll crimp in the end that prevents the end of the line carrying projectile from entering the case.

(15)Match ammunition is used for competitive team shooting. It is stocked in caliber .22, .30, .45 and 7.62mm. This cartridge is identified by the word "MATCH" stamped on the head of the case and the bullet is not crimped in the case.

(16)The spotter-tracer caliber .50 cartridge is used in the caliber .50 spotting rifle M8, for spotting the target for the gunner before firing the 106mm recoilless rifle. The cartridge can be identified by its yellow painted bullet tip with a red annulus to the rear. This cartridge is not authorized for other caliber .50 rifles as it will not chamber in these weapons.

(17)Small arms ammunition, 5.56 millimeter, is currently being used in the M-16 rifle.

(a) The Ball Cartridge, M193, (figure 2-9) is a center fire cartridge with a 55 grain gilding metal jacketed lead alloy core bullet. The primer and case are waterproofed. The ball round is the basic cartridge for field use and has no identifying marks. This cartridge has a muzzle velocity of 3,250 f. p. s.

(b) The tracer cartridge, M196, has the same basic characteristics as the ball and is identified by an orange tip. Its primary uses are for observation of fire, incendiary effect and signalling.

(c) The grenade cartridge, M195, and the blank cartridge, XM 200, are identical in that they both have the rosette crimp, however, the grenade cartridge is further identified by a red tip and the blank cartridge has a cannelure one-half inch from the head.

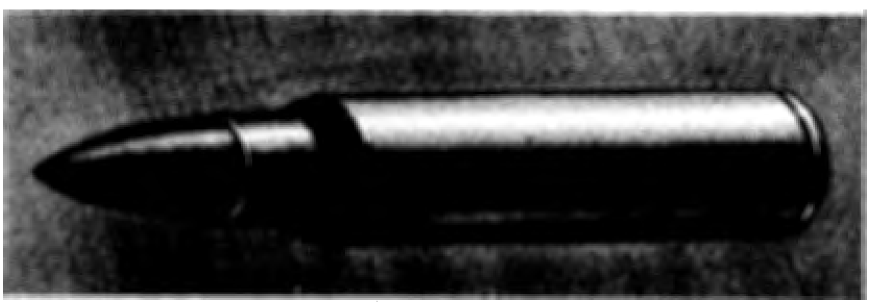

Figure 2-9. Cartridge, Ball 5.56mm.

3. 20 and 30mm Ammunition.

a. General. Ammunition for 20-mm aircraft guns is classed as fixed and some components have the same nomenclature as caliber .50 ammunition. However, missiles are known as projectiles in 20-mm cartridges and as bullets in caliber .50 small arms ammunition. Certain 20-mm cartridges contain high explosives and are assembled with point-detonating fuzes and are primed with both percussion and electric primers.

b. Cartridge, 20-mm: AP-T, M95(figure 2-10).This cartridge is for use against armored targets. The projectile is a solid shot made from forged steel and is covered by a steel windshield crimped into grooves in the projectile body. The base of the projectile contains a red tracer with burning time of 2.0 seconds or equivalent to a range of 1,270 yards. The cartridge case is either brass or steel and contains a propelling charge of single base propellant, Improved Military Rifle (IMR) or double-base type referred to as Western ball. This cartridge has a muzzle velocity of 2,730 fps and a maximum range of 5,900 yards and is identified by a black projectile with white markings.

NOTE:
It should be noted that the painting and marking of 20-mm ammunition does not conform to the standard color coding on other types of ammunition.

c. Cartridge, 20mm: High Explosive Incendiary (HEI), M56 series, with Fuze, PD M505 (figure 2-11). This cartridge is an improvement in blast, fragmentation and incendiary effect over cartridges of earlier manufacture and may be used in the M61 rotating six-barrel automatic aircraft cannon which is electrically or hydraulically powered. The projectile filler is MOX-2B which is a composition of RDX, TNT, aluminum and ammonium perchlorate. The M505 series fuze is a point detonating, single-action, superquick type and is boresafe having the detonator "out-of-line" with the firing pin until fuze is armed. The brass cartridge case is assembled with an electric primer and contains a charge of single or double-base propellant. This projectile has a velocity of 3,430 fps and is painted yellow with black markings.

d. Cartridge, 20-mm, Electric, Ball, M55 series (figure 2-12). This cartridge is used for practice firing (TP). The nomenclature has been changed to "ball" in order to have the designation conform to the small-arms system. The projectile consists of a body, nose, and rotating band. The body is made of steel, is hollow and contains no filler. The brass cartridge case contains a double-base propellant and is assembled with an electric primer. The projectile has a muzzle velocity of 3,380 fps and is painted blue with black markings.

NOTE: An experimental model cartridge XM 599 has an HEI-T-SD (shell-destroying) projectile with a muzzle velocity of 3,460 fps. Another cartridge is the M601E1, HEI-T. The projectile has a muzzle velocity of 3,610 fps and is painted black with orange Ts (tracer), a red tip, and white markings.

e. Cartridge 30mm, Dummy, T252 (figure 2-13). This cartridge is not standardized and is similar in configuration to the service rounds which are also not standard. The dummy cartridge consists of a brass case, steel body, copper rotating band and an aluminum alloy nose. The case normally does not contain a primer or primer hole. The projectile is painted black and is stencilled "DUMMY." Other cartridges under development are the Ball, T239, HEI and the high pressure test, T253.

4. PACKING AND MARKING.

a. The containers and methods for packing small arms ammunition are given in drawings, specifications, and appropriate supply catalogs. Containers being manufactured are of a few standard types, designed to withstand all conditions commonly encountered in handling, storing,

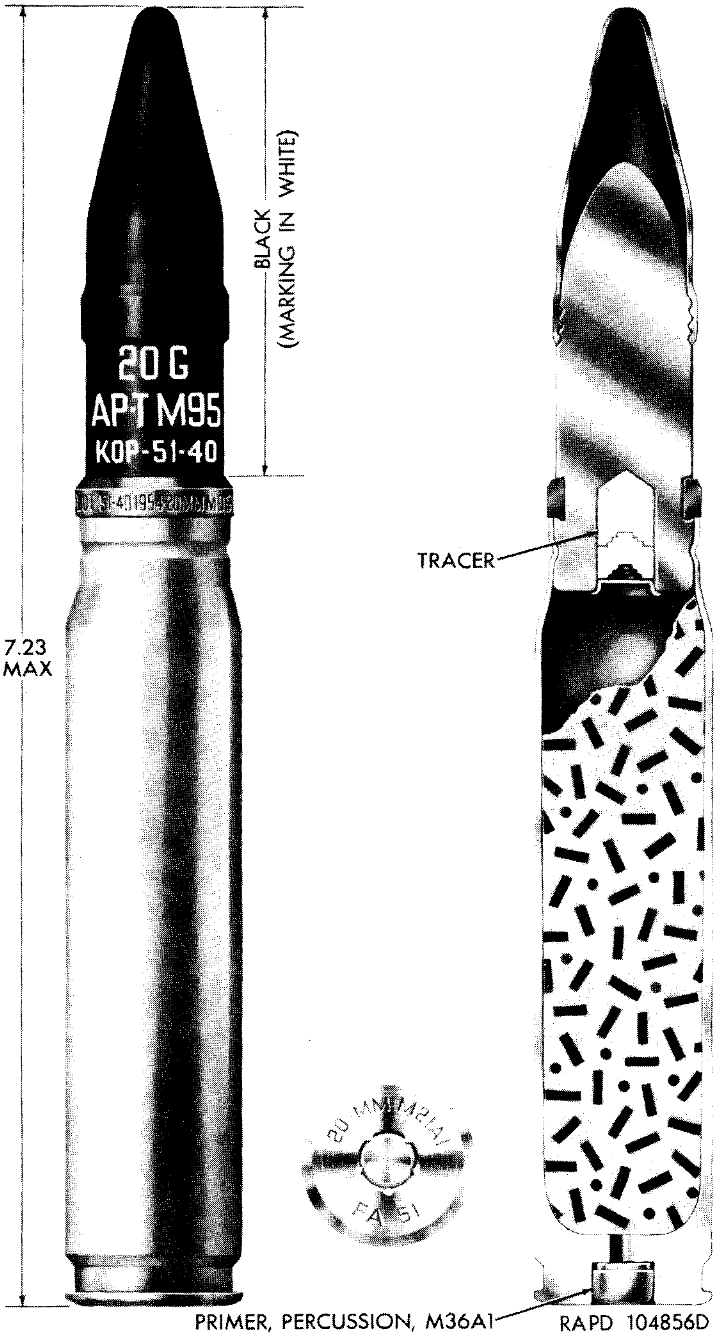

Figure 2-10. Cartridge, 20 millimeter: AP-T,M95.

and transportation of ammunition. A listing of standard boxes, containers, and their contents, dimensions, cubic displacement, and weight are contained in supply catalogs (SCs).

b. Small arms ammunition is packed in either watertight metal liners, plain or wax sealed cartons, metal-foil envelopes, hermetically sealed cans, or in metal boxes having hinged covers sealed by means of a rubber gasket. These containers are overpacked in cleated or wirebound wooden boxes. The ammunition within the container may either be bulk packed in cartons or functionally packed in clips, bandoleers, or in link or web belts.

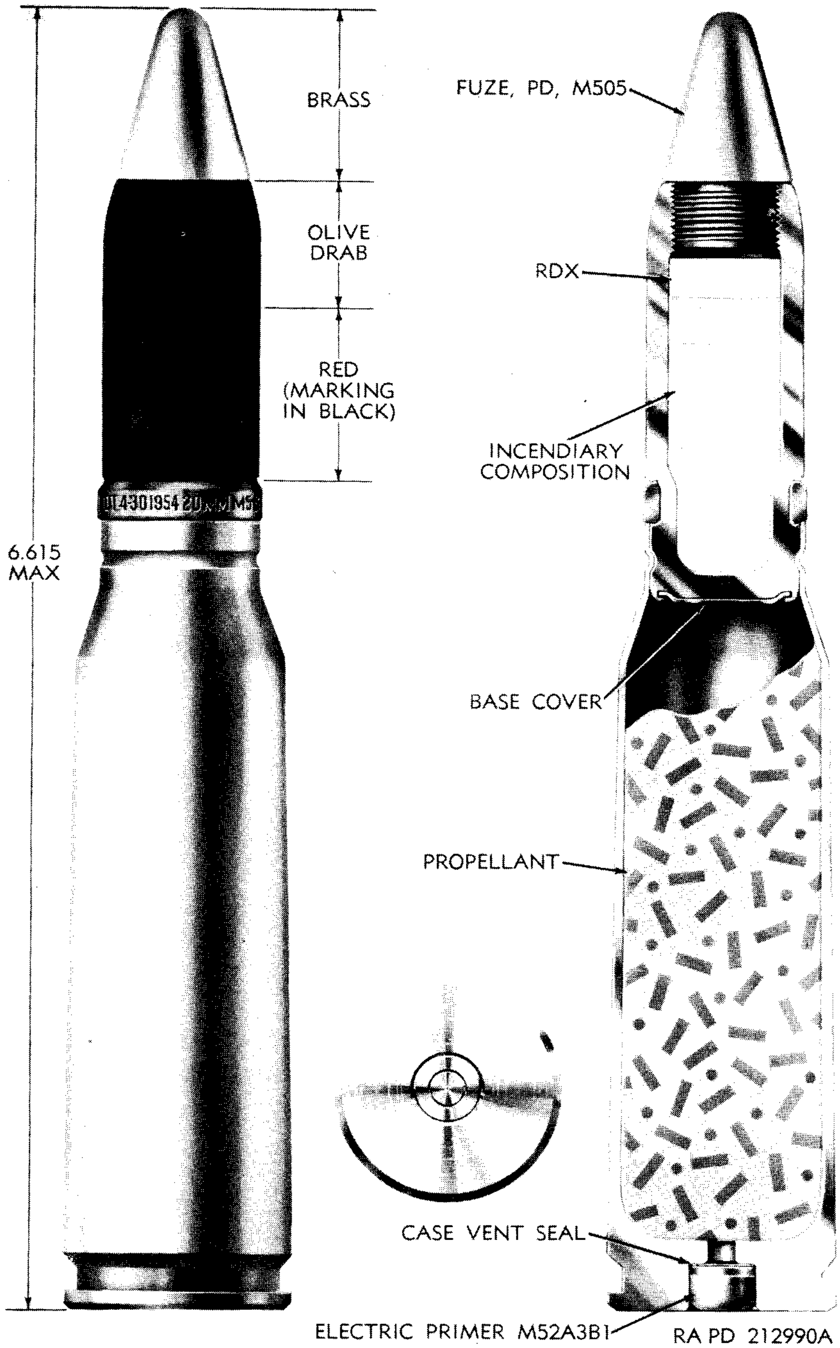

Figure 2-11. Cartridge, 20 millimeter: electric, HEI, M56A1 (T198E1), w/fuze, PD, M505.

c. Each outer shipping container and all inner containers including the smallest unit container, are marked to identify the ammunition within containers so designed to withstand conditions normally encountered in handling, storage, and transportation and to comply with Department of Transportation Regulation Tariff No. 19 (figures 2-14 and 2-15).

d. Federal Stock Number (FSN) is a term applied for each ammunition item of supply as packaged. An FSN, once properly assigned and published, will never be changed. The first four digits of an FSN are always the Federal supply classification (FSC) class in which an item belongs.

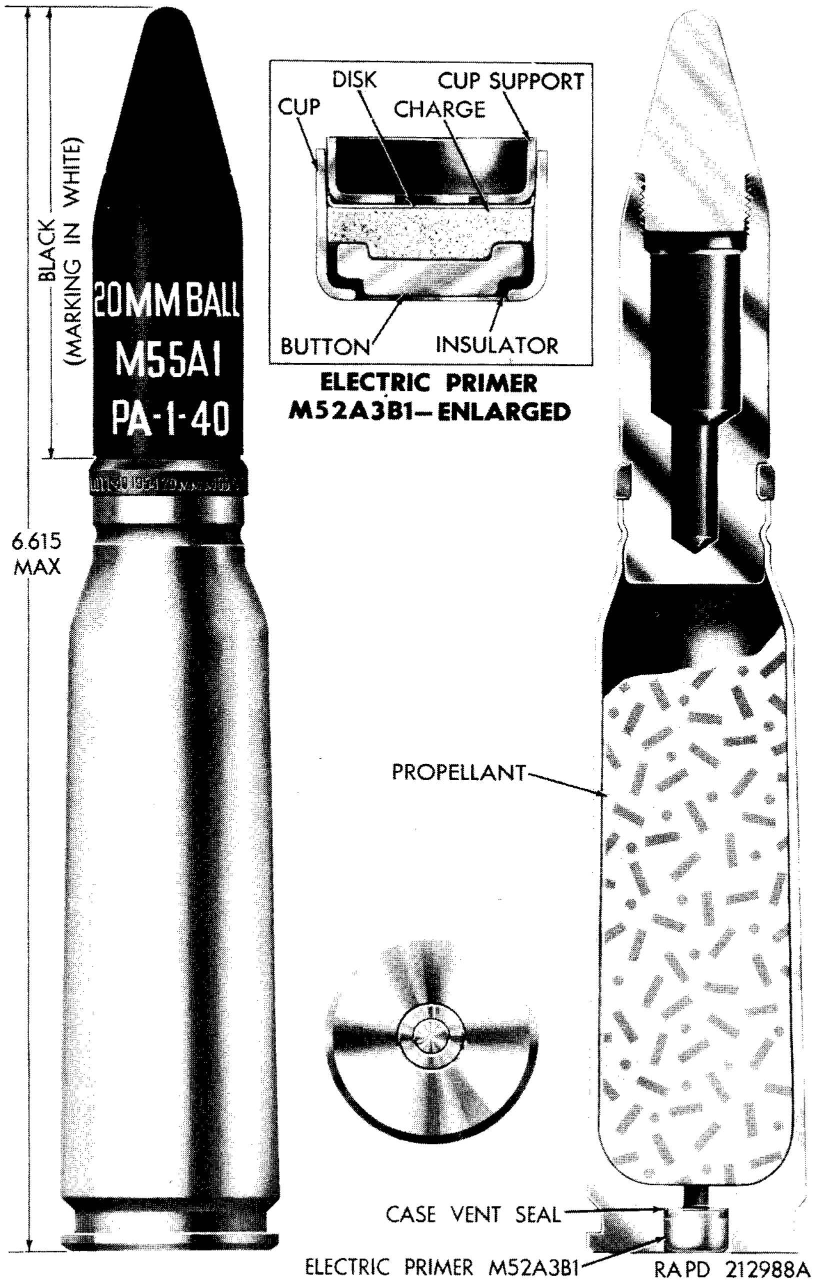

Figure 2-12. Cartridge, 20 millimeter: electric, ball, M55A1

The FSN for an item of supply consists of a 4-digit FSC class code number, and a 7-digit Federal item identification number (FIIN). In the case of an item for which the FSN is 1305-096-3155, "1305" is the FSC class in which the item belongs, and "096-3155" is the FIIN which identifies the item and distinguishes it from every other item of supply. A Department of Defense Identification Code (DODIC), consisting of a letter and three digits has been added as a suffix to FSN's in FSC group 13 to indicate interchangeability of ammunition and explosive items. The same four character code number is assigned to those items within the class that are interchangeable as to function and

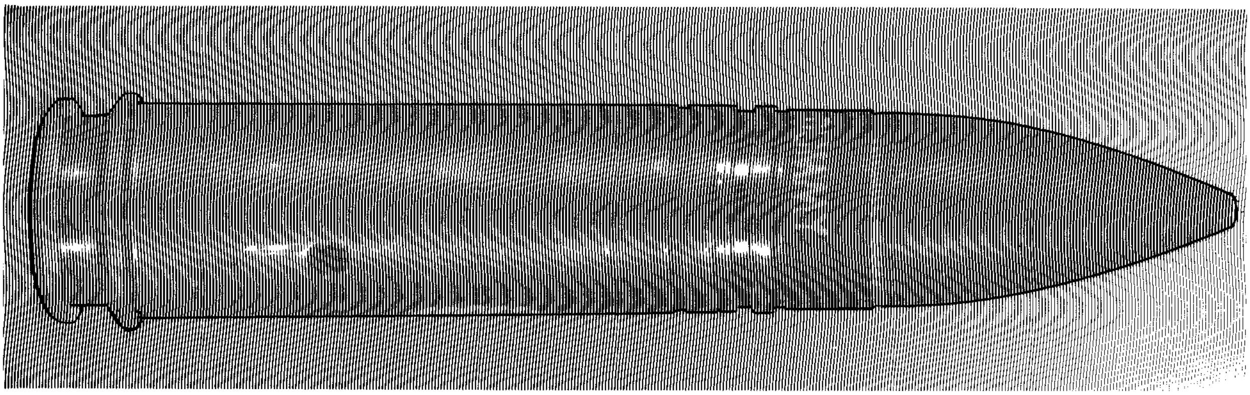

Figure 2-13. Cartridge, Dummy 30mm.

Figure 2-14. Packing containers small-arms ammunition.

use, when the DODIC is attached as a suffix to the FSN, the DODIC is shown in parenthesis. As example: 1305-096-3155(C605). In addition to the preceding, there is a Department of Defense (DOD) ammunition code defined as an 8 character number divided into 2 parts separated by a dash. The first part consists of the FSC and the second part is the DODIC, example 1305-C605. The DOD ammunition code is used for requisitioning purposes.

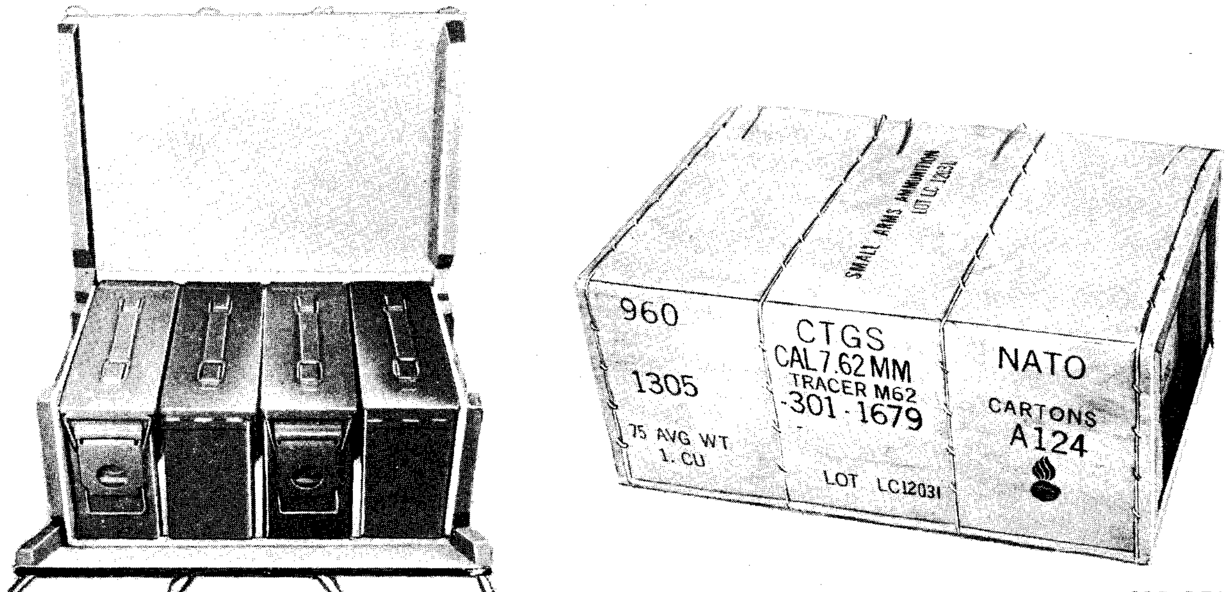

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Figure 2-15. Wirebound box with 7.62-mm ammunition in metal containers M19A1.

e. All shipping container markings (figure 2-15) include the Federal stock number, descriptive nomenclature of the ammunition included, ammunition lot number, and the number of rounds. In addition to the above, the outer shipping container also is marked with the Federal stock number and Department of Defense identification code. Shotgun cartridges vary from this procedure and are explained in a subsequent paragraph.

f. Metal containers are painted olive drab and marked in yellow. Some outer containers are stained light brown and marked in yellow. The containers of current manufacture are unstained and marked in black. Specific lots used for rifle or pistol match requirements will be marked "MATCH" on the nomenclature side and top of outer shipping containers. Boxes containing functionally packed ammunition (ammunition packed in rifle clips, web belts, or link belts) have figure symbols stenciled on the container for quick identification of the type of inner pack. It is necessary that all paintings and markings shown on packing containers be preserved, especially the lot number. Damaged packing containers should be repaired and the original markings restored.

g. Shotgun cartridges are marked on the top wad, indicating the quantity of propellant and the weight and size of shot, load, for example: "3-1-1/8-6C" indicates 3 drams equivalent of bulk propellant and 1-1/8 ounces of No. 6 chilled shot. In addition, the name or symbol of the manufacturer of the cartridge and of the propellant may be stamped on the top wad. The stamping of the metal head of the cartridge case generally consists of initials or symbols of the manufacturer, gage size of the cartridge, and trade name for the particular type of shotgun cartridge. The trade name and type of load is sometimes stamped on the case.

h. Cases and cartons of shotgun ammunition bear the commercial markings of the manufacturer, the lot number, type of load, and the phrase "U. S. PROPERTY." These markings generally include manufacturer's name and address, quantity, gage size, gun chamber length, type of ammunition, type of propellant, and trade names.

i. 20mm Container, M23 (figure 2-16). The wooden box M23 is a typical packing box which is used for both caliber 50 and 20mm cartridges. The only difference in the 20mm container is that in marking which indicates the model number of the applicable cartridge link to be used in a particular weapon. Containers of current manufacture are unstained and marked in black.

Figure 2-16. 20-MM Ammunition packing box M23.

5. SUMMARY.

a. Small arms ammunition comes in various types and sizes used in rifles (except recoilless type), carbines, revolvers, machine guns, submachine guns, and shotguns. Small arms cartridges are similar in general shape and construction with the exception of shotgun cartridges.

b. A cartridge is known as a round of small arms ammunition. The complete assembly consists of the components necessary to fire a weapon once, example: cartridge case, primer, propellant, and bullet or shot.

c. The primer consists of either a centerfire assembly or a primer composition spun into the rim of the cartridge case, in the case of the rimfire.

d. Bullets for service use have a metal core or slug that is covered with a gilding metal or gilding metal-clad steel jacket. Copper plated steel may be used instead of gilding metal for the jacket of caliber .45 bullets. Ball and tracer bullets have a lead alloy or common steel core or slug. Other service-type bullets have a hardened steel alloy core. The base of the bullets is either flat or tapered (boattailed).

e. The two types of small arms propellants generally used are the single-base (nitrocellulose) and the double-base (nitrocellulose and nitroglycerin). The effective difference between the two types is that the double-base type burns more rapidly than the single-base type. The double-base propellant is used in shotgun shells, some caliber .45 rounds, 20-mm, and carbine ammunition.

EXERCISES FOR LESSON 2

1. Which of the following types of small arms ammunition are used for combat?

   A. Frangible, incendiary, explosive, and armor-piercing
   B. Ball, tracer, magnum, and armor-piercing
   C. Armor-piercing, grenade cartridge, incendiary, and tracer
   D. Frangible, high-pressure test, line-throwing, and match

2. The armor-piercing cartridge is identified by

   A. extra serrations on the bullet base.
   B. a black bullet tip.
   C. increased bullet length.
   D. a green bullet tip.

3. The process of sealing by expansion is known as

   A. brisance.
   B. headspacing.
   C. stripping.
   D. obturation.

4. Why is the spotter-tracer caliber .50 cartridge restricted to artillery spotting?

   A. It will not chamber in other weapons
   B. Because of low velocity
   C. Cost
   D. Priority

5. What type small arms ammunition is used for tank gunnery training?

   A. Tracer
   B. Armor-piercing
   C. Frangible
   D. Dummy

6. The line throwing cartridge is a

   A. caliber .50.
   B. 7.62mm.
   C. 10 gage cartridge.
   D. caliber .45 blank.

7. A rosette crimp on the mouth of a cartridge case indicates a

   A. grenade cartridge.
   B. 12 gage cartridge.
   C. dummy cartridge.
   D. test cartridge.

8. A Federal Stock Number (FSN) when assigned and published will

   A. be changed with each modification.
   B. be changed with publication change.
   C. remain the same for 10 years.
   D. never change.

9. What ammunition container marking should always be preserved?

   A. The caliber
   B. Lot number
   C. Date of manufacture
   D. Manufacturer's code number

10. Shotgun shells contain

   A. monopropellant.
   B. bipropellant.
   C. double-base propellant.
   D. single-base propellant.

LESSON 3. ARTILLERY AMMUNITION

MMS Subcourse No 621	Ammunition Materiel
Lesson Objective	To provide you with a general knowledge of the types, characteristics, and identification of representative artillery, recoilless rifle, and mortar ammunition.
Credit Hours	Three

TEXT

1. INTRODUCTION.

a. As an ammunition storage supervisor, it is important that you have a general knowledge of the types, characteristics, and identification of artillery ammunition to include recoiless rifle and mortar. This will involve the classification of items according to type, filler, use, and caliber.

b. A complete round of artillery ammunition (figure 3-1) comprises all the components needed to fire the weapon once. (The term, complete round, applies to such other items of ammunition as rockets, grenades, etc.) In the case of a cartridge, that is, in fixed (e.g., recoilless rifle) and semifixed ammunition, these components include a projectile, a propelling charge, a fuze, a cartridge case, and a primer.

c. Recoilless rifle ammunition is issued in the form of fixed, complete rounds, consisting basically, of projectile, cartridge case, propelling charge, primer, and fuze (except for canister rounds, which are unfuzed).

d. Mortar ammunition is classified as semifixed and is issued as complete rounds consisting of projectile, ignition cartridge and primer, propelling charge, and fuze. This type of ammunition is muzzle loaded into the weapon and is used primarily for high angle fire. The mortar tube may be either rifled or smooth bored.

2. CLASSIFICATION OF ARTILLERY AMMUNITION.

a. Artillery ammunition is classified according to type as fixed, semifixed, separated, and separate-loading.

(1) Fixed ammunition. The propelling charge is nonadjustable for this type of ammunition. The complete round is loaded into the weapon as a unit. Usually, the propellant is loose or in a cloth bag in the cartridge case. The case to which the primer is fitted is crimped securely to the projectile. (figure 3-1).

(2) Semifixed ammunition. In this kind of ammunition the increment-sectioned propelling charge is adjustable because the projectile is not crimped to the cartridge case. As with fixed ammunition, the complete round is loaded into the weapon as a unit; however, the propellant increments are accessible for adjustment in zone firing. (figure 3-1).

(3) Separated ammunition. In this type of ammunition (figure 3-1) the projectile and propelling charge are loaded into the weapon in one operation; however, the propelling charge is an assembly consisting of the propellant sealed in a metal cartridge case by a closing plug. The cartridge case is fitted with a primer.

(4) Separate-loading ammunition. In separate-loading ammunition (figure 3-1), the separate components - projectile, propelling charge, and primer - are loaded into the weapon separately. Separate-loading projectiles are generally shipped with nose (lifting) plugs, which are replaced in the field with fuzes. The projectile is inserted into the breech and rammed so that the rotating band seats in the forcing cone of the weapon. The propelling charge, usually in one or more cylindrical cloth bags secured together with tying straps, is placed in the chamber immediately to the rear of the projectile. After the breechblock of the weapon has been closed and locked behind the charge, the primer is inserted into the firing mechanism of the breechblock.

b. Artillery ammunition is classified according to filler as chemical, inert or explosive. It is further classified according to use, as service, practice, blank, dummy, and leaflet.

(1) Service ammunition is used for combat, against military objectives and target practice. Depending upon the type projectile, it may be classified as antipersonnel (APERS), high-explosive (HE), high-explosive-tracer-shell destroying (HE-T-SD), high-explosive plastic (HEP), high-explosive antitank (HEAT), high-explosive, antitank, tracer, multipurpose (HEAT-T-MP), armor-piercing (AP), armor-piercing capped (APC), hypervelocity armor-piercing (HVAP), armor-piercing discarding sabot-trace (APDS-T). The letter T, as in AP-T, indicates that the projectile contains a tracer. In more recently manufactured ammunition, the presence of a tracer may be indicated by three Ts (TTT), in the same color as the tracer stencilled on the ogive of the projectile.

(a) Chemical agents. A substance which by its chemical action and in concentration attainable in the field, produces a toxic (casualty effect) an irritating (harassing effect), a screening smoke, an incendiary action, or any combination of these. Chemical agents may be persistent or non-persistent. A persistent agent remains effective at the point of release for more than 10 minutes.

(b) Classification according to use.

1. Casualty. Chemical agents used as fillers for this effect are for examples, Sarin (GB) and the V-agent (VX), both nerve poisons. Hydrogen Cyanide (AC) is a blood agent, the mustard series (HD-HN) and lewisite (L) are blister agents.

2. Irritants (harassing agents). The chemical filler (CNS) used for riot control, is a non-persistent, irritant, harassing agent consisting of a solution of chloroacetophenone (CN), chloropicrin (PS), and chloroform. Another harassing agent is adamsite (DM) usually referred to as a vomiting agent.

3. Smoke fillers. The most common smoke filler is white phosphorus (WP) or plasticized white phosphorous (PWP) which, in addition to producing a dense white smoke, also has an incendiary action. Substitutes for WP are sulphur trioxide-chlorosulfonic acid (FS) and hexachloroethane-zinc mixture (HC). A mask is not required for FS smoke, however, HC is toxic.

(2) Practice ammunition. This type of ammunition is used for prepositioning and firing the

weapon. In most instances, practice ammunition simulates a service round in weight, configuration, and ballistic properties. It is used because it is less expensive and less hazardous. While the propelling charge is LIVE, the projectile may be inert, or have a small quantity of explosive filler, such as black powder, to serve as a spotting charge.

(3) Blank ammunition. This type is used for simulated fire. In certain weapons it is used for limited firing practice, maneuvers, and saluting. Blank cartridges contain black powder, but no projectiles.

(4) Dummy ammunition. This type has the appearance of actual items but is not designed for use in conjunction with delivery systems. Lacking internal functioning components, dummy ammunition is used for exhibits and for such training operations as assembly and handling, and dry-run operations of weapons and weapons systems.

(5) Leaflet ammunition. This type is similar to base ejection smoke shells except that it is issued with empty canisters. Printed leaflets are placed in the canisters by field personnel.

c. Explosive trains.

(1) Low explosive train (figure 3-2A). 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 consists of a primer, an igniter or igniting charge, and a propelling charge. Thus, a flash 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 effectively to propel the projectile forward.

(2) High-explosive train (figure 3-2B,C,D,E). The high-explosive train may be defined as a series of steps by which a small, initial amount of energy is built up to a large amount of energy necessary to insure a high-order detonation of a bursting charge. Fundamentally, a high explosive train consists of a detonator, booster, and bursting charge. This sequence is often interrupted by a delay or relay.

(a) The detonator sets up a high-explosive wave when initiated by the stab action of a firing pin or by a flame. This wave is so small and weak that it will not initiate a high-order detonation in the bursting charge, unless a booster assembly 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.

(b) To gain the action necessary to control the time and place at which an explosive will function, it is necessary to add other components in a high-explosive train. The action desired may be a burst in the air, a burst upon impact with the target, or a burst after the projectile has 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 train will remain the same.

(c) A variation of the high-explosive train is found in the chemical projectile. In this train there is no bursting charge such as found in high-explosive projectiles, as it is only necessary to rupture the projectile case and disseminate the chemical contents. The actual bursting of the projectile is accomplished by an enlarged booster, known as a burster charge, contained in a tube extending down the center of the projectile.

3. CHARACTERISTICS OF ARTILLERY AMMUNITION COMPONENTS.

a. Projectiles.

(1) General. An artillery projectile may be either solid or hollow. Projectiles may be filled

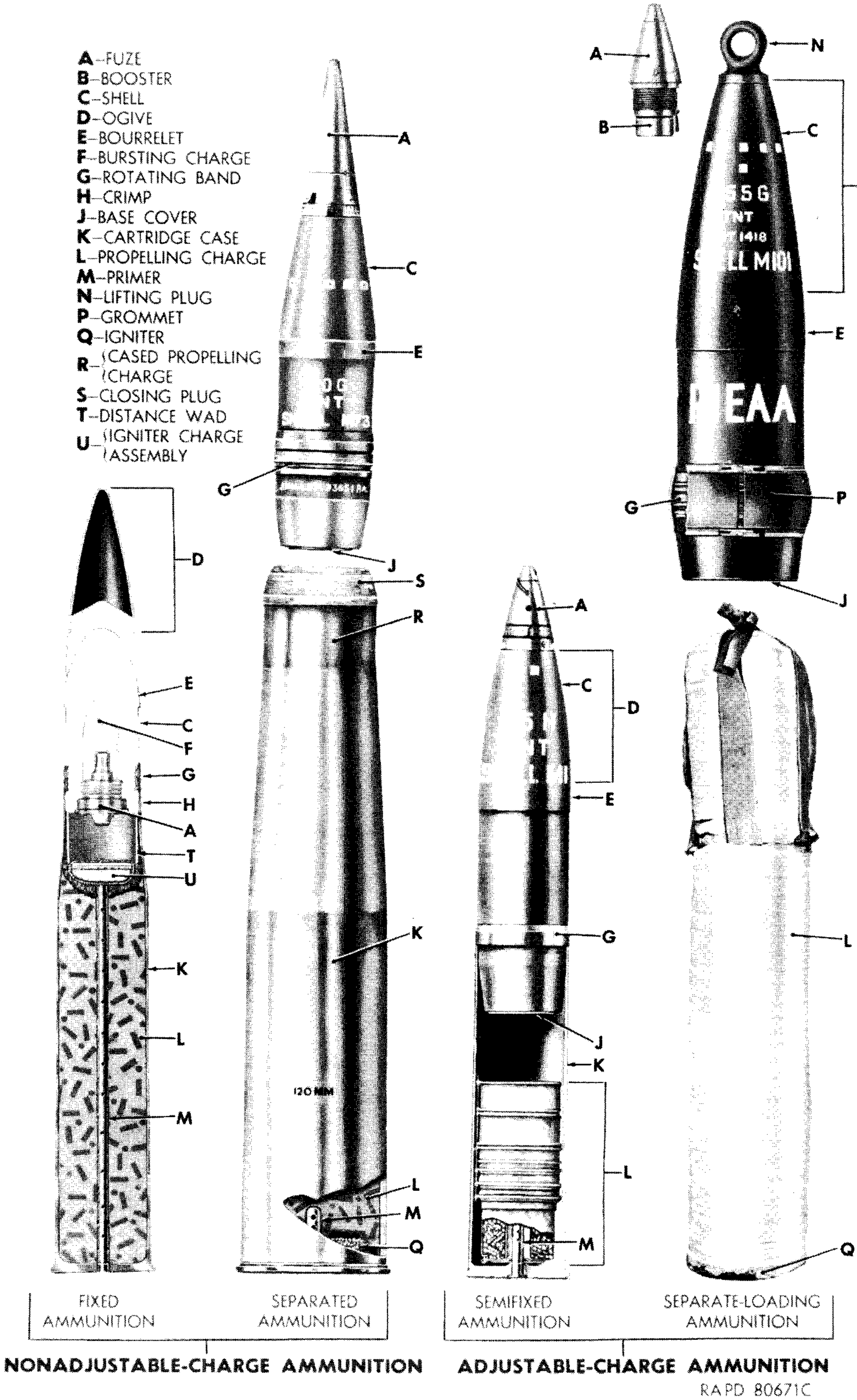


Figure 3-1. Types of complete rounds.

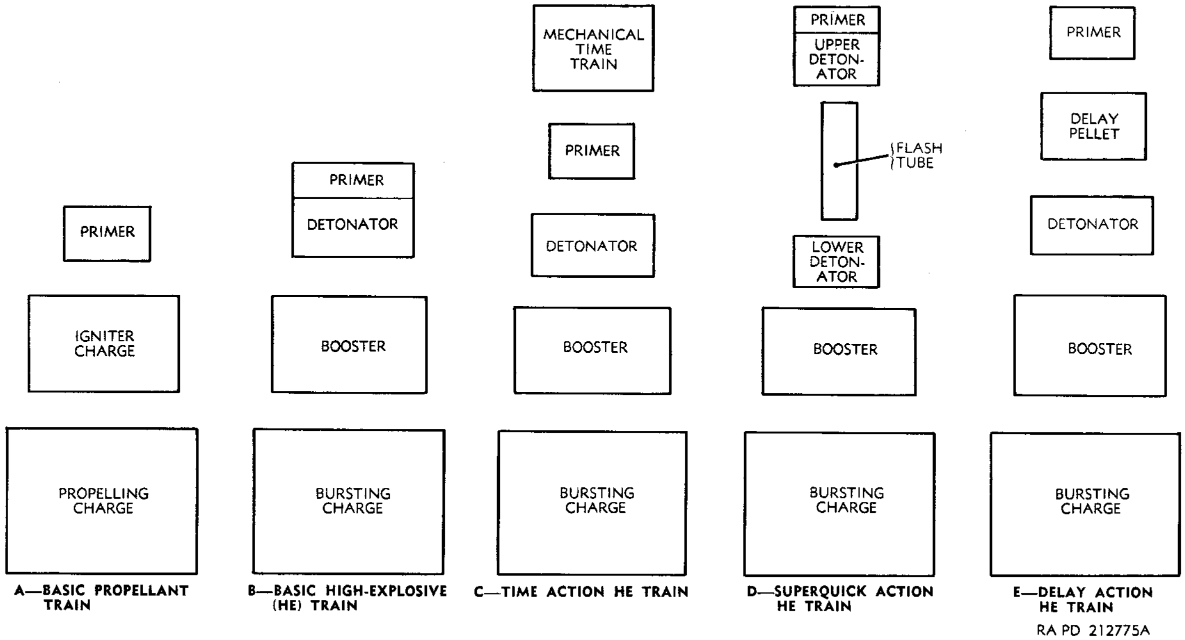


Figure 3-2. Schematic arrangement of explosive train components.

with explosive or inert material, depending on the type. Artillery projectiles, although differing in details, are of the same general shape in that they have a cylindrical body and generally an ogival or conical head (or windshield). Some exceptions are projectiles with spiked heads and the canister projectiles which have blunt heads.

(2) Fuze. The nose or base of the projectile contains the fuze. HE projectiles may be shipped unfuzed and fitted with closing plugs or eye-bolt lifting plugs to protect the fuze cavity threads. These projectiles require point detonating (PD), concrete-piercing (CP), time or variable time (VT) fuzes to be installed prior to use. HEAT projectiles and certain armor-piercing projectiles with explosive fillers require base detonating (BD), point initiating (PI) or PIBD fuzes.

(3) Body. The main section of the projectile is called the body and designates the cylindrical portion of the projectile between the bourrelet and the rotating band (figure 3-3). It is generally machined to a smaller diameter than the bourrelet to reduce the surface in contact with the lands of the weapon tube. Only the bourrelet and rotating band bear on the lands.

(4) Bourrelet. The bourrelet (figure 3-3) is the accurately machined surface that bears on the rifling lands of the weapon. It centers the front end of the projectile in its travel through the bore. The bourrelet is located at the forward end of the projectile, immediately in rear of the ogive. Some projectiles of large caliber have a front and rear bourrelet.

(5) Ogive and windshield. The forward portion of the projectile from the bourrelet to the point is called the ogive (figure 3-3). The length of the ogive influences the flight of the projectile. Since armor-piercing projectiles have a short radius of ogive for purposes of penetration, a windshield is placed over the armor-piercing head to impart adequate ballistic qualities to the projectile.

(6) Rotating Band. The rotating band (figure 3-3) is a cylindrical ring which seats the projectile in the forcing cone, centers the base in the bore, and helps prevent escape (obturation) of

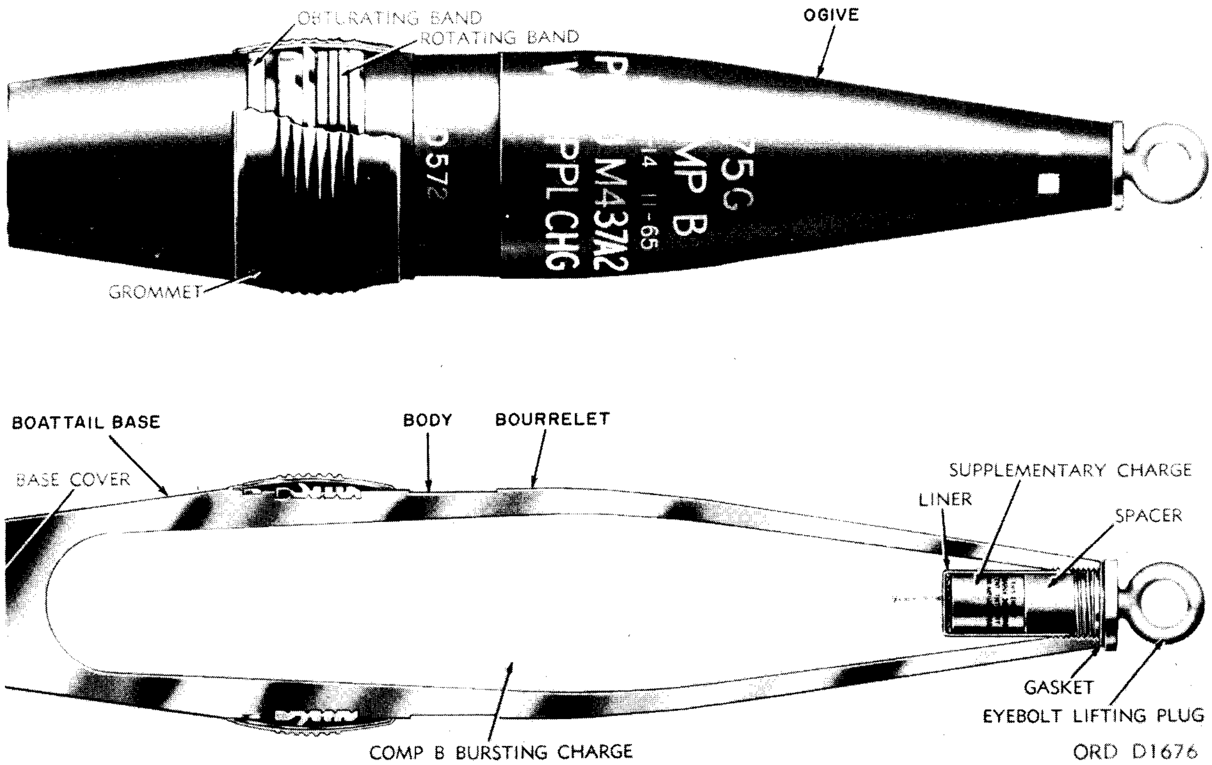


Figure 3-3. HE projectile.

propellant gases forward of the projectile. It is of relatively soft metal (e.g., copper, sintered iron or gilding metal), the band is pressed into a knurled or rough groove near the base of the projectile; if of steel (e.g., in some recoilless projectiles), the band is integral to the base. Rifling of the bore as the projectile moves forward, engraves the band. Because weapon rifling is helical, rotation is imparted to the projectile stabilizing it in flight. The rotating band of recoilless rifle projectiles is preengraved. Projectiles for guns are usually fitted with wide, or double rotating bands, and howitzer projectiles with narrow rotating bands.

b. Type of Bases.

(1) When the surface to the rear of the rotating band is tapered, it is known as "boattailed;" when cylindrical, the projectile is described as having a "square base." In boattailed bases (figure 3-3), the taper decreases drag by reducing vacuum-forming currents of air in the wake of the projectile. This increases projectile range. Fins at the rear of nonrotating or slow-spin rounds stabilize the projectile.

(2) Base Plug. Some armor-piercing projectiles are closed at the base with a steel plug. In the smaller calibers, if an explosive charge is loaded into the cavity of the AP shot, the base plug is replaced by a BD fuze. In certain types of projectiles, the base plug may contain a tracer element.

(3) Base Cover. Each high-explosive shell is provided with a base cover (figure 3-3). This prevents the hot gases of the propelling charge from coming in contact with the explosive filler of the projectile through joints or possible flaws in the metal of the base, and is usually welded to the base of the projectile.

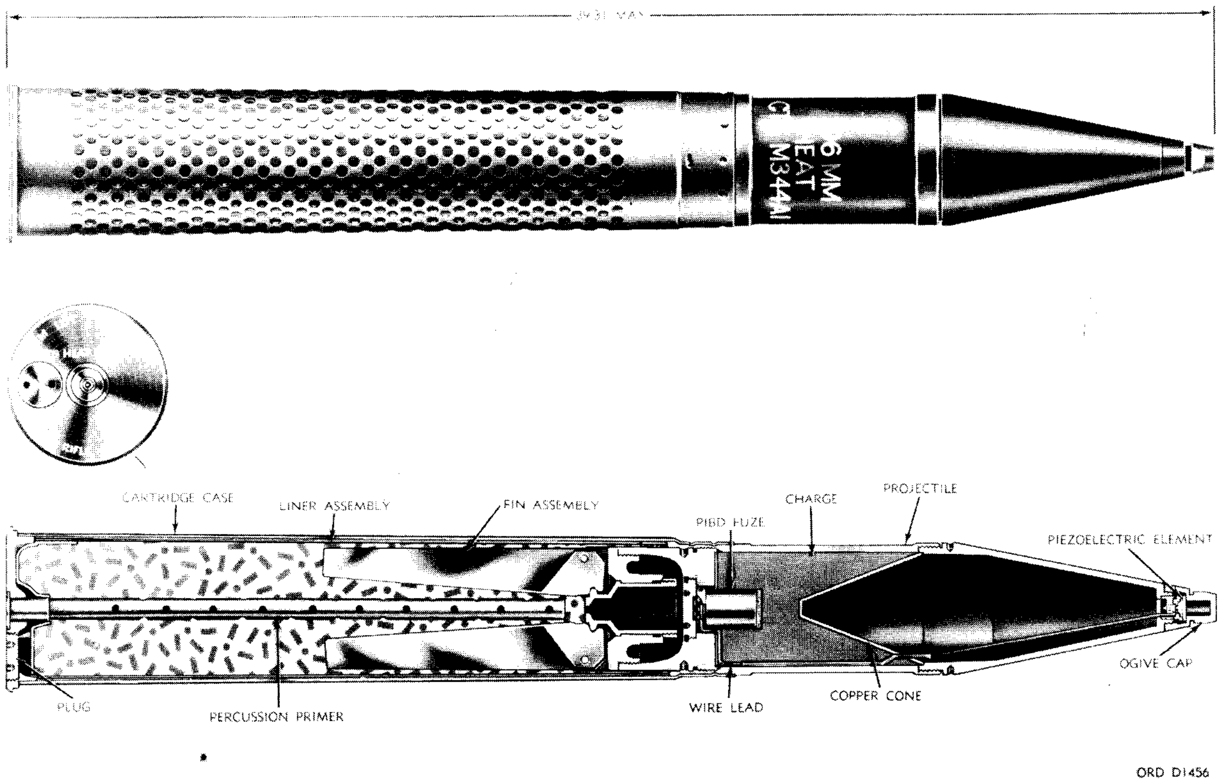


Figure 3-4. 106-mm HEAT cartridge M344A1.

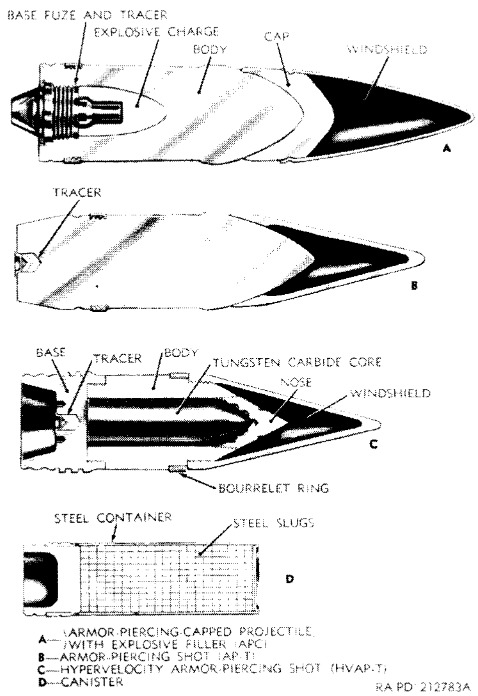


Figure 3-5. Typical AP and canister projectiles.

(4) Tracer. A tracer in the base of some projectiles provides for observation of fire. The tracer in certain aircraft and antiaircraft projectiles contains a shell-destroying (SD) element. The tracer, after burning a prescribed number of seconds, ignites a pellet which detonates the explosive filler and destroys the round should the round fail to impact against the target.

4. TYPES AND IDENTIFICATION OF REPRESENTATIVE ARTILLERY AMMUNITION.

a. High-explosive (HE). Projectiles of this type (figure 3-3), usually made of forged or cold extruded steel, and having comparatively thin walls and HE bursting charges, are used against personnel and materiel to produce blast, mining effect, and fragmentation. According to action desired, this type is fitted with a time, impact, concrete-piercing, or proximity (VT) fuze. To accommodate VT fuzes, HE projectiles have a deep fuze cavity. By placing a supplementary charge in the deep cavity, HE projectiles may be adapted for use with standard time or impact fuzes.

b. High-explosive-antitank (HEAT). This is a special HE type (figure 3-4), the affect of which is derived from its shaped charge. The metal cone which shapes the charge, standoff which is provided by projectile design, fuze action, and rotation, effect the depth of penetration. In high velocity HEAT rounds, greater penetration is achieved with fin stabilization.

c. Armor-piercing (AP or APC). Armor-piercing or armor-piercing-capped projectiles (figure 3-5) of such materials as heat-treated, high-carbon alloy steel, are used to penetrate face-hardened armor.

(1) The AP projectile has a hardened steel head for penetration of armor, and a tough body to withstand force of impact and twist of the projectile at high angles of obliquity. A steel or aluminum windshield is generally attached to the projectile body to increase ballistic efficiency.

(2) The APC projectile (figure 3-5) refers to a shot or a projectile with an armor-piercing cap. The cap is of forged alloy steel, heat-treated to have a hard face and a softer core. On impact, the hardened face of the cap destroys the hardened surface of the armor plate, while the softer core of the cap protects the hardened point of projectile by distributing the impact stresses over a large percentage of the area of the head. A tracer may be present in the base plug or in the base end of the fuze. Some APC rounds contain a small charge of explosive D and are fuzed with BD fuzes.

d. Hypervelocity armor-piercing (HVAP-T). This projectile (figure 3-5) consists of a core of an extremely hard high-density material, usually tungsten carbide, within a lightweight carrier, usually aluminum. The carrier has a skirted base threaded to receive a tracer, and is fitted with a rotating band and forward bourrelet. An armor-piercing cap similar to that used on APC ammunition may be placed on the core. This construction enables velocities above 3,500 fps (hypervelocities) to be obtained without exceeding the allowable pressures in guns designed for lower muzzle velocities of other type projectiles. The carrier does not assist materially in penetrating the target, since it breaks up completely or vaporizes when it hits, leaving the core to penetrate the target by kinetic energy (energy of motion).

e. Armor-piercing discarding sabot (APDS-T). In this type of projectile (figure 3-6), a carbide core, either capped or uncapped, is placed inside a steel or light-alloy sheath (fitted with a tracer) to give good exterior ballistic characteristics. This subcaliber assembly is placed inside a full-caliber carrier (e.g., 40mm core inside a 90mm carrier). This carrier (sabot) is so designed that it will impart velocity and spin to the subcaliber projectile. The sabot, usually made of aluminum, magnesium-zirconium alloy, or plastic, may be released from the subprojectile by a device actuated by setback, propellant-gas pressure, or centrifugal force. The sabot, because of its ballistic shape and low mass loses velocity rapidly and releases the subprojectile shortly after it leaves the gun. Velocities in excess of 4,800 fps have been obtained with this projectile.

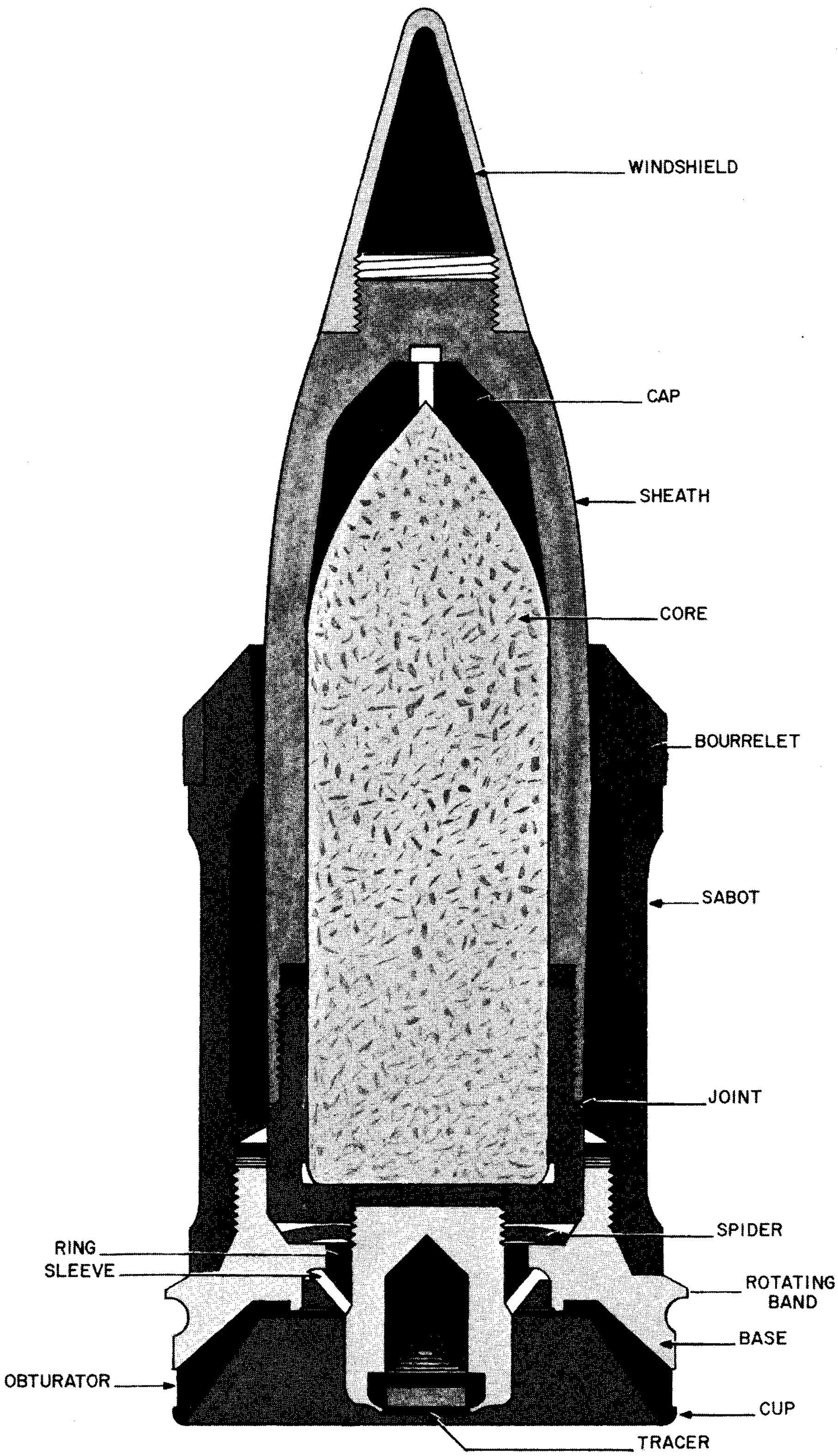


Figure 3-6. 76-mm HVAP-DS-T, M331A2.

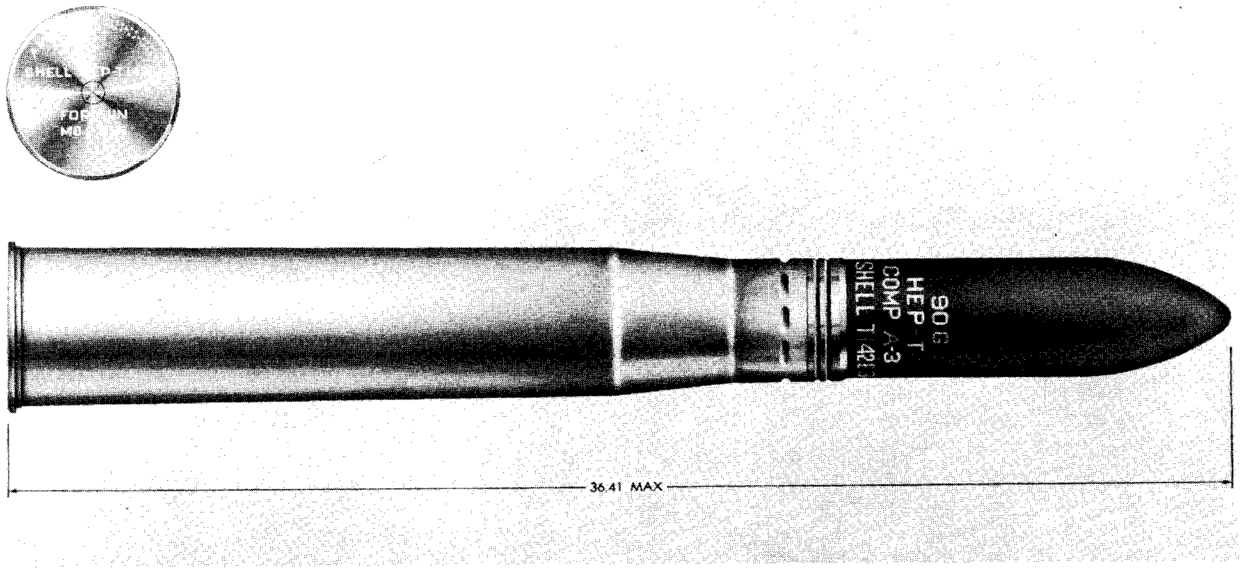


Figure 3-7. High explosive plastic (HEP-T) cartridge.

f. High explosive plastic (HEP-T) cartridge (figure 3-7). (Physical details and functioning of this cartridge is classified. See TM 9-1300-203/2 (C)).

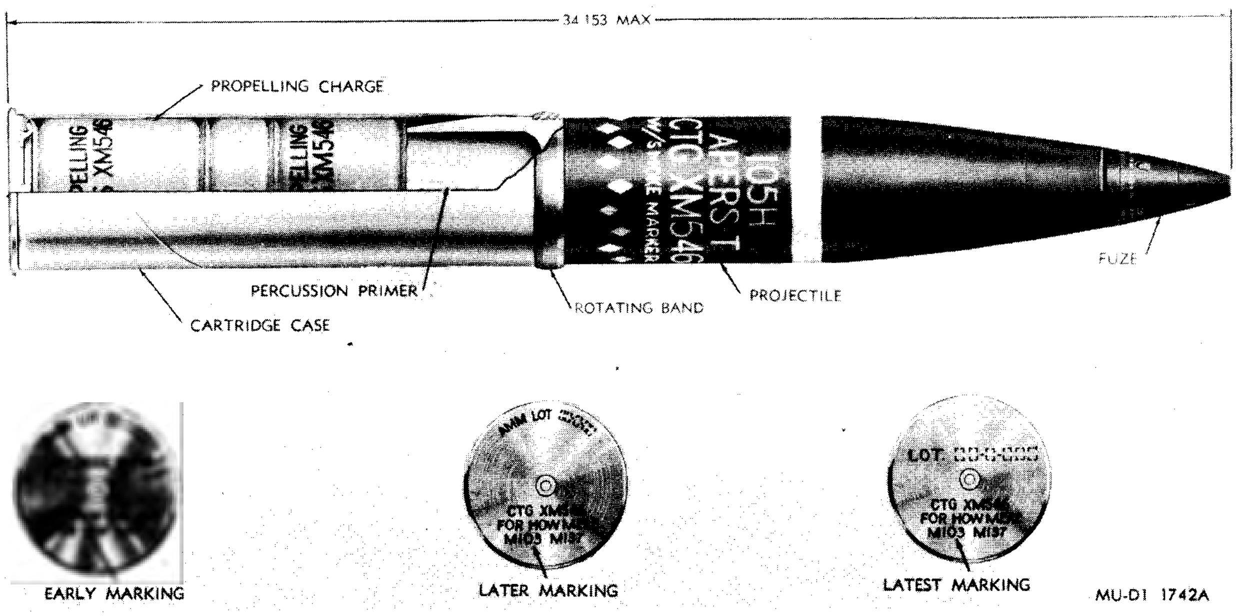


Figure 3-8. 105-mm APERS-T cartridge XM546.

g. Antipersonnel (APERS). This projectile (figure 3-8) commonly known as "beehive," is intended for antipersonnel effect at both close and long range. It is made of steel and/or aluminum and consists of a base (with tracer and rotating band), a body, an explosive loaded fuze adapter, and a mechanical time fuze. The projectile is loaded with steel flechettes (fin stabilized fragments), an expelling and a spotting charge. When the fuze functions, the explosives in the fuze adapter are detonated. This action opens the forward end of the body and ignites the expelling charge. The payload of flechettes is dispersed in a conical pattern by centrifugal force and the gas pressure built up by the burning expelling charge. The spotting charge is also released, indicating the point of payload dispersion.

h. Canister. This projectile (figure 3-5) is intended for antipersonnel effect at close range. The projectile consists of a steel base with rotating band, and a steel body loaded with flechettes, steel slugs (ball or cylindrical), which are held in place by a closing disc attached to the forward end of the body. The body has four lateral slots or grooves extending approximately two-thirds of the body length. Immediately after the projectile leaves the muzzle of the gun, air pressure on the closing disc and centrifugal force acting on the body and the payload,causes the projectile to break at the slots or grooves on the body resulting in conical dispersion of the payload.

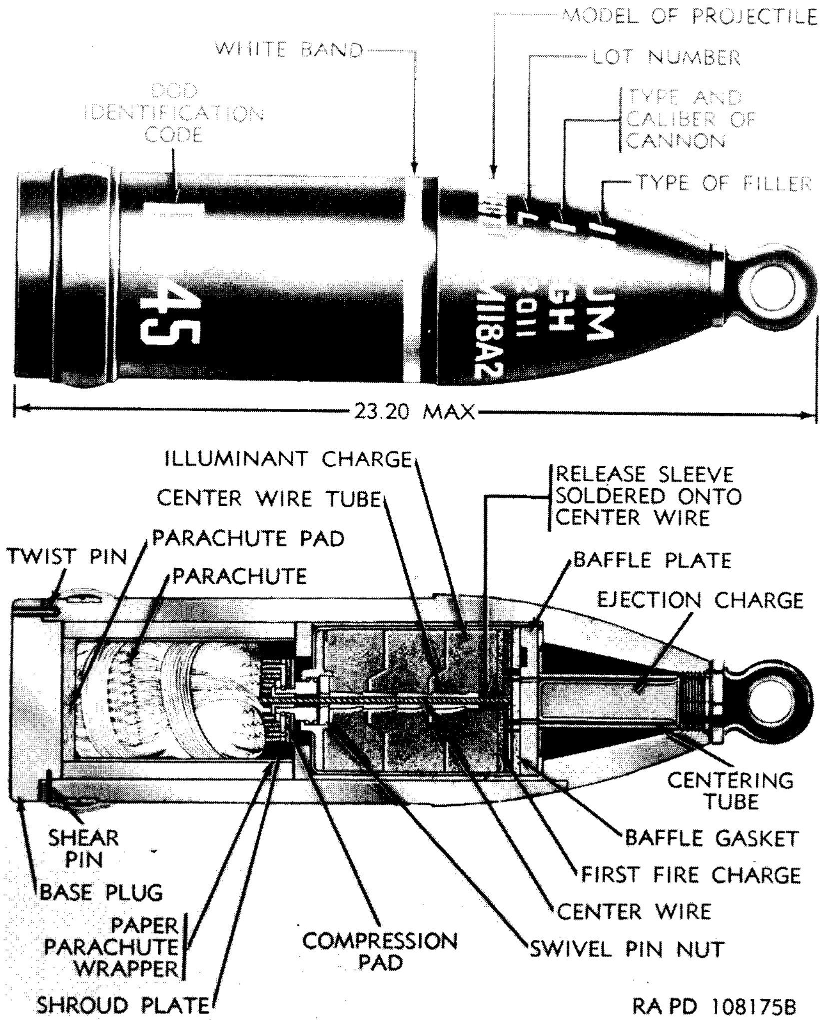


Figure 3-9. 155-mm illuminating projectile M118A2.

i. Illuminating. This type of projectile (figure 3-9) is used to illuminate a target area under conditions of reduced visibility. The projectile contains a payload consisting of a parachute and an illuminant assembly. The projectile is fitted with a pinned base plug and is assembled with a mechanical time fuze. The payload is ejected from the projectile by an expelling charge adjacent to the time fuze and slowly descends, lighting the target area shortly after function of the MT fuze.

j. Chemical.

(1) Burster type (figure 3-10.) This projectile is similar to the high-explosive type except for the filler, which consists of a chemical agent. This projectile has a centrally located burster tube containing an HE burster charge and is fitted with a conventional fuze. The fuze initiates the burster charge which ruptures the projectile body and disperses the chemical filler.

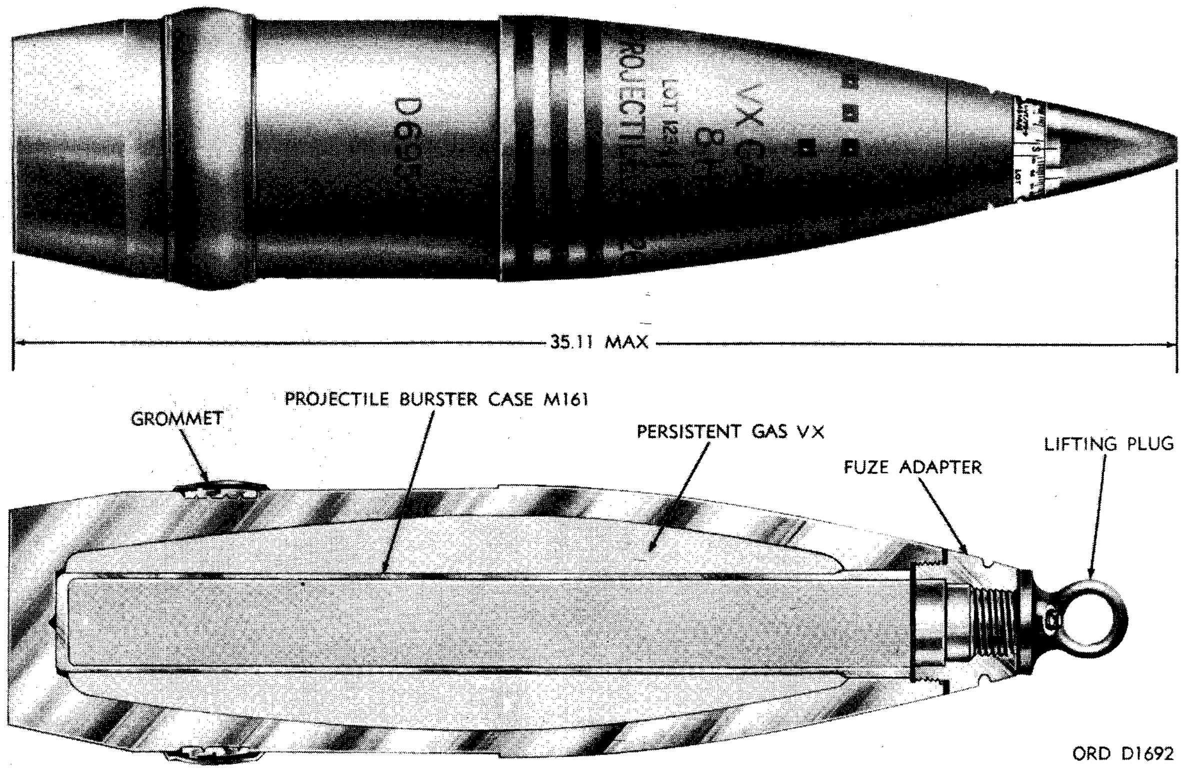


Figure 3-10. 8-inch gas projectile M426.

(2) Base ejection (BE) type. This projectile (figure 3-11) contains a payload of canisters generally loaded with colored smoke composition. The projectile is assembled with a mechanical time fuze, an expelling charge, and a threaded base plug. When the fuze functions, the expelling charge is ignited and expels the base plug and canisters from the projectile. The burning canisters produce a smoke cloud for screening and spotting purposes.

NOTE: The canister in this type of projectile is a container for smoke mixture and should not be confused with the canister round which contains steel slugs or flechettes.

k. Target practice (TP). This type of projectile is usually identical and simulates the ballistic properties of service projectiles and is used for training in marksmanship. The projectile may contain a tracer and/or spotting charge (figure 3-12).

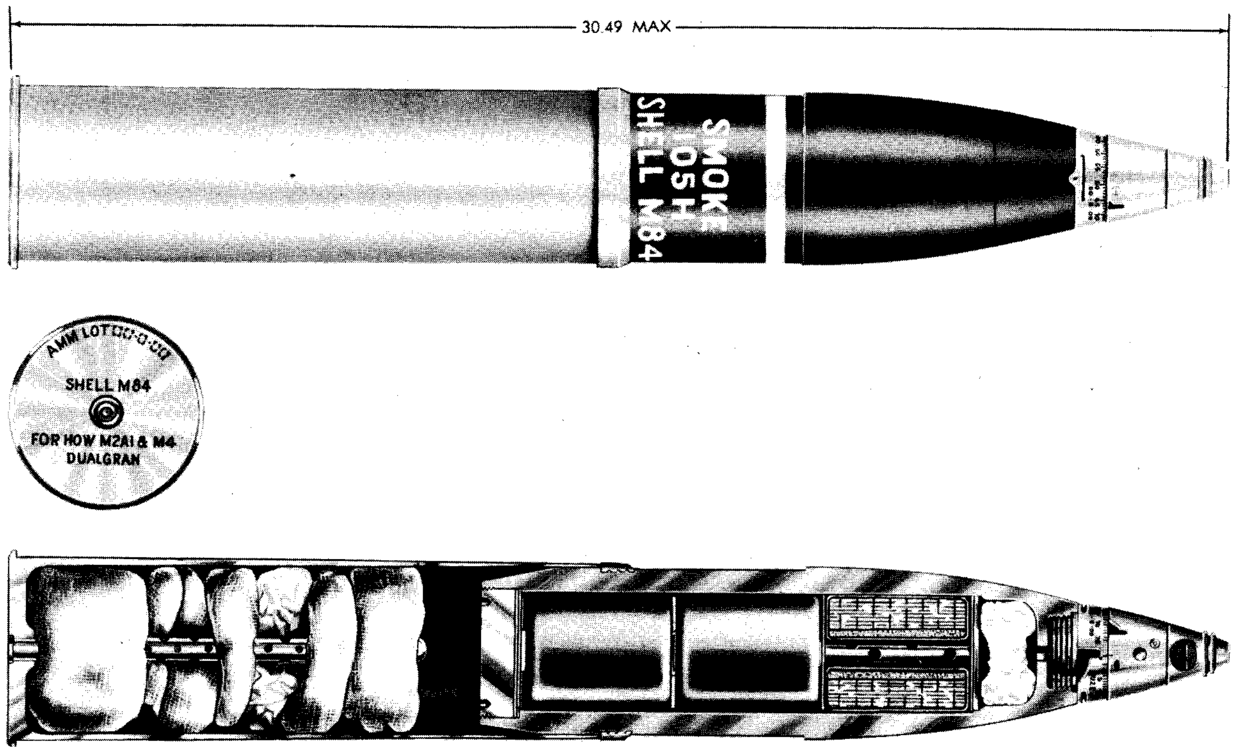


Figure 3-11. 105-mm (HC and colored) BE cartridge M84.

l. Subcaliber ammunition. This ammunition is used in subcaliber guns for the purpose of reducing bore wear, conserving ammunition,and making the use of shorter firing ranges possible during practice firing and training. A representative type cartridge (figure 3-13) is a 37-mm target-practice (TP) round, consisting of a steel projectile loaded with pressed black powder fitted with a base-detonating practice fuse and crimped to a steel cartridge case. This cartridge is used in **the subcaliber weapon applicable to the 75, 76, 90, 105, 155-mm and 8-inch weapons.**

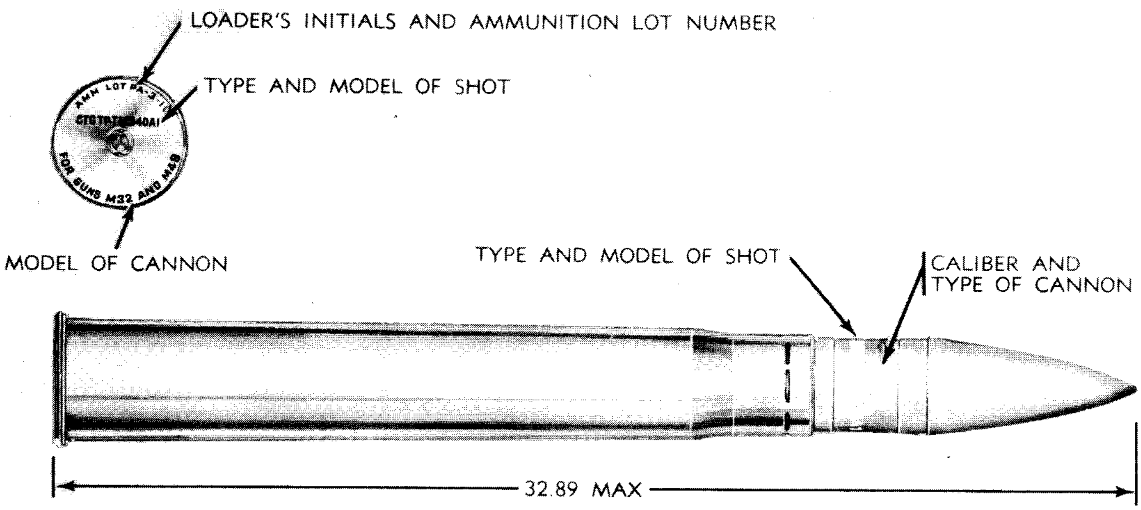


Figure 3-12. 76-mm TP-T cartridge M340A1.

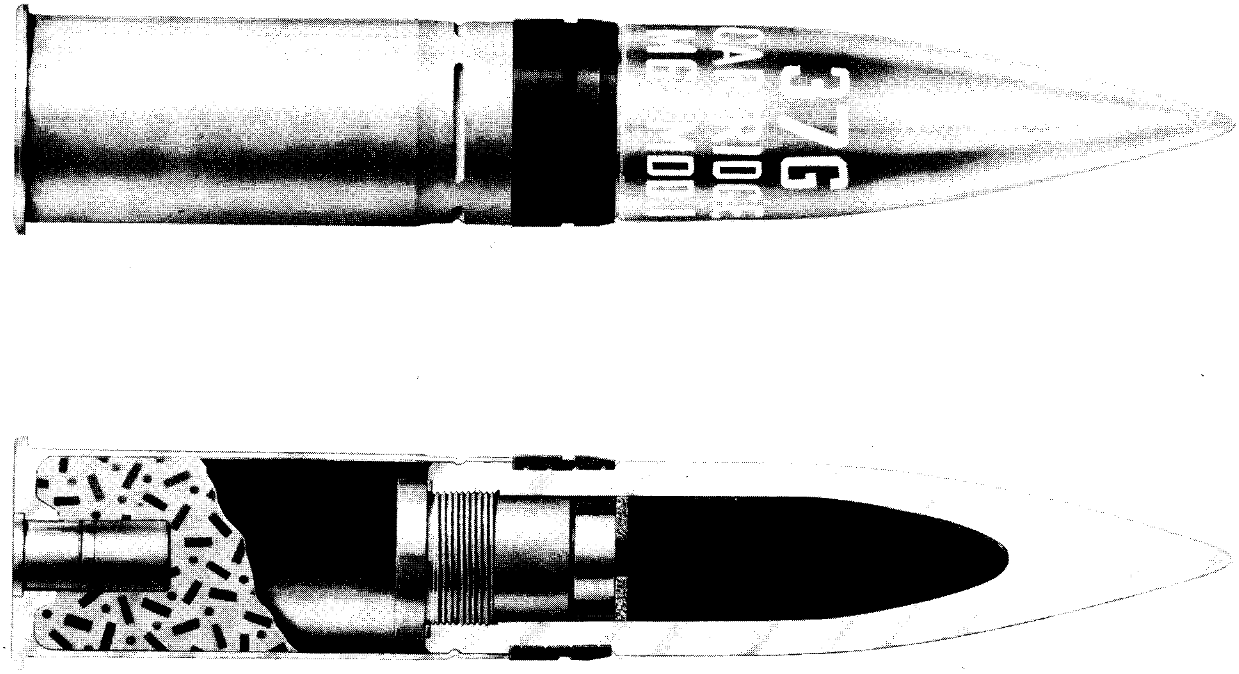


Figure 3-13. 37-mm (subcaliber) TP cartridge M63, Mod 1.

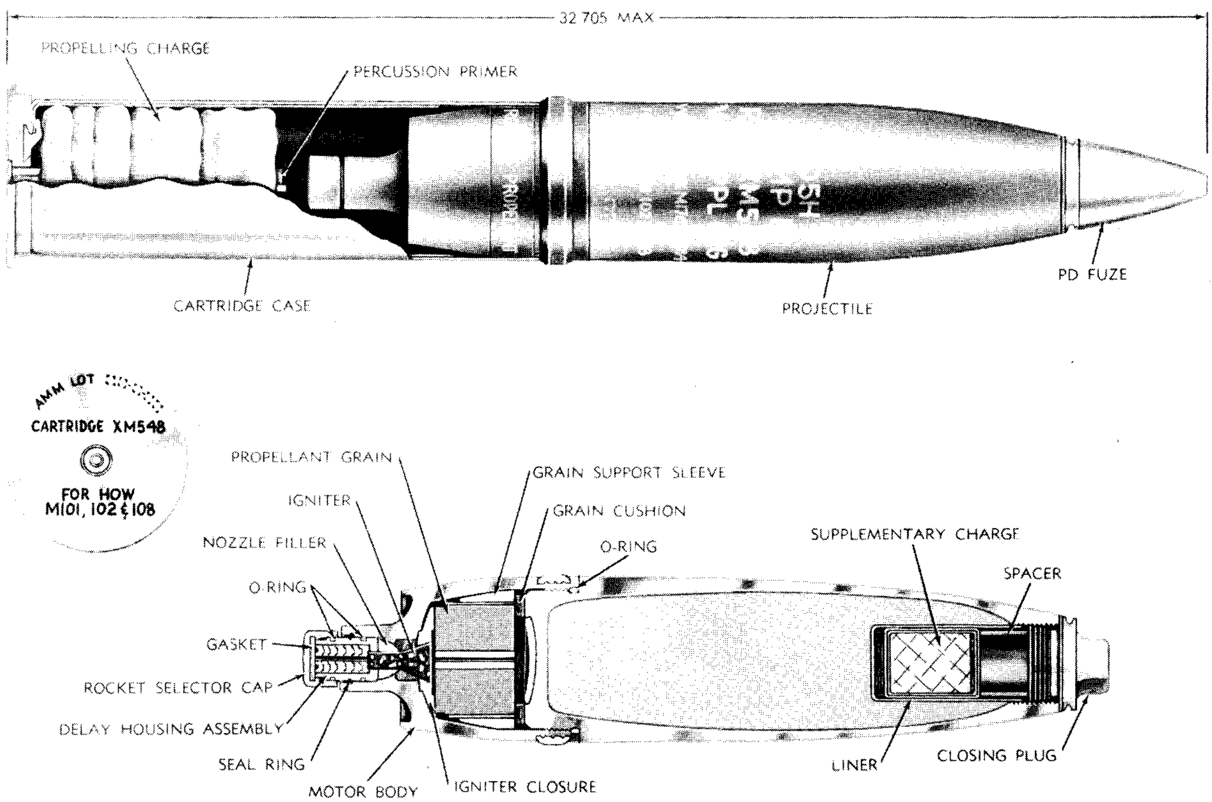


Figure 3-14. 105-mm HERA cartridge XM548.

m. High explosive, rocket assisted cartridge (HERA). This cartridge (figure 3-14) is used against personnel and materiel, producing blast and fragmentation at the target. The cartridge has an increased maximum range, reduced minimum range, and greater lethality than the standard HE cartridge. The projectile is unique in that it is assembled with an integral rocket motor, containing one pound of propellant, threaded in its base. It is a deep cavity type and is loaded with approximately 5.5 pounds of composition B. This projectile has a muzzle velocity of 1,800 fps and a maximum range of 13,716 meters.

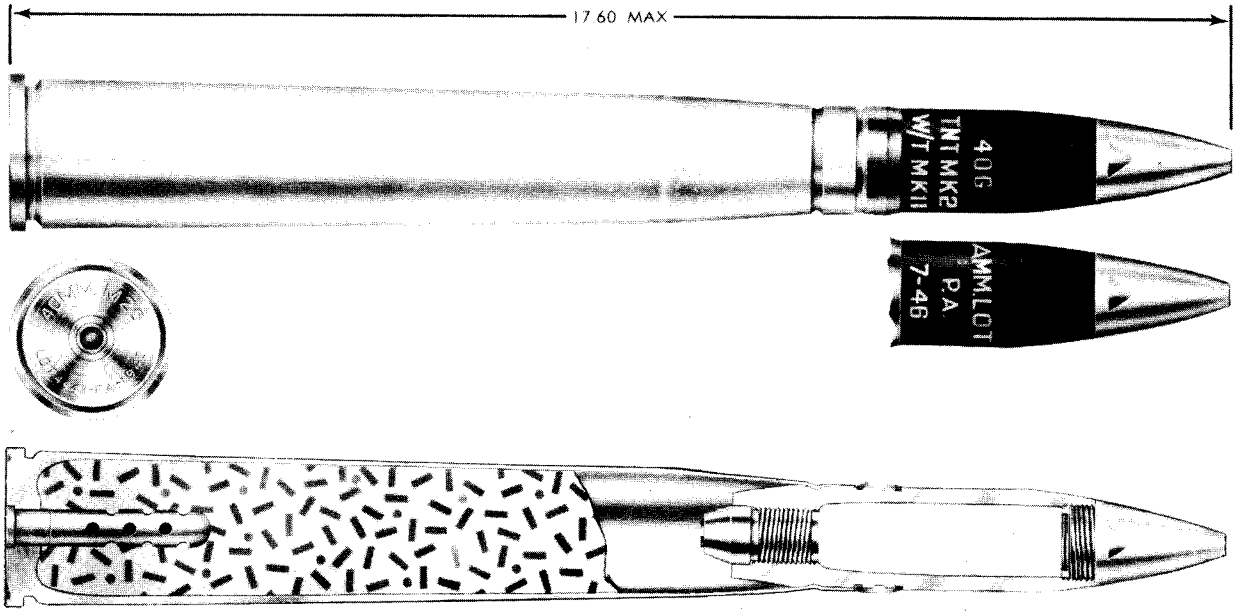


Figure 3-15. 40-mm HE-T, SD cartridge Mk11, Mk2.

n. Cartridge, 40-mm: High Explosive, Tracer, Shell Destroying (HE-T-SD) (figure 3-15) is used for firing against aircraft. The cartridge consists of either brass or steel case primed with a percussion primer, loaded with M1 propellant, and crimped to the projectile by means of a 360 degree crimp. The projectile contains a bursting charge of pressed TNT or a high-explosive incendiary combination (HEI-T) charge. The nose of the projectile is internally threaded to receive a PD fuze. The boattailed base is threaded internally to receive the shell-destroying tracer assembly. The projectile is detonated by contact with the target or by the burning of the shell-destroying tracer, whichever occurs first. The tracer composition burns with a visible trace for 8 to 10 seconds, equivalent to a range of 3,800 to 4,300 yards. The fuze on the HE-T projectile is painted green and white (green tip on fuze); the fuze on the HEI-T projectile is painted red and white (red tip on fuze).

o. Cartridge, 152-mm: High Explosive Antitank, Tracer, Multipurpose (HEAT-T-MP) (figure 3-16). This cartridge is fired from the 152-mm gun/launcher which is capable of firing both the Shillelagh missile and conventional ammunition. The projectile is assembled to a combustible cartridge case and consists of two parts, a base and a body, which are made of felted nitrocellulose. The cartridge case holds a bagged propelling charge and is fitted with a consumable electric primer. The case is also a part of the propelling charge. The projectile is a chemical energy, armor-defeating shaped charge type with antipersonnel capability assembled with a point initiating, base detonating (PIBD) fuze utilizing a control-power supply which provides the electrical energy for initiation, and is housed in a two-piece windshield cap. The projectile is loaded with approximately 6.3 pounds of composition B and is assembled with a base plug containing a tracer element. The fuze PIBD,

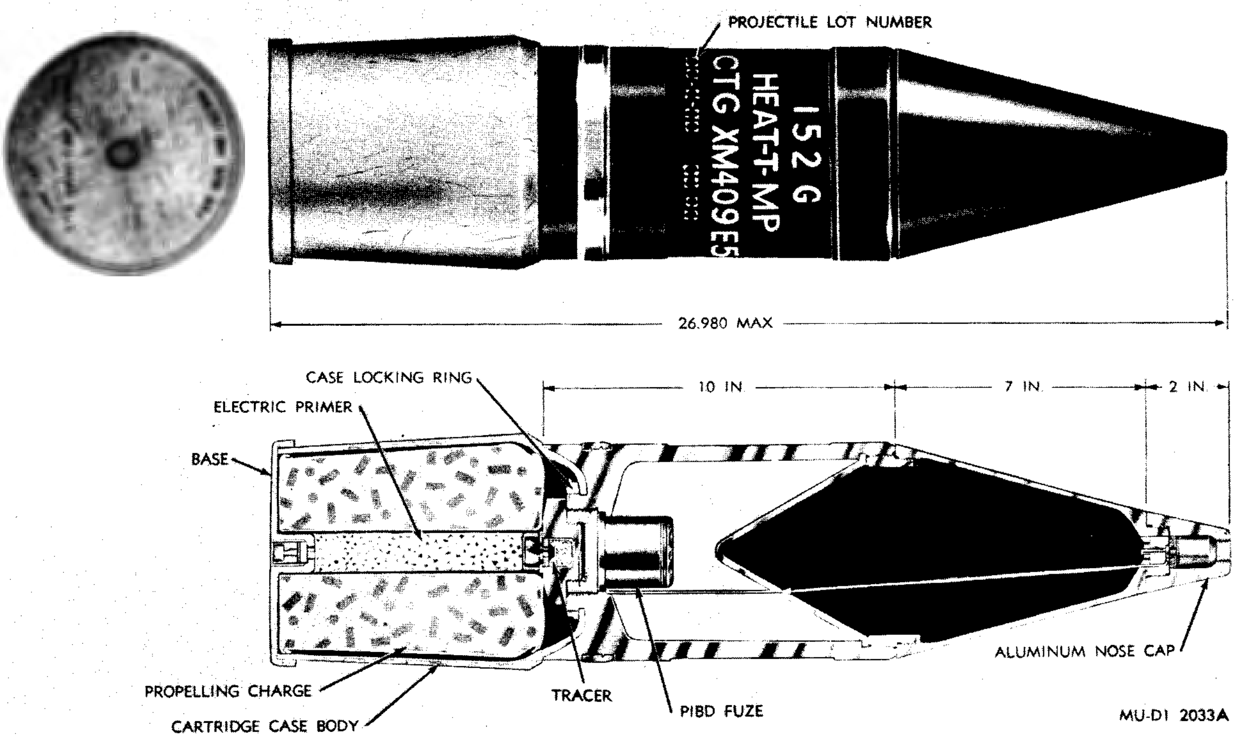


Figure 3-16. 152-mm HEAT-T-MP cartridge XM409E5.

XM539E4 has a controlled power supply XM22E2. The rotor of the fuze is controlled by a rotor return mechanism which returns the rotor to the UNARMED position upon spin decay in case of partial arming during rough handling or in case of failure to function when fired. Upon firing, and due to setback decay, the control-power supply is charged with electric energy which it stores during projectile flight. Arming occurs as spin is developed; the rotor detents move outward by centrifugal force allowing the rotor to align with the detonator. Crushing of the nose on impact or deceleration caused by graze action causes a switch to close, discharging the stored electric energy to the detonator. The functioning of the fuze detonates the explosive charge of comp B, collapsing the copper cone and creating a high-velocity shock wave and a jet of metal particles which penetrate the target. For antipersonnel use, the fuze will function due to graze action rather than impact, and the blast and fragmentation effect created by the detonation of the explosive charge inflects casualties among personnel. The cartridge is easily identified by its distinctive combustible cartridge case which is light yellow and has a texture similar to fiberboard. The projectile is painted black with yellow markings. The propellant assemblage weighs 6 pounds giving the projectile a muzzle velocity of 2,250 fps and a range of 9,850 yards.

p. Painting and color coding.

(1) Ammunition is painted primarily to prevent rust, but is identified by color codes applied to ammunition items at such locations as to be readily visible and identifiable under normal storage and handling conditions. This does not apply to cartridge cases, or packaging from which the ammunition is removed prior to use. Color coding shall be applied to all ammunition items as required by the applicable specifications and drawings (See table 3-1).

(2) Marking (figure 3-17) (stencilled on the projectile).

Table 3-1. Painting and Marking of Ammunition

Ammunition	Painting and marking of ammunition of earlier manufacture	Painting and marking of ammunition of recent manufacture
HE	Olive drab w/yellow marking.	Olive drab w/yellow marking
HEAT	Olive drab w/yellow marking.	Black w/yellow marking
HEP (over 40 mm)	Olive drab, black band, w/yellow marking.	Olive drab, black band, w/yellow marking.
Smoke (except WP or PWP)	Gray w/one yellow band w/yellow marking.	Light green w/black marking
Smoke (WP or PWP)	Gray w/one yellow band w/yellow marking.	Light green, yellow band, w/light red marking.
Illuminating	Gray w/one white band w/white marking.	White w/black marking
Separate Loading, Projectile Illuminating	Gray, white band w/white marking.	Olive drab w/white band and white marking.
Practice w/o explosive filler	Blue or black w/white marking.	Blue w/white marking
Practice w/high explosive	Blue or black w/white marking.	Blue, yellow band, w/white marking.
Practice w/low explosive	Blue or black w/white marking.	Blue, brown band, w/white marking.
Chemical: Persistent Toxic Agent	Gray w/two green bands and green marking.	Gray, two green bands, green marking, add one yellow band w/ explosive burster.
Nonpersistent Toxic Agent	Gray w/one green band and green marking.	Gray, w/one green band, green marking. Add one yellow band w/ explosive burster
Persistent Irritant Agent	Gray w/two red bands and red marking	Gray w/two red bands, red marking. add one yellow band w/explosive burster
Nonpersistent Irritant Agent	Gray w/one red band and red marking	Gray, w/one red band, red marking. Add one yellow band w/explosive burster.
"G" and "V" Series Agent	Gray w/one green band for "G" Series, two green bands for "V" Series, green marking	Gray, w/three green bands, green marking. add one yellow band w/ explosive burster
AP&APDS w/o Filler	Black w/white marking	Black w/white marking
AP w/high Explosive Filler	Black w/yellow marking	Black w/yellow marking
Cartridge, APERS w/Flechettes		Olive drab, yellow band, white marking, white diamonds
Canister w/Slugs	Black w/white marking	Olive drab w/white marking
Canister w/Fletchettes		Olive drab w/white marking and white diamonds
Dummy	Black or blue w/white marking	Bronze w/white marking

(a) Federal stock number and DOD ammunition code on separate loading projectiles (e.g., 1325-028-5298 (E450)).

(b) Caliber and type of weapon (e.g., 75H or G); kind of filler (TNT, WP SMOKE, etc.); use (APERS, CANISTER, etc.).

(c) Type or model of projectile with T to indicate presence of a tracer (PROJECTILE APC-T, M61A1, etc.).

(d) W/SUPPL CHG, when projectile has a deep cavity and contains a supplementary charge.

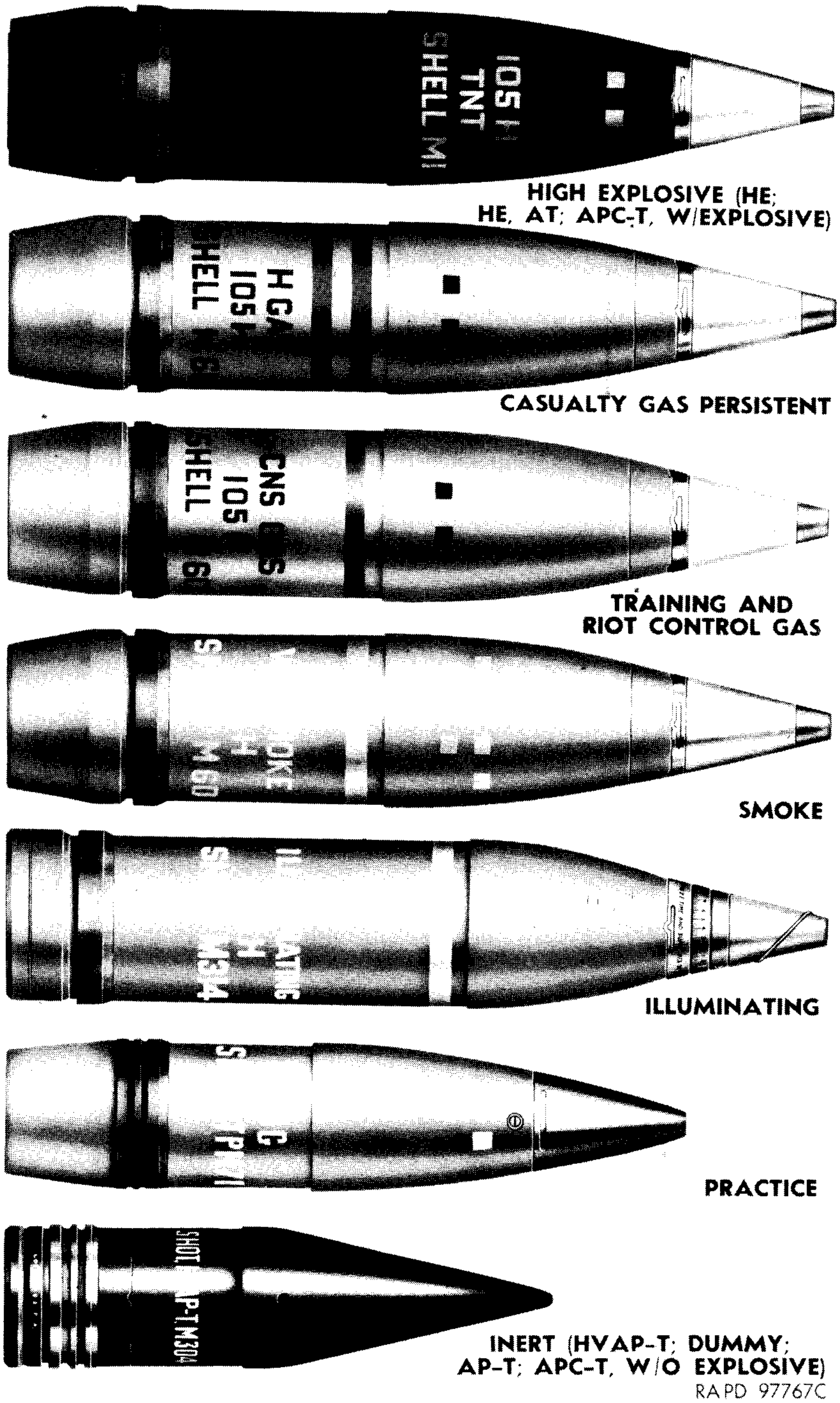


Figure 3-17. Identification and typical markings of projectiles.

(e) FOR PROXIMITY FUZE, FUZE M513 (T226) for projectile having supplementary charge.

(f) W/SPOTTING CHG when a spotting charge is present.

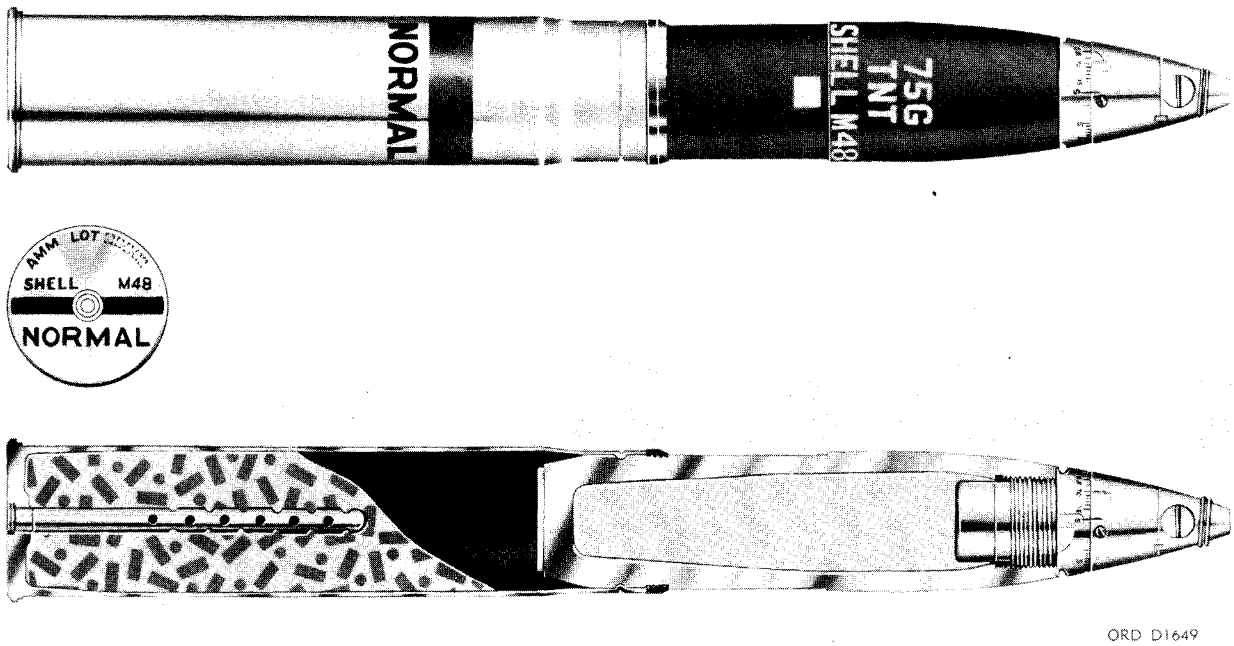


Figure 3-18. 75-mm HE cartridge M48, normal charge.

(g) LOT NUMBER stencilled on all artillery components.

(h) Weight zone (squares) or weight to nearest pound of loaded projectile, 75-mm through 8 inch to indicate variations in weight for ballistic corrections.

(3) Marking (stencilled on cartridge case) (figure 3-18).

(a) Ammunition lot number and loader's initials. For 37-mm and 40-mm cartridges, the ammunition lot number appears on the projectile instead of the base of the cartridge case.

(b) For 75-mm and 76-mm cartridges: NORMAL under one black stripe and REDUCED under two black stripes; SUPER, indicating supercharge.

(c) For HVAP-T rounds: HYPERVELOCITY MV (3,600) in red, indicating a high velocity round and a muzzle velocity of 3,600 feet or meters per second.

(4) Propelling charges (figures 3-19 and 3-20).

(a) Designation of section; e. g., BASE CHG INCR or INCREMENT, CHARGE 2, etc., model of charge; CHARGE M1A1.

(b) Stenciling on igniter e.g., IGNITER 5 OZ. GR. A-1, CHGE M1, 8 IN. H, M1, indicating weight, grade and kind of powder, caliber and model of weapon in which fired.

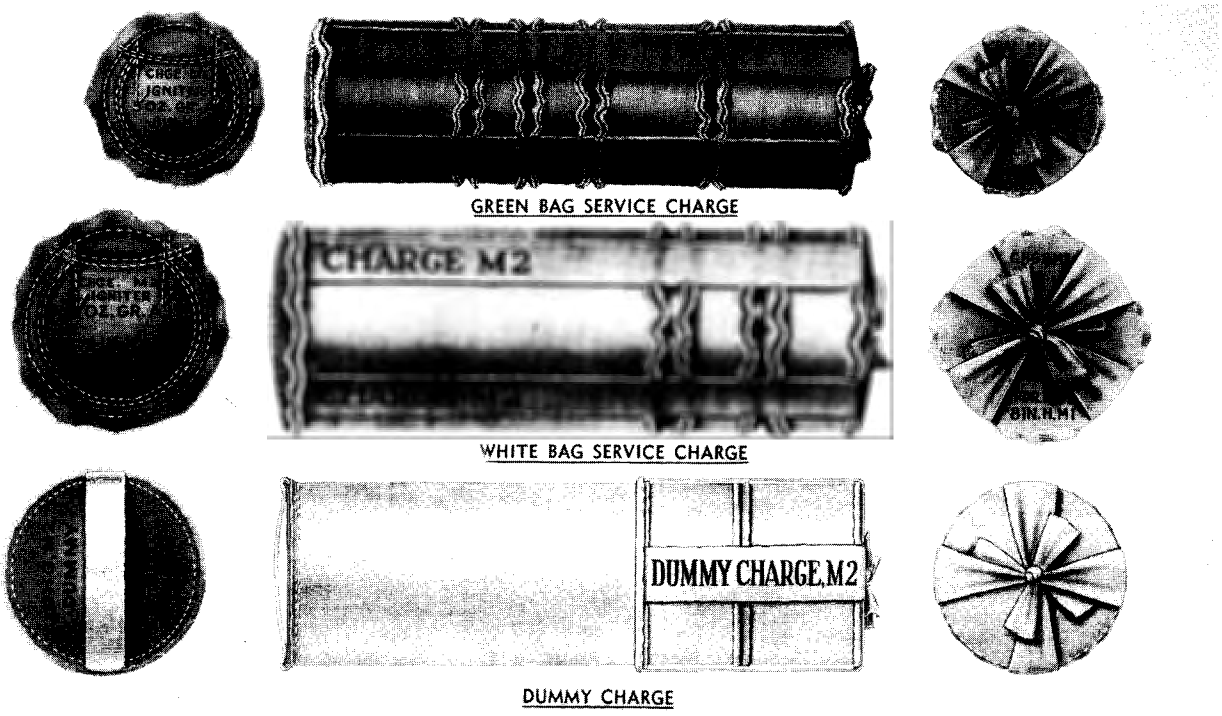


Figure 3-19. Typical propelling charges.

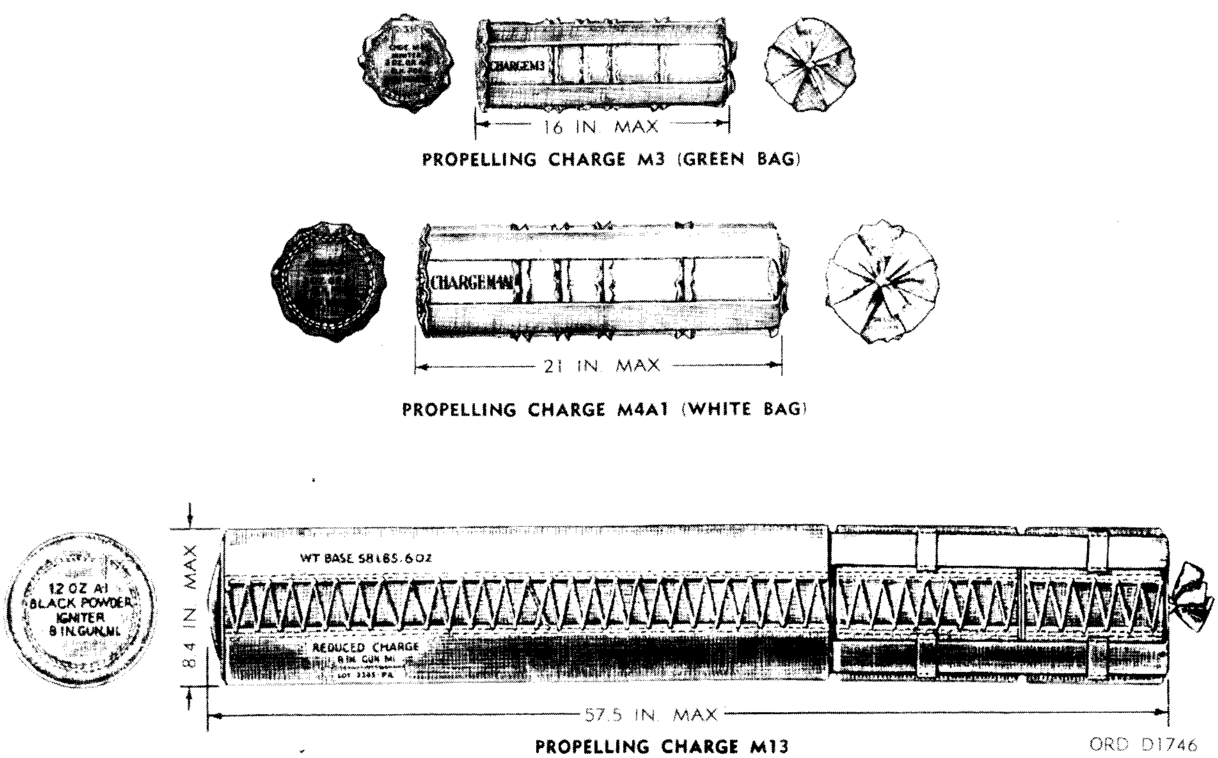


Figure 3-20. Separate-loading propelling charges.

q. Packing and marking.

(1) General. Ammunition packing containers (figures 3-21, 22, and 23) are marked in accordance with pertinent drawings and specifications. Containers are designed to withstand conditions normally encountered in handling, storage, and transportation to comply with Department of Transportation regulations (DOT) (formerly ICC regs). Moisture-resistant containers are used for practically all ammunition except separate-loading projectiles. Jungle packs are steel containers (figure 3-22) sealed to withstand humid and extremely hot climates. Palletization is used to reduce handling time and to facilitate storing and shipping. Specific packing data for each ammunition item will be found in supply catalogs.

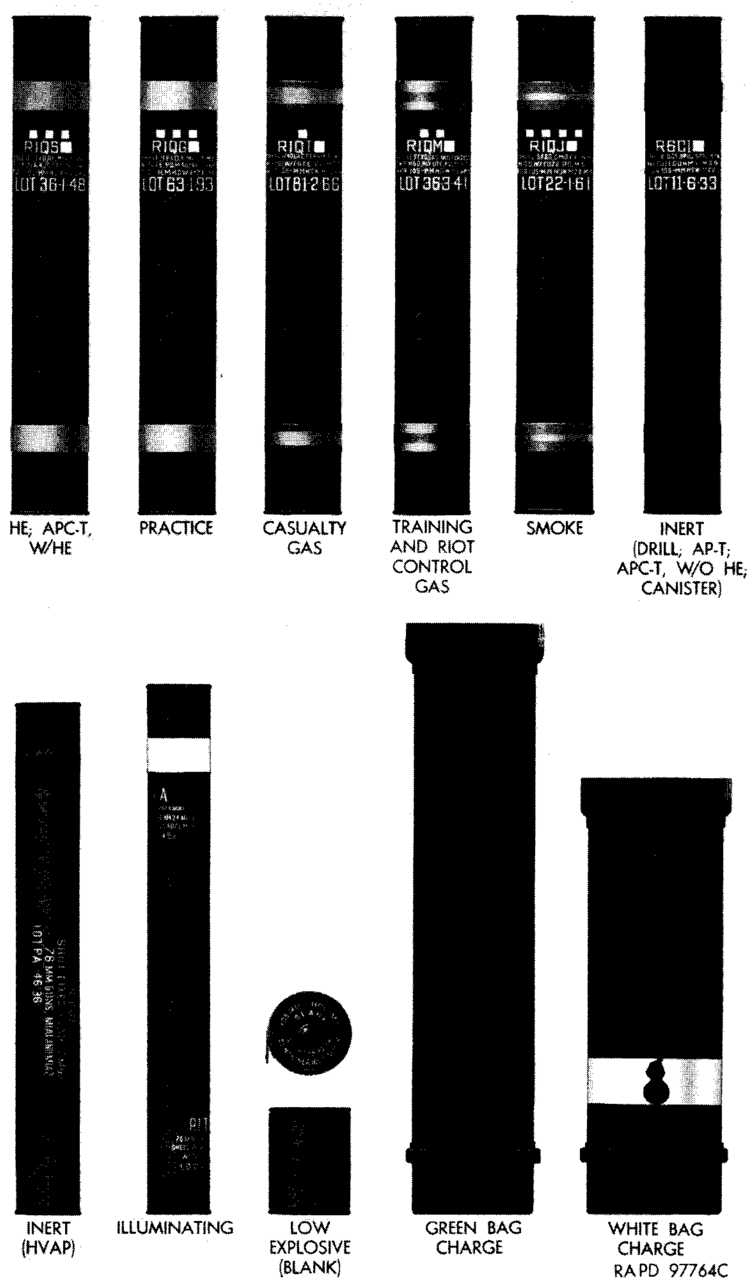


Figure 3-21. Typical fiber and metal containers.

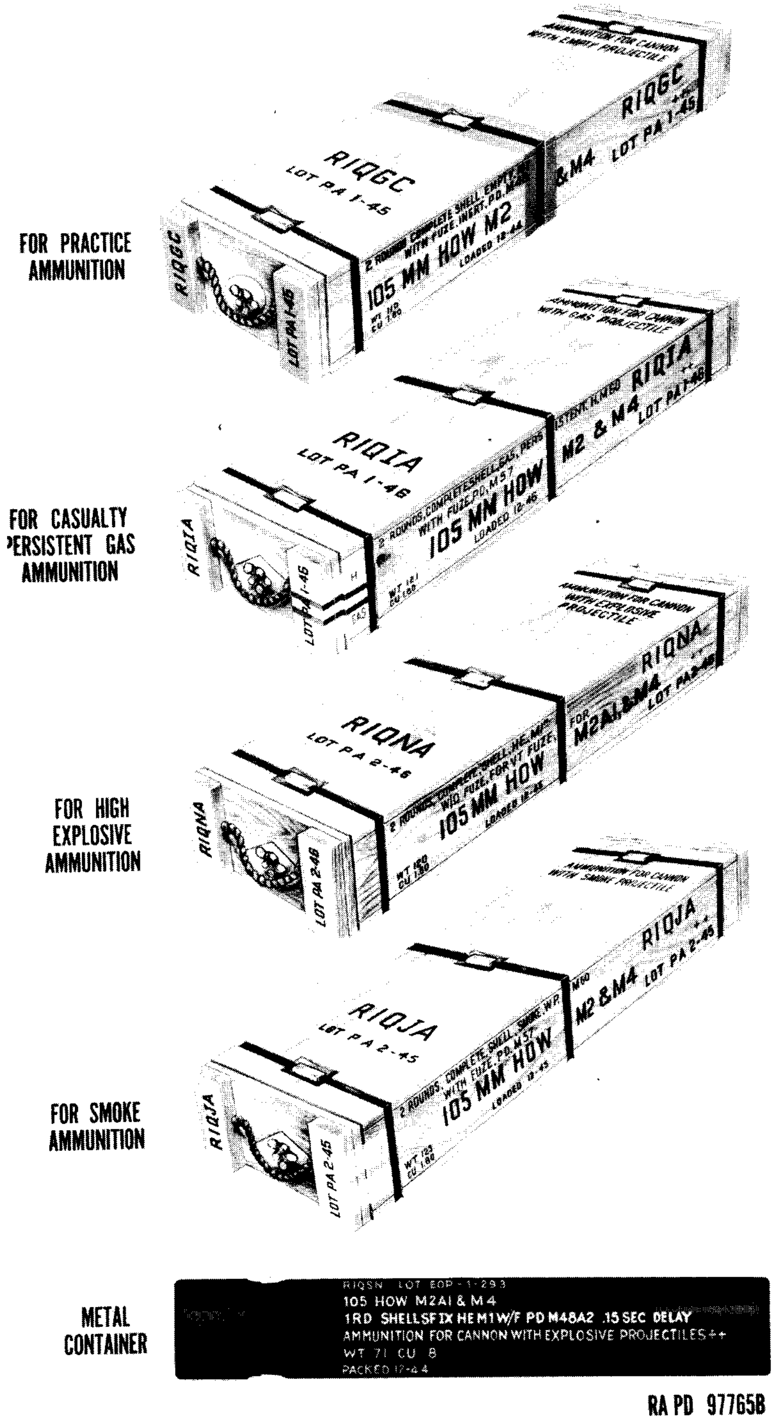


Figure 3-22. Typical packing boxes and metal containers.

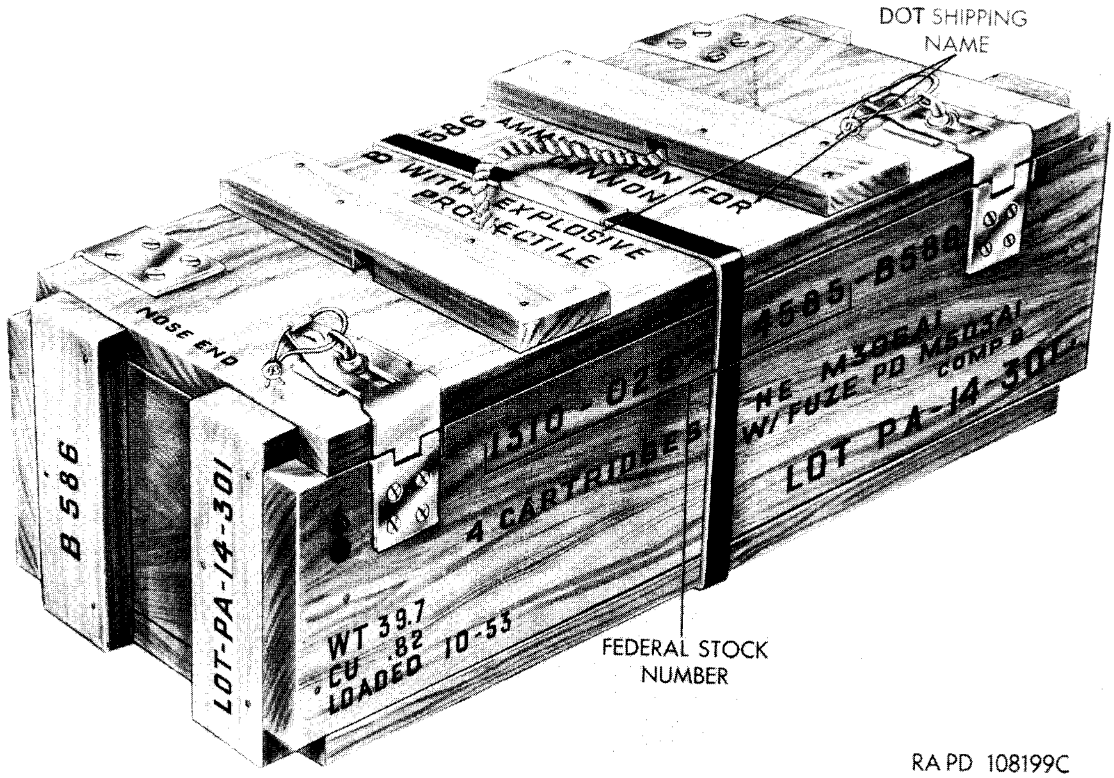


Figure 3-23. Typical packing of ammunition.

(2) Fixed and semifixed ammunition. These cartridges, through 105-mm, are packed in fiber containers (figure 3-21) and overpacked in wooden boxes or metal containers (figures 3-22 and 23). Cartridges in fiber containers assembled with point-fuzed projectiles may have V-shaped packing stops fitted into the fuze wrench slots. These stops must be removed before firing. The one-round container is cylindrical, made of steel, and sealed against moisture by a rubber gasket in the sealing cover. To preclude tampering, the outer packing containers are sealed. Lead seals are stamped US (United States), UES (Europe) or UJS (Japan) to indicate where ammunition is manufactured. Adhesive sealing strips seal the joints of all inner containers and are in the same color as the color coding scheme as indicated in table 3-1. Red sealing strips on blank ammunition, for example, indicate low explosives (black powder); yellow strips indicate cartridges with high explosive projectiles. Ammunition containers manufactured after December 1961 (except those containing chemical ammunition) are sealed with black sealing strips. Inner containers for chemical cartridges will be indicated by a gray strip and for smoke rounds a light green strip.

(3) Separate-loading components. Separate loading projectiles, which require no outer packing, are shipped boxed, crated, uncrated or palletized, and unfuzed with an eye-bolt lifting plug in the nose and a grommet to protect the rotating band. Propelling charges are packed in airtight metal containers or fiber containers overpacked in wooden boxes. An igniter protector cap, of cloth, paper or plastic, covers the igniter end of the base charge during storage and shipment. Primers are packed 48 to a sealed metal can overpacked in a wooden box. (Primers are also packed one or two in the propelling charge container.)

(4) Separated ammunition. Projectiles are packed one per fiber container, two fiber containers per wooden box. Propelling charges are packed one per fiber container (propellant in sealed cartridge case), two fiber containers per wooden box. This ammunition is also packed as a

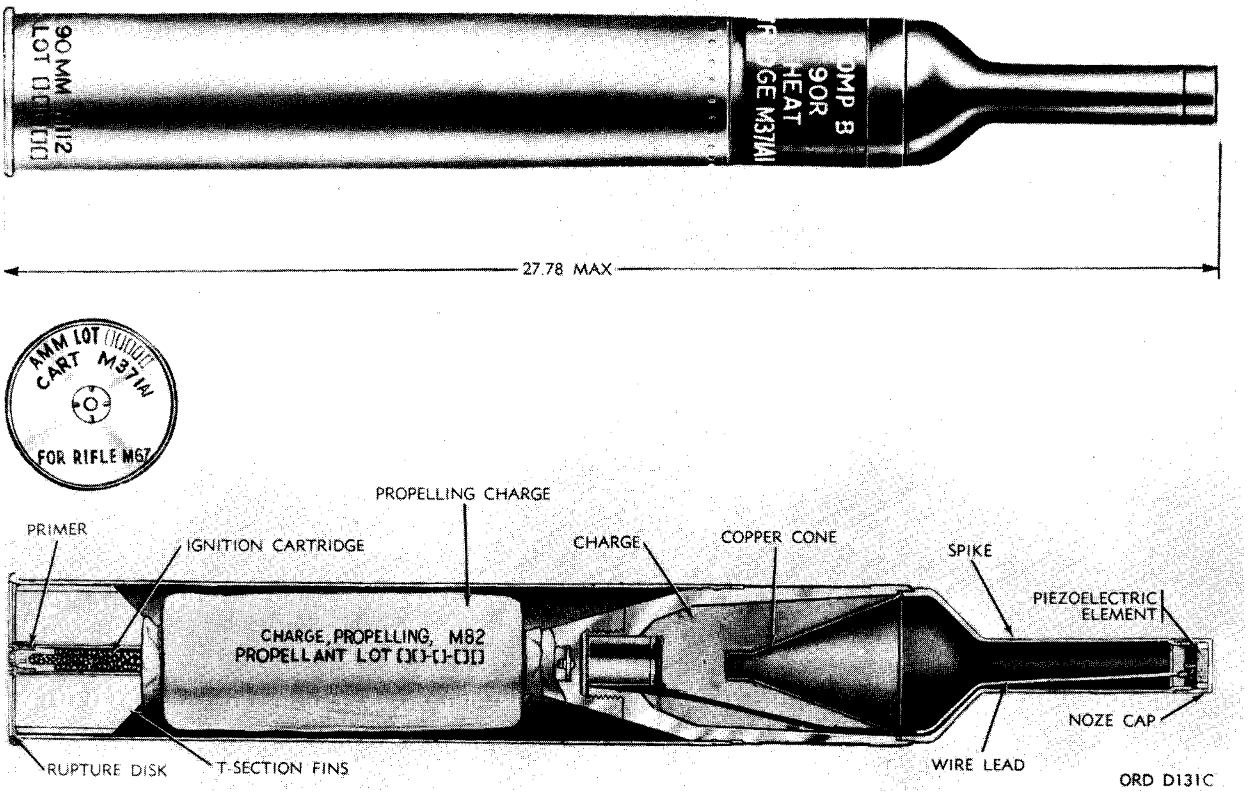


Figure 3-24. 90-mm HEAT cartridge M371A1.

complete round, propelling charge and projectile each in fiber containers, one round per wooden box.

5. RECOILLESS RIFLE AMMUNITION (Figure 3-24).

a. Projectiles for this ammunition, except for canister rounds, are of thin-walled steel with conical, curved or spiked noses and square, boattailed or finned bases. The interior contour of the projectile varies from model to model to accommodate different type fuzes and fillers. Bourrelets provide bearing surfaces for the projectile during its travel through the rifle bore. Stabilization in flight is achieved by rotating bands (for spin stabilization) or fins. Spin-stabilized projectiles have pre-engraved rotating bands made of steel (integral with the projectile) or of gilding metal. Fin-stabilized projectiles are fitted with a fixed boom and fin assembly or folding fins attached to the rear of the projectile.

b. Cartridge case. Cartridge cases used with most recoilless rifle ammunition are made of steel and are distinguished by circular perforations in the sidewalls of the case. These openings allow for escape of gas to the rear of the weapon, counteracting recoil. The propellant is retained in a rayon plastic liner within the cartridge case. In most instances, the cartridge case is rigidly attached to the projectile by equally-spaced ball point or stab crimps. Cartridge cases of all 90-mm recoilless rifle ammunition (figure 3-24) are unlike the perforated cases in other recoilless rifle ammunition; the 90-mm cartridge case is an unperforated aluminum cylinder fitted at the base with a plastic rupture disc. The function of the rupture disc is to obturate the rearward gas flow during the early stages of propellant combustion, and to seal and protect the propelling charge prior to firing. Recoilless rifles use most of the same types of projectiles as are applicable to the standard gun and howitzer weapons.

6. MORTAR AMMUNITION.

a. Major components.

(1) Projectiles. Projectiles for mortar ammunition are made of iron or steel. The interior and exterior configuration varies from model to model to accommodate different fuzes, fillers and means of stabilization in flight. Stabilization in flight is achieved by spin or through the use of fins.

(a) Rotating disks. Spin stabilized cartridges have a rotating disk near the base which expands into the rifling of the mortar tube when the cartridge is fired. The rotating disk provides a gas seal that prevents escape of a large percentage of the propellant gases forward of the projectile and imparts spin to the projectile to stabilize it in flight.

(b) Fins. Fins are attached to the base of projectiles that are fired in smooth bore tubes to stabilize the projectile in flight.

(2) Propelling charges. Propelling charges used in mortar ammunition are adjustable in that the amount of propellant used can be adjusted to engage targets at various ranges. The propellant used in mortar ammunition is of two types: sheet propellant, in increment form (inclosed in cellophane envelopes), or granular propellant contained in water repellant cotton bags.

(3) Ignition cartridges and primers. The ignition cartridges and primers used in this ammunition are the percussion type. They are used as a base charge for training and also serve to ignite the various propellant increment charges as required for adjustment of range.

(4) Types - classification.

(a) High explosive (HE). This type of cartridge contains a large bursting charge of high explosive which produces blast and fragmentation and is used against personnel and light materiel targets.

(b) Smoke (WP), (FS). These are similar to high-explosive cartridges except that they are loaded with white phosphorus or a smoke composition and a burster assembly which ruptures the projectile and aids in dispersing the smoke filler.

(c) Chemical agents. (H, HD, CG, etc.). These cartridges are similar to smoke cartridges except that a casualty-producing chemical agent is used as a filler.

(d) Illuminating (Illum). These cartridges contain a pyrotechnic candle and a parachute assembly that are ejected in flight. They are used to provide night illumination of targets, enemy positions, etc.

(e) Target practice (TP). These cartridges have the same configuration, weight and center of gravity as service cartridges. This ammunition, which may be inert or fitted with a spotting charge and fuze, is used in marksmanship training.

(f) Training. This ammunition is provided to train personnel in the techniques of handling and firing the mortar. The projectile is inert and used with reduced increment propelling charge. Most training cartridges may be recovered and reused by replacing the propelling charge and primer.

b. Representative cartridges of mortar ammunition.

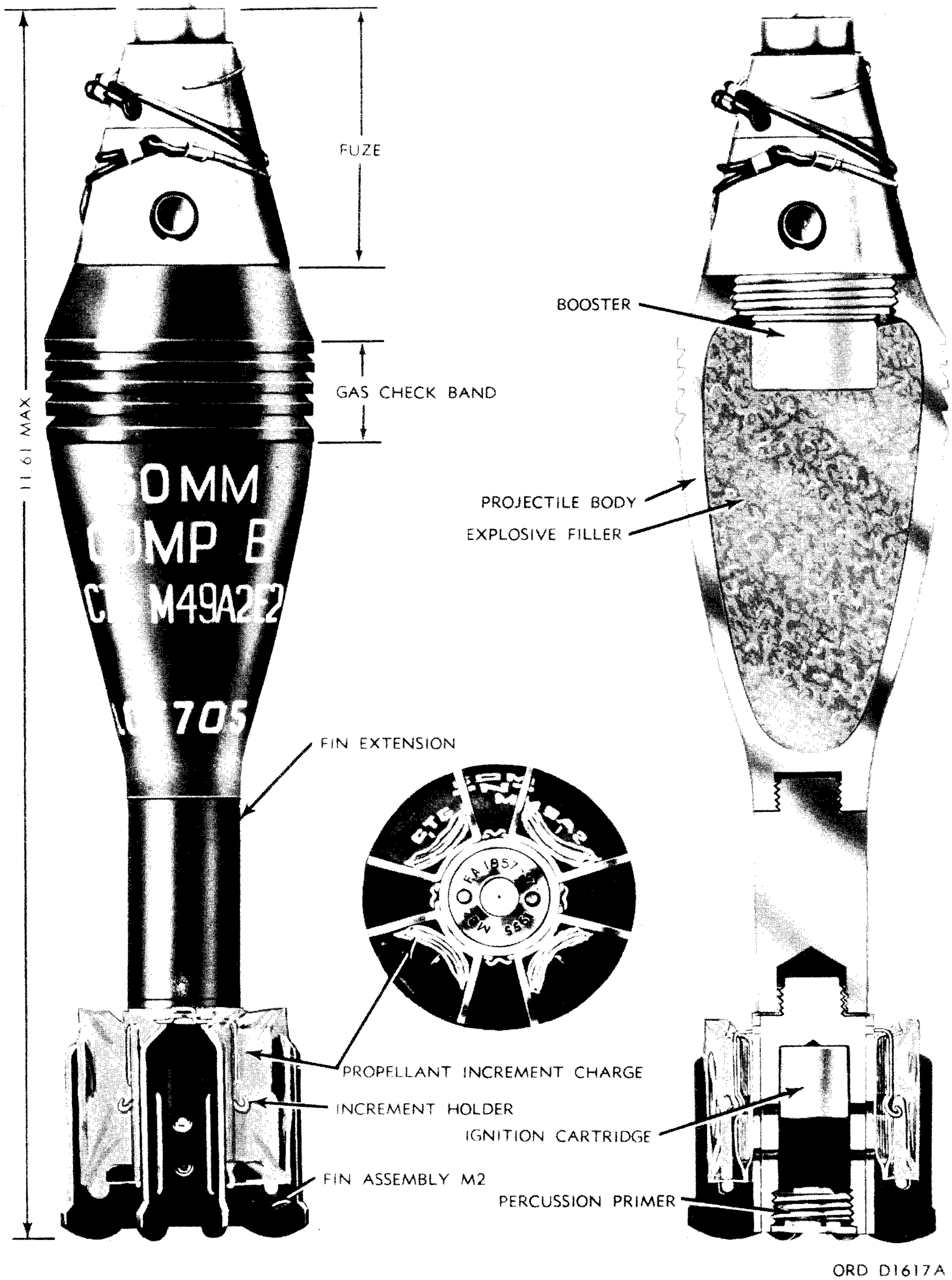


Figure 3-25. 60-mm HE cartridge M49A2E2.

(1) The 60-mm HE cartridge (figure 3-25).

(a) Description. The complete round consists of a forged steel or malleable iron projectile body, a composition B bursting charge, a PD fuze, a 2-inch fin extension, a fin assembly with four propellant increment charges, an ignition cartridge, and a percussion primer. The fuse is assembled and staked to the threaded projectile nose. The fin assembly is attached to the projectile body by the fin extension. The hollow perforated fin assembly shaft is threaded at its base and receives both the ignition cartridge and the threaded percussion primer. The perforations provide for transmission of the cartridge flash to the propellant increment charges. The increment charges are inserted between the blades of each fin and held in position by a spring-clip increment holder. Any or all of the increments may be removed for fire adjustment by pulling them from under the increment holder clips.

(b) Data. This cartridge weighs 3.2 pounds as fired, has a muzzle velocity of 159 meters per second, and a maximum range of 1,795 meters when fired with maximum charge.

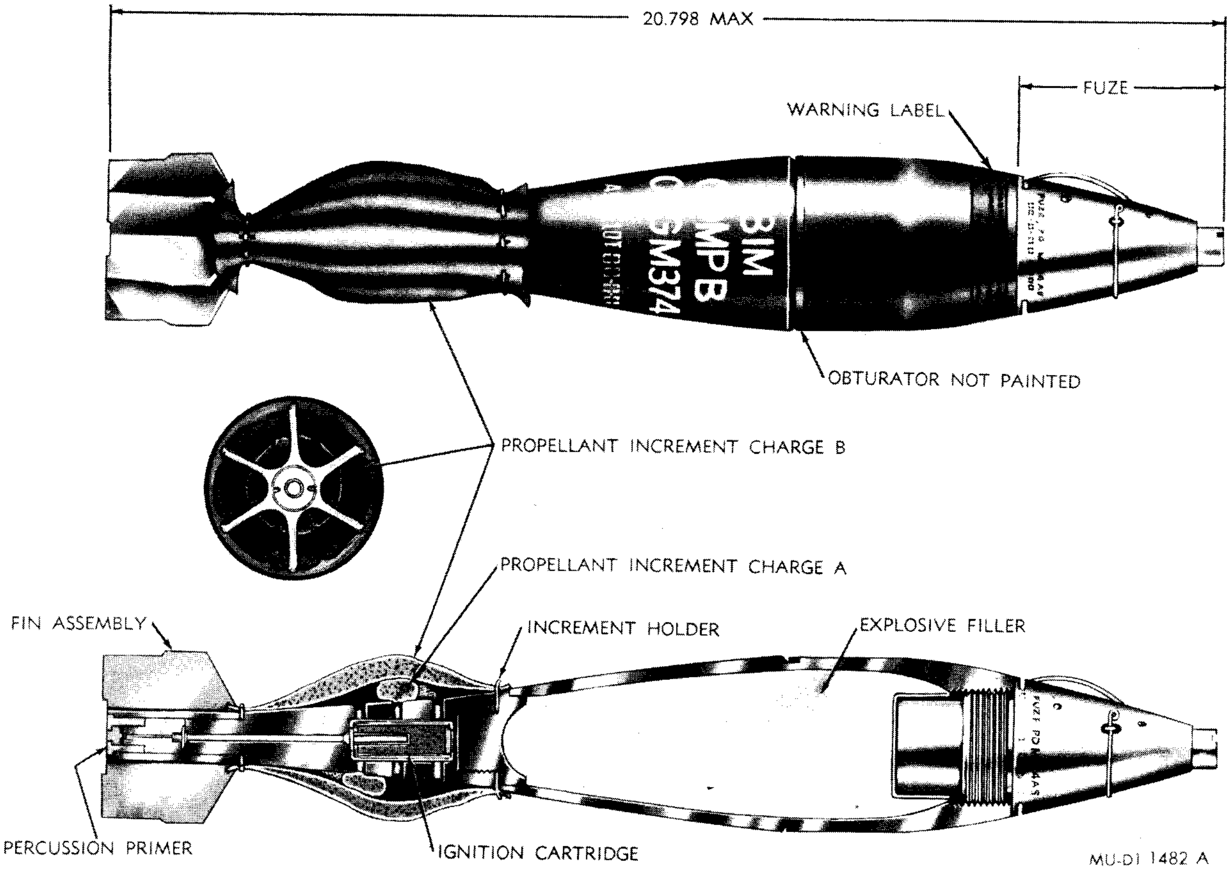


Figure 3-26. 81-mm HE cartridge M374.

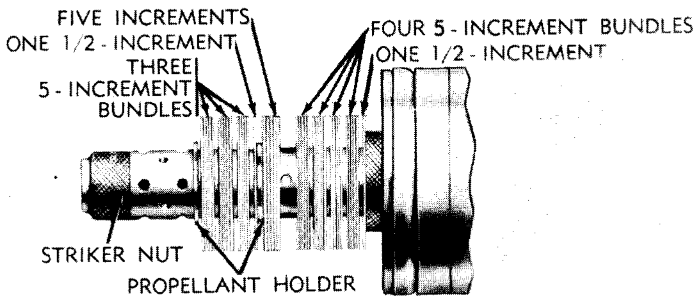
(2) The 81-mm HE cartridge (figure 3-26).

(a) Description. This cartridge provides increased range, accuracy, and terminal effectiveness on all targets. The projectile is fitted with a polyvinyl chloride gas check ring in a groove and serves as an obturator, an aluminum fin assembly consisting of an ignition cartridge housing, and six extruded fins threaded to the rear of the projectile. Steel increment holders hold the propellant increments in place around the exterior of the ignition cartridge housing. The fins, attached to the rear of the housing, are canted counterclockwise five degrees at the rear to impart rotation in flight. The propelling charge consists of nine increments of flake propellant and is contained in water-repellant cotton cloth bags. The bags are attached to the fin assembly housing by engaging buttonholes over projections of the increment holder. Increment A is assembled spirally under the eight B increments.

(b) Data. This cartridge weighs 9.34 pounds as fired and has a range of 4,500 meters when fired with maximum charge of nine increments. Impact or proximity fuzes are used with this cartridge.

(3) The 4.2 inch, HE, mortar cartridge, M329A1 (figure 3-27).

(a) Description. These cartridges, unlike 60-mm and 81-mm mortar cartridges, are spin stabilized in flight and do not employ fins. Instead, this cartridge is distinguished by a pressure plate and a rotating disk (located to the rear of the cartridge) and is similar in appearance to the 4.5 inch spin stabilized rocket. The M36 propelling charge for this projectile consists of one ½ increment, three 5 increment bundles, 5 increments, four 5-increment bundles and one ½ increment - a total of



ARRANGEMENT FOR FIRING FULL PROPELLING CHARGE M36 ON CARTRIDGE CONTAINER AND CARTRIDGE CONTAINER EXTENSION

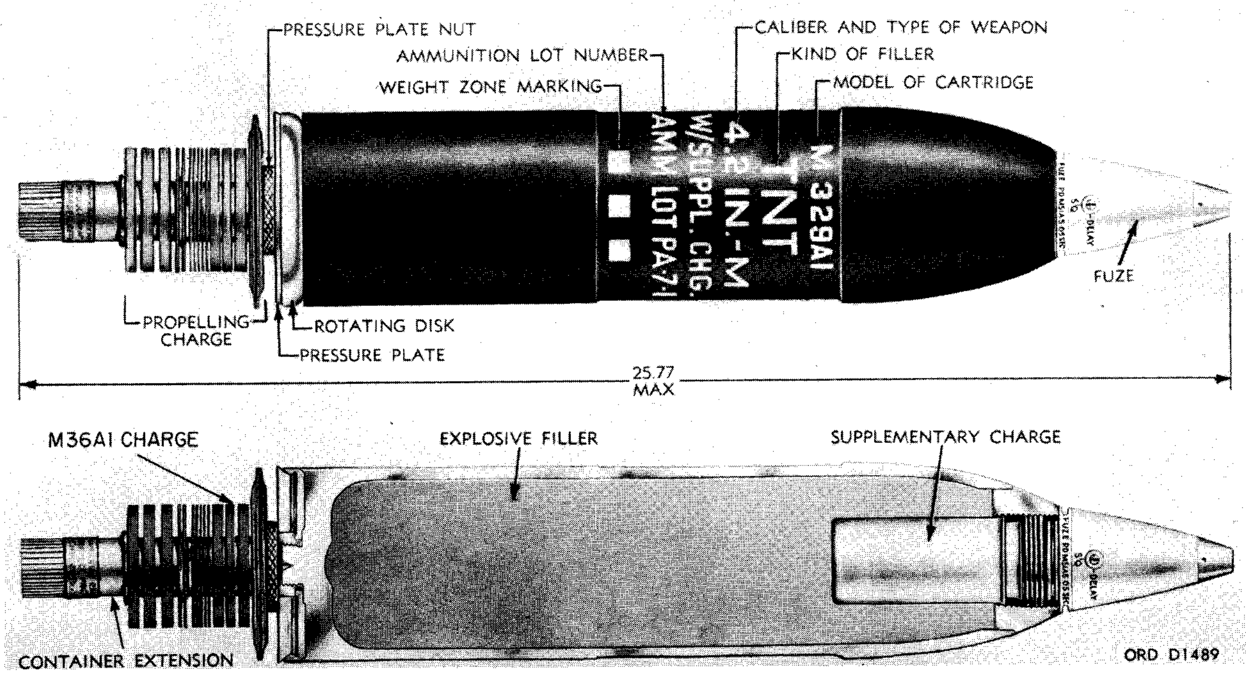


Figure 3-27. 4.2-Inch HE cartridge M329A1.

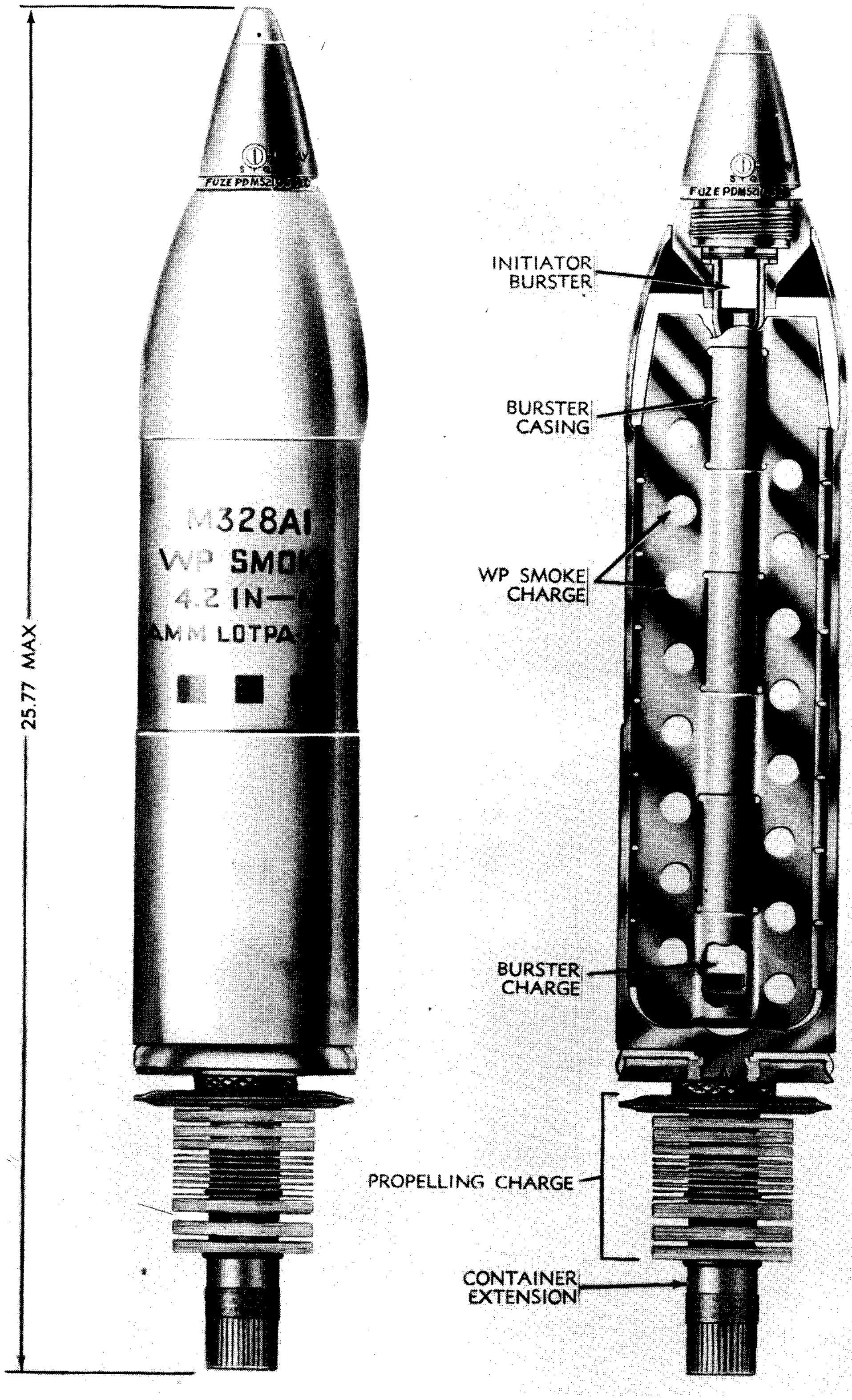


Figure 3-28. 4.2-Inch smoke (WP) cartridge M328A1.

41 increments assembled in that order. This cartridge is provided with a cartridge container extension to accommodate the full charge. The ignition cartridge is assembled in the cartridge container extension. Two propellant holders, one near the center of the cartridge container extension, the other seated near the end of the ignition cartridge container, secure the propellant increments. The propelling charge M36A1 for this cartridge (M329A1) differs from the M36 charge in that a doughnut-shaped cloth bag containing flaked propellant replaces the first five sheet propellant increments of the M36 charge. This doughnut-shaped bag will not be removed at any time.

(b) Functioning. When the cartridge is released, it slides down the mortar tube until the percussion primer strikes the firing pin. The flash from the primer ignites the ignition cartridge which, in turn, ignites the propelling charge. The gases from the propelling charge exert pressure on the pressure plate at the base of the projectile expanding the rotating disk, engaging it in the rifling of the tube imparting spin to the projectile. This cartridge will accommodate an impact, delay, or proximity fuze.

(c) Data. This complete round with fuze weighs 27.07 pounds, has a muzzle velocity of 293 meters per second, and a maximum range of 5,423 meters.

(4) The 4.2 inch smoke (WP) cartridge M328A1 (figure 3-28).

(a) Description. This cartridge is similar to the HE cartridge, M329A1 (para 6b(3)(a)) and is used for screening, incendiary, and casualty purposes. It differs from the HE cartridge in that it contains a perforated vane and is designed to accommodate a PD fuze, and burster casing. The burster casing contains a burster initiator and a burster charge. The perforated vane causes a liquid filler to rotate with the projectile, maintaining the proper center of gravity and eliminating the possibility of erratic flight, and is designed to accommodate the burster tube which extends from the fuze.

(b) Data. This cartridge with fuze weighs 28.66 pounds, has a muzzle velocity of 293 meters per second, and a maximum range of 5,423 meters. Mortar ammunition identification and color coding is described in table 3-1.

7. SUMMARY. The lesson you have just completed has provided an overall coverage of the types, characteristics, and identification of artillery, recoilless rifle, and mortar ammunition. This lesson should be used to your advantage in the supervision and training of personnel in your assigned area of responsibility. You are encouraged to refer to this lesson as needed in order to provide you with refresher information that will assist you in performing your duties as an ammunition storage supervisor. By so doing you will gain a more accurate and comprehensive knowledge of ammunition, which will be reflected in the safety and handling operations associated with these types of munitions.

EXERCISES FOR LESSON 3

1. What are the components of a complete round of artillery ammunition?

   A. Primer, cartridge case, propelling charge, booster and fuze
   B. Cartridge case, propelling charge, projectile, fuze and primer
   C. Propelling charge, burster, fuze, primer and cartridge case
   D. Fuze, base cover, primer, cartridge case and propelling charge

2. What component is protected by a grommet?

   A. Bourrelet
   B. Supplementary charge
   C. Rotating band
   D. Igniter pad

3. The cartridge case is crimped to the projectile in what type of ammunition?

   A. Separate-loading
   B. Separated
   C. Semifixed
   D. Fixed

4. How is the propellant retained in the cartridge case of separated ammunition?

   A. Adapter
   B. Plastic bag
   C. Increment holder
   D. Closing plug

5. Which symbol indicates a nerve agent?

   A. DM
   B. VX
   C. HC
   D. CS

6. What is the color of markings on a PWP projectile?

   A. Light red
   B. Light green
   C. Gray
   D. Blue

7. Which component provides a variation of the high-explosive train?

   A. Bursting charge
   B. Booster charge
   C. Burster charge
   D. Expelling charge

8. What is an identifying characteristic of a recoilless rifle cartridge?

   A. AP shot with filler
   B. Adjustable propelling charge
   C. Sintered iron rotating band
   D. Pre-engraved rotating band

9. What is the purpose of a base cover on HE projectiles?

   A. Provides a base for vertical storage
   B. Prevents hot gases from entering projectile
   C. Reinforces the base of the projectile
   D. Compensates for ballistic weight

10. Which symbol designates a projectile that is designed to be destroyed in flight?

   A. TTT
   B. MTSQ
   C. SD
   D. CP

11. Which markings identify an antipersonnel projectile?

   A. Diamonds
   B. Squares
   C. Bands
   D. Punch marks

12. What type of projectile is designed to contain both a high explosive and a propellant?

   A. HEAT
   B. HVAP
   C. HEP
   D. HERA

13. What marking identifies a cartridge with a reduced propelling charge?

   A. Two red bands
   B. Two black stripes
   C. One green band
   D. One and one-half black stripes

14. What color sealing strips are used on a fiber inner pack containing an ammunition item filled with a nerve agent?

   A. Black w/three green bands
   B. Green w/three yellow bands
   C. Gray w/three green bands
   D. Light green w/two yellow bands

15. What component causes the 4.2 inch mortar cartridge to spin in flight?

A. Obturator ring
B. Rotating band
C. Pressure plate
D. Rotating disk

16. What type of artillery ammunition utilizes a sheet propellant?

A. 4.2 inch mortar
B. 105-mm HERA
C. 90-mm recoilless rifle
D. 76-mm HVAP

17. What type of semifixed ammunition uses a nine increment propelling charge?

A. 155-mm howitzer
B. 106-mm recoilless
C. 81-mm mortar
D. 75-mm howitzer

18. Which artillery propelling charge increments will not be removed at any time?

A. 81-mm mortar bag charge A
B. 105-mm bag charge 5
C. 4.2 inch mortar, two ½ increment charges
D. 4.2 inch mortar 5 increment bag charge

19. Which projectile has the shortest radius of ogive?

A. Armor-piercing (AP)
B. High explosive antitank (HEAT)
C. High explosive plastic (HEP)
D. Antipersonnel (APERS)

20. What affects the depth of penetration of a shaped charge projectile?

A. Sabot carrier
B. Standoff distance
C. Projectile diameter
D. Ogive cap

LESSON 4. FUZES, BOOSTERS, BURSTERS AND PRIMERS

MMS Subcourse No 621 . . . . Ammunition Materiel

Lesson Objective . . . . To give the student a general knowledge of the types, characteristics, identification, function and packing and marking of fuzes, boosters, bursters and primers.

Credit Hours . . . . One

TEXT

1. INTRODUCTION. The lessons you have completed previously have been concerned primarily with ammunition and fillers within the cartridge. A subcourse would be incomplete without providing current information on the components and elements that constitute a complete round assembly and cause it to function according to design intent. This lesson will provide you with information relative to the types, characteristics, identification, function and packing and marking of fuzes, boosters, bursters and primers. The assimilation of this material will enhance your knowledge and improve your supervisory capabilities involving the various areas related to ammunition storage and handling operations.

2. TYPES AND CHARACTERISTICS OF FUZES.

a. Fuzes are designed as a component in an explosive train to effect projectile function at the target area when and under the circumstances encountered. They are classified according to their location on the projectile as point-detonating (PD), base-detonating (BD), point-initiating base-detonating (PIBD) and concrete-piercing (CP). Base detonating fuzes are used with some types of armor-piercing and high explosive projectiles. PIBD fuzes are generally used with high explosive antitank (HEAT) projectiles. A time fuze functions while a projectile is still in flight and sometimes is provided with an impact element. Time (air burst) fuzes are of three types: mechanical time, powder-train time, and proximity. Powder-train time fuzes differ from mechanical-time fuzes in that the former contain a compressed black-powder train which delays functioning for a preset length of time, whereas the mechanical-time fuze uses a clockwork mechanism to achieve the same result.

b. Fuzes usually consist of a connected series (explosive train) of small charges and a mechanical or electrical device (or a combination of both) for initiating the first charge in the train. The initiating device and explosive elements are assembled in the body or fuze housing. That part of the fuze body extending from the nose of the projectile is shaped for ballistic effect. Fundamentally, the explosive train consists of a detonator, booster, and a bursting charge. The linkage in the train between the detonator and booster is known as the booster lead. In fuze arming the detonator is aligned with the booster through the booster lead charge. The booster lead charge is a pressed column of explosive (tetryl) which seals the booster cup body. The basic train described above may include a primer assembled in front of the detonator. When the fuze functions on impact the small detonating wave created by the initiator (primer or detonator) progresses and expands through the booster lead, the tetryl loaded booster and initiates the bursting charge. A fuze designed for delay action contains a compressed black powder pellet; the initial flame from the initiator is passed on to the black powder pellet, and in turn, to the detonator. Black powder is used exclusively in the time train of powder-train time fuzes. It is also used for the magazine charge of both powder-train and mechanical types of time fuzes. Black powder is a low explosive and differs in manner of functioning from that of high explosive charges in that it produces its effect by flame action. Compressed black powder burns slowly, the rate of combustion decreasing as the density increases.

c. Bore Safety. Fuzes contain safety devices that tend to prevent functioning prematurely until after the fuze has been armed. Certain fuzes are said to be bore-safe. A bore-safe (detonator safe) fuze is one in which the path of the explosive train is interrupted so that, while the projectile is still in the bore of the weapon, premature detonation of the projectile is prevented should any of the more sensitive fuze elements, primer, detonator, or both, function. Interruption is most generally obtained by out-of-line components, interruptor blocks or slides. Certain internal parts of an impact fuze are in unarmed position prior to firing. When fired, the projectile is accelerated and rotated applying centrifugal and setback forces upon these parts. As the projectile leaves the muzzle of the weapon, acceleration ceases and hence setback forces cease. The combination of centrifugal and setback force in the bore of the weapon starts arming of the fuze. After the projectile leaves the bore of the weapon, centrifugal force completes the arming. The time train of time fuzes is initiated at the instant of firing by setback. Fuze safety devices, such as safety wires or pins and/or delayed arming mechanisms are used to prevent accidental arming during handling and shipping and must be manually removed before firing. Delayed arming devices are used to prevent complete arming until the fuzed projectile is some distance from the weapon. Arming of proximity fuzes is delayed by a series of internal safety devices. The fuze becomes automatically armed a specified length of time after the cartridge is fired. A fuze is armed when it is ready to detonate the projectile and is accomplished principally by inertia and centrifugal force. Inertia acts in several ways: setback occurs when the projectile accelerates upon being fired, it is used to advantage to lock or unlock safety devices when required. Creep, a phenomenon which can cause malfunction, occurs as the projectile body decelerates in flight. This is taken into consideration when the fuze is designed. Setforward occurs at impact or on sudden deceleration. This effect may be used to drive firing pins into primers or to drive primers against stationary firing pins. Centrifugal force may be used to actuate gear trains, and to move safety devices into their proper position in fuzes and boosters. Such fuzes and boosters are designed to operate in the rotational velocity range of the cartridge-weapon combination in which they are used. Rotational speed in spinning projectiles depends upon the twist of the rifling and the muzzle velocity. Fuzes using centrifugal force must be so designed that they will not become unarmed as the rotational velocity decreases during flight.

d. Detonators. Detonators are divided into three types, depending upon method of initiation and are classed as flash, stab or electric. Each of these types will have a primary charge (initiating explosive, i. e., lead azide) and a secondary base charge of PETN, tetryl or RDX. Most flash detonators contain only these two charges consolidated in a metal cup (aluminum, gilding metal or stainless steel). Flash detonators are usually initiated by the impulse from a separate primer, delay or relay pellet, which acts on the lead azide in the detonator. Stab detonators are basically similar to flash detonators except that they contain a third charge and an abrasive compound mixed with the initiating composition which make them sensitive to the friction of stab action. Electric detonators have, in addition to the intermediate and a base charge, a fine wire bridge or a carbon film covered with lead azide or styphnate held together with a nitrocellulose binder and connected to exterior terminals on the detonator. On application of an electric current across the bridge, the heat generated will ignite the explosive composition of the detonator.

e. Representative fuzes.

(1) Fuze, point detonating, M557 (figure 4-1) (superquick and delay). Fuze M557 has the

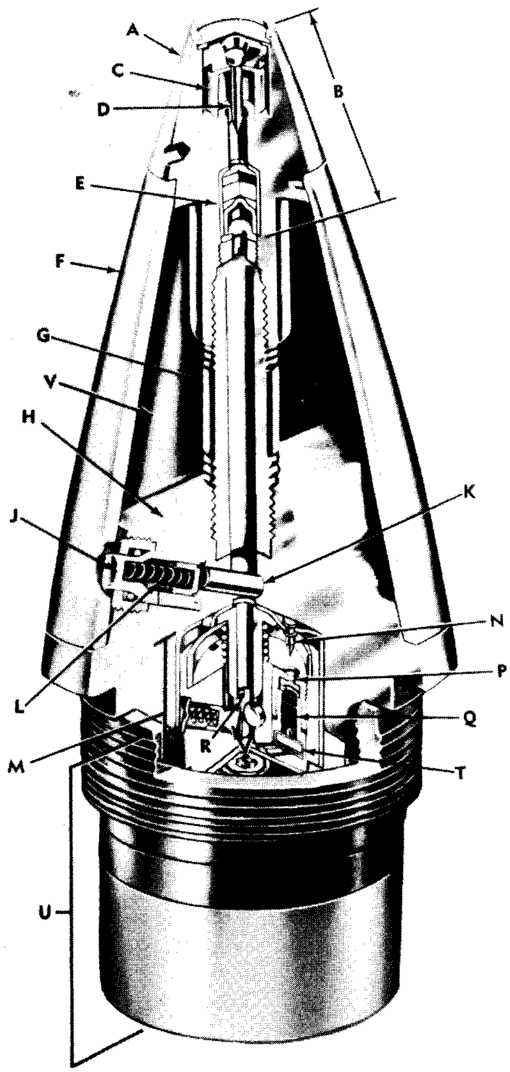


Figure 4-1. Point detonating fuze M557, 0.05-sec delay.

firing pin of the delay plunger assembly housing secured against movement prior to impact. Delay plunger assembly M1 assembled within the fuze includes delay element M2 consisting of a primer, delay charge and relay. Booster M125A1 (figure 4-13) provides a minimum delay arming distance of 60 meters. This fuze is standard A and is presently used in ammunition, 75mm through 8 inch.

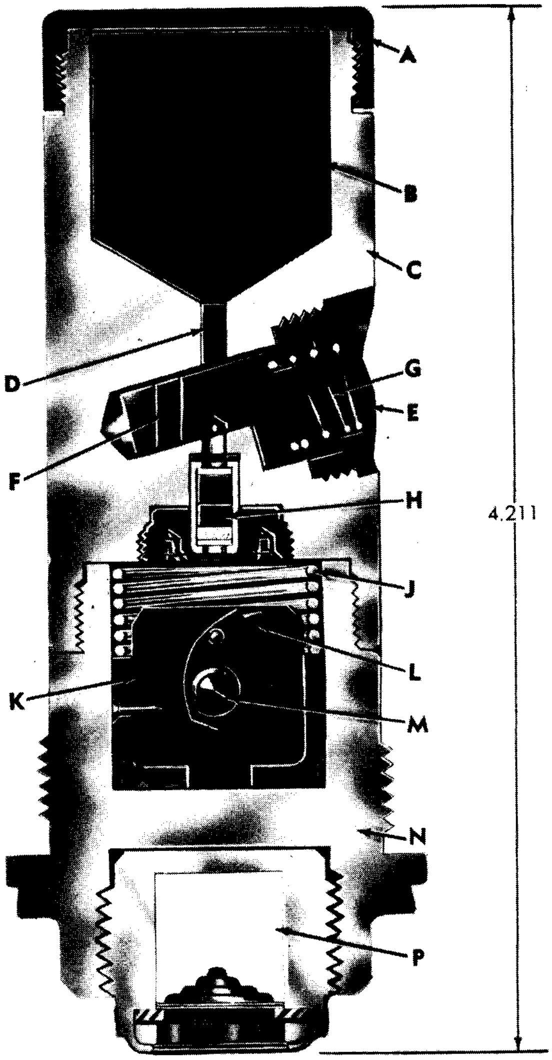
(a) Description. Fuze M557 consists of a head (A) which holds a superquick element (B), a body (H) which holds a delay plunger and its housing, and a selective setting device. These main assemblies are connected by a flash tube (G) which holds the parts firmly in position and are supported by a thin-wall ogive or windshield (F). The superquick element comprises a firing pin (D) supported by a firing pin support (C) and detonator M24 (E). The firing pin support withstands ordinary blows on the firing pin and setback forces on firing, but collapses on target impact. The delay plunger assembly (M) is an inertia plunger-type and includes a firing pin (N) and delay element M2 consisting of primer M54 (P), black powder delay charge (Q), and a relay M7 (T). Booster M125A1, assembled in fuze M557 consists of a brass body containing the spin-activated arming delay mechanism, detonator M17, booster lead charge, and aluminum alloy cup threaded over the body and containing a 340-grain tetryl booster charge. The setting device in an eccentrically positioned interrupter (K) and interrupter spring (L), the functioning of which is regulated by a setting sleeve (J). The head of the sleeve is slotted to facilitate turning when adjusting the setting. To provide for exact alinement, two register lines and the marking SQ and DELAY are stamped on the ogive of the fuze. When the slot in the sleeve head is alined with the SQ line (parallel to the fuze axis), or within 15° thereof, the sleeve, which is thicker on one side than on the other, is turned so that it does not interfere with movement of the interrupter. The interrupter is free, therefore, to move outward under centrifugal force, and thereby opens the passage for superquick action. When the slot is alined with the DELAY line (at right angles to the axis) or within 15° thereof, a section on the setting sleeve rests against the interrupter, securing it in the lower extremity of the recess across the superquick passage. Boresafe superquick action is provided by the interrupter (K). Delayed arming action for a minimum distance of 200 feet from the muzzle is provided by the mechanism in the booster.

(b) Functioning. No action takes place in fuze upon firing until sufficient rotational speed has been established to over come the resistance of springs and the setback force upon the several safety devices. When set for superquick action after the projectile leaves the muzzle of the weapon, centrifugal force causes the interrupter (K) to move outward, opening the flash tube passage. At the same time, the diametrically opposite plunger pins (S) that keep the delay plunger assembly in unarmed position also move outward, releasing that assembly in preparation for impact. Each plunger pin lock (R) then swings on its pivot under centrifugal force, places an arm against the inner end of its plunger pin, thereby preventing return of the pin to the unarmed position. Upon impact, the firing pin of the superquick element is driven against the detonator, initiating the superquick action. Inertia causes the delay plunger body to move forward driving the primer against the delaying firing pin, and initiating delay action. In normal functioning with superquick action, the delay action has no effect, the superquick train will have caused the projectile to explode before the delay train can burn for its prescribed time. However, should the superquick action fail, the projectile will function with delay action rather than become a dud. When set for delay action, the interrupter which interrupts the superquick passage is restrained from moving. Upon impact, the superquick firing pin and detonator function but the effect is prevented from being transmitted to the projectile.

(2) Base-detonating fuze, M91 series.

(a) Description. This fuze (figure 4-2) is used in HEAT-T and HEP ammunition for the 75mm howitzer and 90mm gun; in the 75mm, 105mm, and 106mm recoilless rifles. The M91A2 BD fuze consists of four parts: a steel head (N), a steel body (C), a brass booster cup (A), and a tracer (P). The head holds a rotor firing pin (L) and inertia plunger (K). The body contains a detonator (H), a slider assembly (E) with a slider charge (F), a booster pellet (B), and a booster lead (D). The booster cup seals the booster pellet in its cavity in the fuze body when screwed to the body. The tracer (P) is threaded into the base of the fuze. Bore safety is provided for by the slider assembly.

(b) Functioning. The rotor firing pin (L) is held in the unarmed position in the plunger by a spring-held safety pin (M) which releases the rotor firing pin under the action of centrifugal force. The plunger assembly will not arm at 1,700 rpm or less. The slider assembly normally is positioned under spring pressure in its recess in the fuze body holding the slider charge out of alinement with the other explosive elements. When sufficient centrifugal force occurs, the slider overcomes the resistence of the spring (G) and moves outward, alining the slider charge with the detonator. The slider will not arm when the fuze rotates at 2,400 rpm or less. Upon firing and after sufficient rotational force has been created, the firing pin and slider move into the armed position. However, the plunger assembly is held during the flight of the projectile by the restraining spring (J). Upon impact, the plunger (K) overcomes the resistence of the spring (J) and carries the firing pin (L) forward against the detonator (H), initiating the slider charge (F) and, in turn, the booster lead (D), the booster pellet (B) and the bursting charge. The tracer which is ignited by propellant



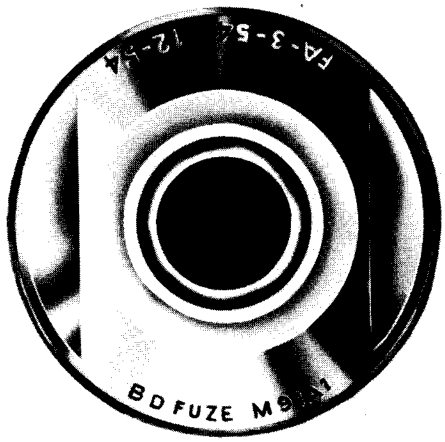


Figure 4-2. Base detonating fuze M91A1.

gases, provides a luminous trace during the flight of the projectile and inertia (setforward) causes fuze to function at target.

(3) Mechanical time and superquick fuze M548.

(a) Description. This fuze (figure 4-3) is designed for use with spin-stabilized projectiles where time or superquick function is desired. This fuze is an improvement over older MTSQ fuzes in that it provides a longer timing mechanism (100 seconds) for longer range functioning. The main components consist of the point-detonating assembly, rotatable lower cap assembly, the fuze body, the movement assembly, and the safety adapter assembly. See exploded view (figure 4-4) for details of components assembly.

(b) Functioning. This fuze is designed to function either at a set time or upon impact, depending upon whichever occurs first after firing. The safety adapter arms after traveling a minimum distance of 60 meters from the muzzle of the weapon. The fuze is assembled in the

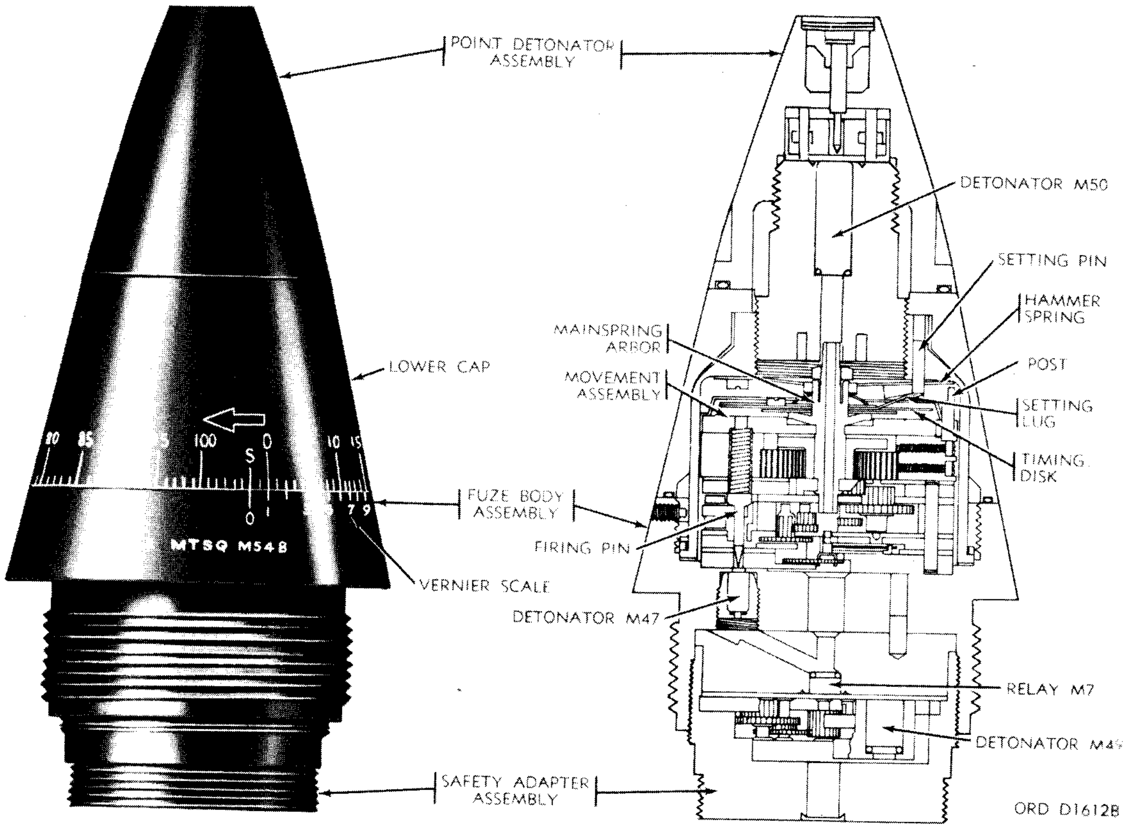


Figure 4-3. Mechanical time and superquick fuze M548-external and cross section views.

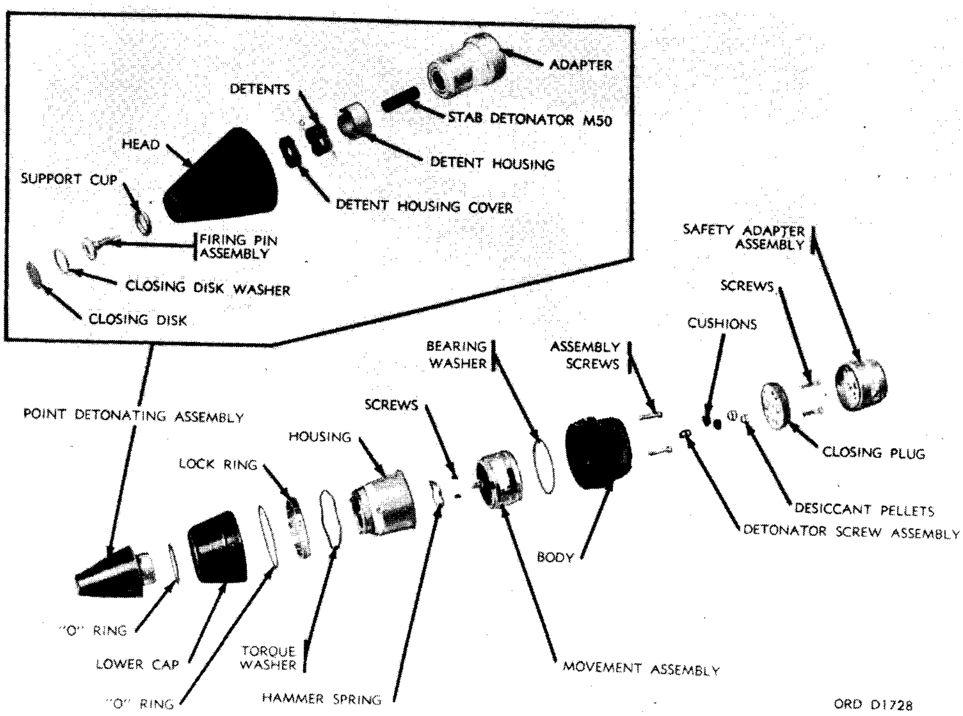


Figure 4-4. Mechanical time and superquick fuze M548-exploded view.

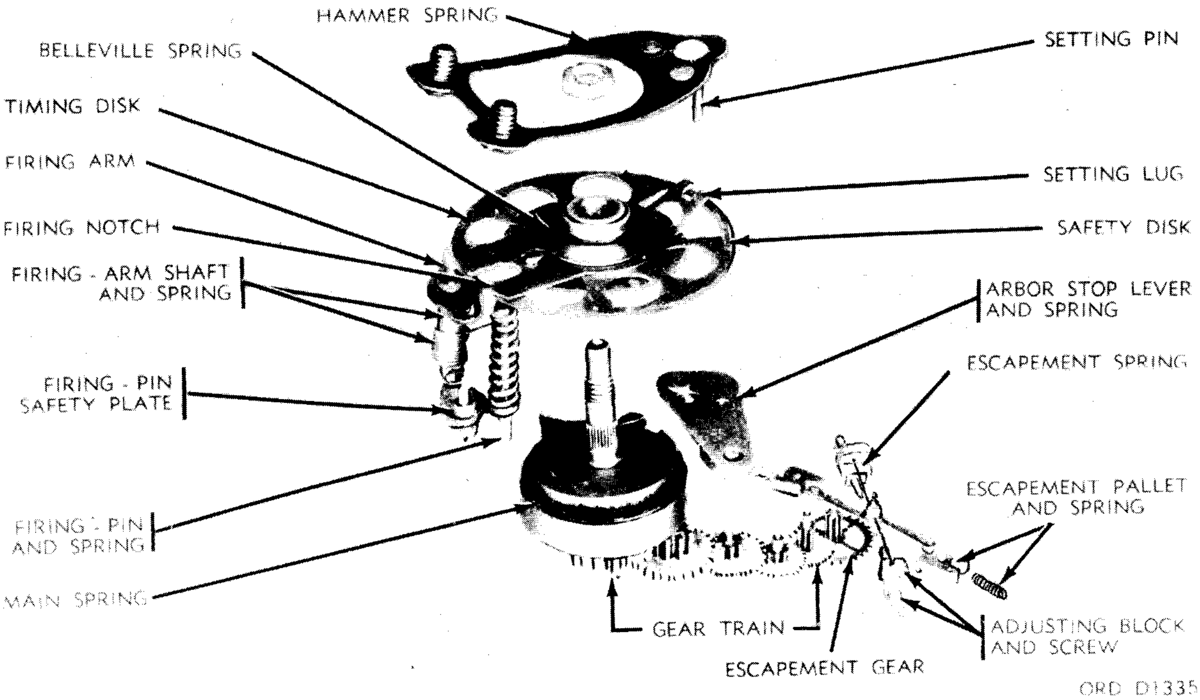


Figure 4-5. Mechanical time and superquick fuze M548-movement assembly.

unarmed position and remains in this condition during transportation and storage. When the fuze is set, the turning of the lower cap (figure 4-3) rotates the timing disk by means of the setting pin, which is engaged in the setting lug (figure 4-5) of the timing disk assembly. All other parts of the mechanism remain in position, since the gear train and escapement components are locked until firing. Upon firing, setback causes the hammer spring (figure 4-5) to strike the setting lug of the timing disk, depressing the lug and releasing the disk from the setting pin (refer to figure 4-5 for arming function). The hammer spring returns to original position as setback ceases. When sufficient centrifugal force has developed, the detents holding the escapement lever of the movement assembly (and the detents holding the rotor of the delayed-arming safety adapter) move outward, leaving the escapement components free to run. At the same time centrifugal force actuates the stop lever arbor, which disengages from the arbor and thus releases the main spring. As the main spring drives the movement, the rate of rotation of the arbor and, therefore, of the timing disk is governed by the escapement through the gear train. When the notch in the rotating timing disk reaches the upright of the firing arm, the firing arm turns, permitting the firing pin safety plate to swing out from under the firing pin flange and allowing the firing pin to strike detonator M47. Detonator M47 initiates relay M7 which in turn, initiates flash detonator M49 in the safety adapter. The safety adapter becomes armed depending on the weapon, muzzle velocity and rate of spin. When the projectile is fired, centrifugal force withdraws the detents from the rotor which, in the unarmed position, holds the detonator in an out-of-line position to the flash path of the fuze. The rotor gear tooth segment drives the main gear (see safety adapter assembly, figure 4-3) of the delay arming mechanism. The rotor swings into the armed position, in which flash detonator M49 is alined with relay M7 in the fuze. It is locked in this position by a lock pin. Initiation of the flash detonator is by relay M7 which is common to both the time explosive train and the superquick explosive train (see figure 4-6 for fuze M548 explosive trains).

(4) Proximity (VT) fuzes M513A1 and A2.

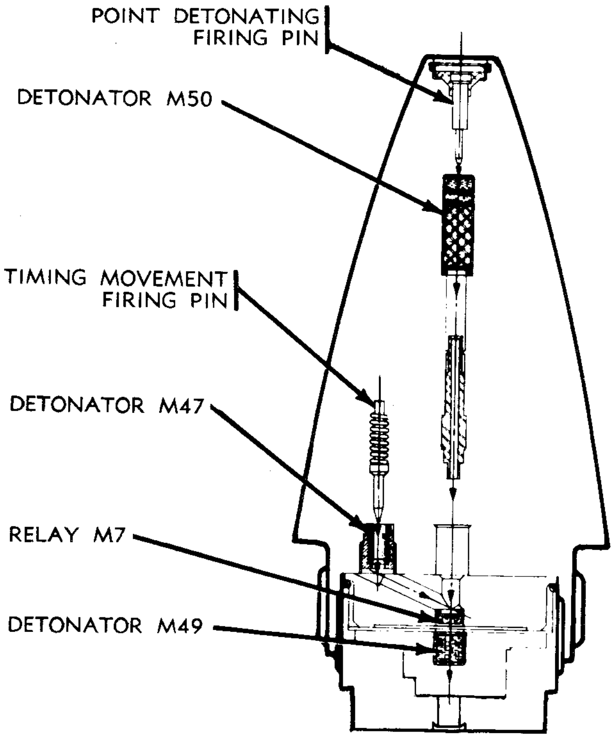


Figure 4-6. Mechanical time and superquick fuze M548-explosive trains.

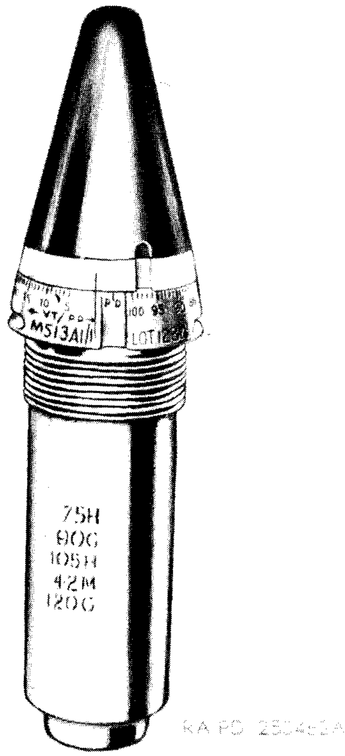


Figure 4-7. Proximity fuze M513A1.

(a) Description. These fuzes (figures 4-7 and 4-8), provided for use with deep-cavity high-explosive projectiles (figure 4-9), are essentially self-powered radio transmitting and receiving units. In flight, the armed fuze transmits radio waves. When any part of the radio wave front is reflected back from the target, it interacts with the transmitted waves. The ripple or beat caused by this interaction trips a switch, thereby closing an electric circuit. This initiates detonation of the explosive train which causes the projectile to detonate at optimum distance from the target.

(b) Functioning. It is intended that these fuzes be set for the anticipated time of flight (in seconds) to the target. In these fuzes the PD element will always become armed within 2 to 3 seconds after firing, and will remain armed throughout flight, finally detonating the projectile if the proximity element should fail. When set at any value between 5 seconds and 100 seconds, the proximity element will become armed at approximately 3 seconds prior to set time. The proximity element will then detonate the projectile at the optimum distance above land or water surfaces. (Note: The long line with the arrow point is the shipping line. The metal ring above the sleeve shoulder has a single index line. When the fuze is unpacked, this index line will normally coincide with the shipping line (figure 4-8). If the fuze is fired as received, with the index line set at the shipping line, the fuze will become fully armed within 2 to 3 seconds (i.e., both the proximity element and the PD element will be armed throughout the remainder of the trajectory). When set at the PD line, the proximity element will never become armed, there will be no air burst and the fuze will function as a simple PD fuze.

(c) Cartridge-fuze combinations. Cartridge-fuze combination interchangeability charts (figures 4-10, 11, and 12) list the necessary cartridge-fuze combinations. Needs for changing fuzes are necessitated by tactical situations and available supplies. Other reasons are the removal of unsafe fuzes and renovation activities.

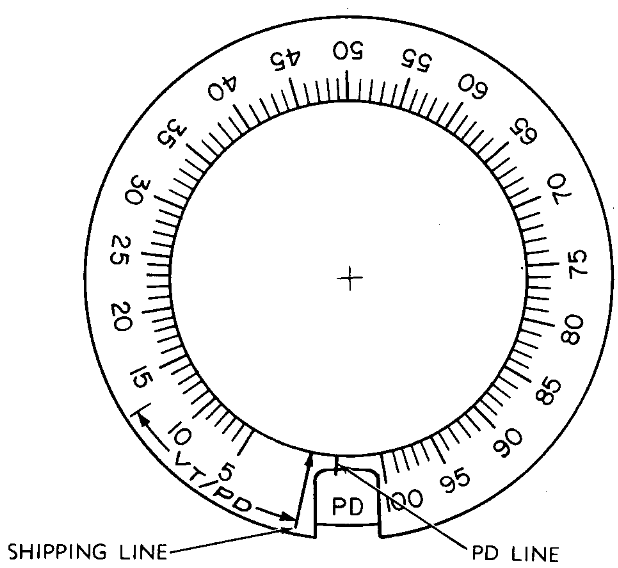


Figure 4-8. Proximity fuses M513A1, M513A2 and M514A1-time graduations.

3. BOOSTERS, BURSTERS AND PRIMERS.

a. Boosters.

(1) Description. A separate charge, the function of which is to increase or boost the effectiveness of the explosive train, is known as the booster charge. The booster charge may be assembled in the fuze itself or encased in a metal or plastic cup threaded permanently to the fuze and handled as a unit with the fuze. Boosters are generally provided with a bore-safety mechanism (arming delay) and incorporate, in addition to the main charge, one or more other charges (e.g., a detonator and a booster lead charge). Some of the latest boosters (figure 4-13) have a delay arming mechanism which prevents the booster from arming until the projectile is a desired minimum distance from the weapon.

(2) Functioning. Booster M125A1 requires a minimum of 60 meters of projectile travel to reach the armed position. The arming delay mechanism (figure 4-13) consists essentially of a rotor that holds detonator M17 out of line, and a gear train. Centrifugal force on the rotor alines the detonator with the booster lead completing booster arming. Before firing, the rotor is locked out of line by the rotor detents. Centrifugal force moves the detents outward releasing the rotor, and turns the rotor against the gear train which, with the balance wheel and its pallet, controls the turning speed of the rotor. Upon alinement of the detonator with the booster lead, the rotor is locked in the armed position. Locking is accomplished by a spring loaded pin arrangement, which under centrifugal force, locks the rotor in place.

b. Bursters. The burster (figure 4-14) in a chemical projectile or cartridge provides the explosive charge to rupture the projectile casing and disperse the chemical contents. The charges generally are known as burster charges and the assembly as a burster. The burster consists essentially of a high explosive charge in a suitable thin-walled container. The burster is contained in a long tube assembly extending into the interior of the projectile. This long tube assembly is called a burster casing. The burster casing hermetically seals the chemical agent within the shell body. This prevents the burster from coming into direct contact with the chemical filler. The burster casing is press-fitted to the projectile.

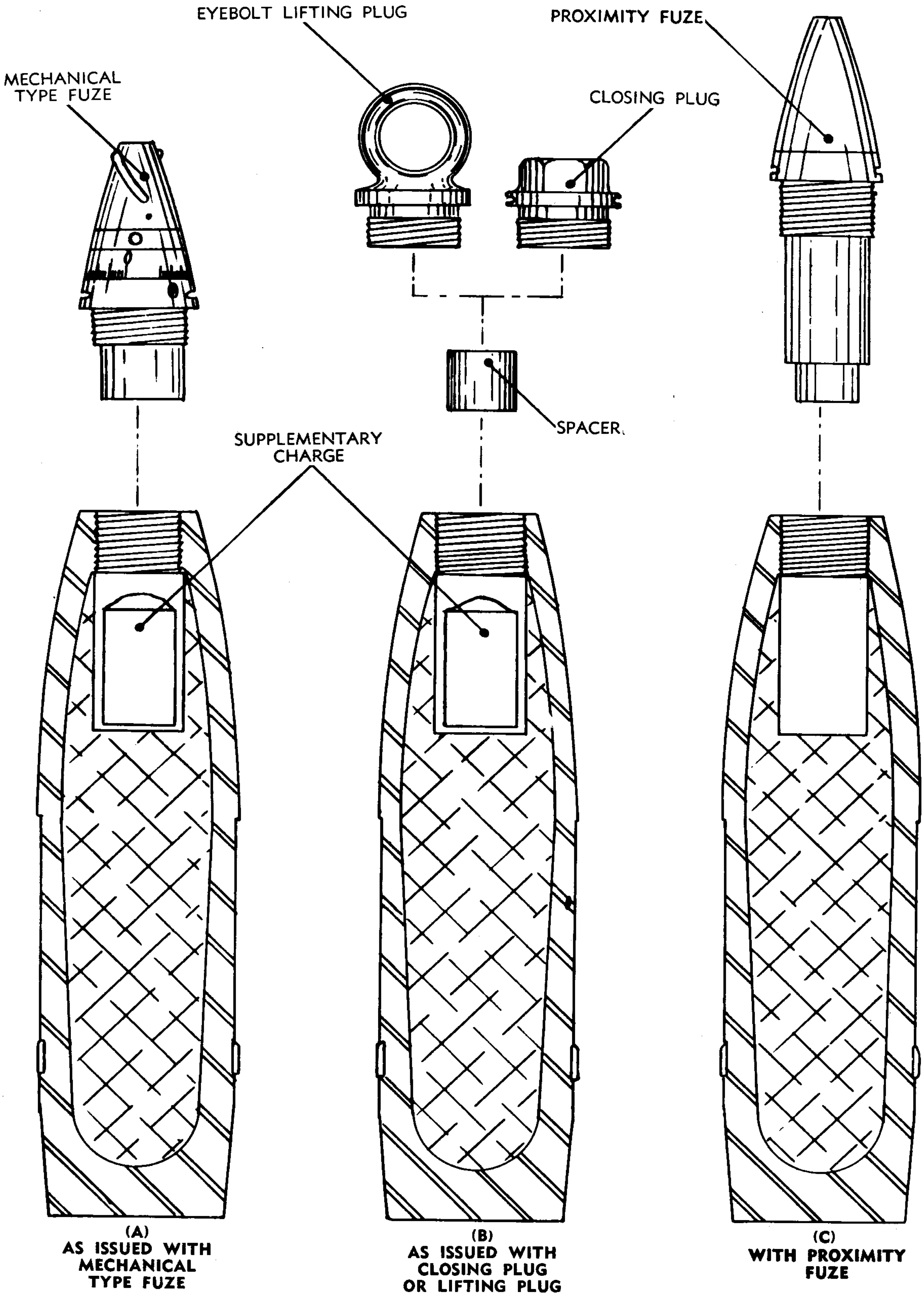


Figure 4-9. Deep-cavity projectile-disassembled view.

KEY: ■ - AS ISSUED OR COMPATIBLE
P - REQUIRES REMOVAL OF SUPPLEMENTARY CHARGE, IF PRESENT

WEAPON	CARTRIDGE / PROJECTILE	FUZE: PD																PIBD		MT				MTSQ					TSQ	BD					PROX.			
		M48A2	M48A3	M51A4	M51A5	M57 (MOD)	M57 (MOD) W/BOOSTER	M64A1	M78 SERIES (CP)	M508 SERIES	M521	M535	M557	M572	MK27	T234E2	XM720 SERIES	M509 SERIES	XM539E4	M43 SERIES	M67A3	XM571E3	XM711	M501 SERIES	M502 SERIES	M518 SERIES	M520 SERIES	M564	M55A3	M62 SERIES	M68 SERIES	M91 SERIES	M534 SERIES	M578	M513 SERIES	M514 SERIES	M515	M516
40 MILLIMETER	HE-T, HEI-T, MK2, SD, MK11, M3A1														■																							
	HE-T, MK2, SD, M3							■																														
75 MILLIMETER	HE, M334 (DEEP CAVITY)			■	■							■	■			■									■	■	■	■										P
76 MILLIMETER	HE, HE-T, M352 SERIES			■	■				■			■	■								■						■	■	■									
	HEAT-T, M496																	■																				
	WP, M361 SERIES										■																											
90 MILLIMETER	APC-T, M82																														■							
	APERS, XM580E1																						■															
	HE, M71 (NORMAL CAVITY)			■	■		■		■			■	■							■	■						■	■	■									
	HE, M71 (DEEP CAVITY)			■	■		■		■			■	■							■	■						■	■	■						P		P	
	HE-T, M71A1				■							■	■																									
	HE-T, T91			■	■		■		■			■	■								■						■	■	■									
	HEAT, M348 SERIES																	■																				
	HEAT-T, M431																	■																				
	HEP-T, T142 SERIES																															■						
	SMOKE, WP, M313 SERIES	■	■			■																		■														
105 MILLIMETER	APERS-T, XM494E3																					■																
	HEAT-T, M456 SERIES																	■																				
	HEP-T, M393 SERIES																																■	■				
	SMOKE, WP-T, M416																																■					
120 MILLIMETER	HE-T, M356			■	■		■		■			■	■								■						■	■	■									
	HEAT-T, M469																	■																				
	SMOKE, WP, M357			■	■		■					■	■								■						■	■	■									
152 MILLIMETER	HE-T, XM657E2																■																					
	HEAT-T-MP, XM409 SERIES																		■																			
	TP-T, XM411E3												■																									
155 MILLIMETER	GB, M122									■																												
	HE, M101 (NORMAL CAVITY)			■	■		■		■			■	■								■						■	■	■									
	HE, M101 (DEEP CAVITY)			■	■		■		■			■	■								■						■	■	■							P		
	SMOKE, WP OR GAS, HD, M104			■	■		■					■	■								■						■	■	■									
165 MILLIMETER	HEP, M123A1																													■								
175 MILLIMETER	HE, M437 SERIES													■																						P		

Figure 4-10. Cartridge-fuze combination chart for guns.

WEAPON	CARTRIDGE/PROJECTILE	FUZE																									
		PD										MT					MTSQ						TSQ	BD		PROX.	
		M48A2	M48A3	M51A4	M51A5	M57 (MOD)	M57 (MOD) W/BOOSTER	M78 SERIES (CP)	M508 SERIES	M535	M557	M67A3	M562	XM563 SERIES	M565	M565 (MOD)	M501 SERIES	M520 SERIES	M548	M548 (MOD)	M554	M564	M55A3	M62 SERIES	M91 SERIES	M513 SERIES	M514 SERIES
75 MILLIMETER	HE, M48 (NORMAL CAVITY)			■	■		■	■		■	■	■						■				■	■				
	HE, M48 (DEEP CAVITY)			■	■		■	■		■	■	■						■				■	■			P	
	HEAT-T, M66																							■	■		
	SMOKE, WP, M64	■	■			■																					
105 MILLIMETER	APERS-T, XM546													■													
	BE, M84, M84B1	■	■														■										
	CS, XM629														■				■								
	GB, M360								■																		
	HE, M1 (NORMAL CAVITY)			■	■		■	■		■	■	■						■				■	■				
	HE, M1 (DEEP CAVITY)			■	■		■	■		■	■	■						■				■	■			P	
	HE, M413																				■						
	HE, M444															■				■							
	HEAT, M67																							■			
	HEAT-T, M67																								■		
	HEP, M327																							■			
	HEP-T, M327																								■		
	HE, RA, XM548			■	■		■	■		■	■	■						■				■	■			P	
	ILLUM, M314A2, M314A2B1																■										
	ILLUM, M314A2E1														■				■								
	SMOKE, WP OR GAS, H, HD, M60			■	■		■			■	■	■						■				■	■				
155 MILLIMETER	BE, M116	■	■														■										
	CS, XM631														■				■								
	GB OR VX, M121A1								■																		P
	HE, M107 (NORMAL CAVITY)			■	■		■	■		■	■	■						■				■	■				
	HE, M107 (DEEP CAVITY)			■	■		■	■		■	■	■						■				■	■				P
	HE, M449														■				■								
	ILLUM, M118 SERIES																■										
	ILLUM, M485 SERIES														■				■								
	SMOKE, WP OR GAS, HD, M110			■	■		■			■	■	■						■				■	■				
	SMOKE, WP, M105			■	■		■			■	■	■						■				■	■				
8-INCH	GB OR VX, M436								■																		P
	HE, M106 (NORMAL CAVITY)			■	■		■	■		■	■	■						■				■	■				
	HE, M106 (DEEP CAVITY)			■	■		■	■		■	■	■						■				■	■				P
	HE, M404														■				■								

KEY: ■ - AS ISSUED OR COMPATIBLE   P – REQUIRES REMOVAL OF SUPPLEMENTARY CHARGE, IF PRESENT

Figure 4-11. Cartridge-fuze combination chart for howitzers.

WEAPON	CARTRIDGE	FUZE																						
		PD												PI			MT		MTSQ		TSQ	BD		PROX.
		M48A2	M48A3	M51A4	M51A5	M57 (MOD)	M57 (MOD) W/BOOSTER	M78 SERIES (CP)	M89	M503 SERIES	M535	M557	XM593 SERIES	M90 SERIES (BD)	M509 SERIES (BD)	M530 SERIES (BD)	M67A3	XM592 SERIES	M520 SERIES	M564	M55A3	M62 SERIES	M91 SERIES	M513 SERIES
57 MILLIMETER	HE, M306								■															
	HE, M306A1									■														
	HEAT, M307 SERIES													■										
	SMOKE, WP, M308								■															
	SMOKE, WP, M308A1									■														
	TP, M306A1									■														
75 MILLIMETER	HE, M309 SERIES			■	■						■	■							■	■				
	HEAT, M310																					■		
	HEAT-T, M310A1																						■	
	HEP-T, M349																						■	
	SMOKE, WP, M311	■	■			■																		
	SMOKE, WP, M311A1		■			■																		
	TP, M309A1				■							■												
90 MILLIMETER	HE, XM591												■											
	HEAT, M371 SERIES															■								
	PRACTICE, M371															■								
105 MILLIMETER	HE, M323 (DEEP CAVITY)			■	■		■	■			■	■					■		■	■	■			P
	HEAT, M324																					■		
	HEAT-T, M324																						■	
	HEAT, M341														■									
	HEP, M326																					■		
	HEP-T, M326																						■	
	SMOKE, WP, M325			■	■		■				■	■					■		■	■	■			
106 MILLIMETER	APERS-T, XM581																	■						
	HEAT, M344 SERIES														■									
	HEP-T, M346 SERIES																						■	

KEY: ■ - AS ISSUED OR COMPATIBLE P - REQUIRES REMOVAL OF SUPPLEMENTARY CHARGE, IF PRESENT

Figure 4-12. Cartridge-fuze combination chart for recoilless rifles.

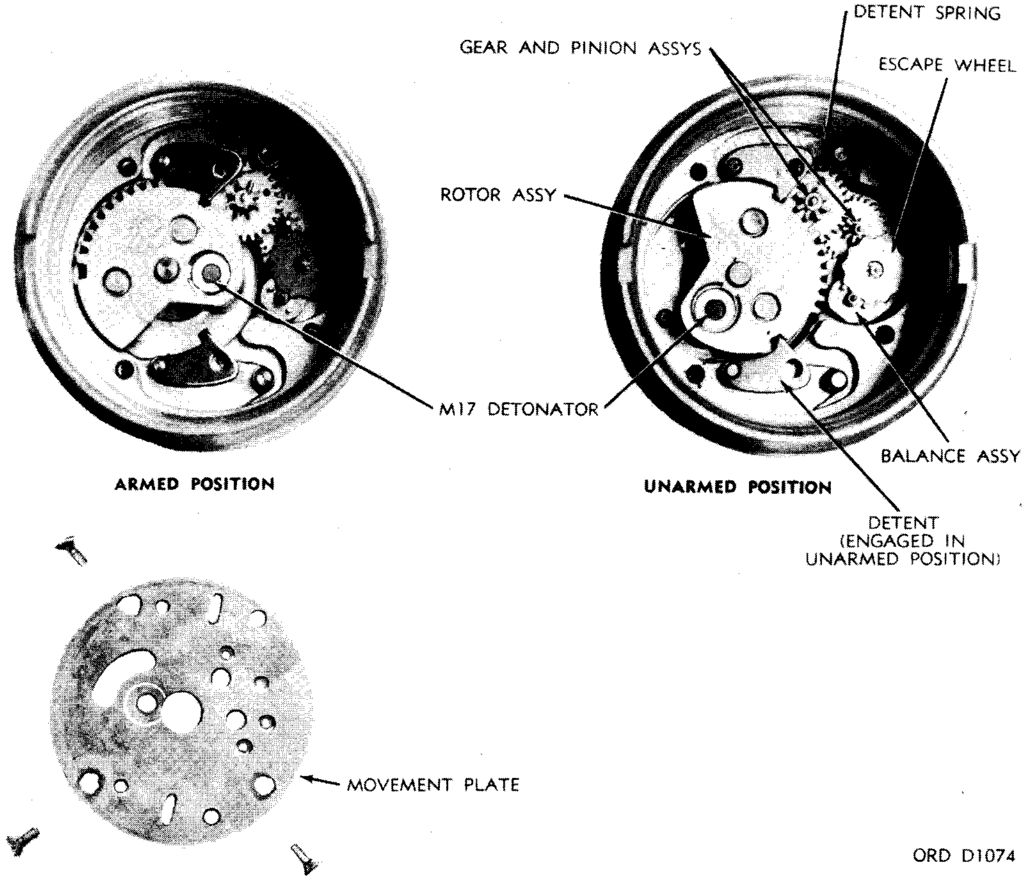


Figure 4-13. Booster M125A1.

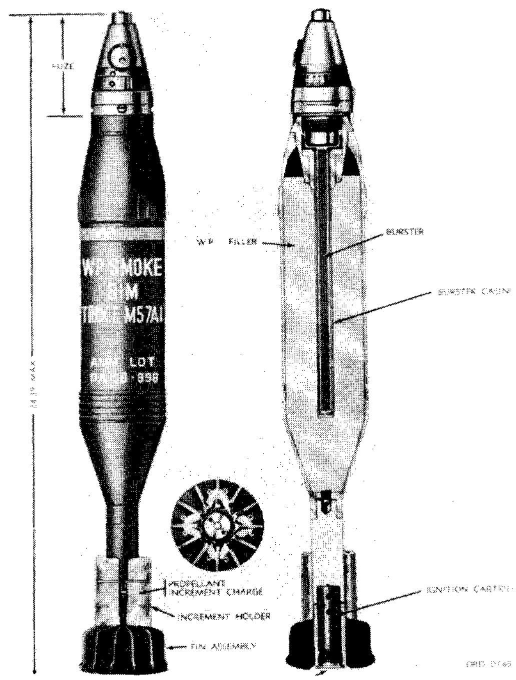


Figure 4-14. 81-mm smoke (WP) cartridge M57A1.

c. Primers. A primer is that component in a propelling charge explosive train which produces a flame to initiate burning of the propelling charge. Primers vary in size and complexity according to type of ammunition in which used. A primer of the artillery type used in fixed, semifixed or separated ammunition (figure 4-15) contains a sensitive element of primer mixture plus a primer charge of black powder to insure ignition of the propelling charge. This type of primer is assembled in the base of the cartridge case and extends into the propelling charge contained in the case. Primers (percussion and electric) used in weapons firing separate-loading ammunition (figure 4-16 and 17) contain a sensitive element of primer mixture and a relatively small black powder charge to ignite a larger black powder igniter charge attached to the base charge of the propellant increment charges. The separate loading type of primer is inserted separately into the breechblock of the weapon.

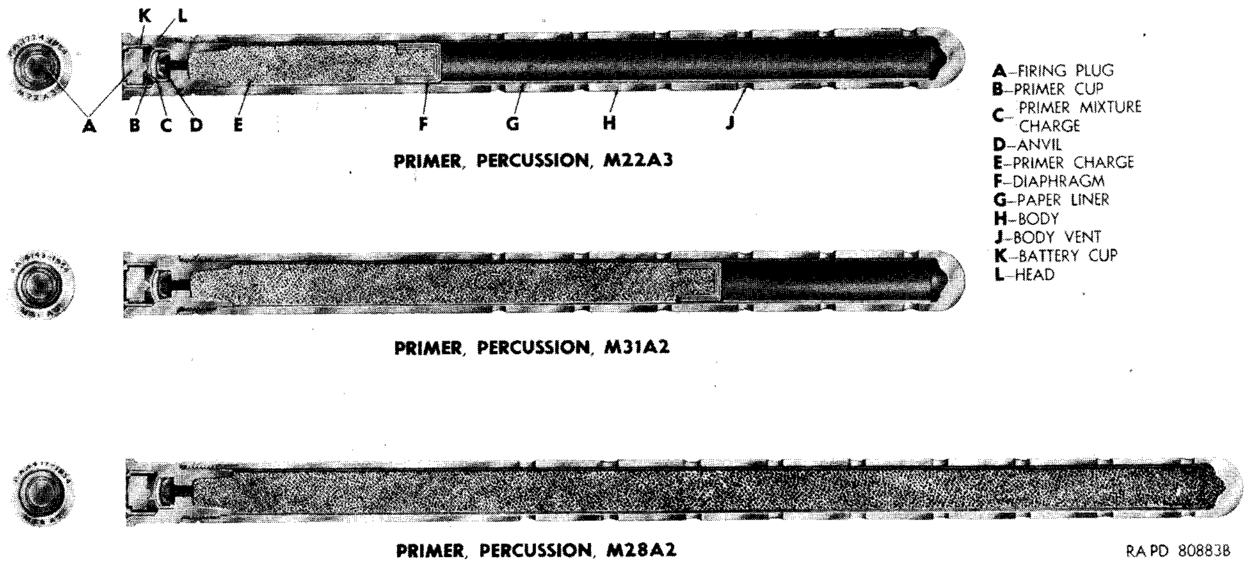


Figure 4-15. Typical percussion primers for fixed, semifixed and separated ammunition.

d. Identification of fuzes, boosters, bursters and primers.

(1) Fuzes are identified by embossed markings of type fuze, model number, lot number and date of manufacture.

(2) Boosters and bursters are provided with a model and lot number designation as are other components of ammunition.

(3) Primers are identified by embossed markings of model, lot number and date of manufacture.

e. Packing data.

(1) General. Packing material for the items discussed in this lesson is so varied that comprehensive coverage is not considered feasible. However, representative samples of fuze and primer packing will be included. For complete information supply catalogs (SC's) should be consulted for packing and shipping data covering other items.

(2) There are approximately eleven different types of packing for the M557 fuze. One type of packing for this fuze is 8 fuzes per metal box, 2 boxes (16 fuzes) per wirebound box. Another type of packing for this fuze is 1 fuze per fiber container, 22 fiber containers (22 fuzes) per wooden box.

(3) The VT fuze, M513 series is packed in 1 fuze per metal can, 12 cans (12 fuzes) per metal box or it may be packed 1 fuze per metal can, 25 cans (25 fuzes) per metal box.

(4) Primer, MK2A4 (figure 4-16) may be packed 50 primers per metal container, 48 containers (2,400 primers) per wooden box or they may be packed 48 per metal can, 30 cans (1,440 primers) per wooden box.

(5) Standard packing for boosters and bursters is not available since these items are assembled as integral components of the projectile.

4. **SUMMARY.** We have presented a comprehensive coverage of fuzes, boosters, bursters and primers in this lesson. Description, characteristics, classification, use, types, identification, packing and marking were discussed at length. Construction, functioning and safety features were shown in detail with the inclusion of many illustrations. This information should be of the utmost value to the ammunition supervisor in the handling and storage of these items. Items of recent manufacture have been included in this lesson and should be reviewed periodically to keep abreast with present **doctrine.**

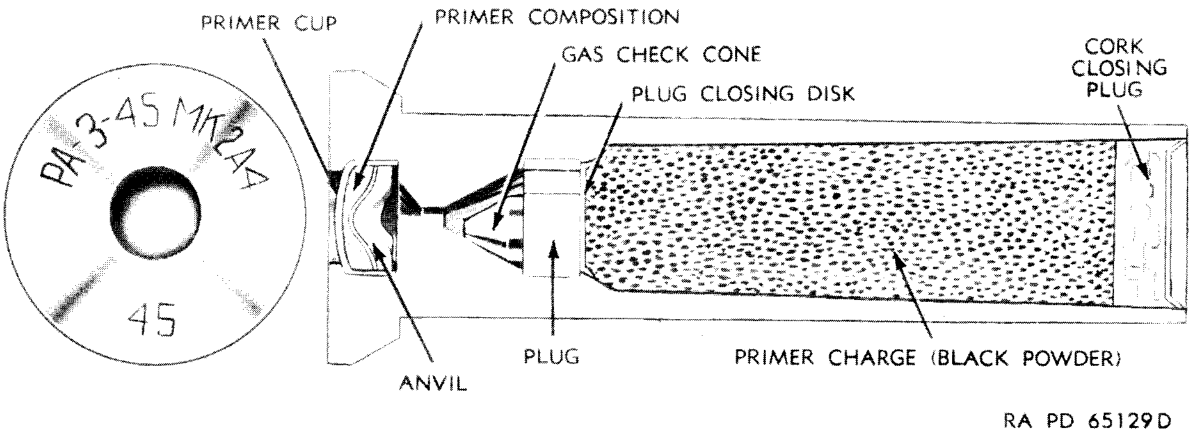


Figure 4-16. Percussion primer for separate-loading ammunition.

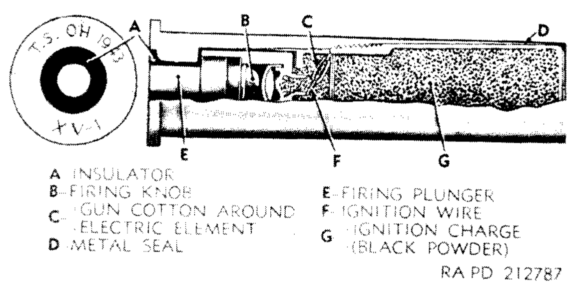


Figure 4-17. Combination electric and percussion primer for separate-loading ammunition.

EXERCISES FOR LESSON 4

1. What is the minimum distance of projectile travel (in meters) required to arm the M125A1 booster?

   A. 30
   B. 60
   C. 90
   D. 120

2. How is bore safety achieved?

   A. Interrupting the firing pin
   B. Placing delay in train
   C. Interrupting the explosive train
   D. Installing desensitizing cap

3. When does setback occur in a fuze?

   A. At present time
   B. When projectile accelerates
   C. When safety pin is removed
   D. At impact

4. What explosive component has no effect on the explosive train in the PD fuze M557 when set for delay action?

   A. M54 primer
   B. M17 detonator
   C. M24 detonator
   D. M125A1 booster lead

5. What causes the M91 series BD fuze to function at the target?

   A. Set forward
   B. Set back
   C. Creep
   D. Centrifugal force

6. What action takes place in the MTSQ fuze M548 upon firing?

   A. Freeing of the escapement lever of the movement assembly
   B. Depressing of the setting lug freeing the timing disk
   C. Holding the rotor of the delayed arming safety adapter
   D. Activating the firing pin safety plate

7. When will the VT fuze M513 become fully armed if the fuze is fired as received?

   A. Between 5-10 seconds
   B. After 3 seconds
   C. Within 2-3 seconds
   D. In .05 second

8. What type of fuze is assembled to the HE-T, M356 gun cartridge?

   A. Base detonating (BD)
   B. Proximity (PROX)
   C. Point initiating, base detonating (PIBD)
   D. Concrete piercing (CP)

9. How is the burster casing assembled to the projectile?

   A. Press fitted
   B. Threaded
   C. Caulked
   D. Hermetically sealed

10. What type of inner container is required to pack 2,400 MK2A4 primers in a wooden box?

   A. Waxed container
   B. Waterproof bag
   C. Fiber container
   D. Metal container

LESSON 5. MINES AND GRENADES

MMS Subcourse Number 621	Ammunition Materiel
Lesson Objective	To give the student a general knowledge of the types, characteristics and identification of mines and grenades.
Credit Hours	Two

TEXT

1. INTRODUCTION. This lesson presents instruction on the types, characteristics and identification of mines and grenades. The contents of this lesson should be of sufficient coverage to provide you with assistance in your duties as a supervisor involving ammunition operations and also may be used for training of personnel in the technical aspects of ammunition materiel. The knowledge that you gain from this lesson will assist you in other phases of instruction you may receive as an Ammunition Supervisor.

2. LAND MINES.

a. General. Land mines (figure 5-1) are explosive items which may be planted in the path of the enemy to hinder his movement or to deny him access to certain areas. The mines are generally concealed and so rigged that they will be initiated by the enemy's presence or contact (figure 5-2) except in instances where the mines may be initiated by remote control. Mines may produce casualties by blast, fragmentation, shaped-charge effect, or by release of a harassing or toxic chemical agent. Since land mines have various uses, they are produced in a variety of types, sizes, and shapes and may also differ in material, quantity or type of explosive charge, incendiary or chemical content or fuze type. Some mines are boobytrapped to discourage neutralization, others propel a projectile into the air for more effective fragment distribution. Directional fragmentation type mines,aimed by sighting mechanisms, may be remotely controlled and initiated electrically.

b. Components.

(1) Body. Bodies of mines, some of which have actuator or secondary fuze wells, usually serve as a fuze holder and explosive charge container. Depending upon the degree of non-detectability or fragmentation desired, cast or sheet metal or plastics are used in body construction.

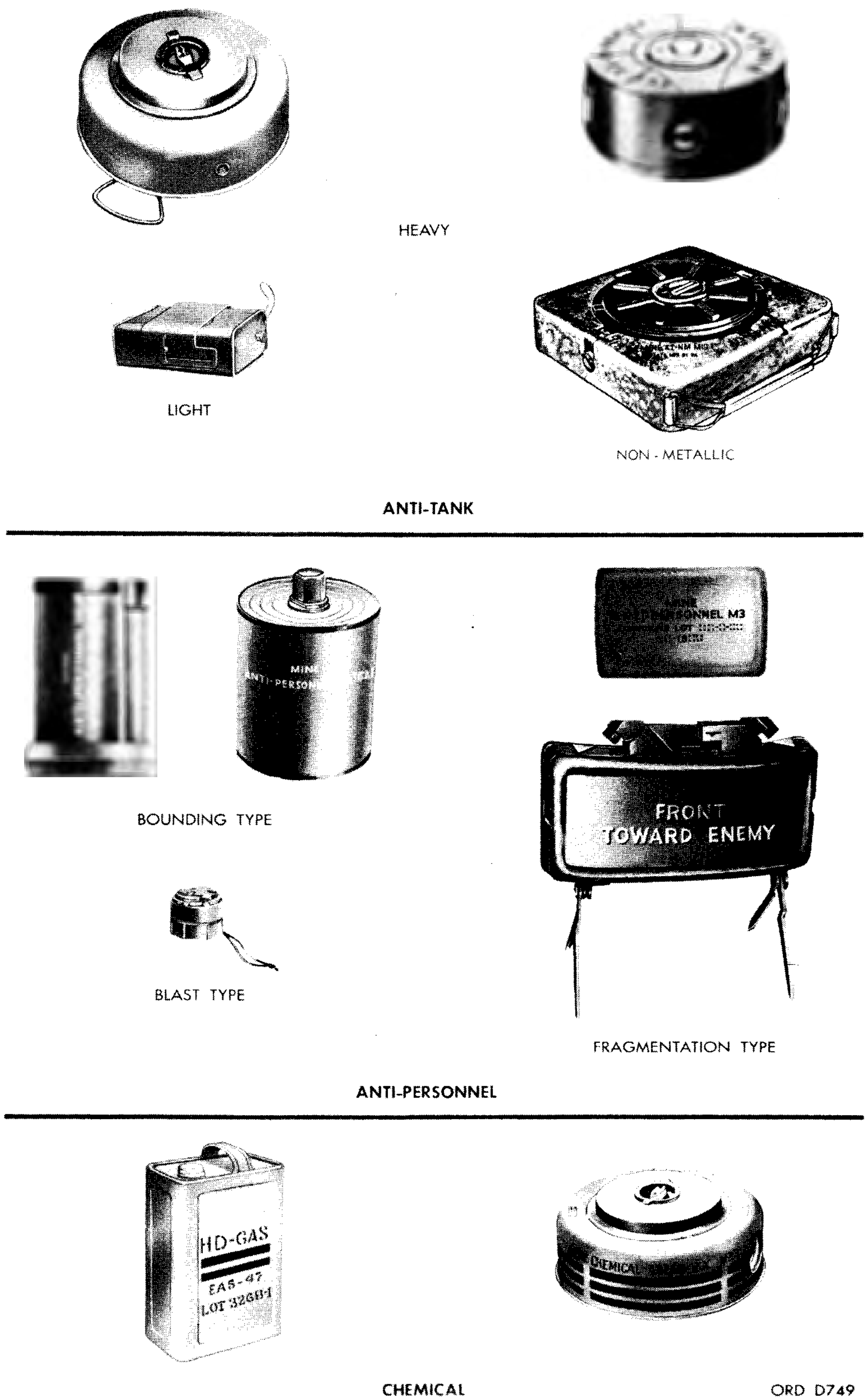


Figure 5-1. Representative types of land mines.

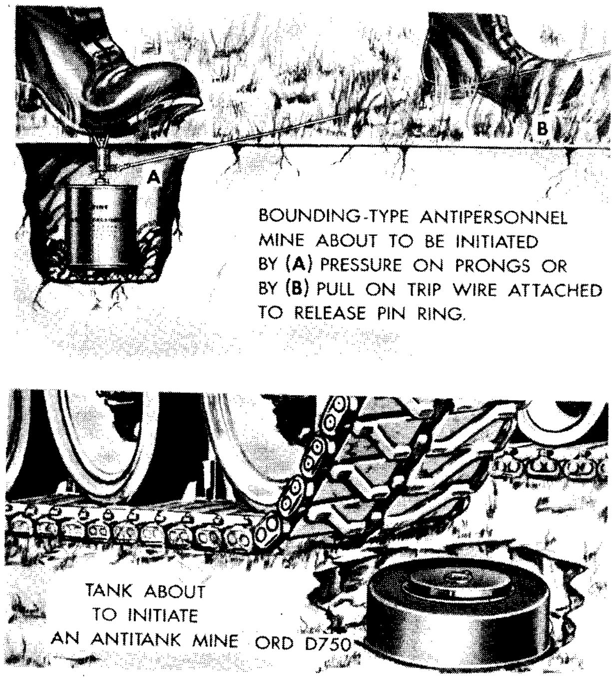


Figure 5-2. Initiating actions on antipersonnel and antitank mines.

(2) Filler. The major component of a mine is the explosive charge or filler, which provides the energy necessary for the mine to accomplish the desired effect. This energy may produce a fragmentation effect, may be used to propel a solid metal slug, or defeat armor by means of a shaped charge. Antivehicular mines usually depend upon direct contact, but a shaped charge or steel disk aimed at the underside of a tank, the tank treads, or wheel of a vehicle, is sometimes used. The type of explosive used for the main charge-tetryl, TNT, H6, Comp B, Comp C4 - is selected on the basis of greatest effect consistent with ease of loading, compatibility and logistics.

(3) Fuzes. The mechanical or electromechanical land mine fuze is usually activated by direct pressure from the target, such as being run over or stepped upon, or by pressure exerted upon a trip-wire or tilt-rod. Fuzes contain safety elements to prevent accidental firing, and most mines are issued fuzed. However, special purpose initiating devices may be used in boobytrapping and demolition materials.

(4) Types.

(a) Antipersonnel (APERS) mines. These mines (figure 5-1) are designed for use against personnel. The two basic types of APERS mines are:

1. Fragmentation.

a. Bounding. This type mine is placed below the surface of the ground. When the mine functions, a fragmentation projectile is projected from the mine body at a height of approximately two meters above the ground causing fragments to be propelled laterally in all directions.

b. Fixed nondirectional. This type mine is placed on, or just beneath the surface of the ground. When the mine functions, fragments are projected upward and outward in all directions.

c. Fixed directional. This type mine is placed on the ground or attached to an obstacle, such as a tree, pole or other object and in the path of the enemy. When the mine functions, fragments are projected outward in a fanshaped pattern above the ground. This type mine may be initiated by the approaching enemy or by remote control.

2. Blast. This mine depends for its effect on direct force developed by its explosion. The mine functions without delay while still in contact with the enemy who has initiated it.

(b) Antitank (AT) mines. These mines are used to immobilize or destroy enemy tanks or other vehicles. Blast type mines are generally employed in minefields and are usually laid on, or slightly below, the surface of the ground. Current standard mines consist of 3 to 22 pounds of high explosive in a metallic or nonmetallic casing fitted with a primary fuze, with provision for attachment of one or two secondary fuzes. Antitank mines usually require a pressure of 300 to 400 pounds for actuation, but they can be detonated by being stepped on by running troops. One newer type antitank mine immobilizes or destroys tanks by projecting a steel plate upward at a high velocity. The two general classes or antitank mines are heavy and light.

(c) Chemical mines. These mines are designed to disperse chemical agents from fixed locations to provide area contamination. The chemical agent may be in liquid or vapor form. These mines may be used in anti-tank mine fields or elsewhere as an antipersonnel mine. Minefields containing chemical, HE antipersonnel and antitank mines are particularly effective. The presence of HE mines impedes travel, thereby forcing greater exposure to chemical agents. Chemical mines slow breaching operations as it discourages rapid mine-clearing techniques. Chemical mines are usually shipped empty and are filled in the field. Contents of chemical mines are dispersed by the action of burster charges.

(d) Improvised mines. These mines are made of any available material such as cans, bottles, boxes, etc. They are used when standard mines are not available or cannot produce the desired result.

(e) Phony mines. These mines, as the name implies, are not real mines. They usually consist of scrap material or some disturbed earth to simulate an actual mine emplacement. Phony minefields may be used to supplement a live minefield. They are laid, primarily, to deceive, delay, and confuse the enemy.

(f) Practice and training mines. Practice mines are the same size, weight and shape as service mines. They contain a charge of black powder or pyrotechnic composition which produce a smoke puff and noise to simulate the explosion of a service mine. Training mines are identical to service mines except that they are filled with inert material or they may be left empty and are used only for training in handling.

(g) Boobytraps. A boobytrap (figure 5-3) is a device containing an explosive charge which is initiated when an unsuspecting person disturbs an apparently harmless object or performs a presumably safe act. A boobytrapped mine is any mine having a supplementary fuze or separate charge so arranged that it will detonate the mine when the mine is disturbed. Most antitank mines have one or more secondary fuze wells; however, secondary fuze wells are not provided in current antipersonnel mines. The secondary fuze wells of antitank mines are adapted to receive an activator into which is threaded one of several firing devices. (An activator is an explosive item which is essentially a detonator - booster acting as an adapter between the firing device and the mine).

(h) Explosive trains. Explosive trains are basically similar to trains discussed in the lesson on artillery ammunition. Both types of trains (high and low) are shown in antipersonnel mine (figure 5-4). High explosive trains, primary and secondary (with activator), are shown in antitank mine (figure 5-5)

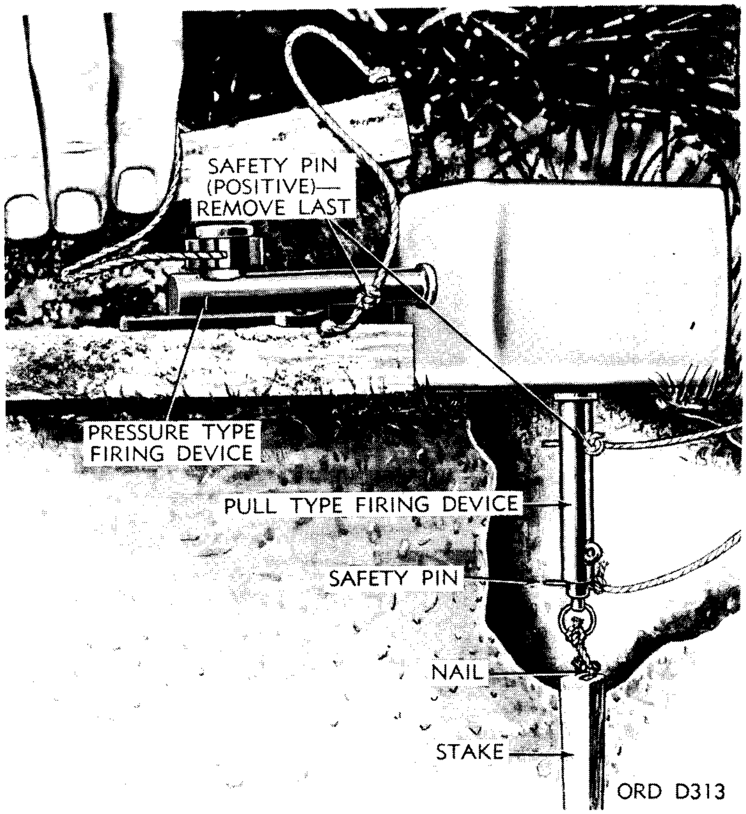


Figure 5-3. Boobytrapped antipersonnel mine.

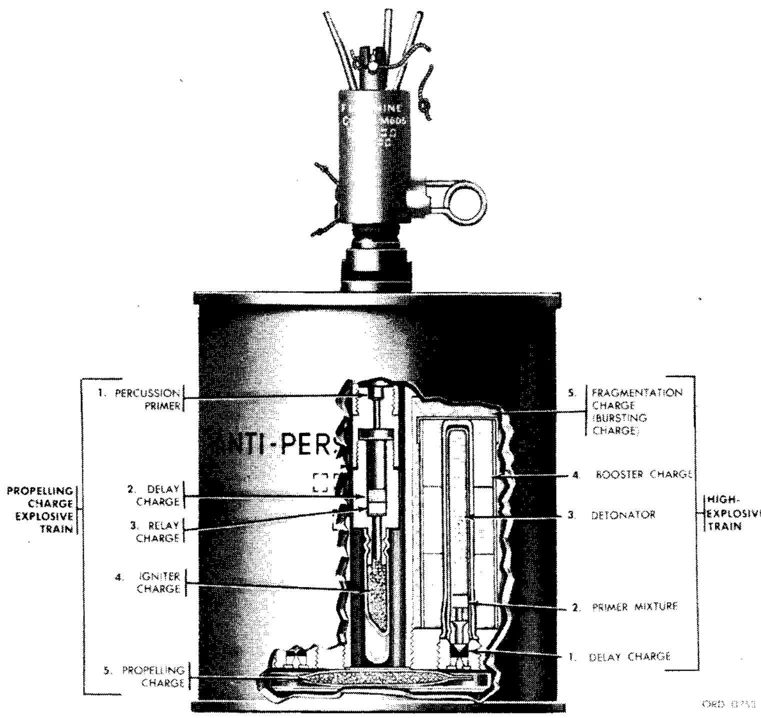


Figure 5-4. Explosive trains in bounding type antipersonnel mine.

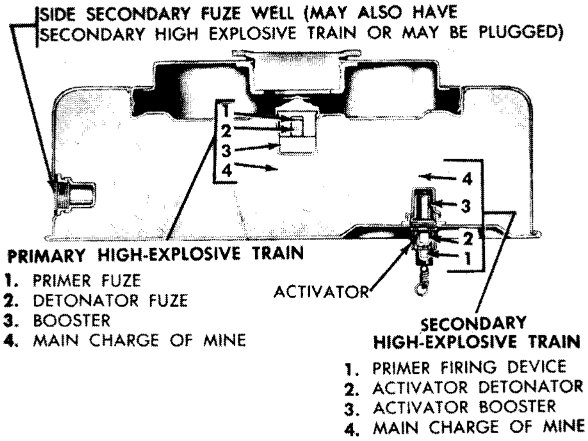


Figure 5-5. Explosive trains in antitank mine.

3. IDENTIFICATION OF LAND MINES.

a. Land mines are identified by standard nomenclature, lot number, model, painting, and marking. Such means of identification are used on all packing containers and on the item itself if it is not too small.

b. Standard nomenclature consists of an item name followed by sufficient information to differentiate between items having the same item name. An example is MINE, ANTITANK: HE, heavy, M15, and fuze, mine, AT, M603 and activator M1.

c. The ammunition lot number is assigned when item is manufactured. It consists of loader's initials or symbols, and the lot number. This lot number is stamped or marked on every mine and on all packing containers. It is required for all purposes of record.

d. A model designation is assigned at the time an item is classified as an adopted type. The model designation becomes a part of the standard nomenclature and is included in the marking on the item. The present method of model designation consists of the letter M followed by an arabic numeral. An example, "M6A1" indicates the first modification of an item for which the original model designation was M6.

e. Ammunition is painted for preservation and to aid in identification of type, filler, high or low explosive,or toxic.

(1) HE mines and related items are painted olive drab with yellow markings. Some items may also have yellow stripes or bands, or have their closing plugs painted yellow.

(2) Practice mines are painted blue and marked in white. Under "new" system, practice mines containing low explosives have brown markings.

(3) Inert mines are painted black (old) or blue (new) with markings, including the word "INERT" in white.

4. REPRESENTATIVE ANTIPERSONNEL MINES.

a. APERS mine, M16A1 (Bounding type).

(1) Characteristics. This mine (figure 5-6) consists of combination mine fuze M605, a propelling charge, and a projectile, all contained in a sheet steel case. The projectile contains one pound of TNT. The fuze threads into the top of the case and extends through the center of the projectile to the bottom of the case, where the expelling charge is located.

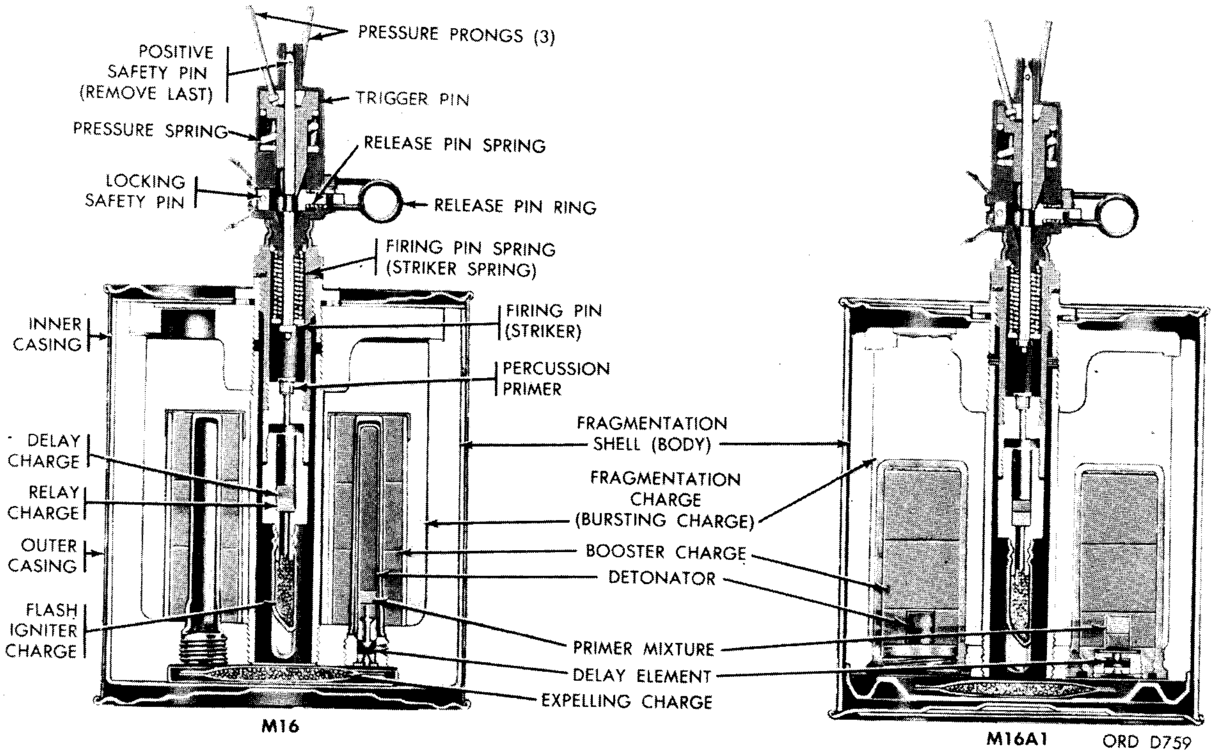


Figure 5-6. Comparison of antipersonnel mines M16 and M16A1.

(2) Functioning. The fuze of this mine is activated by a pressure of 8 to 20 pounds on either of the three prongs of the fuze releasing the firing pin or by a pull of 3 to 10 pounds on the trip wire attached to the release pin. The low explosive train ignites the expelling charge projecting the cast iron projectile upward from the mine body and at the same time ignites the two detonator delay charges which cause the projectile to detonate at optimum height for fragmentation effect (approximately 3 meters). The burning delay charge of the fuze explosive train allows time for personnel to move from directly over mine after stepping on either of the three prongs. The difference between the M16 and M16A1 mines are in detonator and booster modifications.

b. APERS mine, M18A1 (Claymore).

(1) General. This mine (figure 5-7) is a directional, fixed fragmentation mine that is used primarily for defense of bivouac areas, outposts, and against infiltration tactics. This mine is effective against thin-skinned vehicles such as jeeps, automobiles, trucks, etc., readily perforating the outer body causing casualties. The fragments will also puncture tires, gas tanks, crankcases, radiators, and engine accessories. When detonated, a fan-shaped pattern of round steel fragments is projected in a 60 degree arc covering a casualty area of 50 meters to a height of 2 meters.

(2) Characteristics. Mine M18A1 is identified as a curved, rectangular, olive drab, molded

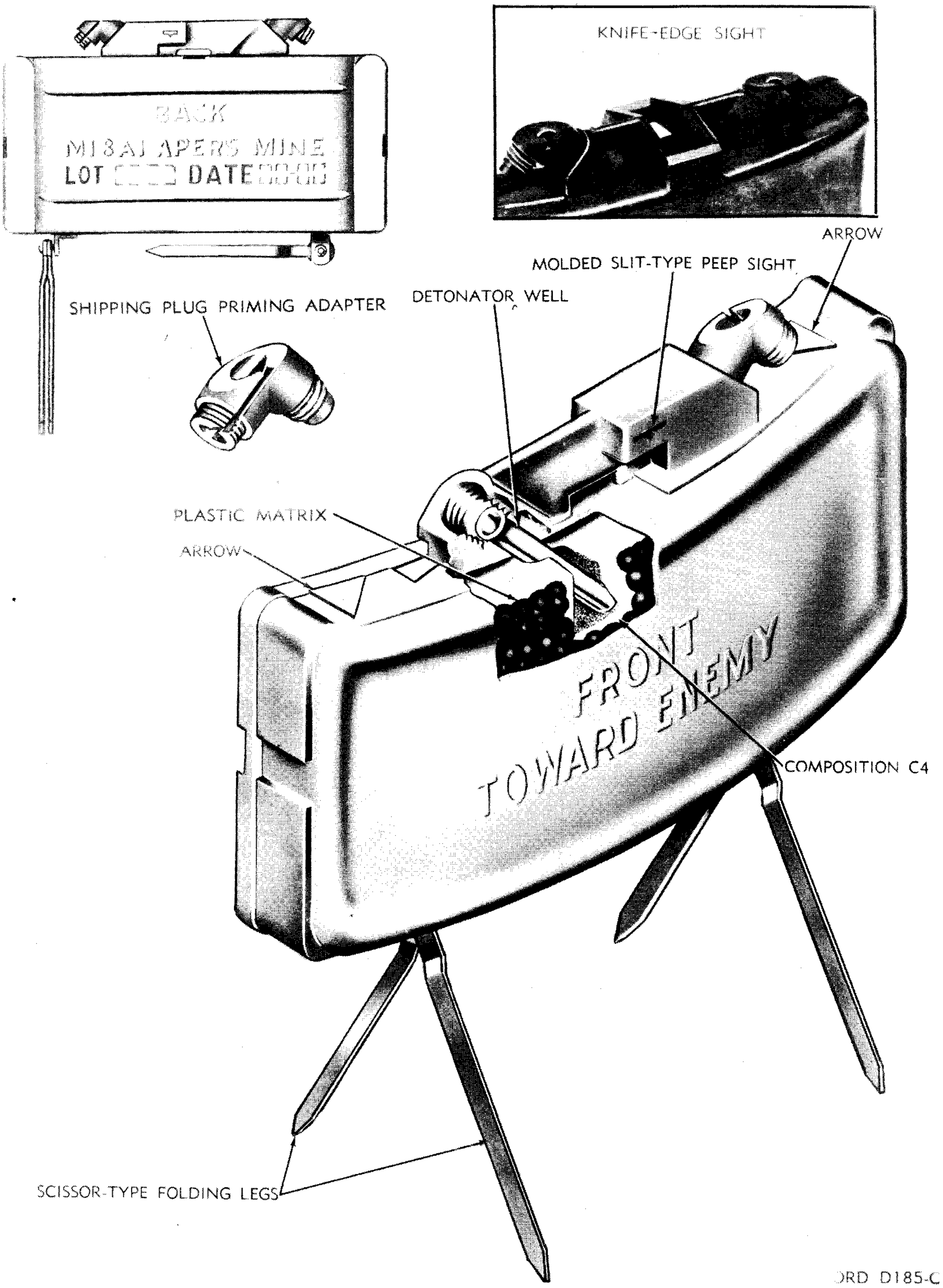


Figure 5-7. Antipersonnel mine M18A1.

plastic case. In the front portion of the case is a fragmentation face containing 700 steel balls imbedded in a matrix. The back portion of the case, behind the matrix, contains a 1.5 pound layer of composition C4. The fragmentation face is convex horizontally and concave vertically to direct the fragmentation pattern. The mine is assembled with two detonator wells with shipping plug priming adapters, a molded slit-type peep sight, and two pairs of scissor type folding legs. The two detonator wells, located in the top of the mine, enable the mine to be fired from two locations or to be fired by nonelectric single or dual priming. The end of the shipping plug priming adapter is slotted to hold an electric or nonelectric blasting cap in place when the mine is armed. The molded slit-type peep sight and arrows located on top of the mine are used for aiming. The mine, the firing device M57 (pulse generator), Test Set M40 (for testing circuit continuity) electric blasting cap M4 (M6 blasting cap with 30 meters of firing wire) and instruction sheet are packed in the bandoleer M7 (figure 5-8) and overpacked 6 bandoleers (6 mines) in a wooden box (figure 5-9).

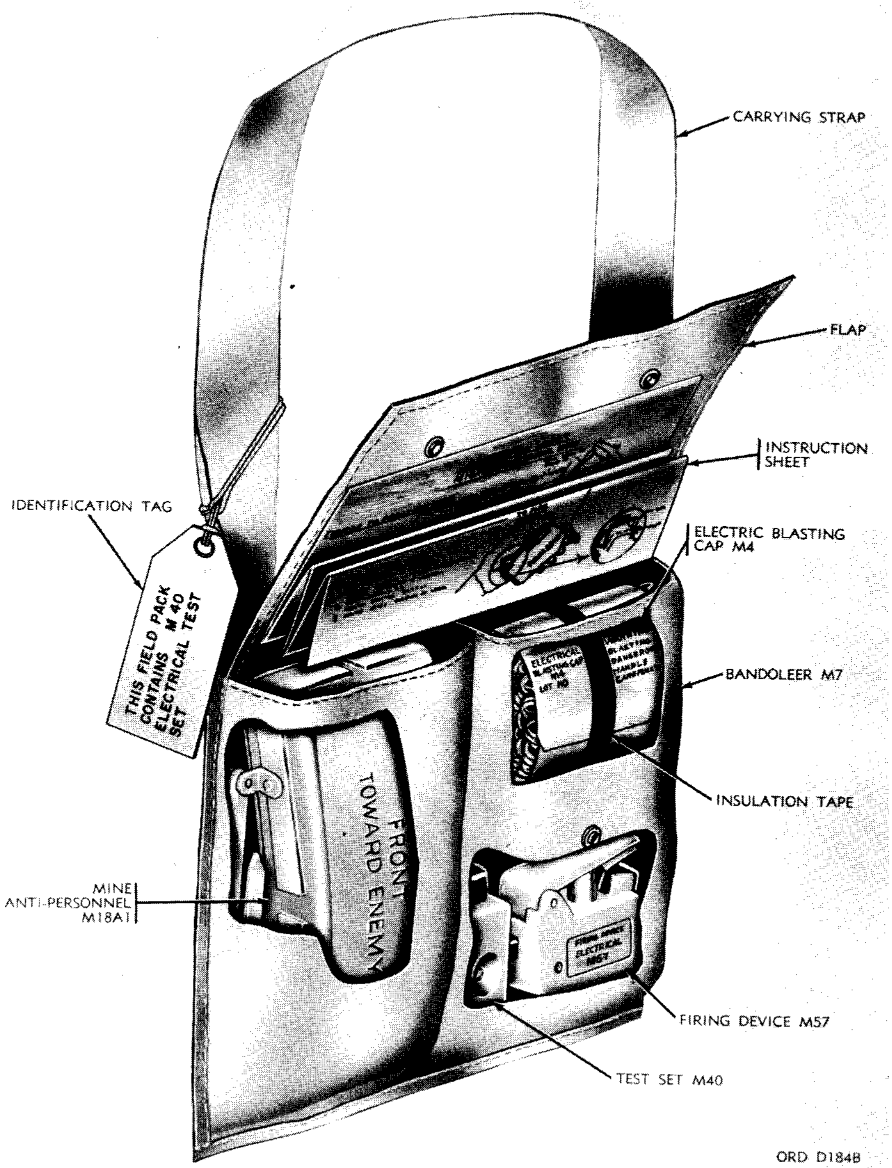


Figure 5-8. Antipersonnel mine ,M18A1 and accessories packed in bandoleer M7.

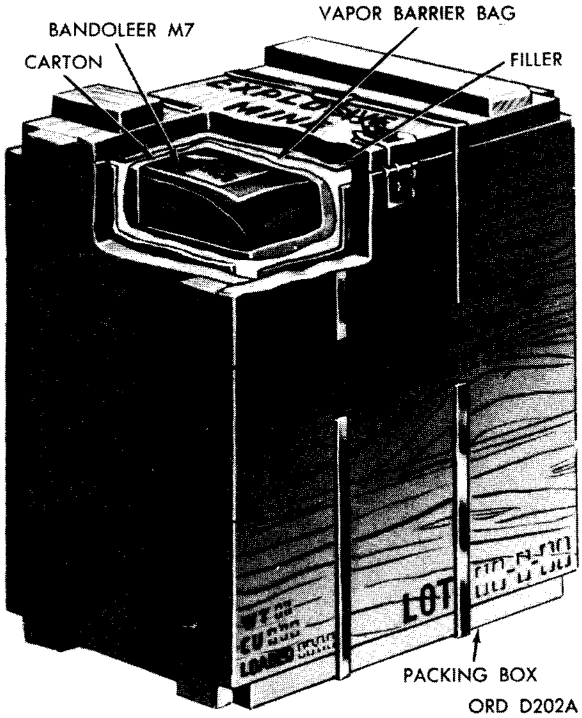


Figure 5-9. Packing box for antipersonnel mine M18A1.

(3) Functioning. When the M18A1 mine has been armed, the actuation of the firing device handle (figure 5-10), with the safety bail in armed position, will provide sufficient electrical energy to detonate the blasting cap M6 which detonates the composition C4 high explosive charge. The resulting detonation projects the fragments outward in a fan-shaped pattern (figure 5-11). This mine may also be initiated by a trip wire and pull-type firing device hook up (figure 5-11).

c. APERS mine, nonmetallic (NM) M14.

(1) General. This mine (figure 5-12) is a nonmetallic, blast type, high explosive, antipersonnel mine consisting of an all plastic body, an integral plastic fuze, having a steel firing pin, a pull cord, a safety clip, a carrying cord and containing a 1 ounce tetryl charge.

(2) Characteristics. The mine is cylindrical in shape. Six ribs on the outside of the body provide strength and serve as a means for identifying the mine in darkness. For safety, the plug-type plastic detonator holder, with detonator, is packaged separately in the same shipping container with the mine. During shipment the detonator well is closed with a circular head shipping plug. Two letters, "A" and "S," on the top of the fuze designate "armed" and "safe," respectively. The slots in the pressure plate are for insertion of the steel U-shaped safety clip attached to a pull cord. A lock key restrains the pressure plate when plate is in "safe" position. A belleville spring with attached lock ring and firing pin assembly is seated against the spider and is held in place by a ridge on the rim of the partition. The partition also holds the main charge in place and prevents any explosive from getting into the firing mechanism of the fuze.

(3) Function. A force of 20 to 35 pounds will depress the pressure plate and lock key. The lock key forces the lock ring to slide through notches in the inner ring of the spider and depresses the belleville spring. The belleville spring snaps through center (reverse action) driving the firing pin into the detonator which detonates the main charge. No provision is made for boobytrapping the mine.

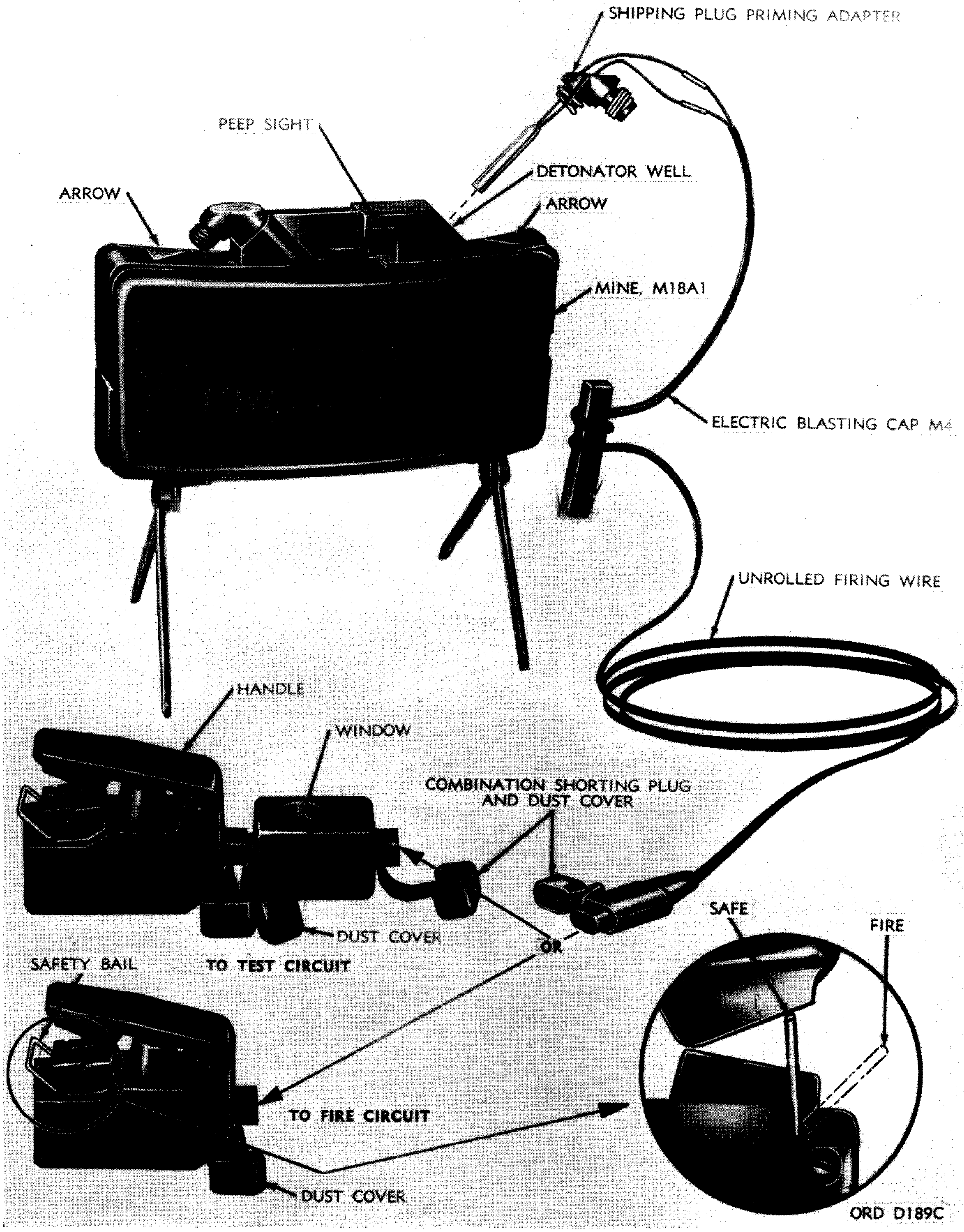


Figure 5-10. Arming and testing antipersonnel mine M18A1.

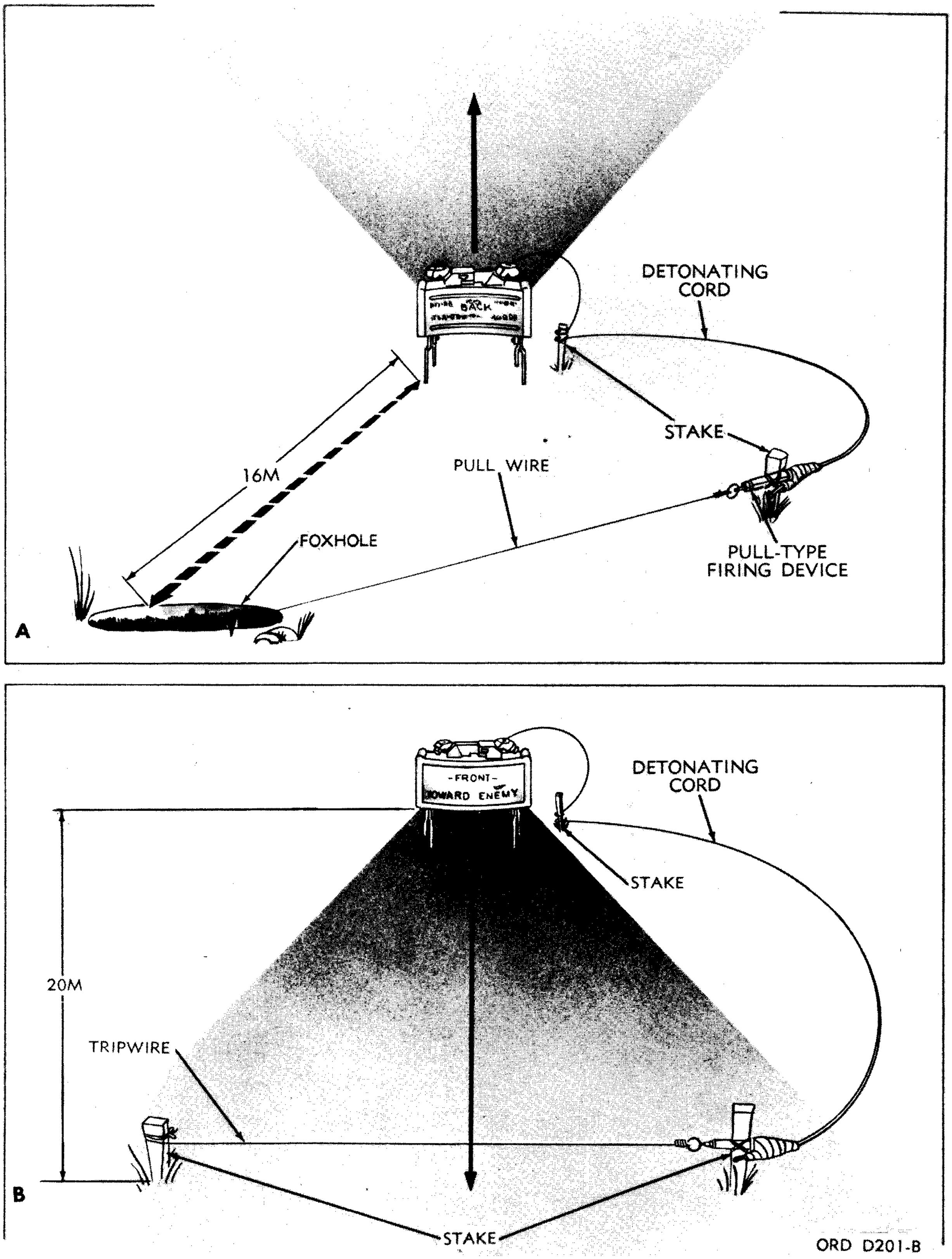


Figure 5-11. Antipersonnel mine M18A1 ready for firing - A. By observer, B. By enemy.

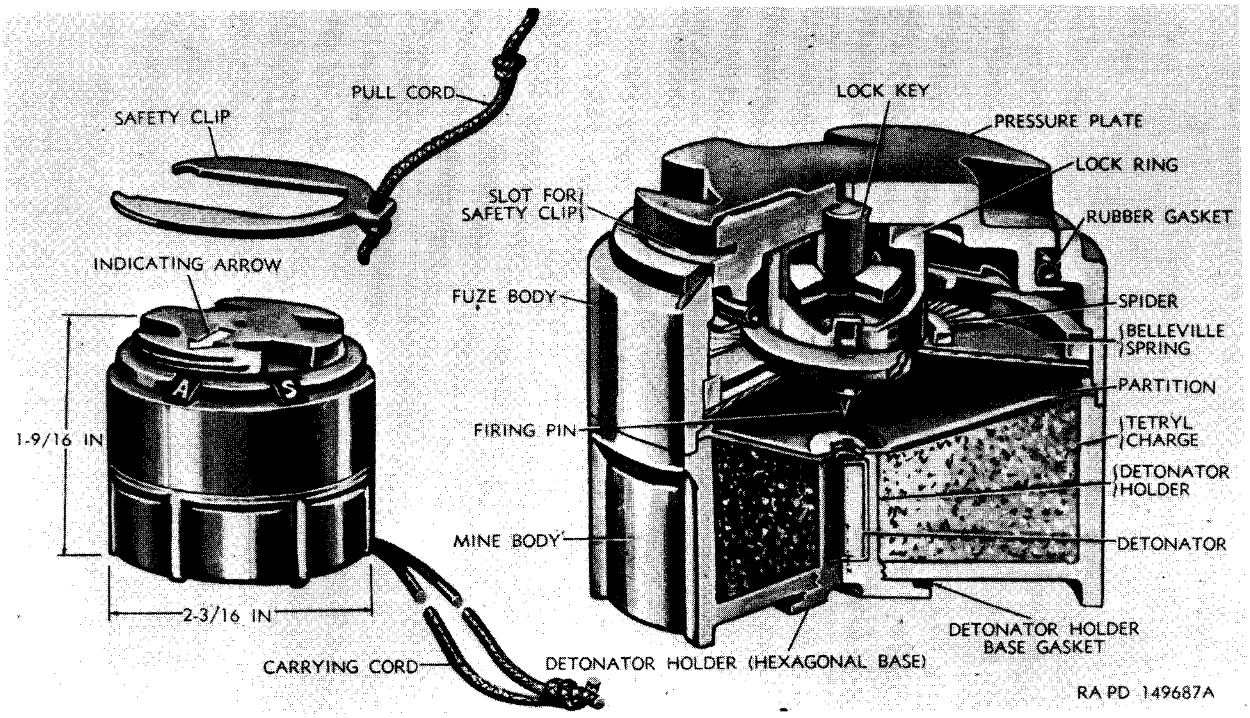


Figure 5-12. Nonmetallic antipersonnel mine M14 with safety clip removed and detonator installed.

5. REPRESENTATIVE ANTITANK MINES.

a. Mine, AT, HE, heavy, M15.

(1) Characteristics. This is a high capacity mine (figure 5-13) intended for use against heavy tanks. A minimum force of 565 ±174 pounds on the fuze is required to initiate this mine, therefore, it will not ordinarily be initiated by foot troops; however, it is possible that running troops could initiate the mine. This mine contains 22 pounds of explosive B incased in a round steel container. This mine is armed by the M4 or M4B1 fuze arming plug. This plug (figure 5-14) is in place over main fuze well of mine as shipped. It has a steel shutter which moves from a side position as the setting knob is moved from SAFE through DANGER to ARMED position. The mine has two secondary (boobytrapping) fuze wells, one located in the side and one in the bottom covered by tape. Any standard firing device or activator M1 may be threaded into the secondary fuze wells. The booster M120 is located in the bottom of the main fuze well. The primary fuze (figure 5-15) is the M603 and is the mechanical belleville spring type having pressure plate and safety fork. Fuse M603 and activator M1 are packaged separately with the mine.

(2) Functioning. When the shutter of the arming plug is moved to ARMED position (using arming plug wrench) (figure 5-16), a force of 300 to 400 pounds on pressure plate of mine depresses the belleville spring of the mine causing the shutter to depress the pressure plate of the fuze. The fuze pressure plate depresses the fuze belleville spring which snaps into reverse, driving the firing pin

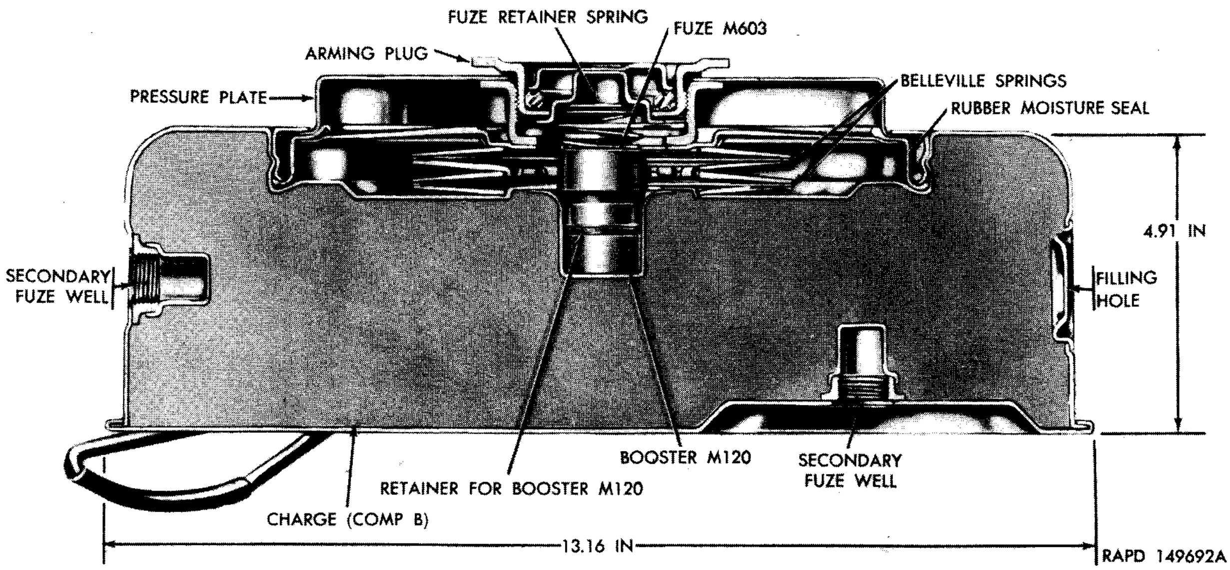


Figure 5-13. Mine, antitank, HE, heavy, M15 (T27)-cross section with fuze M603 installed.

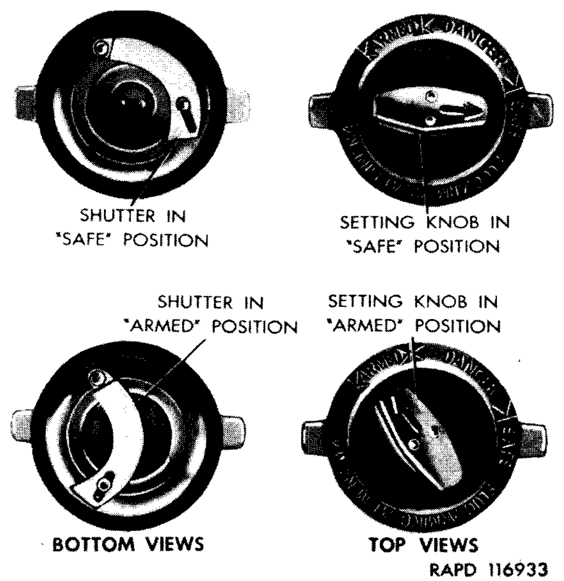


Figure 5-14. Arming plug M4 or M4B1, for antitank mines M15 service, M6 empty and M12 practice.

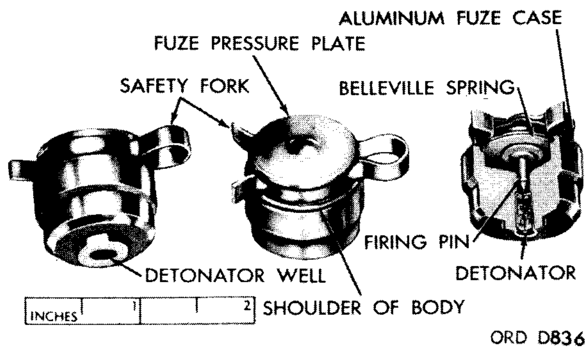


Figure 5-15. Fuze, mine, AT. M603-bottom, top and cross section.

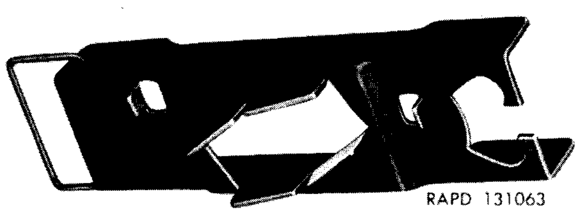


Figure 5-16. Wrench, arming plug, M20, for arming plug M4 or M4B1.

into the detonator initiating the booster which detonates the main charge.

b. Mine, AT, HE, heavy, M21.

(1) Characteristics. This mine (figure 5-17) with antitank mine fuze M607 is used primarily for destroying tanks and other types of tracked and wheeled vehicles. The fuze M607 with extension rod and adapter can be actuated by contact with any portion of a tank or other vehicle which exerts 3.75 pounds pressure on the extension (tilt) rod. With the extension rod and adapter removed, the fuze may be used as a pressure-type fuze. This mine derives its effectiveness against armor from the energy produced by the high explosive charge (Comp H6), propelling a mass of steel upward at a velocity sufficient to perforate the tank belly armor. The mine contains 11 pounds of HE (H6) and is provided with a carrying strap. The cover assembly (figure 5-18) contains a shipping plug assembly, a cover assembly, a charge cap assembly, and a black powder expelling charge. The body of the mine contains a concave steel plate, firing pin assembly, HE charge and delay assembly consisting of primer M42, a delay element and a relay assembly. The M607 fuze assembly (figure 5-19 and 5-20) consists of a pressure ring, cap, body, tilt rod, band, stop, pull ring assembly, plastic collar, seal, bearing cap, belleville spring, retainer ring, O ring, firing pin assembly, fork, detonator M46, gasket, and closure assembly. The band and the stop are held together by the pull ring assembly which provides safety until the fuze is armed. The fork of the closure assembly prevents the firing pin from accidently striking detonator M46 during shipment or handling.

(2) Functioning. The fuze will function with or without the extension rod and adapter. With the extension rod and extension rod adapter assembled to the fuze (after the pull ring assembly, stop, and band have been removed), the tilting of the extension rod with a minimum horizontal force of 3.75 pounds, acting through an angle of approximately 20 degrees or more, will shatter or break the plastic collar. When used without the extension rod and adapter, a minimum

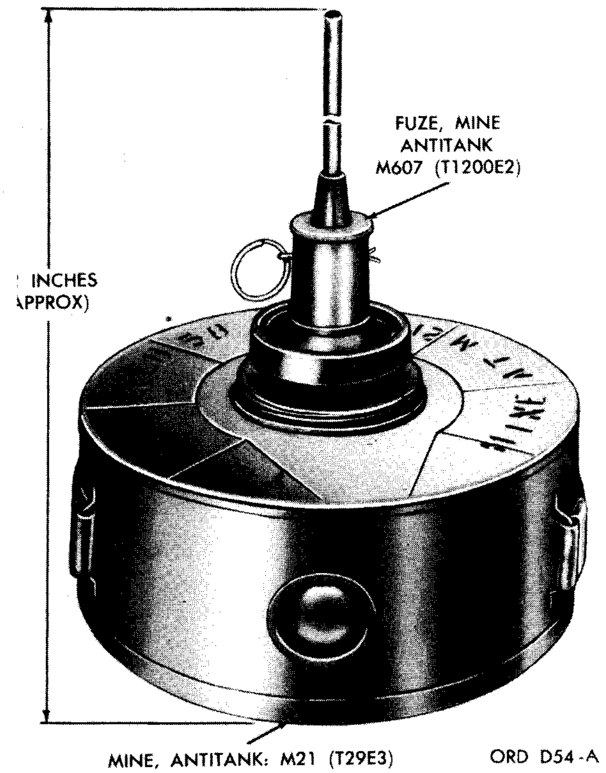


Figure 5-17. Mine, antitank, HE, M21 and fuze mine, antitank M607.

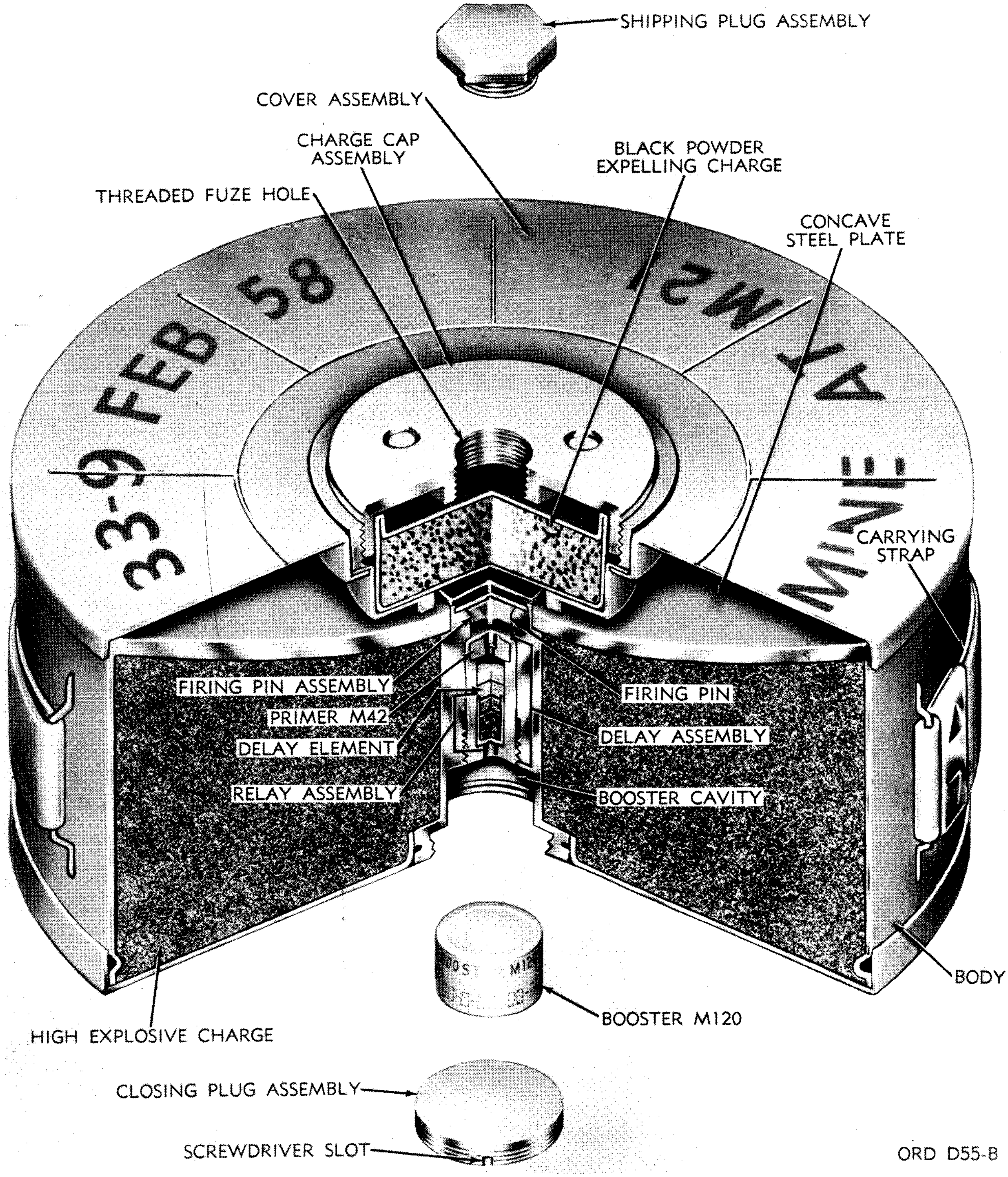


Figure 5-18. Mine, antitank, HE, M2l-sectional view.

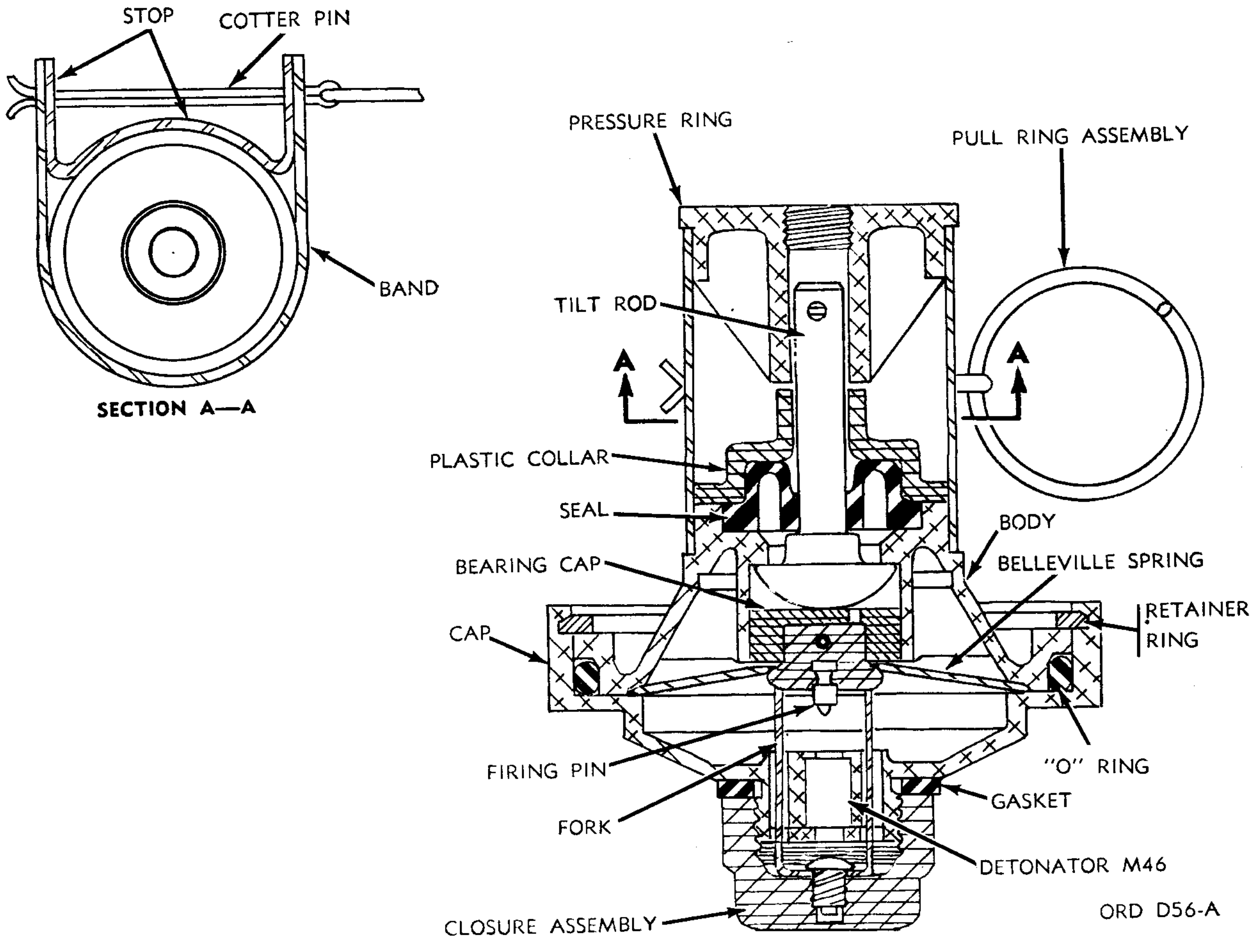


Figure 5-19. Fuze, mine, antitank, M607-cross sectional view.

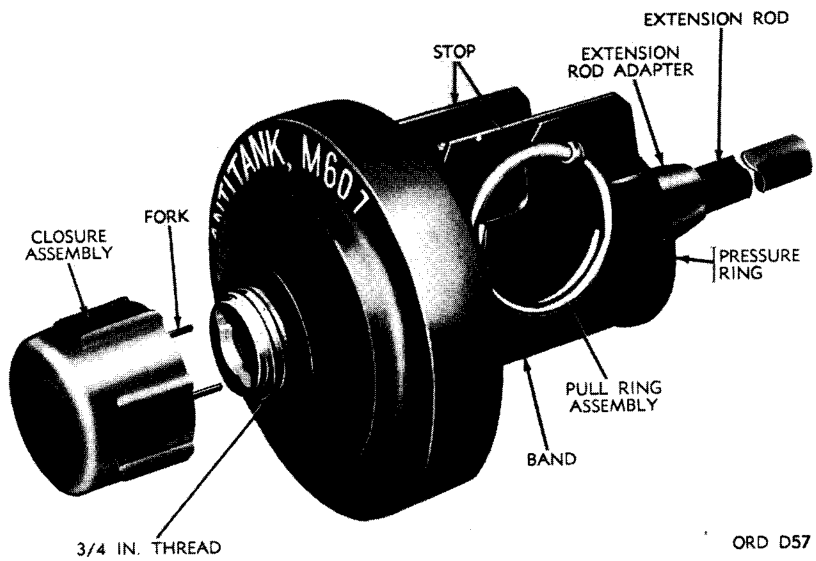


Figure 5-20. Fuze, mine antitank, M607-before installation in mine M21.

force on the pressure ring of 290 pounds acting through a distance of 1/8 inch, will shatter or break the plastic collar. Once the plastic collar is shattered or broken, the rounded base of the tilt rod rolls against the bearing cap, forcing it downward, and causing the belleville spring to snap into reverse position. This action drives the firing pin into detonator M46, initiating the detonator which, in turn, fires the black powder expelling charge. The blast from the black powder expelling charge blows off the fuze and cover assembly, and the dirt or camouflage material which covers the mine. The pressure created by the black powder expelling charge drives the firing pin into the primer M42 initiating the primer and the delay assembly. After a delay of 0.15 of a second, the relay assembly is initiated. The relay detonates booster M120, which detonates the high explosive charge. The detonation of the HE charge blows the body of the mine apart and causes the concave steel plate to be projected upward at a high velocity. The booster, fuze, arming wrench, extension rod, and adapter are shipped unassembled in the mine container (figure 5-21).

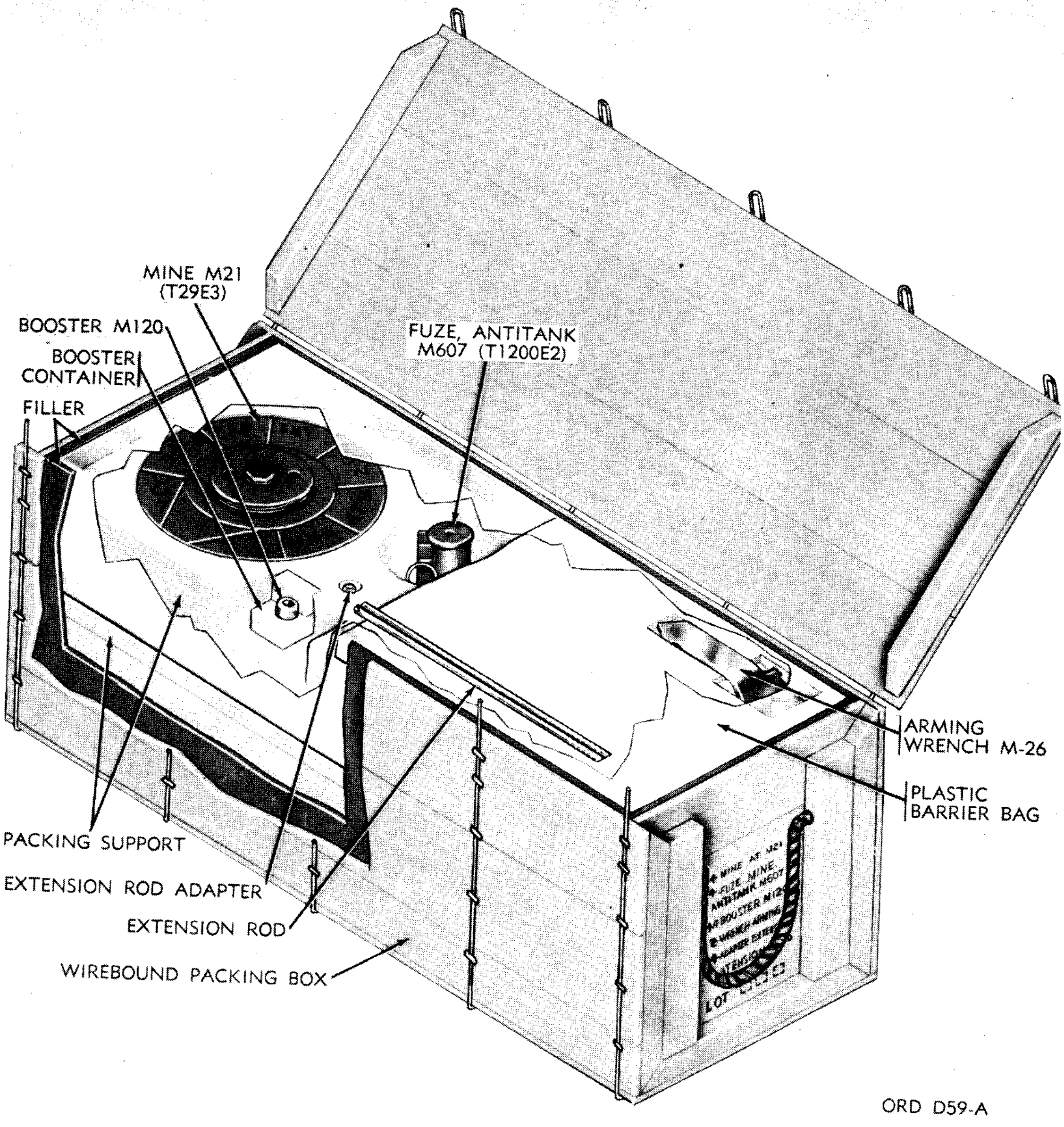


Figure 5-21. Packing for antitank mine M21 and components.

c. Mine, AT, HE, nonmetalic (NM), M19.

(1) Characteristics. This mine (figure 5-22) is intended for use against heavy tanks and other types of heavy tracked and wheeled vehicles. Being of nearly all plastic construction, the mine is nondetectable by magnetic mine detectors. The mine is assembled with fuze M606 which is a mechanical pressure type fuze and is also constructed of plastic material. The mine is square and contains 21 pounds of composition B. The mine body contains the HE charge, a tetryl booster and the fuze. It has two activator wells, one located in the side and the other in the bottom, which are threaded to receive activators M1 or M2 (figures 5-23 and 5-24). Activator M1 is similar to activator M2 except that it is 0.2 of an inch longer. These activators are essentially detonator boosters and usually are used with the pull type or pull release type firing devices to provide an antitank mine with a secondary fuze for antilift or boobytrapping purposes.

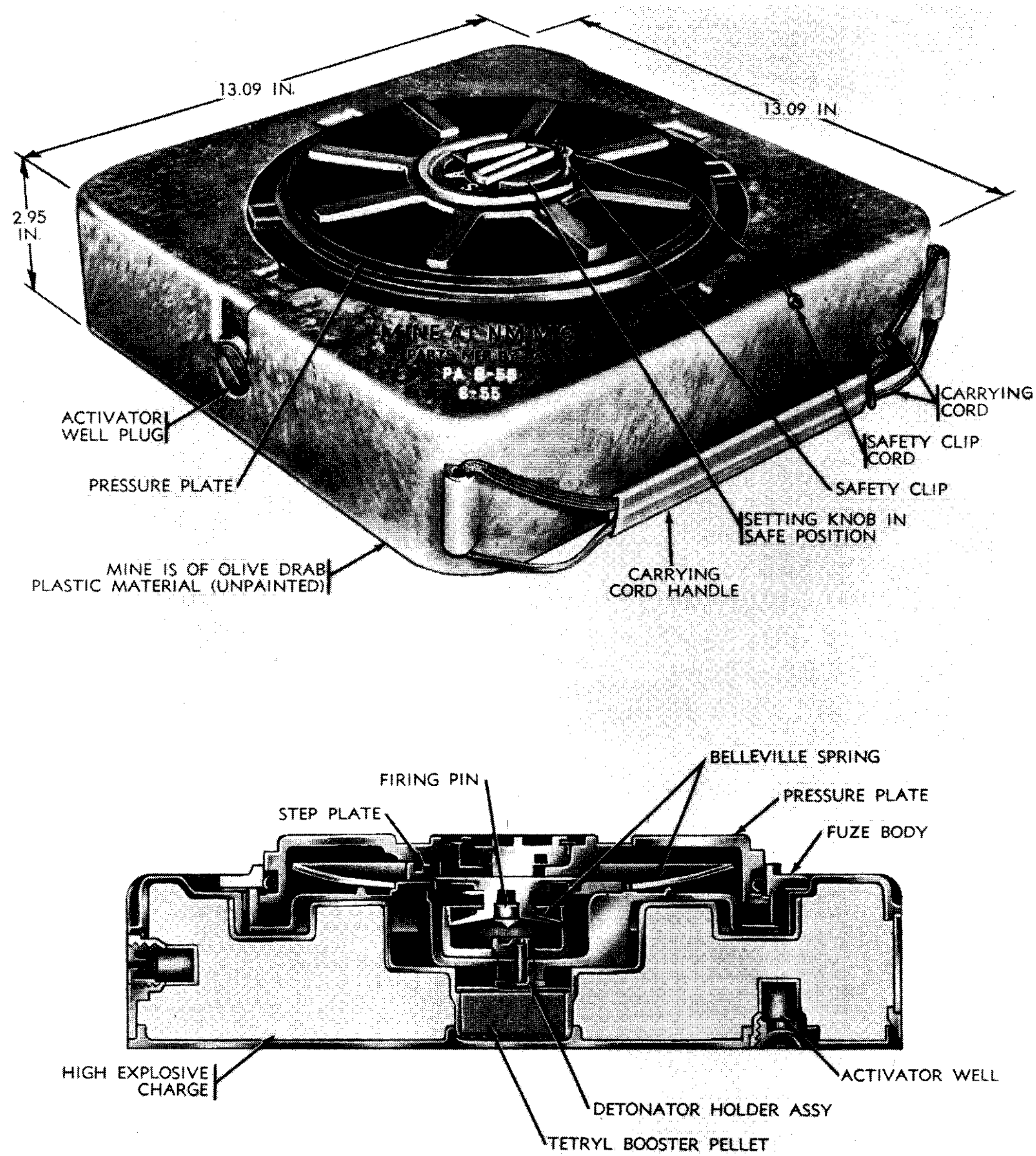


Figure 5-22, Mine, antitank, NM, M19 and fuze, mine antitank, M606.

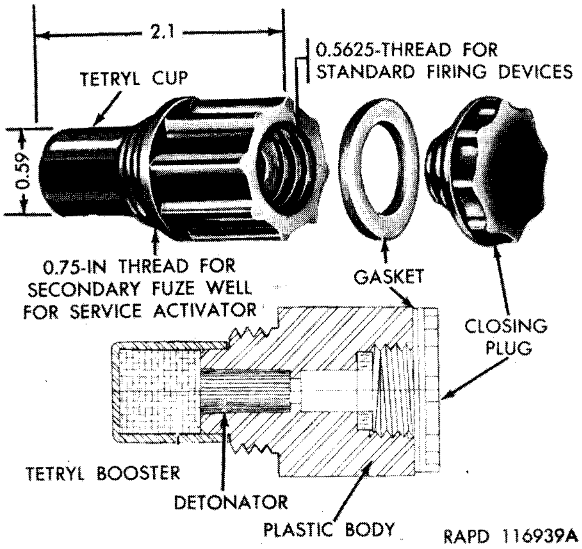


Figure 5-23. Activator, antitank mine. M1.

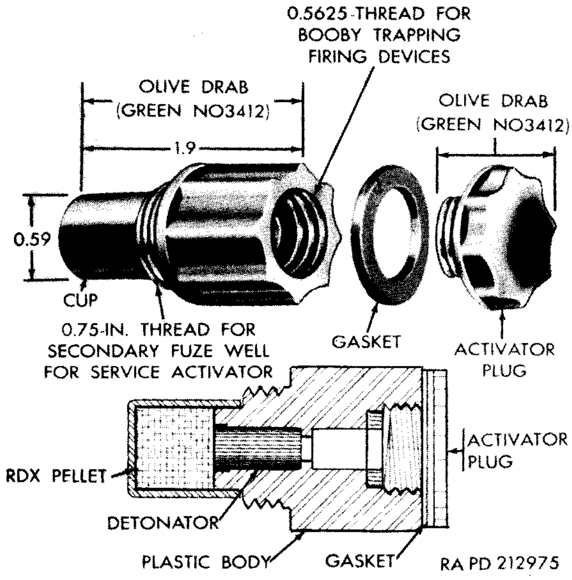


Figure 5-24. Activator, antitank mine, M2.

(2) Functioning. When the setting knob is in the safe position (S), the mine cannot function by action of the main fuze since the detonator is out of line with the firing pin and the position of the step plate prevents depression of the pressure plate. Turning the setting knob to the armed position (A), alines the firing pin with the detonator and rotates the step plate to a position in which the pressure plate can be depressed permitting function of the fuze. The mine is packed and shipped with safety clip in place to prevent accidental movement of the setting knob. After the safety clip has been removed and the setting knob turned to the armed position (A), a minimum force of 350 to 500 pounds on the pressure plate depresses the belleville spring of the fuze causing the belleville spring to snap through center into reverse, driving the firing pin into the detonator initiating the high explosive train causing the mine to detonate.

6. GRENADES.

a. General. Grenades are classified according to method of projection as hand or rifle: according to use as service, practice, or training; and according to filler as explosive, chemical, illuminating, inert,or with a spotting charge filler.

b. Method of projection. Certain grenades are designed to be thrown by hand and others are designed to be projected from a rifle by means of a grenade launcher (figure 5-25), a special grenade cartridge (figure 5-26),and a grenade projection adapter (figures 5-27 and 5-28).

c. Use. Service grenades are intended for use in tactical situations. Practice grenades are intended for use in providing realistic training for troops in the proper care, handling, and use of grenades. Training grenades are used for training troops to handle, throw, and arm grenades.

d. Filler. Explosive grenades contain a high explosive charge for the purpose of inflicting casualties by fragmentation, by blast effect,or by penetration of armor plate. Chemical grenades contain gas, smoke, and incendiary fillers. Illuminating grenades contain an illuminant composition. Practice grenades contain a spotting charge and training grenades are inert.

7. IDENTIFICATION OF GRENADES.

a. General. Grenades, both hand and rifle (figure 5-29), in common with other types of

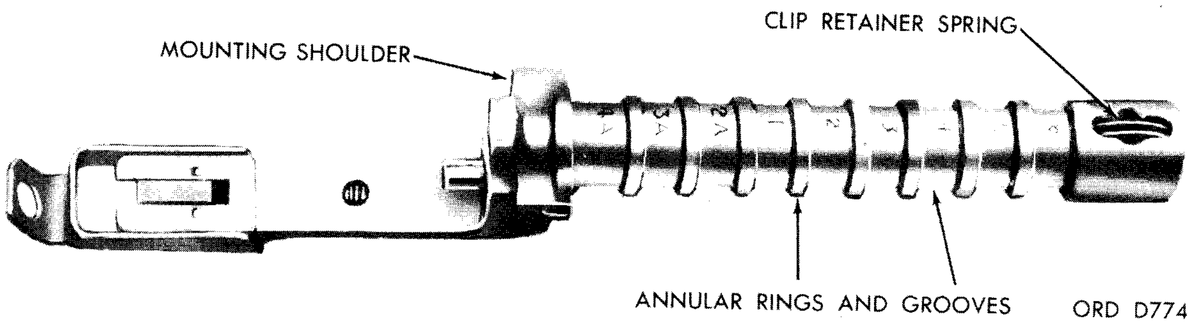


Figure 5-25. Grenade launchers, M7A3.

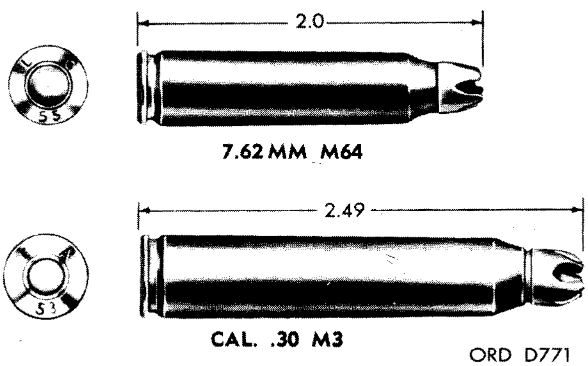


Figure 5-26. Rifle grenade cartridges.

ammunition, are identified by standard nomenclature and the lot number of the item. There are markings on all containers and on the item itself unless it is too small, or the shape too irregular.

b. Standard nomenclature. Standard nomenclature provides that each item may be specifically identified by name. The use of standard nomenclature is mandatory for all purposes of record.

c. Ammunition lot number. A lot number is assigned when the ammunition is manufactured and becomes an essential part of the marking. The lot number is made up of the loader's initial or symbol, the interfix number, and the serial number of the lot. The lot number is stamped and marked on every item and on all packing containers. It is required for all purposes of record, including reports, conditions, functioning, or accidents in which the ammunition may be involved.

d. Model. A particular design is identified by a model number. This number becomes an essential part of the nomenclature and is included in the marking of the item. The present system of model designation consists of the letter M followed by an arabic numeral, for example, M1. Modifications are indicated by adding the letter A and the appropriate arabic number. Thus, M1A1 indicates the first modification of an item for which the original model designation was M1. Whenever a B suffix appears in a model number, it indicates an item of substitute design material. The prefix AN indicates an item standardized for use by both Army and Navy. Items under development are indicated by the prefix XM (or T for older items) plus an arabic number and modification by the addition of E and an arabic number, for example, XM28E2 or T28E2. Items of Navy design consist of MK signifying the word MARK followed by an arabic numeral, together with the modification (Mod) number, for example, MK6Mod2.

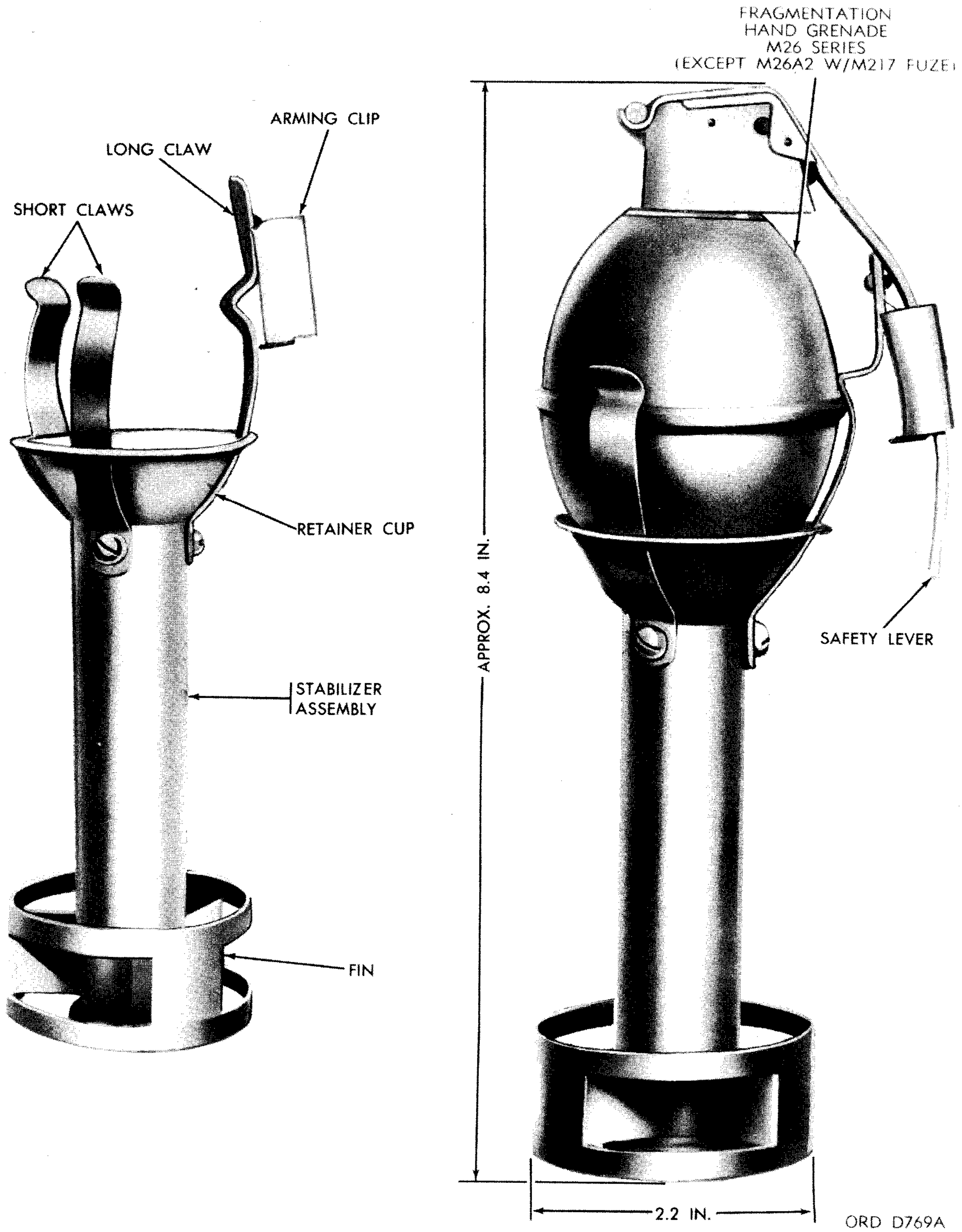


Figure 5-27. Adapter, grenade projection, M1A2 with fragmentation hand grenade.

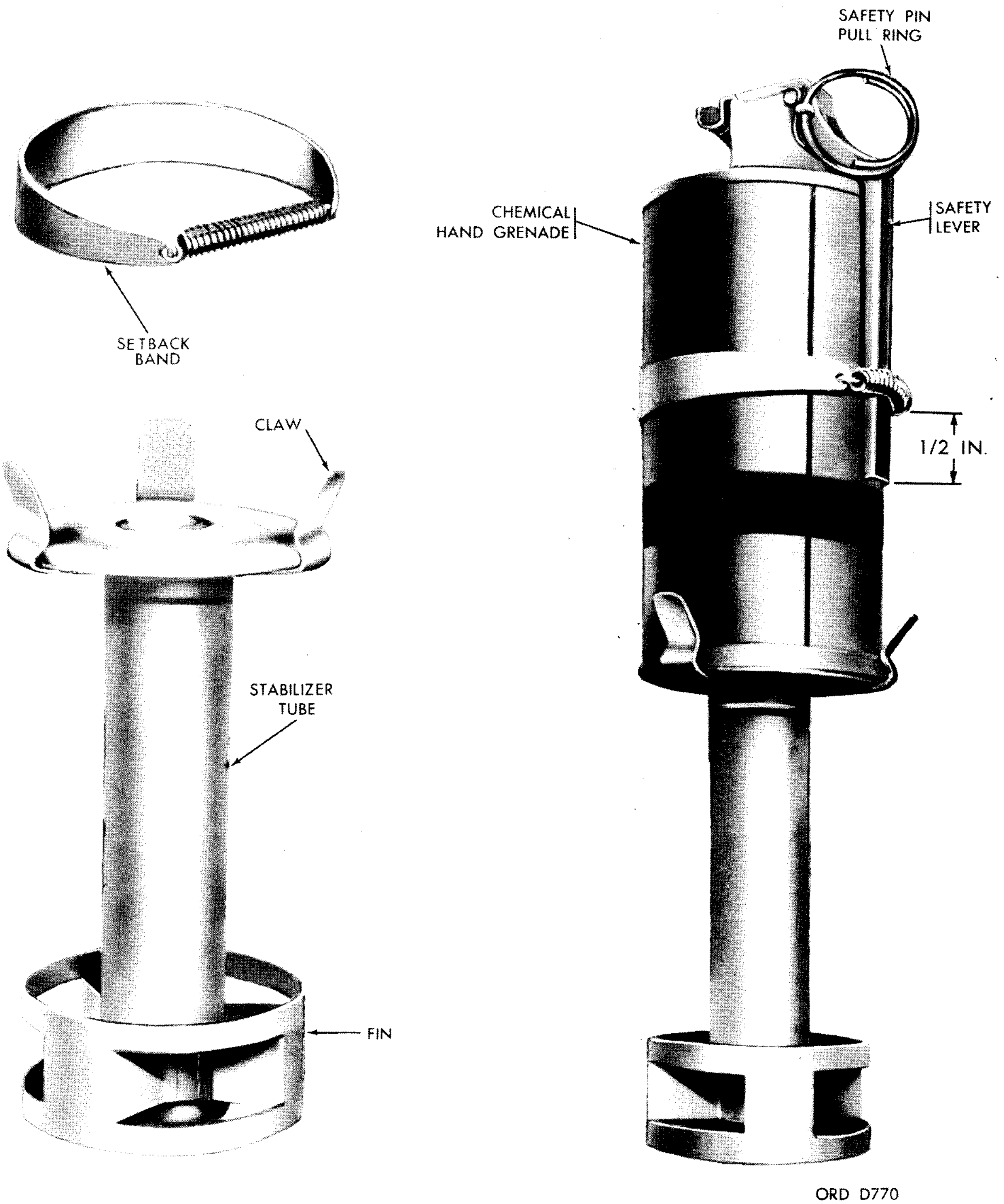


Figure 5-28. Adapter, grenade projection, M2A1 with chemical hand grenade.

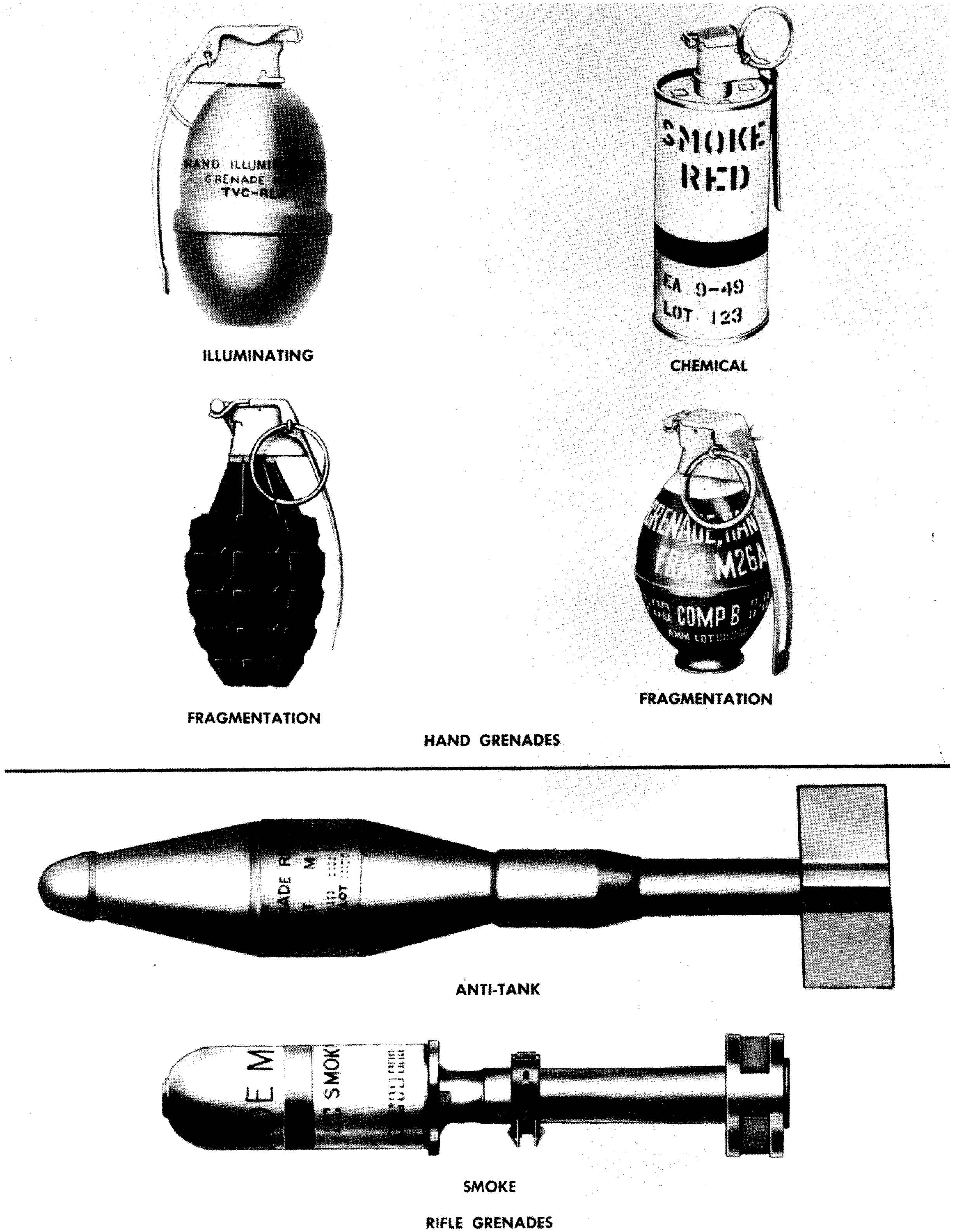


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Figure 5-29. Representative types of grenades

e. Color coding. Grenades are painted primarily for preservation. Secondary purpose is to provide, by color, a ready means of identification. The color coding used on hand and rifle grenades is indicated in table 5-1.

Table 5-1. Color Coding of Grenades

Grenades—color coded prior to implementation of MIL–STD 709			Grenades—color coded in accordance with MIL–STD 709	
Type of grenade	Color of body	Color of marking	Color of body	Color of marking
		HAND GRENADES		
Fragmentation	Olive drab	Yellow	Olive drab	Yellow
Illuminating	Unpainted	Black	All white or unpainted with white band.	Black
Practice	Blue	None or white	Blue with brown band.	None or white
Training	Black[1, 2]	None	Blue[2]	None
		RIFLE GRENADES		
High explosive, antitank.	Olive drab	Yellow	Black	Yellow
WP smoke	Gray with yellow band and olive drab stabilizer assembly.	Yellow	Light green with olive drab stabilizer assembly.	Light red and 1 yellow band.
Colored smoke	Gray with yellow band and olive drab stabilizer assembly.	Yellow	Light green	Black (Early production marked in white)[3]
Practice	Black[2]	White	Blue	White
		CHEMICAL HAND/RIFLE GRENADES		
Harassing (special purpose agents).	Gray	Red and one red band.	Gray	band[1] Red and one red
WP (smoke)	Gray	Yellow and one yellow band.	Light green	Light red and one yellow band.
Smoke (M18)[4]	Gray	Yellow and one yellow band.	Light green	Black (Early production marked in white).
Incendiary	Gray	Purple and one purple band.	Light red	Black
Practice	Blue	White	Blue	White, yellow or brown band.
Inert	Black	White (bronze or brass assemblies are unpainted).	Blue	White
Offensive	Black	Yellow	Black	Yellow

[1] May have longitudinal white stripes painted 90 degrees apart around body.
[2] This item is completely inert.
[3] "CCC," in the color of smoke produced, is marked on the ogive.
[4] In addition to the standard color marking, the top of each M18 grenade is painted the color of the smoke produced by the grenade.

8. TYPES AND CHARACTERISTICS.

a. Hand grenades.

(1) All standard hand grenades have delay type fuzes, except for grenade M26A2 with fuze M217 which has an impact-delay-type fuze. A grenade assembled with an impact-delay- type fuze will function on impact action or, should the grenade fail to function on impact, it will function on delay within 3 to 7 seconds. All other HE, practice and WP(Smoke) grenades have a 4 to 5 second delay. Irritant agent type, riot control, and incendiary grenades have a 1.2 to 2 second delay time.

(2) Types.

(a) Fragmentation. This type is used to produce casualties by fragmentation and has an effective casualty radius up to 15 meters.

(b) Illuminating. This grenade, used to illuminate terrain for night operations, provides approximately 55,000 candle power for 25 seconds.

(c) Chemical. This grenade is used for incendiary, screening, signalling, riot control and training purposes.

(d) Offensive. This grenade is used principally for blast effect and is also used for demolition purposes.

(e) Practice and training. These grenades are used for training in care, handling and use of service grenades.

(3) Representative hand grenades.

(a) Fragmentation hand grenade, M26 series. This grenade (figure 5-30) has a larger explosive charge, produces more fragments and has a more effective casualty radius than older type grenades. It consists of three basic parts, a body consisting of smooth sheet steel lined with a notched wire coil, a composition B filler and a fuze. All the fuzes for this series grenade are delay type except the M217 (figure 5-31) which is an impact and delay type (para 8,a(1)). Upon releasing the lever, the striker assembly impacts the percussion primer. The primer initiates the thermal power element which causes the fuze to arm within 1 to 2 seconds. After arming, the grenade will function on impact, or if proper impact does not occur, it will function on delay. If the fuze fails to function, it will become a dud within 30 seconds. NOTE: Grenade M26A2 with fuze M217 is not authorized for use as a rifle grenade.

(b) Smoke grenade, WP, M34. This is a bursting type grenade (figure 5-32) and is used for antipersonnel, incendiary and smoke effect. It has a cylindrical steel body which is scored to assure uniform breakup of the case, a WP filler and a fuze. The bottom of the body is tapered and grooved so that the grenade can be mounted on a grenade projection adapter. The fuze has a delay element of 4 to 5 seconds after which bursting occurs, breaking the grenade body into uniform fragments and scattering WP particles over a 35 meter radius. The WP will burn for approximately 60 seconds.

(c) Offensive hand grenade, MK3A2. This grenade (figure 5-33) is the standard offensive grenade, has a cylindrical body, and weighs 15.6 ounces (0.4 ounces heavier than the M26A2 grenade). The grenade is filled with 8 ounces of flaked TNT and is provided with a "silent" type, detonating fuze M206A2. The grenade body of pressed asphalt impregnated fiber is painted black with yellow markings. It will produce concussion, blast and casualties and can also be used as a half-pound demolition charge to destroy equipment and against such fortified positions as caves and bunkers. After a delay of 4 to 5 seconds the fuze detonates the explosive filler which dissipates its energy in the form of shock waves, rather than in fragments. The effective casualty range in open terrain is approximately 2 meters but is much greater inside a closed room, cave, or bunker.

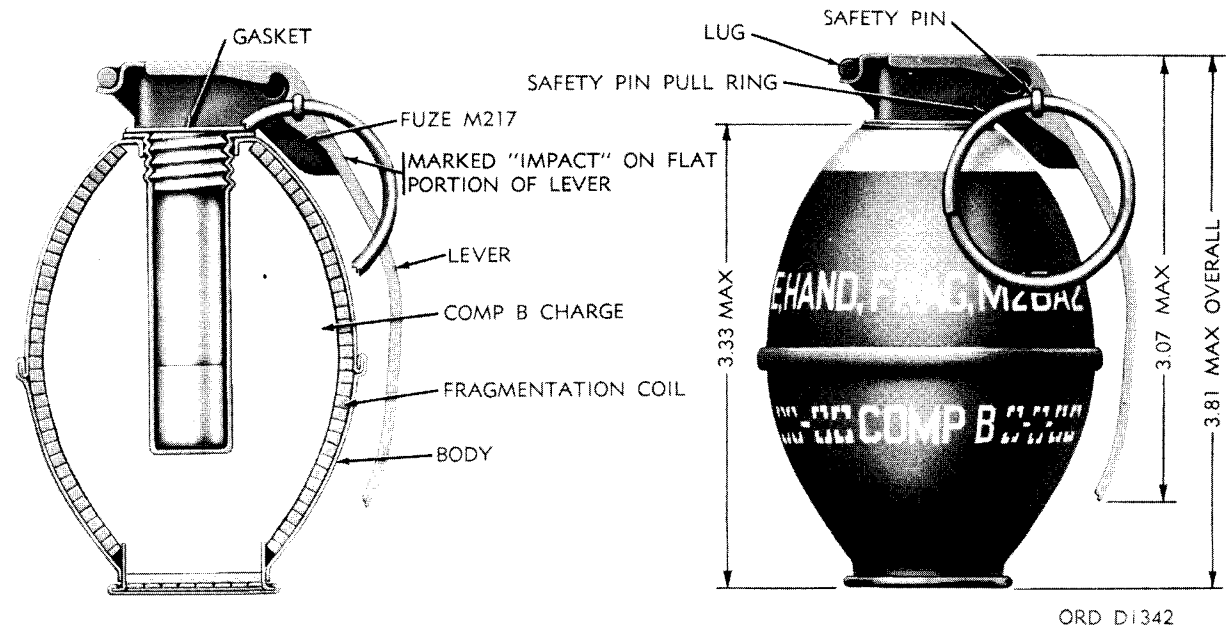


Figure 5-30. Grenade, hand: Fragmentation, M26A2 w/fuze, hand grenade: M217-cross section and external view.

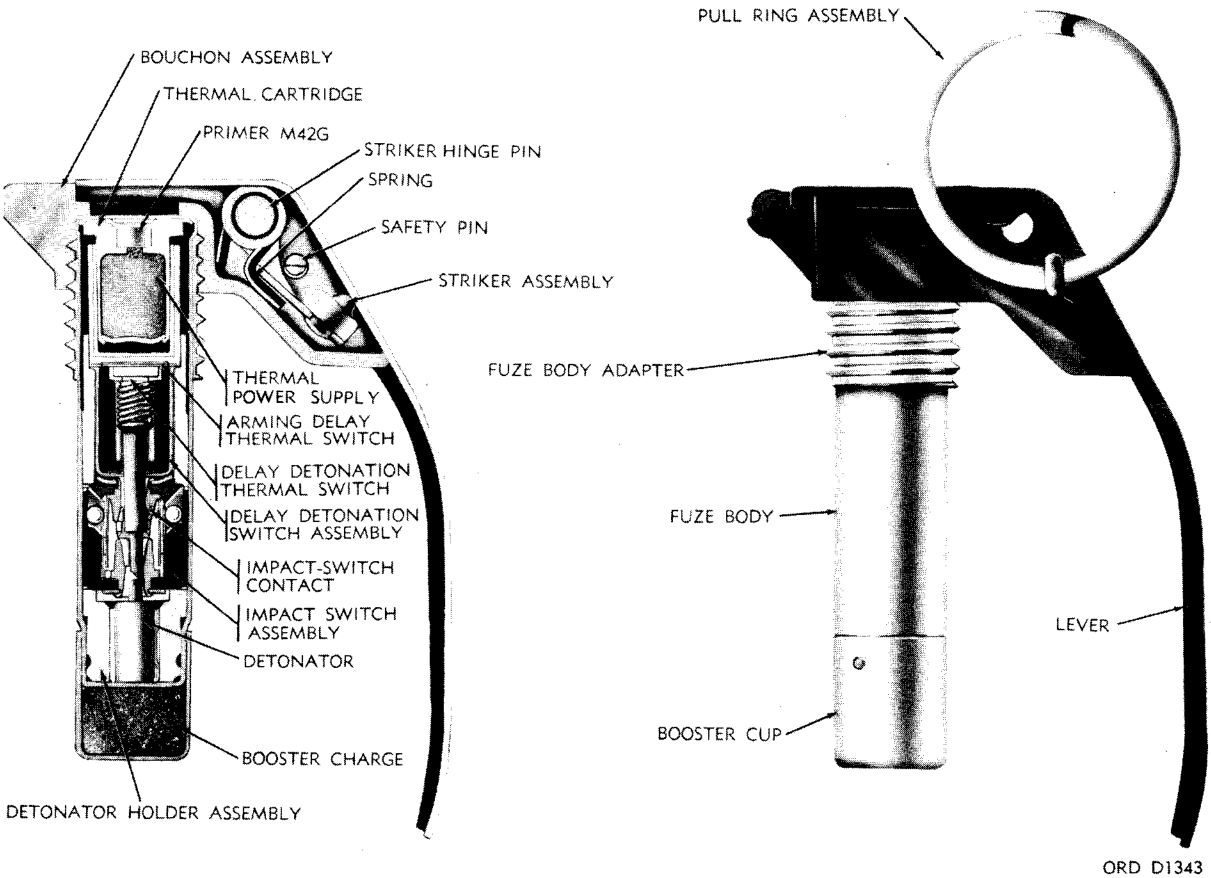


Figure 5-31. Fuze, hand grenade: M217-cross section and external view.

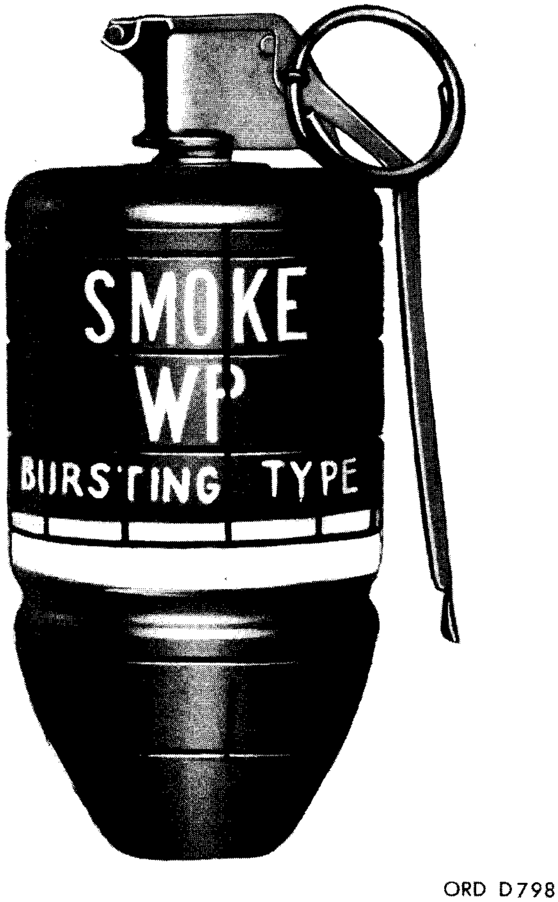


Figure 5-32. Grenade, hand and rifle: Smoke, WP, M34 w/fuze, M206A2.

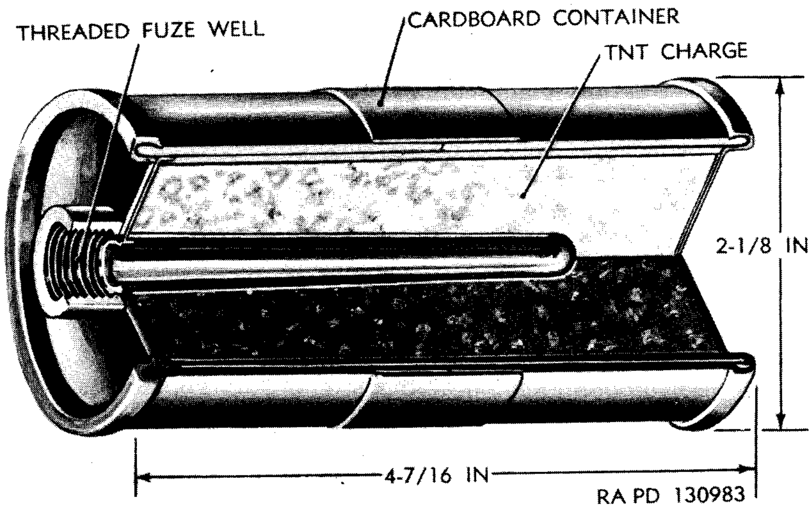


Figure 5-33. Mk3A2 offensive hand grenade.

b. Rifle grenades.

(1) These grenades are fin stabilized and designed to be projected from a launcher (figure 5-25) attached to the end of a rifle. The propelling force for the grenade is provided by a grenade cartridge (figure 5-26). Rifle grenades are used against armor, personnel, for screening or signalling, or for incendiary effect. Hand grenades may also be projected from a rifle by the use of grenade adapters (figures 5-27 and 5-28).

(2) Types.

(a) Antitank (AT) rifle grenades are designed for use against armored targets. The body contains a high explosive in the form of a shaped charge which is initiated by a point initiating base detonating (PIBD) fuze.

(b) Smoke rifle grenades are designed primarily for producing smoke, either for screening or signalling. One type of smoke grenade, the WP grenade, also has incendiary capability. There are two other types of smoke grenades: the colored smoke grenade which functions on impact and the colored smoke streamer grenade which functions on firing, emitting a stream of colored smoke over its entire trajectory.

(c) Practice rifle grenades are designed for training personnel in care, handling,and use prior to training with live or service types. Practice grenades are completely inert and are fired at the target without danger to the target other than from impact.

(3) Representative rifle grenades.

(a) Rifle grenade, HEAT, M31. This rifle grenade (figure 5-34) is a fin stabilized, point initiated, base detonated, high explosive, antitank grenade. This grenade is effective against targets at all angles of obliquity up to 65 degrees. The grenade uses a piezoelectric assembly (LUCKY) which generates an electric current upon impact with the target initiating the explosive charge. This grenade has a cylindrical steel body with a conical ogive and rear section. The ogive contains the LUCKY element in the nose and is connected to the fuze M211 in the base of the body by a lead wire in a conduit. The body contains 9.92 ounces of composition B cast around a steel shaped charge liner. Fuze M211 consists of an out of line rotor with an electric detonator, a setback leaf assembly and a booster pellet. When the rifle grenade is fired the setback leaf assembly delays alinement of the detonator with the booster until a safe distance is reached. When the grenade impacts the target the LUCKY element is crushed, generating an electrical impulse which is conducted through the conduit to the detonator, however, the circuit within the fuze is grounded so that stray currents cannot pass through the detonating circuit if the LUCKY crystal is accidentally crushed. Setback causes the first of the three leaves to overcome spring tension, releasing setback leaf number two, the second leaf rotates, releasing setback leaf number three, leaf number three rotates releasing the rotor assembly. The rotor assembly turns 90 degrees opening the shorting switch and closing the firing circuit. The impulse generated by LUCKY through impact passes through the resistance wire in the detonator initiating the explosive train. M31 grenade is capable of penetrating more than ten inches of armor plate or twenty inches of reinforced concrete with a maximum range of 185 meters.

(b) Smoke grenade, WP, M19A1. This grenade (figure 5-35), designed primarily to produce smoke, also has an incendiary capability and may be used to ignite flammable targets or inflict injury on personnel. It consists of three basic parts, a stabilizer tube assembly, a fuze,and a body. The fuze is a mechanical impact detonating type held in place by a spring assembly and a safety wire. The body, made of sheet steel and filled with white phosphorus, is completely sealed to prevent entrance of air. After the grenade is fired and strikes the ground, the firing pin overcomes spring tension and strikes the primer which, in turn, initiates the detonator which ruptures the body of the grenade causing particles of white phosphorus to be spread over a 20 meter area.

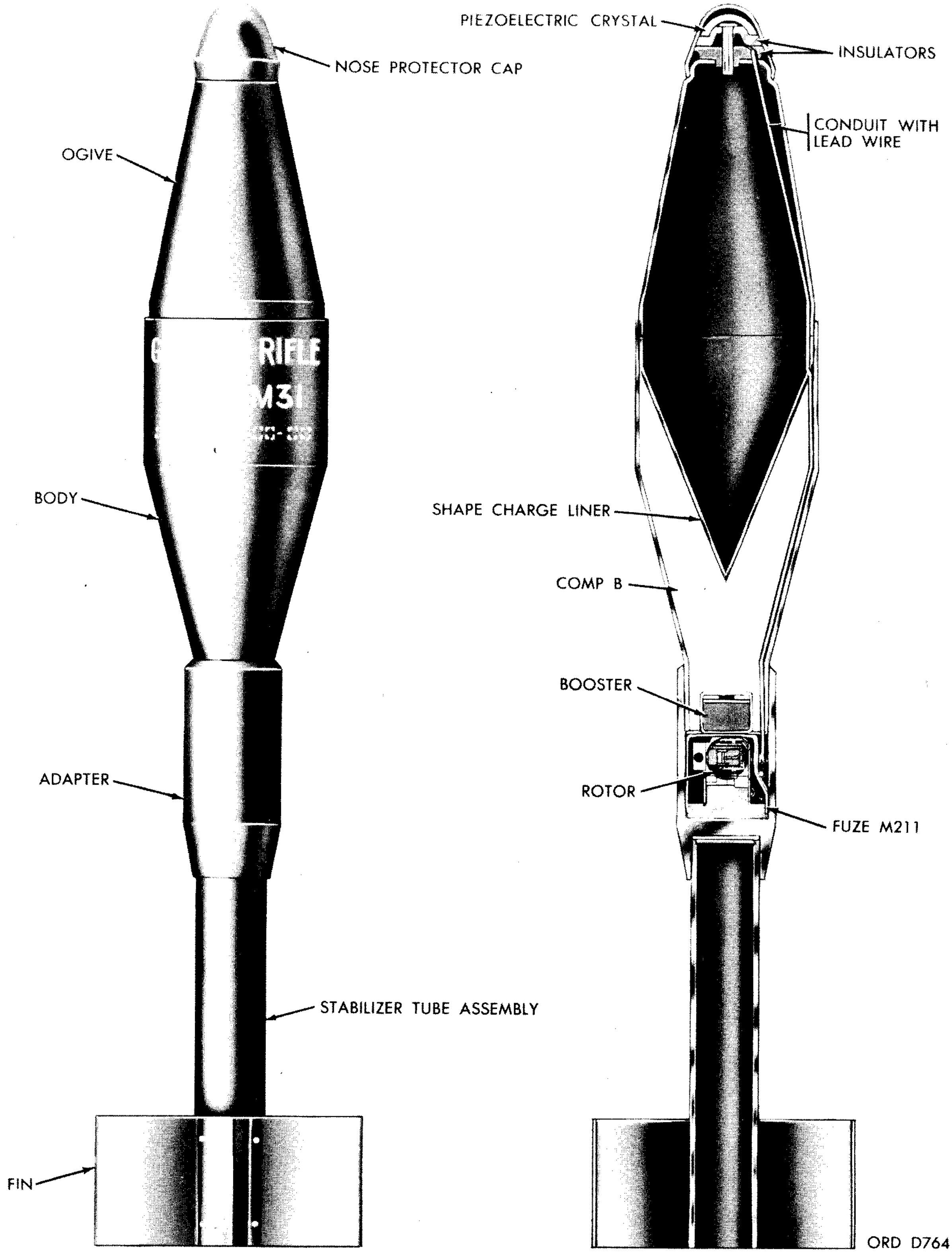


Figure 5-34. Grenade, rifle: HEAT, M31 w/fuze M211.

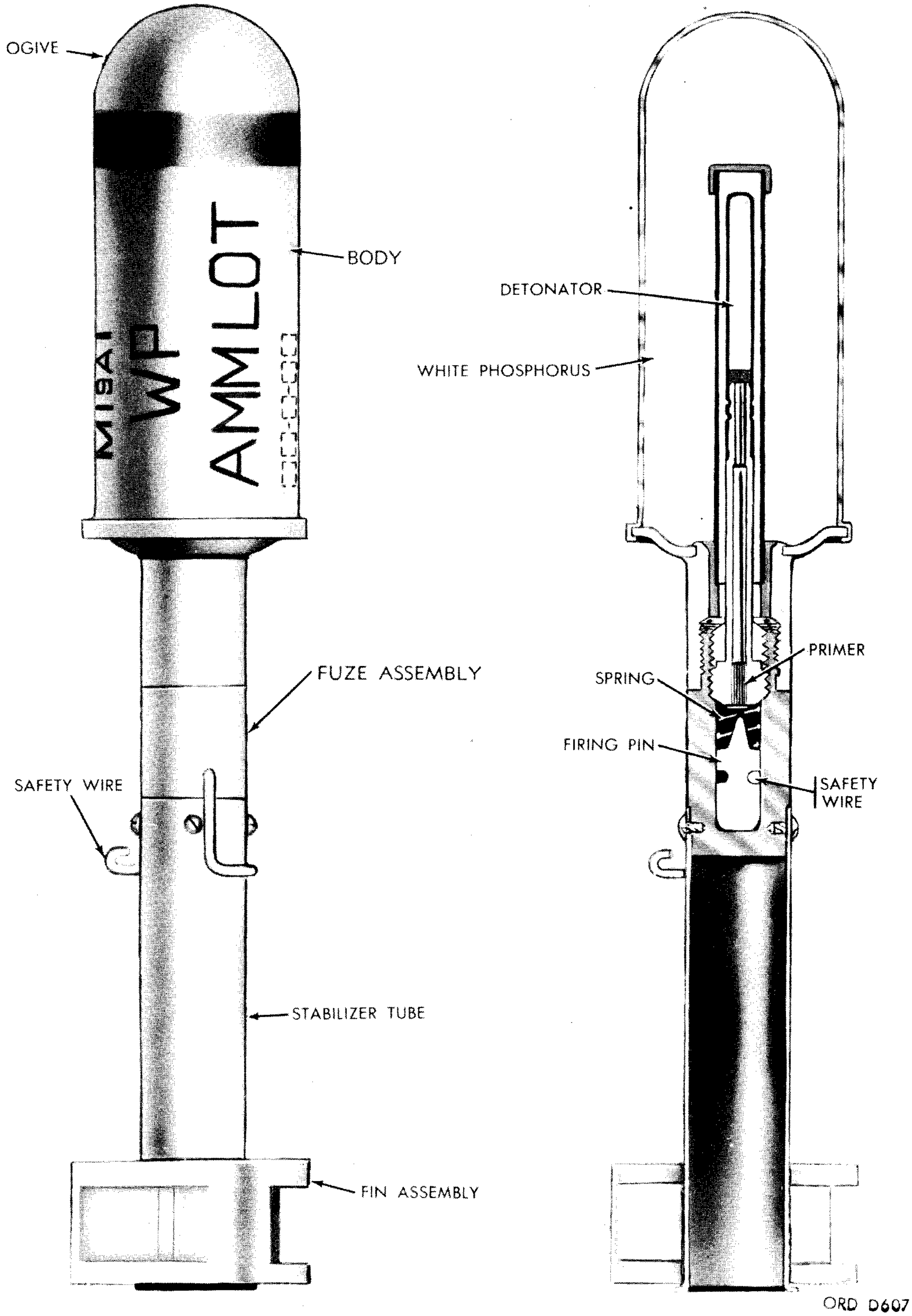


Figure 5-35. Grenade, rifle: smoke, WP, M19A1.

(c) Practice rifle grenade, antitank, M29. This grenade (figure 5-36) is completely inert and is designed to simulate the HEAT grenades. The M29 grenade may be fired at a target without danger to the target other than impact. The cast iron body may be used repeatedly if the stabilizer tube fin assembly is replaced when it becomes damaged.

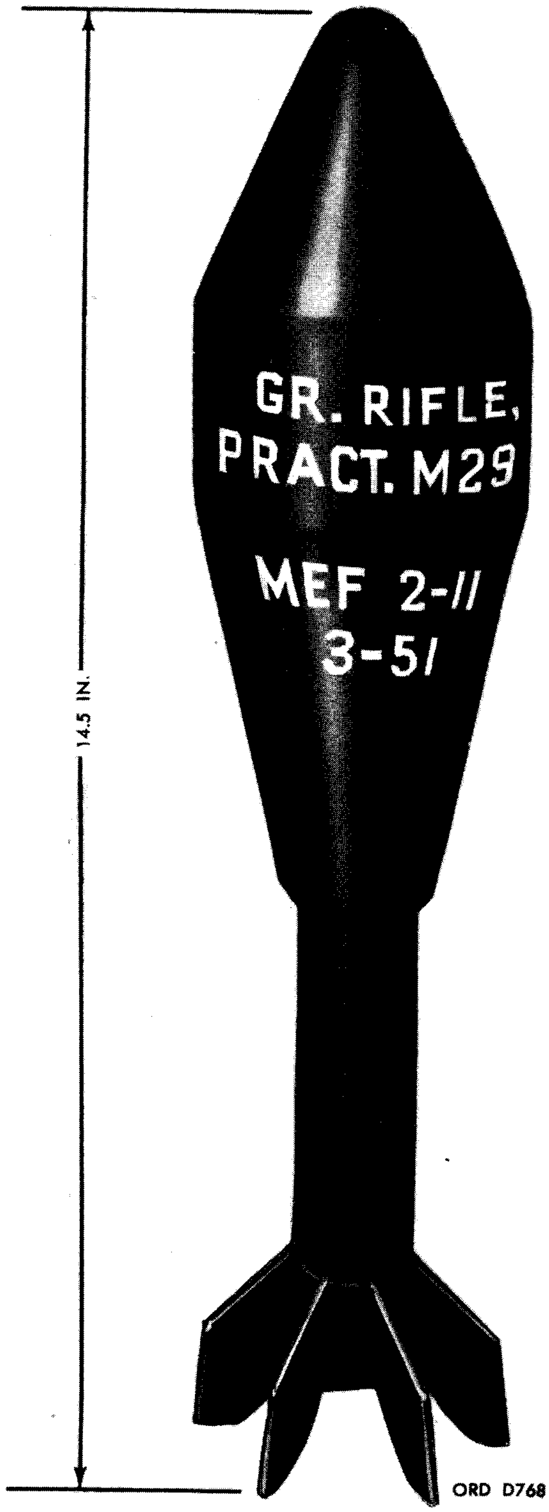


Figure 5-36. Grenade, rifle: antitank practice, M29 (T42).

9. 40-MM GRENADE CARTRIDGES.

a. General. These cartridges were designed to be fired from the launcher M79 and the 40-mm grenade launcher XM203 (attached to the M16/M16A1 rifle).

(1) Cartridges M386 and M441 (figures 5-37 and 5-38) are antipersonnel, ground-burst cartridges and are identical except for their fuzing systems. The fuse M551 used in cartridge M386 arms at 14 to 27 meters from the launcher, after firing. The fuze M552 used in the M441 cartridge arms at 2.4 to 3 meters from the launcher after firing.

(2) Cartridge M397 (figure 5-39) is an antipersonnel, ground-impact, air-burst cartridge. The fuse M536 used in the M397 cartridge arms at 14 to 27 meters from the launcher after firing.

b. Fuze functioning.

(1) Before firing, the rotor in fuze M551 (figure 5-40) is held in the unarmed position by a firing pin, a centrifugal lock, and a setback pin. Upon firing, setback force causes the setback pin to move rearward and clear the rotor. Rotation of the projectile causes three pivoted inertia weights and the centrifugal lock to move outward causing the spring-loaded firing pin and lock to retract from the rotor and gear train, respectively. The rotor, now free to rotate, lines up the detonator with the explosive train. An escapement mechanism controls the movement of the rotor and delays arming until the projectile has traveled at least 14 meters (45 feet). Upon impact, the firing pin is driven into the detonator which initiates the explosive train and detonates the composition B HE charge in the projectile.

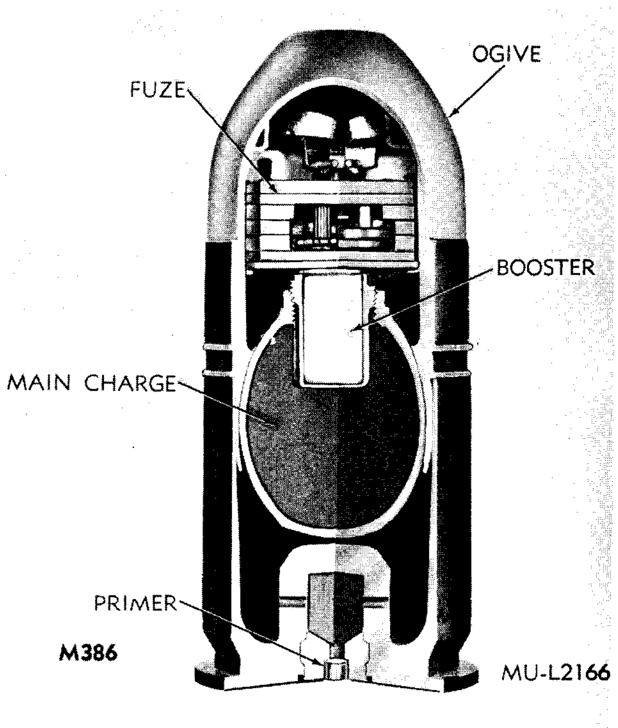


Figure 5-37. Cartridge M386--cutaway view.

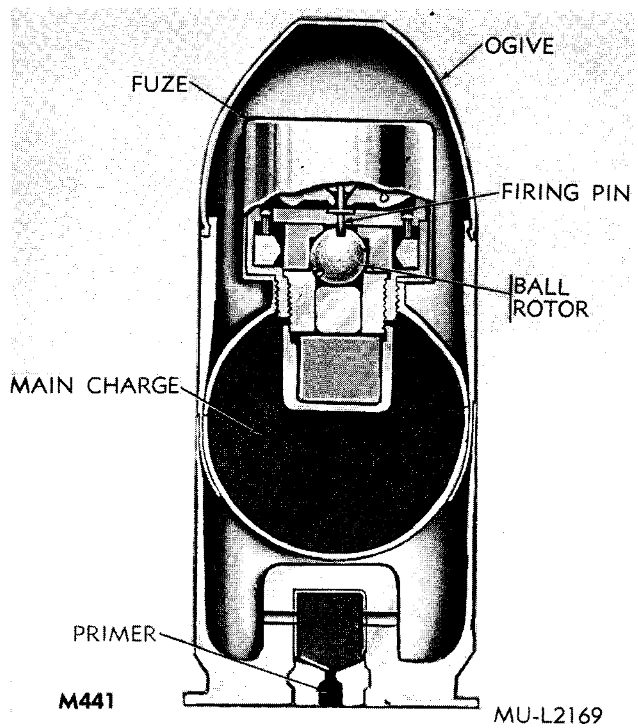


Figure 5-38. Cartridge M441--cutaway view.

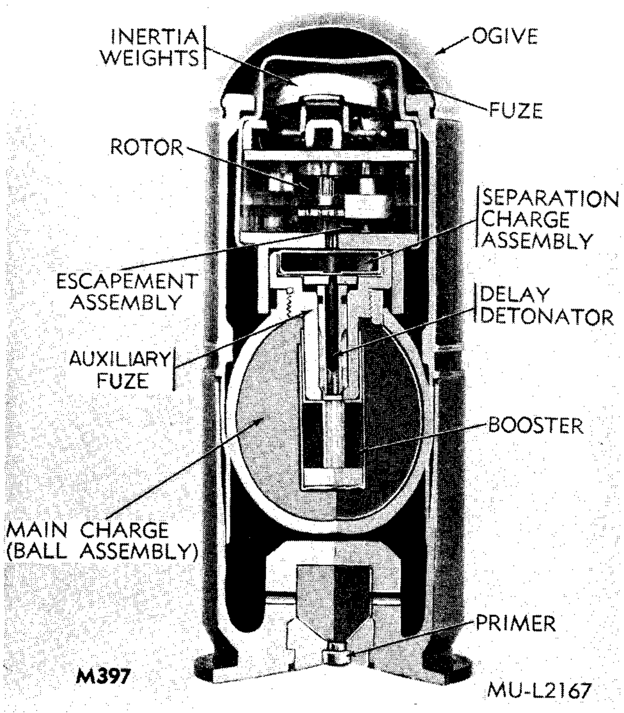


Figure 5-39. Cartridge M397--cutaway view showing fuze M536.

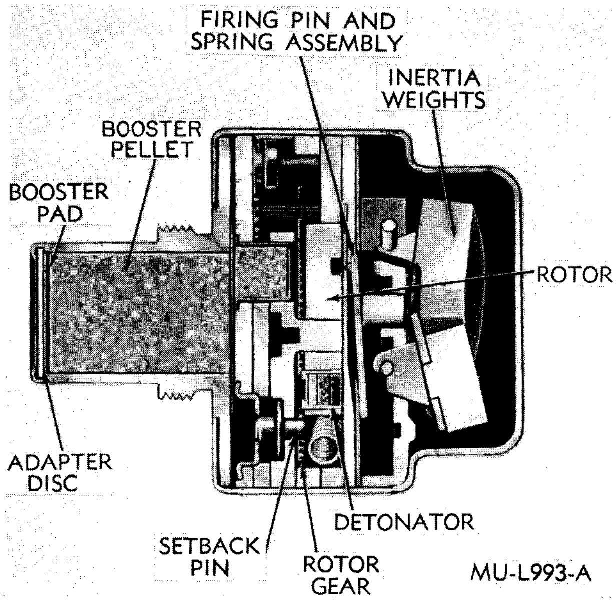


Figure 5-40. Fuze M551--cross-sectional view.

(2) Before firing, the rotor ball assembly in fuze M552 (figure 5-41) is held in an out-of-line position with respect to the explosive train by the firing pin. As the projectile leaves the tube of the launcher, setback forces cause the firing pin to be withdrawn from the ball detente and rotation of the projectile causes the rotor ball assembly to aline the detonator with the explosive train. The fuze becomes armed after the projectile has traveled approximately 2 to 4 meters (8 feet) from the launcher. Upon graze or impact, the inertial ring acts on the push pins pivoting the levers inward, forcing the firing pin into detonator initiating the explosive train.

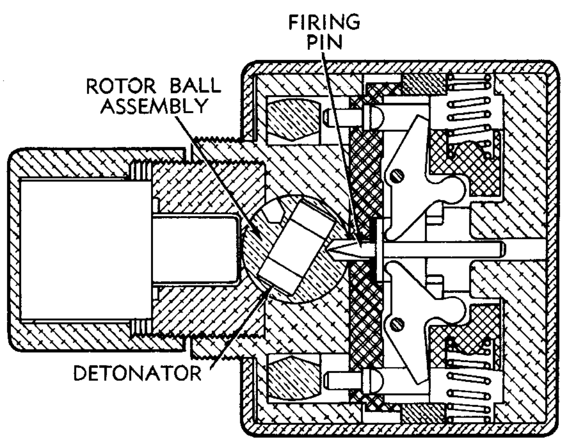


Figure 5-41. Fuze M552--cross-sectional view.

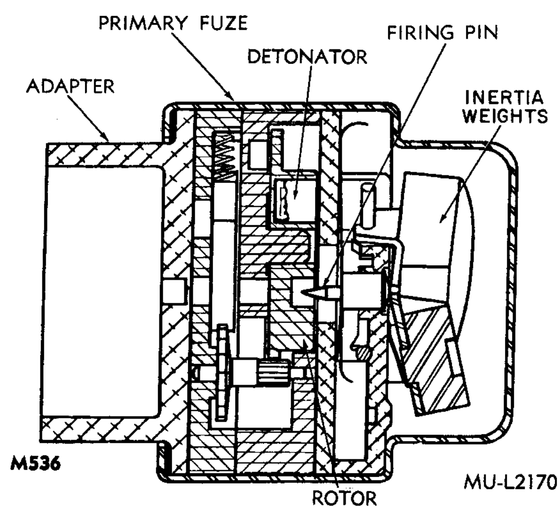


Figure 5-42. Fuze M536--cross-sectional view.

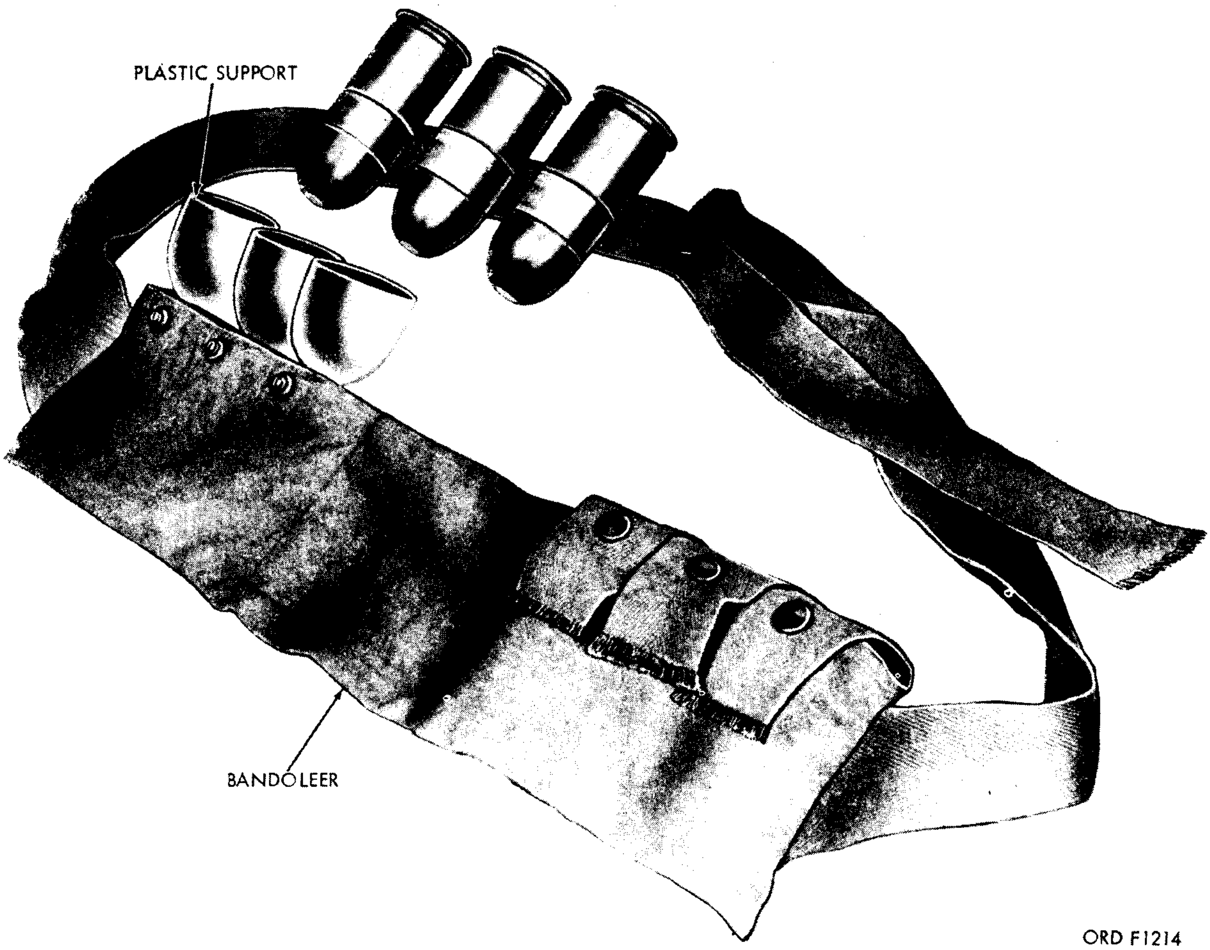


Figure 5-43. Items used for packing and carrying 40-mm ammunition.

(3) Before firing, the rotor in fuze M536 (figure 5-42) is held in the unarmed position by a setback pin, a firing pin, and centrifugal lock which keeps the detonator from alining with the separation charge assembly. When the projectile is fired the fuze functions like fuze M551 described in paragraph 9, b, (1), above, and has the same minimum arming distance of 14 meters (45 feet) from the launcher. However, upon impact, the detonator initiates the separation charge assembly. The flash from the separation charge assembly initiates a delay detonator of the auxiliary fuze and the explosive ball assembly. Gas pressure drives the delay detonator into the armed position. Simultaneously, the ball assembly (with the auxiliary fuze) is ejected into the air. Approximately 120 milliseconds from the time of ejection, the pyrotechnic delay detonator, detonates the booster which, in turn, detonates the octol filler in the ball assembly approximately 5 feet above the impact surface.

c. Complete round functioning. Upon firing (all rounds) the firing pin strikes the primer, igniting the propelling charge located in the high-pressure chamber of the cartridge case. The propelling charge generates sufficient pressure to rupture the metal propellant cup within which it is contained. This, in turn, releases the propellant gases (through vents) to the adjacent low-pressure chamber in the cartridge case. The pressure created by the propellant gases in the low-pressure chamber propels the projectile forward. The projectile rotating band engages the lands of the launcher tube imparting the necessary spin to the projectile.

d. The cartridges are packed (figure 5-43) in two three-pocket plastic containers connected with a webbed band. This assembly forms a 6 round bandoleer. 12 bandoleers (72 grenades) are packed in a cardboard box. The box is placed in a moisture proof (plastic) bag, which is overpacked in a wirebound wooden box .

10. SUMMARY. The lesson on mines and grenades which you have just completed has provided an overall coverage of the types, characteristics and identification of representative items in these two categories of ammunition. This lesson should be used by you to the best advantage compatible with your duties and responsibilities as an Ammunition Supervisor and in the training of personnel in the munitions field. This lesson should be reviewed periodically to provide you with refresher information that will assist you materially in the performance of your tasks, and by so doing you will gain and retain a more accurate and comprehensive knowledge of the construction and function of these ammunition items. This information can also be applied to the safety aspects involved in handling and storage operations

MMS SUBCOURSE NUMBER 621, AMMUNITION MATERIEL

EXERCISES FOR LESSON 5

1. What is the explosive filler in the M21 heavy antitank mine?

   A. MOX 2B
   B. H6
   C. HBX 3
   D. OCTOL

2. What component of a mine provides the energy necessary to accomplish the the desired effect?

   A. Shaped charge cone
   B. Steel fragmentation coil
   C. Filler
   D. Detonating fuze

3. Which grenade is identified by a brown band?

   A. Illuminating
   B. Training
   C. Harassing
   D. Practice

4. What components apply to only one land mine?

   A. Three delay elements
   B. Two low explosive trains
   C. Three expelling charges
   D. Four fuze wells

5. Which grenade utilizes the "silent" type fuze?

   A. WP smoke
   B. Fragmentation
   C. Offensive
   D. Incendiary

6. Which component initiates action of the M217 grenade fuze?

   A. Thermal power supply
   B. Striker assembly
   C. Primer
   D. Detonator

7. What is the purpose of the delay charge in the combination fuze M605 of the M16A1 antipersonnel mine?

   A. Provides safety while boobytrapping mine
   B. Permits friendly troops to take cover
   C. Insures ignition of flash igniter charge
   D. Allows personnel to move from directly over mine

8. What action causes the belleville spring to function in antitank mines?

   A. Stab
   B. Friction
   C. Setback
   D. Reverse

9. What is the minimum distance in feet required to arm the 40mm grenade fuze M536?

   A. 15
   B. 45
   C. 50
   D. 90

10. Which item is required for all purposes of record?

   A. Lot number
   B. Inventory report
   C. Explosive filler
   D. Weight

11. Which mine indicates by marking that it is a directional mine?

   A. AP, M16A1
   B. AP, M18A1
   C. AT, M21
   D. APXM41

12. The top of what grenade is painted the color of the smoke produced?

   A. M18
   B. M31
   C. M34
   D. MK3A2

13. What is indicated by disturbed earth in a mine field?

A. Entrance to tunnel
B. Boobytrap
C. Animal tracks
D. Phony emplacement

14. What is the purpose of the taper and groove on the body of the M34 WP grenade?

A. Provide for a more secure grip
B. Permit mounting on projection adapter
C. Facilitate fragmentation
D. Stabilize grenade in flight

15. What action is taken to discourage neutralization of land mines?

A. Camouflaging
B. Boobytrapping
C. Burying
D. Pulling trip wire

LESSON 6. MILITARY PYROTECHNICS

MMS Subcourse Number 621	Ammunition Materiel
Lesson Objective	To provide the student with a general knowledge of the types, characteristics, identification, packing, marking, and filler of representative pyrotechnics.
Credit Hours	One

TEXT

1. **INTRODUCTION.** This lesson provides general technical information and specific data concerning the characteristics and functioning of representative types of military pyrotechnics. If you have had previous training in this area, you may use this lesson as a refresher or review source; however, if your formal training is limited, this lesson may be used to good advantage in furthering your knowledge of this type of munition. Military pyrotechnics have inherent hazards with which you should be concerned. Although these items are not considered to be high explosives, they are unstable and will cause fires, accidents, and fatalities just as surely as the detonation of a high explosive projectile. Recently, a pyrotechnic item was the cause of extensive loss of life and material on board a naval vessel, so it is important to you, as an ammunition supervisor, that extreme care and caution be exercised in the handling and storage of this sensitive and potentially destructive munition. This munition is particularly susceptible to deterioration in storage under adverse weather conditions and readily absorbs moisture from the atmosphere (hygroscopicity) and as a result rapidly becomes unserviceable and unfit for its intended use. Personnel under your supervision should be made aware of the unusual and inherent instability associated with this type of munition.

2. **TYPES AND CHARACTERISTICS OF MILITARY PYROTECHNICS.**

a. Military pyrotechnics are items of ammunition used in military operations which produce, through chemical reaction, a desired effect or combination of effects, such as light (instantaneous or continuous), smoke, heat, noise, delay timing, and gas pressure. These items are used for such purposes as signalling, illumination, simulation of battlefield effects, warning, marking, tracking, screening, and incendiary effects. These items produce their effect by burning and are usually 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 which are projected from weapons are all pyrotechnics, but, because of their association in use are not included in this lesson. Photoflash bombs, location markers, and various other miscellaneous items, though not in strict conformance with some concepts, are classed as pyrotechnics.

b. Pyrotechnics are generally assembled with all the elements essential for proper functioning. Exceptions are certain aircraft flares and photoflash bombs for which the fuzes are issued separately for assembly in the field. An illustration depicting the size ranges of principal pyrotechnic items is shown in (figure 6-1).

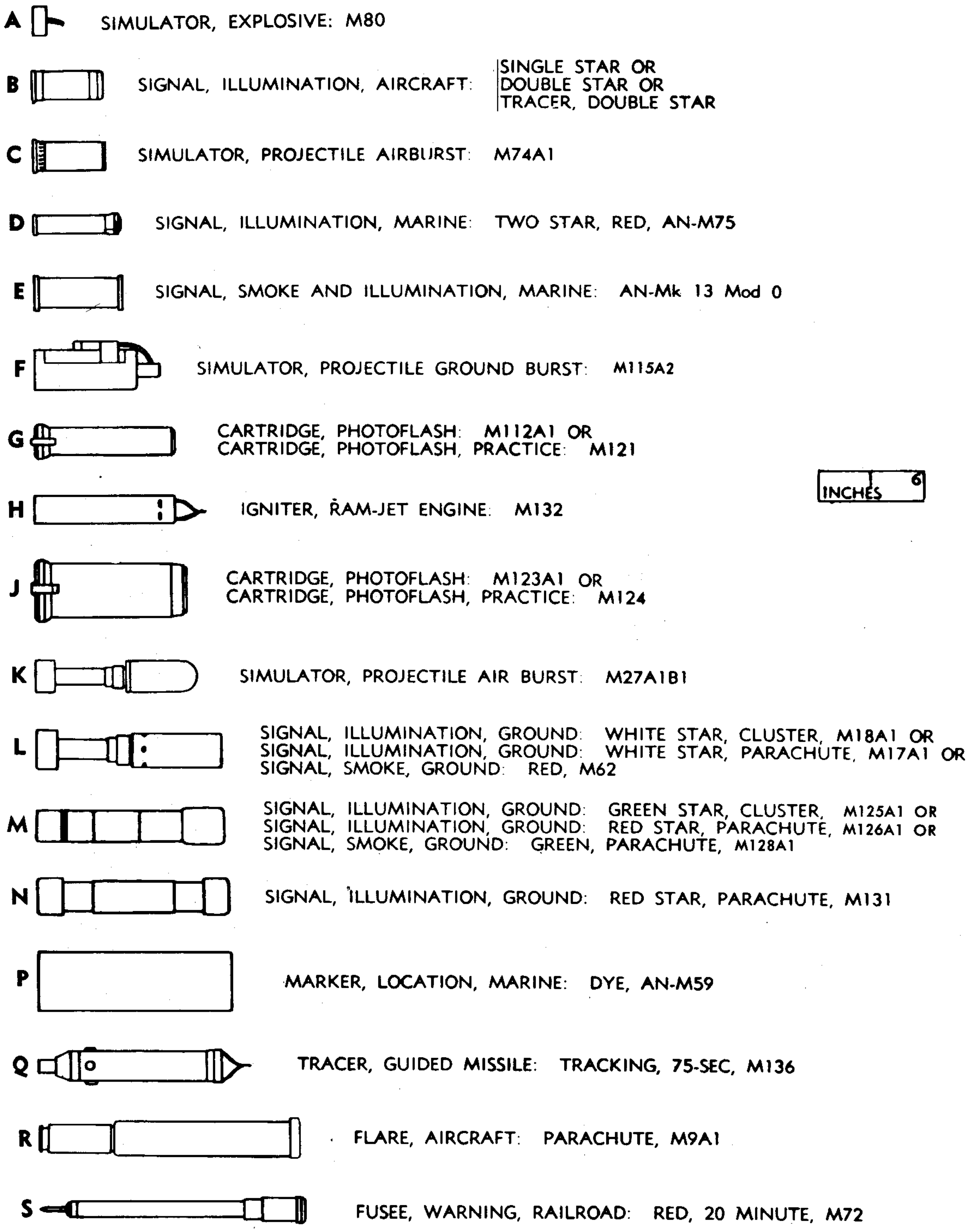


Figure 6-1, Military pyrotechnics comparative sizes of representatives types.

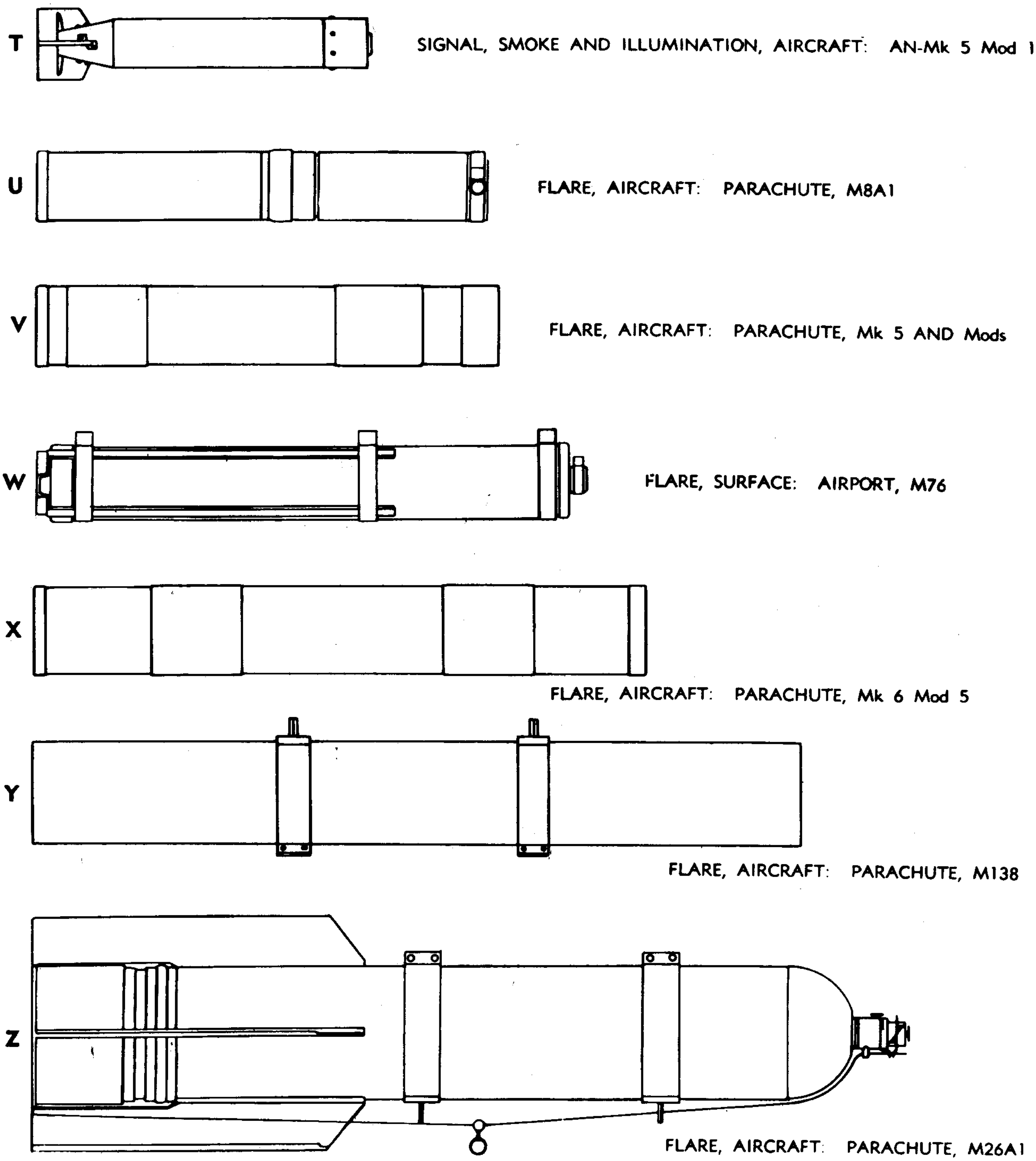


Figure 6-1. Military pyrotechnics comparative sizes of representative types. (continued)

c. Pyrotechnics generally function by means of an ignition or low explosive train (figure 6-2). The train is initiated usually by a primer, which may be of the percussion, friction, or electric type. The initial energy produced is transmitted successively to a propelling charge, delay element, expelling charge, and finally to the main charge of pyrotechnic composition. One or more of the intermediate elements between initiator and main charge may be omitted, depending upon pyrotechnic requirements.

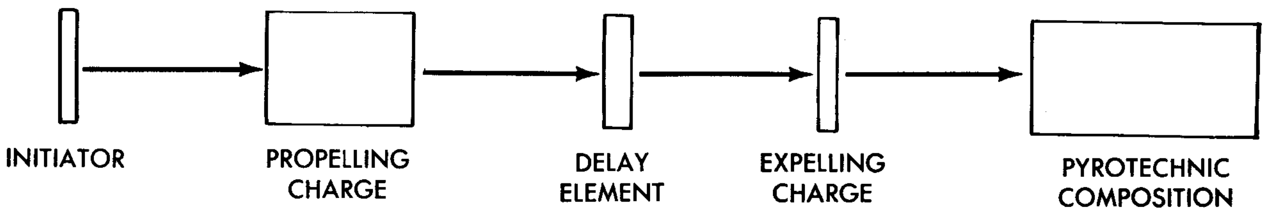


Figure 6-2. Representative ignition train for pyrotechnics.

3. FILLERS.

a. Explosive train. Explosives used in the parts of the explosive train leading up to the main charge are especially selected sensitive primer compositions (mixtures) for the initiator. Loose black powder is used for propelling charges and expelling charges; compressed black powder and special nongaseous compositions are used for delay elements.

b. Main charge pyrotechnic compositions. The earliest pyrotechnic compositions consisted of varying mixtures of the constituents of black powder; namely, charcoal, sulphur, and saltpeter (potassium or sodium nitrate). Other materials, such as iron filings, coarse charcoal, or realgar (arsenic sulfide) were added to produce special effects. Many other materials were added or substituted as additional knowledge was acquired. Present day pyrotechnic compositions are generally physical mixtures of various chemicals. Functions of these chemicals may be listed as follows:

(1) Oxidizers, such as chlorates, perchlorates, peroxides, chromates, and nitrates provide oxygen for burning. Additional oxygen may be obtained from the air. Nongaseous powders, such as barium chromate boron mixtures which do not require oxygen from the air are used in closed delay columns.

(2) Fuels, such as aluminum and magnesium powder, their alloys, sulfur, lactose, and other easily oxidizable materials.

(3) Combustible binding and waterproofing agents such as shellac, linseed oil, resins, resinates, and paraffin.

(4) Color intensifiers, such as polyvinyl chloride, hexachlorbenzene, or other organic chlorides mixed with barium and copper salts to produce green or with strontium salts to produce red.

(5) Dyes, such as methylaminoanthraquinone to produce red and auramine to produce yellow.

(6) Coolants, such as magnesium carbonate and sodium bicarbonate.

c. Pyrotechnic smoke compositions are of two general types:

(1) Those that burn with practically no flame but give off a dense, colored smoke as a combustion product.

(2) Those that burn at a temperature so low that an organic dye, ((5) above), volatizes instead of burning and colors the smoke.

d. Friction igniters consist of a primer cup and a ripple wire. The primer cup contains a mixture of potassium chlorate, charcoal, and dextrin binder. The ripple wire is coated with red phosphorus and shellac and then covered with nitrocellulose. The wire extends through the primer cup which, when pulled through the primer cup composition, causes friction with resulting spark and ignition.

e. Quickmatch is a term applied to strands of cotton soaked in a mixture of black powder and gum arabic and coated with mealed powder. It is used as initiator to transmit flame to igniting, priming, or pyrotechnic charges.

f. The priming charge is a dried black powder paste in intimate contact with the first fire composition. Newer pyrotechnic items use a special nonhygroscopic priming paste and a plastic binder.

g. The first-fire composition is generally a mechanical mixture of illuminant charge and black powder. For certain items, however, it may be a special nonhygroscopic easily ignitible composition that burns with a high temperature.

4. CLASSIFICATION ACCORDING TO PURPOSE.

a. Photoflash bombs and cartridges were designed to produce a single flash of intense light for aerial photography during reconnaissance missions.

b. Flares produce a single source of illumination which is generally of high candlepower and sustained duration. Aircraft flares are usually parachute supported or towed for target practice. Stationary or surface flares are used to illuminate a specific area and also are used for recognition and signalling purposes. While their primary function is illumination, they may be used also for identification, ignition, location of position, targets, or warning.

c. Simulators imitate actual battle sounds and flashes of light produced by service items of ammunition such as high explosive artillery projectiles, hand grenades, boobytraps and gunflashes. They are designed for use in training.

d. There are two types of effects obtained with signals, light and smoke. A particular model may produce both effects. Light producing signals are much smaller and faster burning than flares and may consist of a single parachute supported star or multiple freely falling stars, with or without colored tracers. Smoke signals are of either the slow burning streamer type, which leave a trail of smoke, or the parachute suspended type, which produce a cloud of smoke.

e. Miscellaneous pyrotechnics include railroad fusees, ram jet engine igniters, marine location markers, railroad torpedoes, and fire starters.

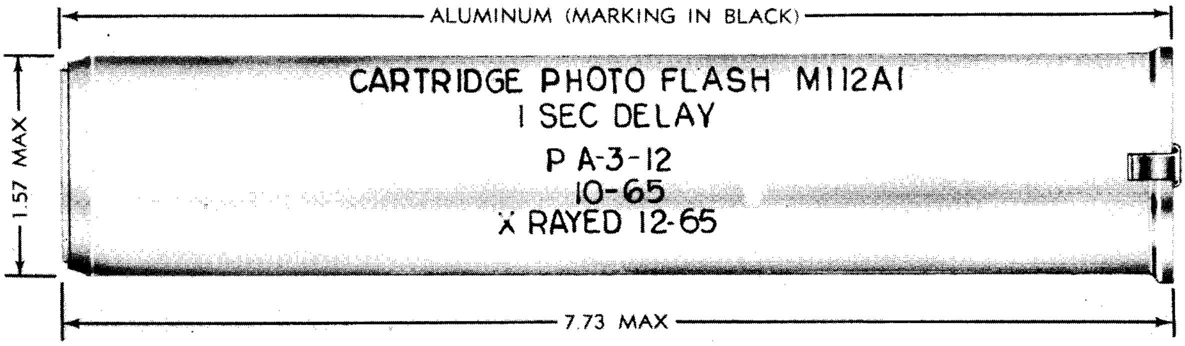
5. IDENTIFICATION. Pyrotechnics in common with other types of ammunition, are identified by the standard nomenclature and the lot number of the item. Such identification is marked on all containers and, unless the item is too small, on the item itself. Standard nomenclature is established in order that each item may be specifically identified by name. The use of standard nomenclature is mandatory for all purposes of record. The lot number is assigned when ammunition is manufactured and consists of the loader's initials or symbol and the number of the lot. The model number is assigned at the time the item is classified as standard and becomes an essential part of the nomenclature and is included in the marking of the item. Pyrotechnic assemblies are painted in accordance with the color coding standard. They are usually painted white except those having an outer case of aluminum or plastic, which are unpainted. Ground flares of the M49 series, which have primary roles of giving warning of infiltrating enemy troops and secondary roles as signals, are painted light green. Pyrotechnics, in general, are marked in black. Signal types are identified by colored bands or other markings to indicate the color produced by the signal. The tops of launcher type and hand held signals are painted the color of the signal and marked with two embossed letters for identification in darkness. The first letter designates the color, the second letter the type, i.e., WP indicates the signal will produce a white star supported by a parachute. A band of red letters (T's) indicates a signal with a red tracer. A signal containing a red and yellow star will be indicated by a band of red letters (C's) (color) and a band of yellow letters (C's). A marine location marker producing a green-colored slick on the water will be identified by a band of green letters (D's) (dye). The color of the wrappers of some signals corresponds with the color of the signal.

6. REPRESENTATIVE PYROTECHNICS.

a. Photoflash cartridge, M112A1.

(1) Characteristics. This cartridge (figure 6-3) produces 100 million candlepower one second after being fired. This cartridge consists of an inner charge case assembled within an outer aluminum cartridge case. The inner case contains a seven ounce photoflash charge and a delay element; the outer or cartridge case contains an electric primer with a small propelling charge and a metal shunting clip over the base of the case which short circuits and protects the electric primer from accidental firing during storage, shipment, and handling.

(2) Functioning. Electric current from the aircraft fires the electric primer and ignites the propelling charge which ejects the inner charge case containing the photoflash powder charge and at the same time ignites the delay element in the base of the inner charge case. At the end of the delay **the photoflash charge is initiated producing a flash of light for 0.04 of a second.**



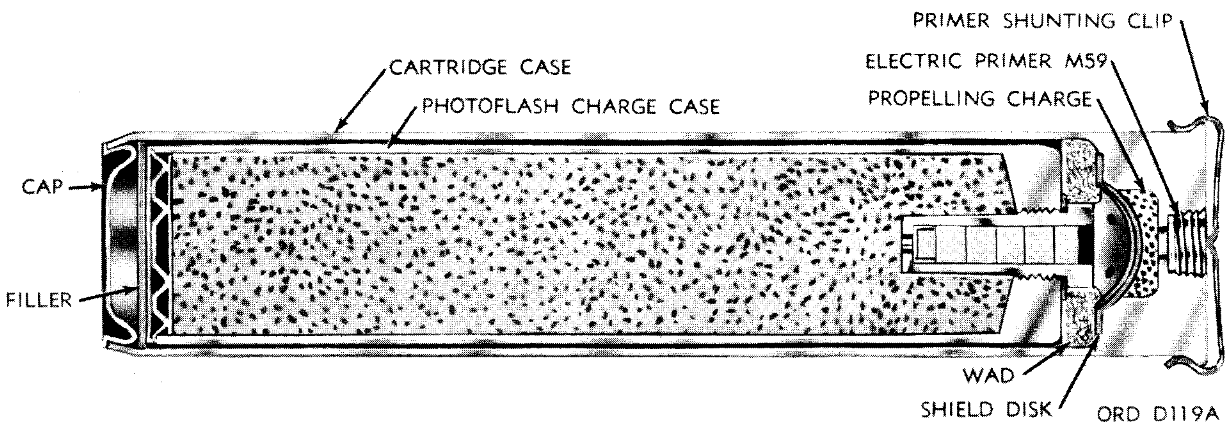


Figure 6-3. Cartridge, photoflash: M112A1, 1-second delay.

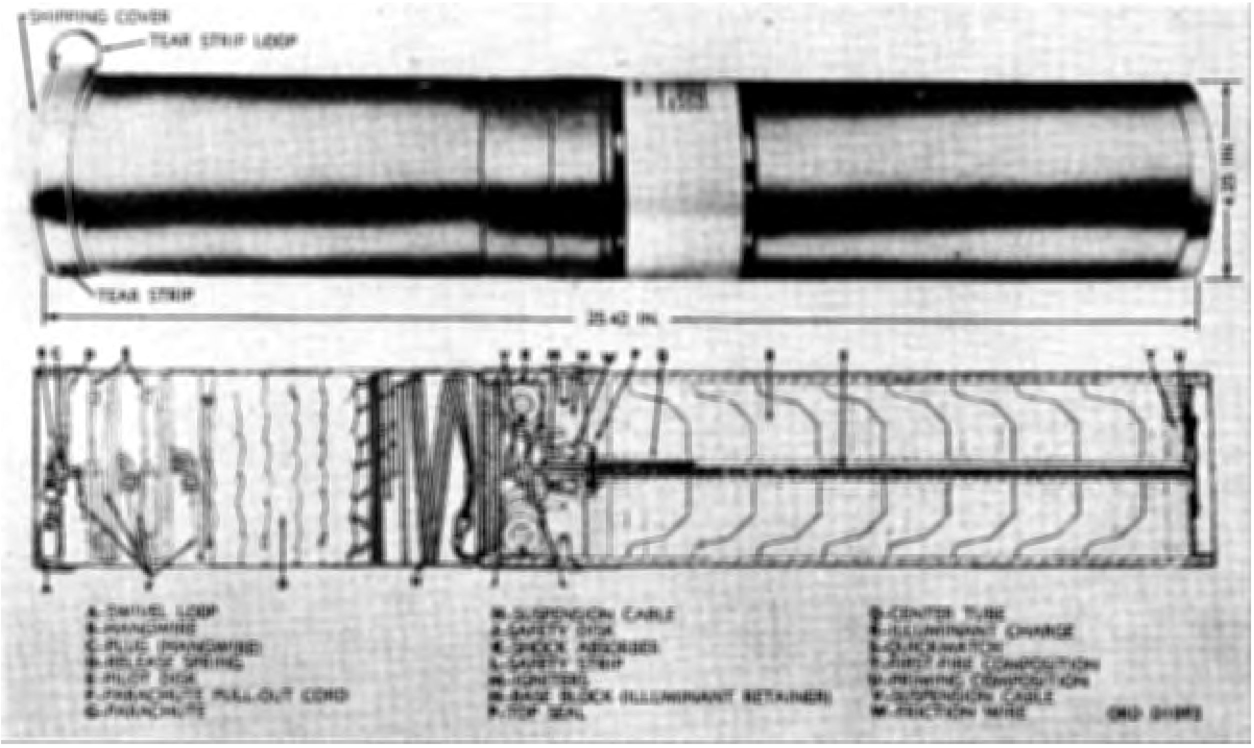


Figure 6-4. Flare, aircraft: parachute, M8A1.

(3) Packing. 10 per carton per lead foil envelope, 4 envelopes (40 cartridges) per wooden box.

b. Aircraft flare, Parachute, M8A1.

(1) Characteristics. This flare (figure 6-4) is intended for use in emergency night landings or for use as an emergency airport flare. It weighs 17.6 pounds and produces 350 thousand candlepower to a maximum of 195 seconds burning time. The illuminant charge (R) weighs 10 pounds and is contained in a paper tube encased in a zinc sheeting. The illuminant composition consists of:

(a) Barium nitrate

(b) Magnesium

(c) Aluminum

(d) Sodium oxalate

(e) Linseed and castor oil

A quickmatch (S) passes through the length of the center tube (Q) and provides a means of relaying the flame from the igniters (M) to the priming composition (U) and thence, in turn, to the first fire composition (T) and illuminant charge. A top seal (P) of fire clay separates the igniters from the illuminant charge. The aluminum base block (N) fits immediately over the top seal. This base block holds screws which fasten the parachute case to the illuminant case. The base block also provides an anchorage for the suspension cable (V) and contains the two friction igniters (M) which consist of a friction composition and a friction wire (W) coated with red phosphorus. One end of the friction wire is attached to the suspension cable (V) above the shock absorber (K). So that an appreciable pull will be required to operate the igniters, the friction wires are secured against the base block by an aluminum safety strip (L) secured, in turn, by a brass retainer. The shock absorber (K) consists of the flexible steel suspension cable encased in a hand drawn copper tube, the whole formed into a closely wound helix. A paper safety disk (J) closes the cup housing shock absorber assembly. The disk must be removed by a jerk on the suspension cable before the friction igniters will fire. The parachute (G) is made of silk or synthetic fabric and is 15 feet in diameter. The shroud lines are braided cotton cord, having a 100 pound breaking strength. The shroud lines are 14 feet in length and are attached to the suspension cable by means of the suspension cable spool (H). Two pilot disks (E), through which the parachute pullout cord (F) passes, are assembled underneath the hangwire cover. The parachute case is closed by the hangwire cover which is in the position of a cup opening outward. The hangwire (B) with swivel loop (A) is not permanently attached to the cover but is assembled to hangwire plug (C) passing through a central hole in the cover and held by a release spring (D) on the underside of the cover. One end of the release spring (D) is held in a clip soldered or welded to the underside of the hangwire container. The other end passes through the central hole in the release plug. The release spring is held in this position by the parachute case. As soon as the hangwire cover is free of the case, the spring releases the hangwire plug, then the hangwire and its plug separate from the cover. A shipping cover, held by a tear strip, protects the parachute case end of the flare; a closing cover closes the open end of the illuminant end of the flare; this cover is a press fit and is loose enough to be blown off when the composition begins to burn.

(2) Functioning. When the flare is released, the hangwire cover is removed by the resulting jerk on the hangwire. The flare is now free of the aircraft. The pilot disks (E) and parachute pull out cord (F), withdraw the parachute from its case and the parachute opens. As soon as the hangwire cover leaves the case, the release spring (D) pulls away from the hangwire plug and the cover is free to fall away from the hangwire. The sudden pull of the opened parachute causes the suspension cable (V) and shock absorber assembly (K) and the safety disk (J) to pull out of the case and simultaneously cause the friction wire (W) to pull through the friction composition. The resultant flame is transmitted by the quickmatch (S) to the priming composition (U) and, in turn, to the first fire composition (T) and the illuminant charge (R). The pressure produced by the burning compositions blows off the closing cover on the illuminant end of the flare, completing the operation.

(3) Packing. 1 per fiber container, 1 fiber container per wire bound box, or 2 fiber containers per wooden box.

c. Tracking, guided missile flare, M136.

(1) Characteristics. This flare (figure 6-5) is used for the tracking of ground launched guided missiles. The flare is designed to function prior to, or at, missile ignition. It is attached to a missile by means of a shank. Electric lead wires from an electric squib assembly in the flare are for connection to a power source within the missile. A 1-volt, 1.1 ampere current is required to cause the flare to function. This flare has a case which is 1.75 inches in diameter by 10.5 inches (including shank). The case contains two electric squibs, electric lead wires, quickmatch, first fire charge, and an illuminant charge. The lead wires extend through the plastic body near one end of the case. These wires, which are secured in place by adhesive tape, extend through the tape at this end of the case. The other end of the case is closed by an aluminum shank which is secured to the case by screws. The two squibs are wired in parallel so that, should one fail, the other will initiate the igniter. As issued, the ends of the lead wires are twisted together to short the squibs, thereby preventing accidental functioning due to stray charges from electrical sources outside the signal.

(2) Functioning. When the flare is installed in the receptacle provided in a guided missile

and the electric circuit closed, the electric squib ignites the quickmatch. The closing cover is blown off as the flame is transmitted by the first fire charge to the flare illuminant charge, which produces an illumination of 70,000 candlepower for a period of 75 seconds.

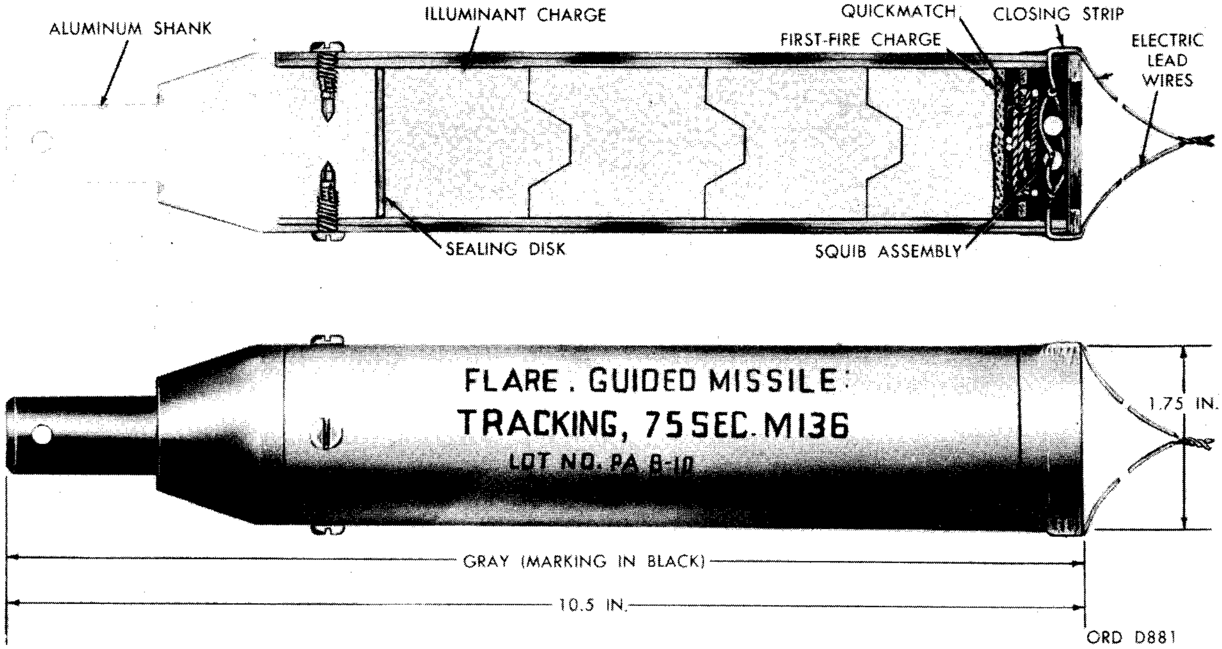


Figure 6-5. Flare, guided missile: tracking, 75-seconds, M136.

(3) Packing. 1 per metal container, 20 metal containers per wooden box.

d. Surface trip flare, M49A1.

(1) Characteristics. This flare (figures 6-6 and 6-7) is intended to give warning of infiltrating troops. When the flare is activated by a trip wire, a pyrotechnic illuminant mixture ignites with nondelay action and burns with a yellowish white light with an intensity of 40 thousand candlepower. The flare, as issued, includes the U shaped mounting bracket. The flare consists of an illuminant assembly, cover loading assembly, and mounting bracket assembly. The illuminant assembly consists of a cupped aluminum case which contains an ignition pellet (with its first fire composition) and three illuminant pellets. The cover loading assembly consists of a cover to which the following components are assembled: percussion primer M42, intermediate charge, disk, hinge pin, spring loaded striker, spring, lever, and safety clip and pull pin assembly. The cover is pressed into the flare case. Sealing compound is used around this joint to provide a waterproof seal for the flare. The mounting bracket assembly (figure 6-8) consists of the U shaped mounting bracket, two carriage bolts (with wing nuts), and a trigger assembly consisting essentially of trigger pivot, spring loaded trigger, trigger spring, and trigger washer. The lower end of the trigger has a necked down portion with a trip wire hole in its center to facilitate anchoring of the trip wire to it. Above this portion is a raised lug to which the looped end of the trigger spring is anchored. The other end of the trigger spring is anchored on a bracket lug. The upper end of the trigger is a narrow tongue which serves to retain the lever in place when the trigger is in the armed position. The bracket has a perpendicular extension with two nail holes for nailing to a tree or board. The lower portion of the bracket is pointed to facilitate forcing the bracket into the ground (as a spade) for ground installation.

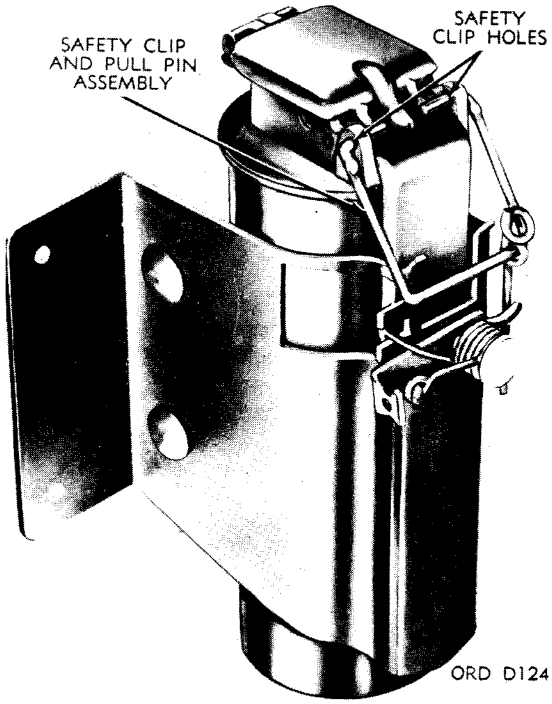


Figure 6-6. Flare, surface: trip, M49A1.

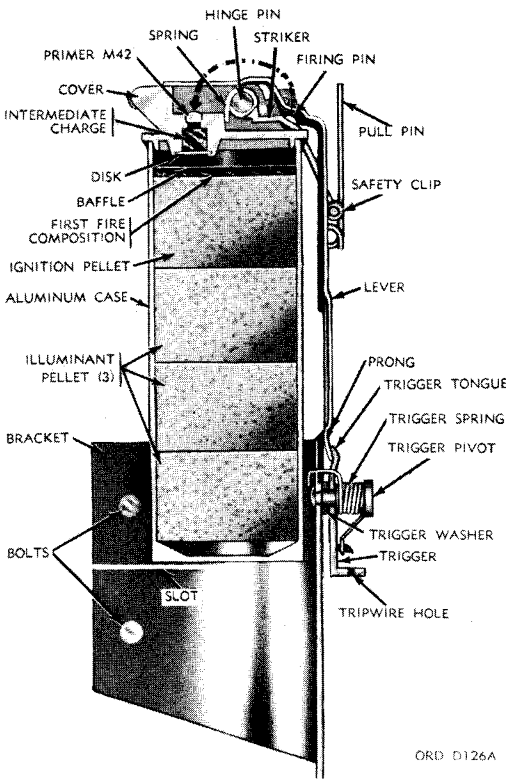


Figure 6-7. Flare, surface: trip, M49A1 (cross-section view).

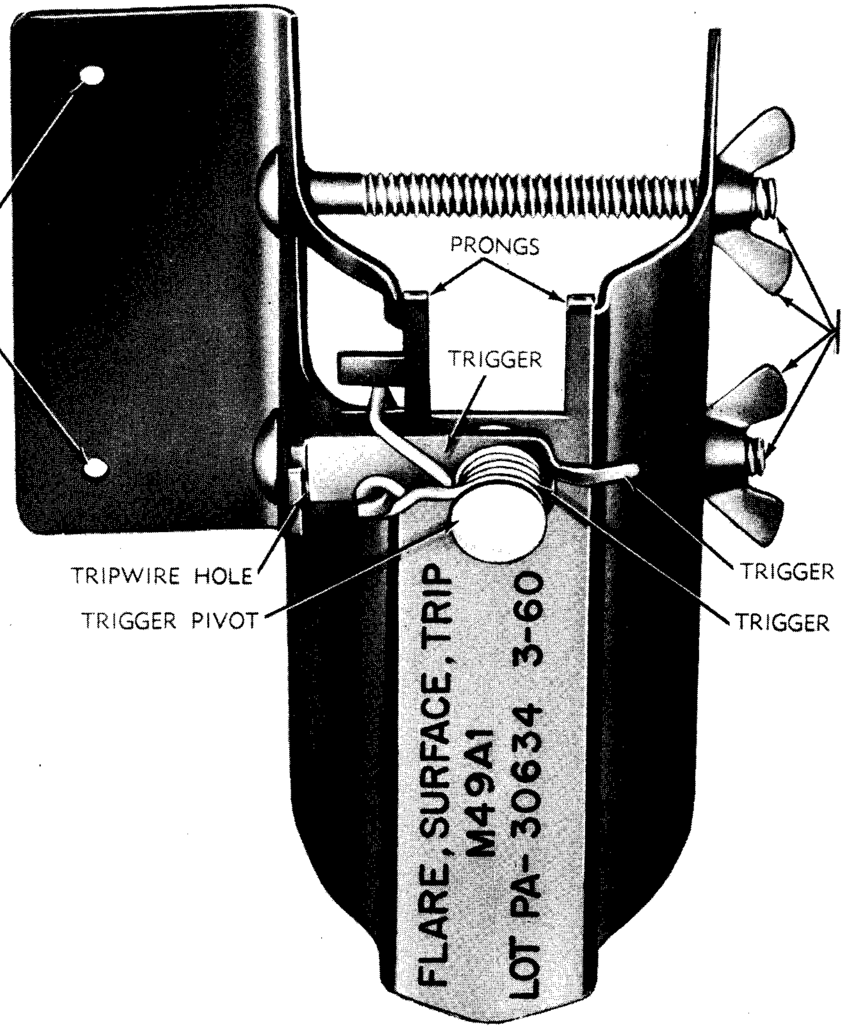


Figure 6-8. Mounting bracket assembly.

(2) Functioning. *Trip wire attached to trigger assembly.* When the trip wire is attached to the trigger, a pull of 2 to 9 pounds (or more) will rotate the tongue of the trigger mechanism in a counterclockwise direction from the lever. If the wire is severed, the trigger mechanism spring will snap the trigger tongue in a clockwise direction. In either case, the movement releases the lever, which, in turn, releases the striker which causes the firing pin to strike the primer. The primer ignites the intermediate charge below it and this, in turn, ignites the first fire composition of the ignition pellet. When the ignition pellet functions, it blows off the cover, ignites the illuminant pellets, and illuminates the surrounding area for 55 to 70 seconds. *Trip wire attached to pull pin.* When the trip wire is attached to the pull pin the flare can be initiated only by removal of the pull pin. Severing of the trip wire will not cause the flare to function. However, a pull of 2 to 4 pounds (or more) is required to remove the pull pin and release the lever, causing the flare to function as above.

(3) Packing. Thirty-two flares are packed in a fiberboard carton with 70 nails in a small bag and 32 coils of wire (45 feet long each in a small carton for each flare). The carton with contents is overpacked in a wood box.

e. Aircraft signal, double star, red-red, AN-M 37A2.

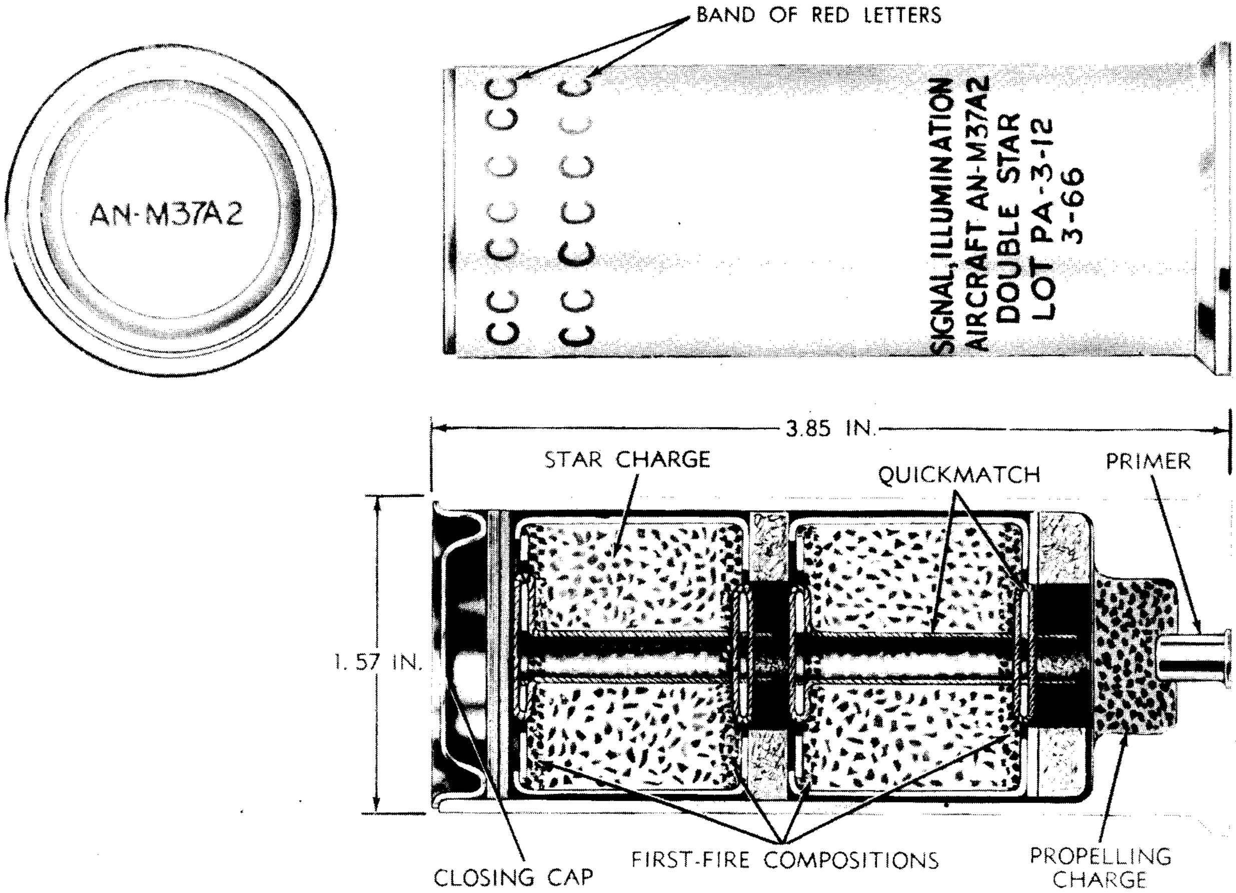


Figure 6-9. Signal, illumination, aircraft: double star, red-red, AN-M37A2.

(1) Characteristics. This signal (figure 6-9) has a one piece aluminum case with extracting rim resembling a large shotgun shell. A no. 4 primer is inserted in the base of the case. Two candles of red fire producing pyrotechnic composition contained in individual aluminum cases are loaded in the signal case. The steel closing cap is colored to indicate the color of light produced by the burning illuminants (stars) and marked with the model number. It is manufactured under rigid specifications as to moisture resistance and has improved characteristics over earlier models, enabling its use in airplanes with higher speeds and altitudes. The illuminant assembly of two stars weighs about 0.25 pound. The signal is 1.57 inches in diameter by 3.85 inches long and weighs about 0.35 pound. The item is marked in black with the nomenclature, lot number, and date of manufacture and has color bands showing the color of the light produced by the stars.

(2) Functioning. When fired in the pistol AN-M8 or projector M9, the primer ignites a black powder propelling charge, which ignites a quickmatch, which, in turn, ignites the first-fire compositions and stars. The two stars reach the full brilliance of 25,000 candlepower simultaneously after rising vertically to about 40 to 50 feet and then continue rising to about 250 feet, burning for about 10 seconds.

(3) Packing. This signal is packed 12 per carton, 12 cartons per wood box.

f. Ground signal, illumination, green star cluster, M125A1.

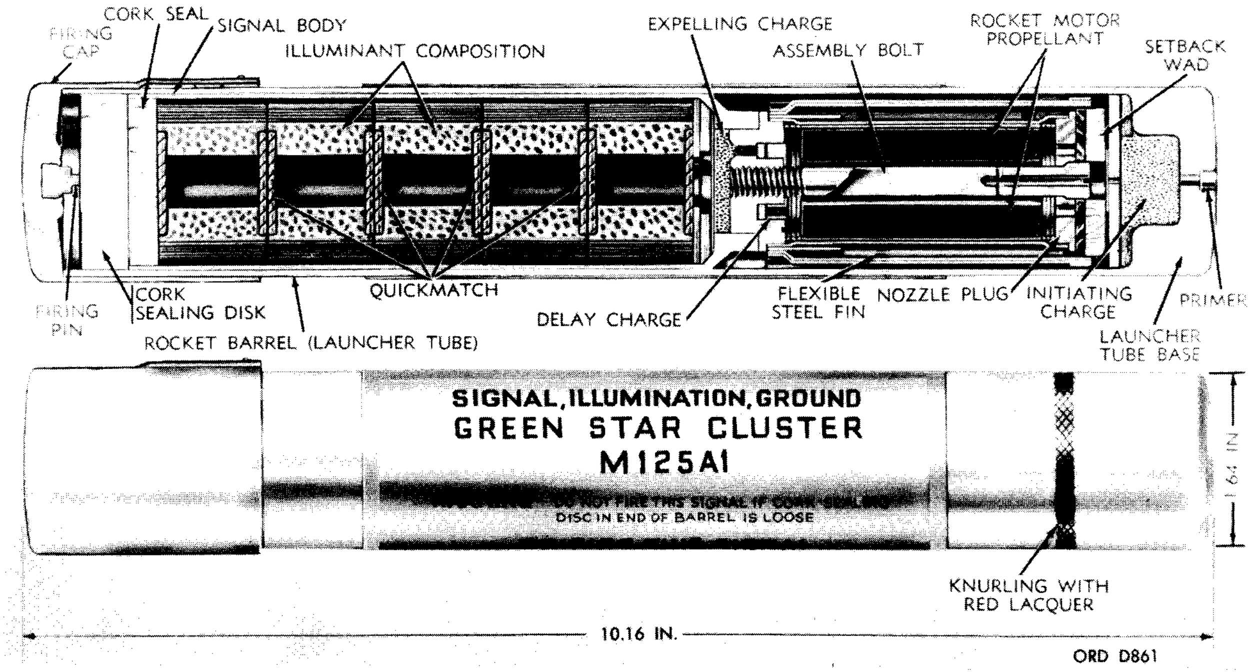


Figure 6-10. Signal, illumination, ground: green star, cluster, M125A1.

(1) Characteristics. This signal (figure 6-10) 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. The signal consists of an illuminant composition assembly of five star candles (each with first fire charge and quickmatch) and a candle initiating assembly (black powder delay element and black powder charge) enclosed in an aluminum signal body. The quickmatch elements at each end of each candle surround axial openings in the candles and are thus in position to be ignited by the expelling charge. Attached to the candle initiating assembly is a rocket motor assembly containing rocket motor propellant. At the base of the rocket motor assembly are the nozzle plug and the steel stabilizing fins folded into a position parallel to the axis of the signal. All of the above are contained in a rocket barrel (launcher tube), the base of which contains a primer and initiating charge. A narrow (1/8 in.) circumferential knurl coated with red lacquer is located in the rocket barrel (launcher tube) 1¼ inches from the primer end of the signal. The top (end opposite the primer) of the rocket barrel (launcher tube) is sealed by a cork disk and covered by a firing cap. This cap contains a firing pin partly embedded (during storage and shipment) in the cork sealing disk. The firing cap is withdrawn and placed over the launcher tube base (primer end of the signal) when preparing the signal for firing. When the firing cap has been withdrawn from the signal, the cork sealing disk is visible. It is colored green, the same color as indicated in nomenclature.

(2) Functioning. When the primer is fired, the flame from the primer ignites the initiating charge of black powder in the cavity immediately adjacent to the primer. As this charge is relatively small, it propels the signal only to a height of 20 feet and produces a slight recoil. The flame from the initiating charge travels through holes in the assembly bolt and, simultaneously, ignites the rocket motor propellant and the black powder delay charge. The propellant is contained in the propellant casing tube and the delay charge is inclosed in an aluminum housing at the bottom of the signal body. Gases from the burning initiating charge expel the signal from the rocket barrel (launcher tube). As the signal is expelled, the four flexible steel fins of the tail assembly unfold to stabilize the signal during flight. After rising to a height of 20 feet, burning gases from the propellant expand through four nozzles in the nozzle plug in the base and continue the propulsion of the signal upward. During its ascent, the delay charge burns and, at the highest point of the

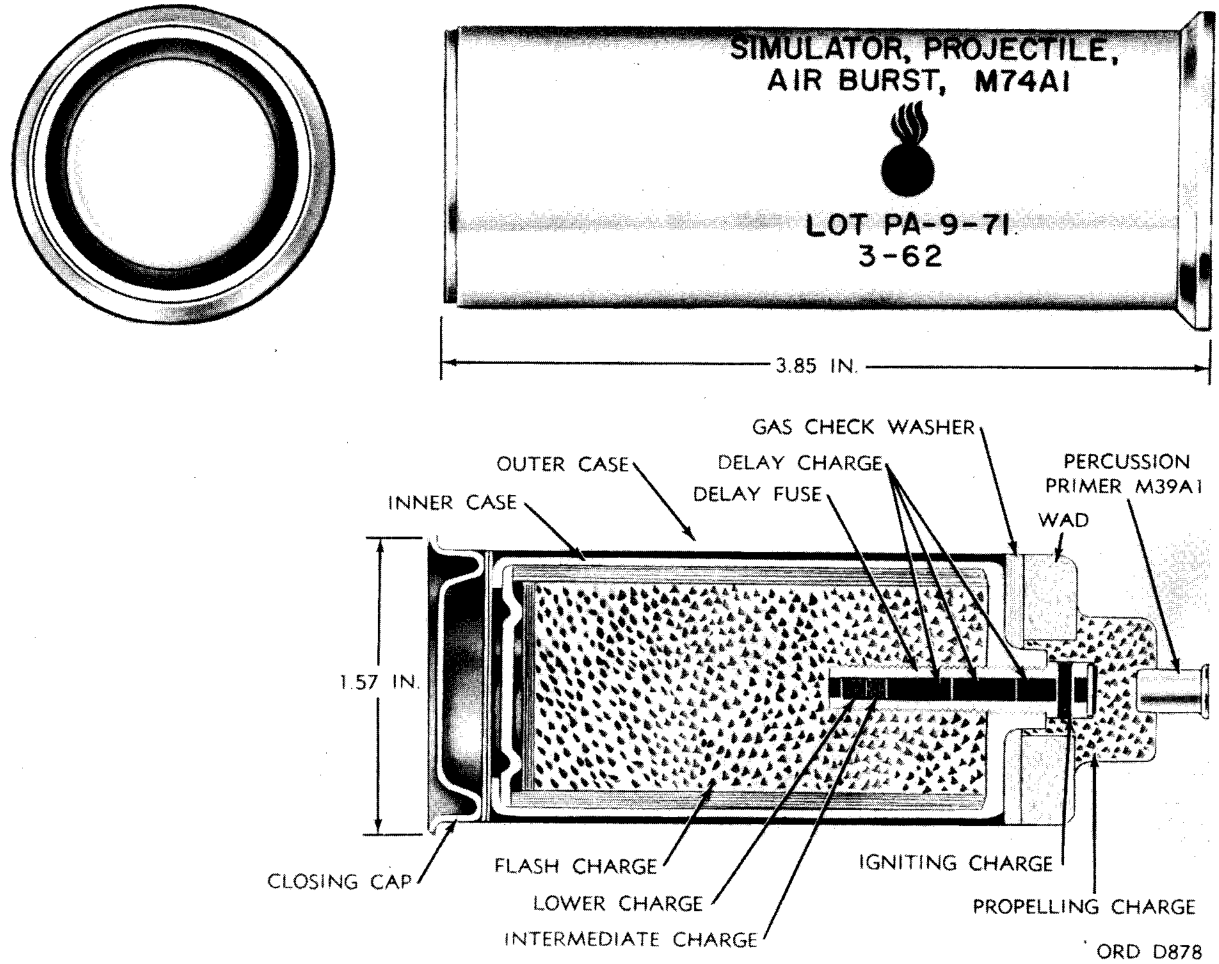


Figure 6-11. Simulator, projectile, air burst: M74A1.

signal's flight, ignites the black powder expelling charge. This expels the 5 star illuminant composition candle assembly out of the signal body and, simultaneously, ignites the quickmatch and, in turn, the first fire charges (attached to each candle) and the illuminant compositions (star candles). The five candles burn with a green light.

(3) Packing. Signals of this model are packed in individual metal containers, 36 containers per wood box.

g. Air burst simulator, projectile, M74A1

(1) Characteristics. This simulator (figure 6-11) is intended primarily for umpires to simulate air burst of artillery fire for training troops. It is fired from the pyrotechnic pistol AN-M8. It was formerly fired from the hand pyrotechnic projector M9, but because of malfunctions, simulator M74A1 *will not* be fired in projector M9. The simulator consists of a one piece outer aluminum case, a black powder propelling charge, and a closed inner cylindrical aluminum case containing a boron-barium chromate delay fuse and a black powder-aluminum flash charge. An M39A1 percussion primer is located in the base of the outer case and extends into the propelling charge which in turn is in contact with the delay fuse.

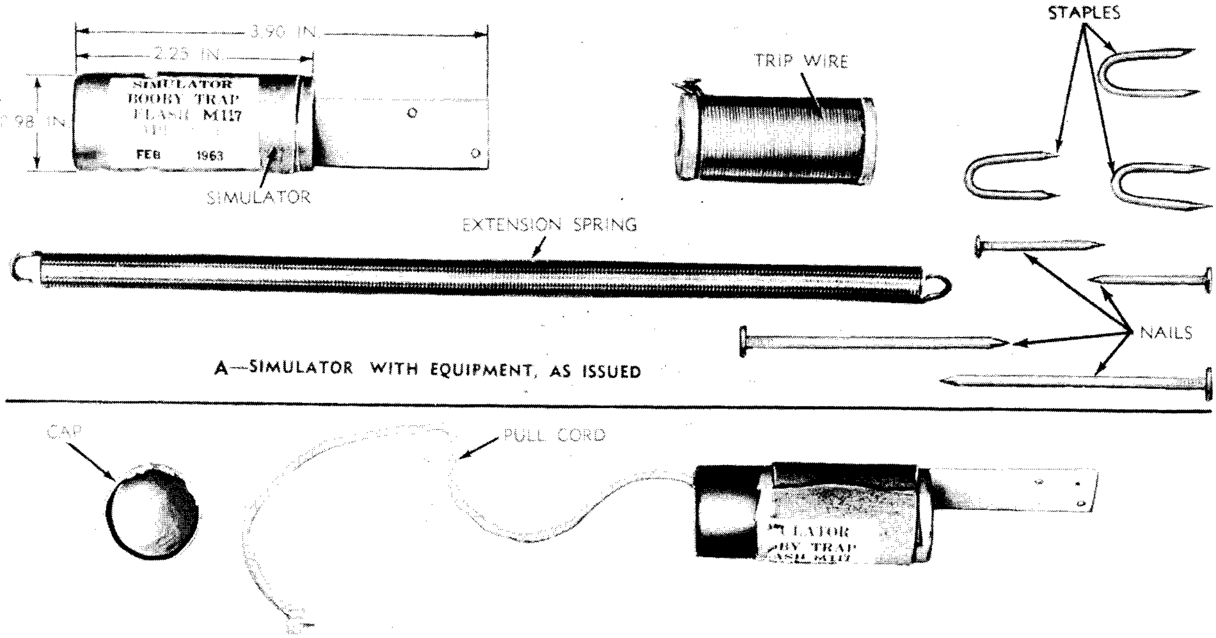


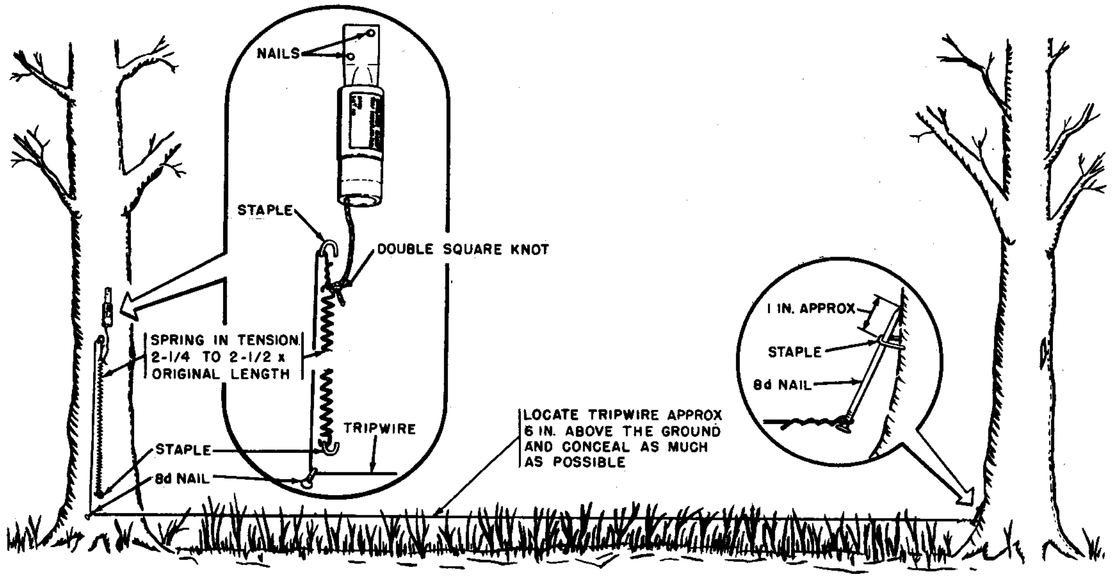
Figure 6-12. Simulator, boobytrap: flash, M117.

(2) Functioning. When fired, the primer ignites the propelling charge. This ignites the delay fuse and propels the inner case of the flash charge out of the outer case. After a delay of 2 to 3 seconds, the fuse ignites the flash charge, which produces a bright flash and loud noise. The fragments from the inner case lose velocity quickly and are so small that they become harmless in a relatively short distance.

(3) Packing. The simulators are packed 10 per waterproof carton, 8 cartons (80 simulators) per wood box.

h. Boobytrap Simulator, M117

(1) Characteristics. This simulator (figure 6-12) is for use during maneuvers and in troop training where there is need for a small pyrotechnic device which can be installed as safe boobytrap. It functions with a loud report and flash when its victim unwittingly fires the simulator. This device is intended to provide training in the installation and use of boobytraps, as well as to instill caution in troops exposed to traps set by an enemy. Included with each simulator, as issued, is a spool of wire for use as trip wire, an extension spring, three staples, and four nails. The flash simulator M117 consists of a cylindrical body (outer tube) and a flat, metal nailing bracket which extends from one end of the body. The body is 0.98 inch in diameter and, without nailing bracket, 2.25 inches long. The nailing bracket increases the length to 3.90 inches. An inner tube of approximately half the body diameter is located within the body and houses the charge composition. The assembly used for initiating the charge is located in the space between the inner and outer tubes. This assembly consists of a strip of paper coated with a friction-sensitive composition and folded into a pad so that the coated surfaces are face-to-face. The pad is attached to the inner tube. Over the top of the pad is a strip of felt held in place, under light pressure, by adhesive tape wrapped around the inner tube. A length of pull cord runs between the coated surfaces of the pad. One end of the pull cord is covered with friction composition; the other end is coiled and placed in the end of the body opposite the nailing bracket. A paper cap, held on by a strip of tape, covers this end of the simulator.



1- SELECT TWO TREES, STAKES, OR OTHER OBJECTS TO WHICH A TRIPWIRE CAN BE FASTENED SO THAT THE WIRE WILL EXTEND ACROSS THE PATH TO BE TRAPPED.
2- DRIVE A NAIL INTO ONE TREE APPROX 6 INCHES ABOVE THE GROUND.
3- DRIVE A STAPLE AT A CONVENIENT HEIGHT ABOVE THE NAIL (WHEN USING THE M117, THE STAPLE MUST BE LOCATED AT LEAST 7-1/2 FEET ABOVE THE NAIL, AS THE SIMULATOR MUST BE PLACED 10 FEET ABOVE THE GROUND).
4- DRIVE A SECOND STAPLE APPROX 20 INCHES (2-1/2 TIMES OVER-ALL SPRING LENGTH) ABOVE THE FIRST STAPLE.
5- DRIVE A THIRD STAPLE INTO THE SECOND TREE APPROX 6 INCHES ABOVE THE GROUND.
6- MAKE A LOOP IN ONE END OF THE WIRE AND PASS IT DOWNWARD THROUGH THE TOP STAPLE ON THE FIRST TREE.
7- HOOK ONE END OF THE SPRING ON THE LOOP AND THE OTHER END ON THE LOWER STAPLE.
8- EXTEND THE SPRING UPWARD TO APPROX 1 INCH BELOW THE TOP STAPLE, WHILE KEEPING THE WIRE TAUT. A NAIL MAY BE USED TO HOLD THE SPRING IN THE EXTENDED POSITION.
9- KEEPING SPRING EXTENDED AND WIRE TAUT, RUN THE WIRE AS FOLLOWS:
   A. TURN IT THROUGH 180° AGAINST RESISTANCE OF ONE PRONG OF TOP STAPLE.
   B. RUN IT DOWNWARD PARALLEL TO SPRING.
   C. TURN IT THROUGH 90° AGAINST RESISTANCE OF BOTTOM NAIL, AND ACROSS TO SECOND TREE.
10- FASTEN TRIPWIRE TO SECOND TREE AS FOLLOWS:
   A. KEEPING SPRING EXTENDED AND WIRE TAUT, WRAP THE WIRE AROUND A NAIL, JUST BELOW ITS HEAD.
   B. WEDGE THE NAIL BETWEEN THE STAPLE, MENTIONED IN PARAGRAPH 5, AND THE TREE SO THAT THE NAIL IS HELD BY FRICTION OF THE STAPLE AND THE TREE TO INSURE A TAUT AND SECURE TRIPWIRE.
11- IF A NAIL WAS USED TO HOLD THE EXTENDED SPRING IN POSITION, THE SPRING MUST BE RELEASED WHEN BOTH ENDS OF THE TRIPWIRE HAVE BEEN FASTENED IN PLACE.
12- CAREFULLY REMOVE TAPE SECURING CAP. REMOVE THE CAP FROM THE SIMULATOR AND TIE THE PULL CORD TO HOOK AT THE UPPER END OF THE SPRING. NAIL THE SIMULATOR IN POSITION DIRECTLY ABOVE THE SPRING.

WARNING: THE FLASH TYPE, M117 IS SAFE FOR PERSONNEL AT A DISTANCE OF 6 FEET. DRY GRASS OR LEAVES WITHIN A RADIUS OF 3 FEET MAY BECOME IGNITED.
THE ILLUMINATING TYPE, M118 AND WHISTLING TYPE, M119 ARE SAFE FOR PERSONNEL, EXCEPT IN CONTACT. DRY GRASS OR LEAVES DIRECTLY UNDERNEATH MAY BECOME IGNITED.

Figure 6-13. Boobytrap instructions.

(2) Functioning. If, after the simulator is prepared for use as outlined in h(3) below, the trip wire is pulled or cut, the pull cord will be drawn through the friction-sensitive pad h(1) above. The flame produced by this action ignites the charge composition, which functions with a loud report and accompanying flash.

(3) Preparation for use. Remove cover from the packing box and carefully break open the waterproof lining. Remove the desired number of simulators and the instruction sheet (figure 6-13). Refold the waterproof liner and install the box cover; this is essential since the simulators are not otherwise waterproofed. The simulator is prepared for use in accordance with the instruction sheet, which outlines the procedure for setting up the simulator and the hazards involved.

(4) Packing. This simulator is packed 1 per carton, 25 cartons per cardboard container, 4 paperwrapped containers (100 simulators) per wooden box.

i. Ground burst simulator, projectile, M115A2.

(1) Characteristics. This simulator (figure 6-14) is a pyrotechnic device used to provide battle noises and effects during troop maneuvers. The simulator M115A2 is ignited by the action of time blasting fuse igniter M3A1. Following a delay of 6 to 10 seconds after ignition, the simulator

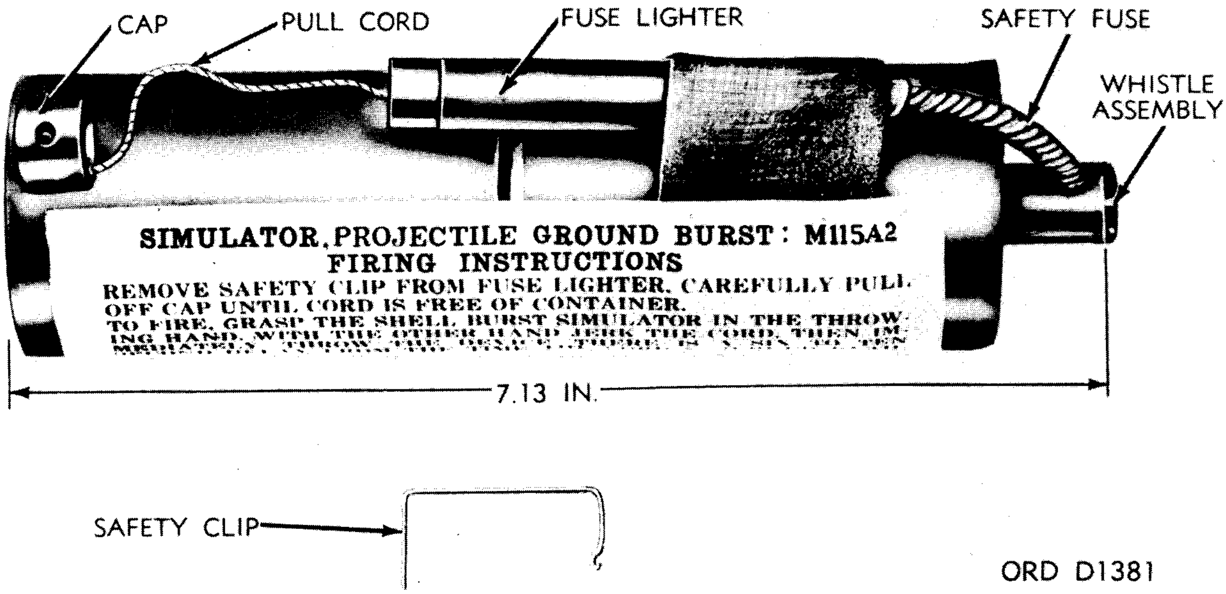


Figure 6-14. Simulator, projectile, ground burst: M115A2 (safety clip removed and cord extended).

produces a high-pitched whistle which lasts two to four seconds. After a fraction of a second, the simulator explodes, producing a flash and loud report. The body of the simulator consists of a cylindrical paper tube (closed at each end) containing approximately 2 ounces of photoflash powder and a whistle assembly which extends from one end of the tube. The simulator is 2.38 inches in diameter (including fuse lighter) and 7.13 inches long. The whistle assembly is a paper tube containing a pressed, slow-burning powder charge. Extending from the side of this assembly is a length of safety fuse which, after a 90° bend, is inserted in a fuse lighter M3A1 taped to the side of the simulator. The fuse lighter contains a double pull cord and a cellulose nitrate coating on the phosphorous-coated friction wire and ignition composition.

(2) Functioning. When the cord is pulled to fire the simulator, it jerks the coated ripple wire through the ignition composition; the resultant flame ignites the safety fuse, which burns for 6 to 10 seconds, and then ignites the powder charge in the whistle assembly. The burning whistle composition emits a high-pitched whistle of 2 to 4 seconds duration, after which the photoflash charge is ignited and explodes, producing a flash and loud report. **Warning: Throw simulator immediately after pulling the pull cord.**

(3) Packing. These simulators are packed 5 per waterproof carton, 20 cartons (100 simulators) per wooden box.

j. Hand grenade simulator, M116A1

(1) Characteristics. This simulator (figure 6-15) is used to provide battle noises and effects during troop maneuvers. It is ignited by the action of a time blasting fuse igniter (fuse lighter) M3A1 and is thrown like a hand grenade. The time blasting fuse (safety fuse) burns for 5 to 10 seconds after ignition, followed by a flash and accompanying loud report. The body of the hand grenade simulator consists of a cylindrical paper tube (closed at each end), containing one and one-quarter ounces of photoflash powder. The simulator body is 1.6 inches in diameter (2.18 inches across time blasting fuse igniter) and 3.75 inches long (4.27 inches with time blasting fuse). A length of time blasting fuse extends from the center of one end of the body and, after a 180° bend, is inserted into time blasting fuse igniter M3A1 taped to the side of the simulator. The time blasting

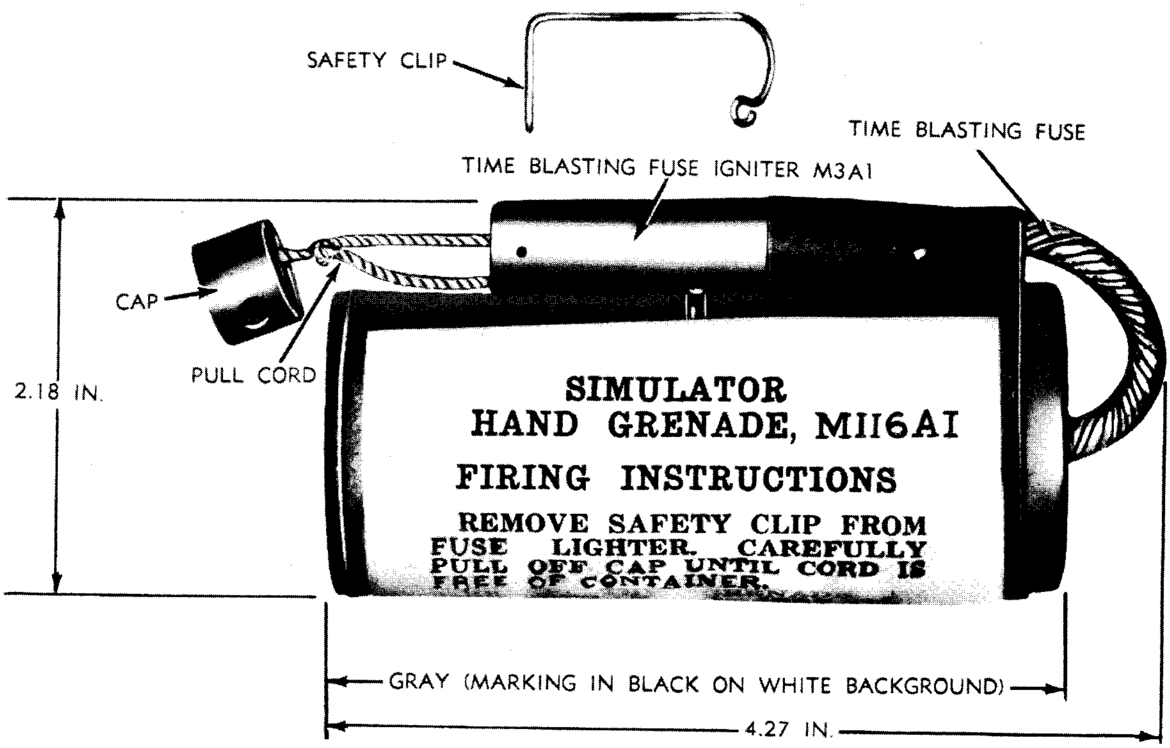


Figure 6-15. Simulator, hand grenade: M116A1.

fuse igniter contains a double pull cord, a ripple wire coated with a phosphorous friction composition, and a small metal cup filled with ignition composition. There is a cellulose nitrate coating on the phosphorous coating and on the ignition composition. One end of the pull cord is attached to the coated wire; the other end is attached to the cap, which seals the end of the time blasting fuse igniter. The sealing cap is held in place during shipment and handling by a spring type wire safety clip.

(2) Functioning. When the cord is pulled to fire the simulator, it pulls the coated wire through the ignition composition; the resultant flame ignites the time blasting fuse, which burns for 5 to 10 seconds, and then ignites the photoflash powder charge, thus causing it to produce the flash and report.

(3) Packing. These simulators are packed 5 per paperboard container, 30 containers (150 simulators) per wooden box.

k. Explosive simulator, M80

(1) Characteristics. This simulator (figure 6-16) is used to simulate explosive charges in boobytrap, landmine detection, and training programs. It may be used to simulate hand grenades, boobytraps, land mines, rifle or artillery fire. This simulator is a paper cylinder 1.56 inches long and 0.69 inches in diameter, containing three grams of potassium perchlorate, aluminum powder, sulfur, and antimony sulfide charge composition. The fuse is inserted into the side of cylindrical body of the simulator.

(2) Functioning. The fuse is ignited by flame from an ordinary match or similar source causing the simulator to function in from 3 to 7 seconds.

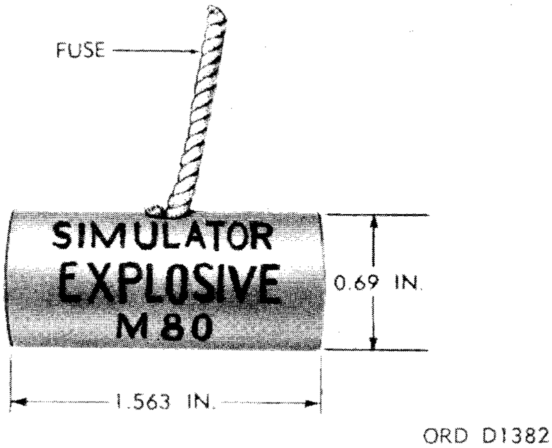


Figure 6-16. Simulator, explosive: M80.

(3) Packing. Simulators are packed 50 per waterproof, wrapped, wax-dipped, chipboard container, 50 containers (2500 simulators) per wooden box.

l. Miscellaneous pyrotechnics.

(1) Railroad warning fusee, red M72

(a) Characteristics. This fusee (figure 6-17) is intended for use in outlining emergency airport boundaries under conditions of poor visibility. It may also be used for recognition and signaling. The fuse is 15.88 inches long by 0.9 inch in diameter and weighs 0.64 pound. It consists of a cylindrical paper tube filled with a 9-ounce red-flare composition. It is capped with a wooden block, on the top surface of which is a striking composition with which the priming charge, imbedded in the top of the red-flare composition may be initiated. A bonnet of red Kraft paper covers the striking charge and cap assembly and may be removed by the tear strip. A soft paper filler is located over the match head. A stake protrudes from the wooden bottom plug.

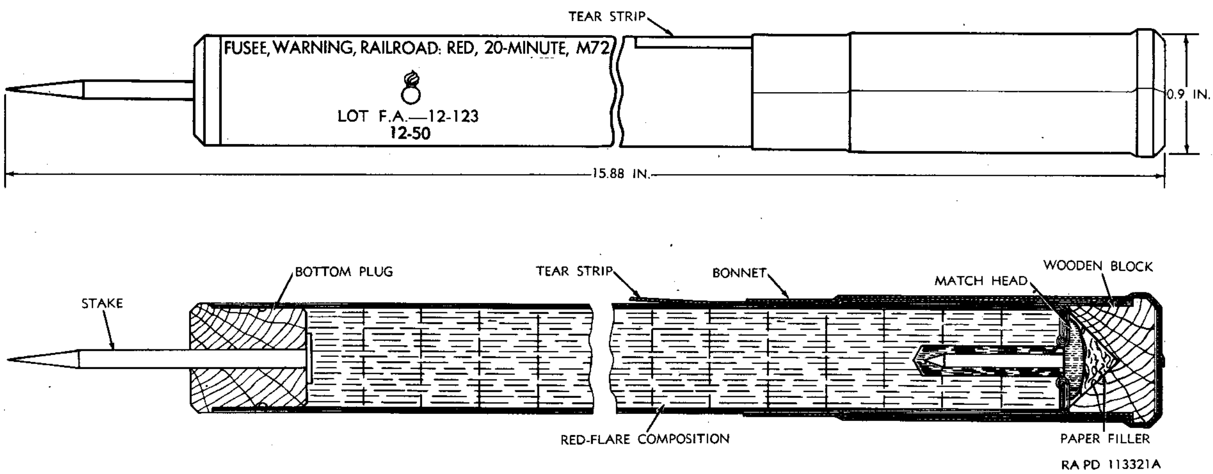


Figure 6-17. Fusee, warning, railroad: red, 20 minutes, M72.

(b) Functioning. To use the fusee, remove the paper covering over the wood block with the aid of the tear strip. Remove the wooden block and ignite the fusee by striking the match head with the striking composition which is on the outer surface of the cap. Stick the fusee in an inclined position in the ground or in soft wood. Step clear.

(c) Packing. These are packed 10 per carton, 4 cartons (40 fuses) per wooden box.

(2) Marine location marker, Mk 1 Mod 3

(a) Characteristics. This marker (figure 6-18) may be launched by hand from the decks of surface vessels or from aircraft at any altitude. When launched from surface craft or from aircraft flying lower than 1,000 feet, the marker is dropped in the armed condition; that is, the safety pin is removed and the burster explodes to spread the dye on the surface of the water. When launched from aircraft, however, at any altitude, the marker may be dropped in the unarmed condition; that is, the safety pin in place. The pigment containers will then be crushed upon hitting the surface of the water. The slick produced in this instance will be only slightly smaller than that produced when the marker is dropped armed. The marker consists of two pigment-filled, cylindrical, Kraft-paper containers, each attached to a flat side of a circular wooden block. A grenade firing mechanism is mounted on the wooden block. A plastic tube that holds a bursting charge of black powder extends through the wooden block into both containers. Each container is filled with a pigment which appears yellow or yellow-green on the water. The marker has a diameter of 3.5 inches and a length of 11.88 inches. The firing mechanism protrudes seven-eighths inch from one side.

(b) Functioning. To launch the marker from surface craft or from aircraft at altitudes up to 1,000 feet, grasp it firmly in one hand, holding the release lever against the body of the marker. Pull the safety ring to pull out the safety cotter pin and throw the marker over the side. When the marker has been launched, the release lever is forced off by the striker, which at all times is under the tension of the striker actuating spring. The striker rotates about the hinge pin, and the striker point impinges on the primer. The primer ignites the time fuse which introduces a short delay before igniting the bursting charges. The expanding gases burst the pigment containers and spread the pigment on the water. The size of the colored slick area will be governed by the amount of dispersion of the insoluble pigment. The spot will last approximately 45 minutes.

(3) Fire starter M1

(a) Characteristics. The M1 fire starter is used for starting fires under adverse climatic conditions, such as in wet jungles or on snow-covered terrain. The M1 fire starter (figure 6-19) is a cylindrical cellulose nitrate container 1.25 inches in diameter by 3.25 inches in length filled with 0.8 ounce of thickened kerosene and provided with an ignition device. The kerosene is thickened to a gel with M1 thickener. The gel ignites easily and burns relatively slowly. The ignition device is a match head attached to a disk which covers the filler. A scratcher is attached inside a metal cap which covers the match head end of the fire starter. The cap is fastened to the container with adhesive tape.

(b) Functioning. To ignite the M1 fire starter, pull off the adhesive tape and remove the metal cap. Take the scratcher from under the cap, hold the fire starter by its base with the match head pointed downward, and draw the scratcher rapidly across the match head. Allow the filler to burn for several seconds, then set the fire starter on its base in the desired position. The burning time of the fire starter is approximately 13 minutes.

(c) Packing. These are packed 216 per wooden box.

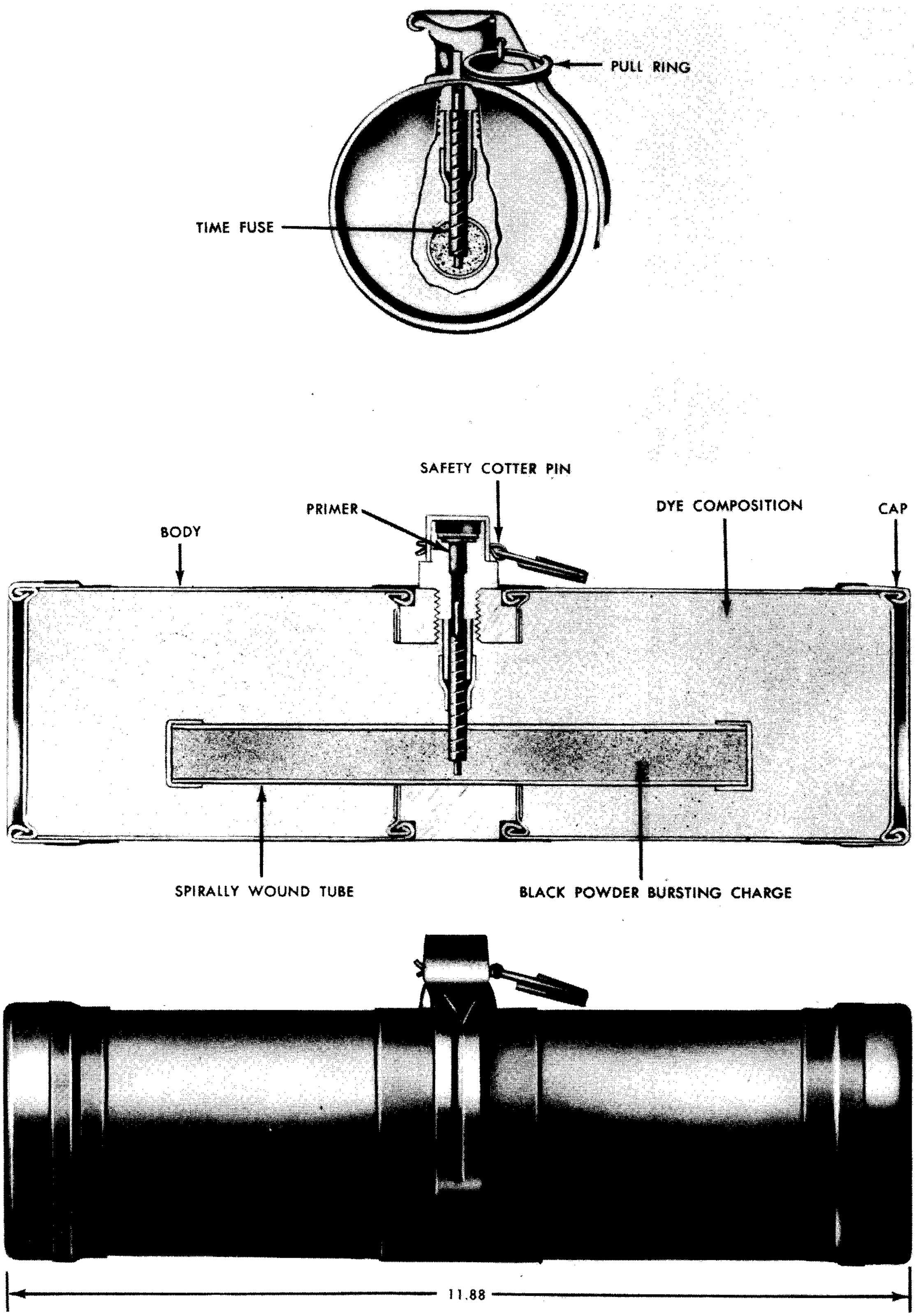


Figure 6-18. Marker, location, marine: Mk 1 mod 3, yellow.

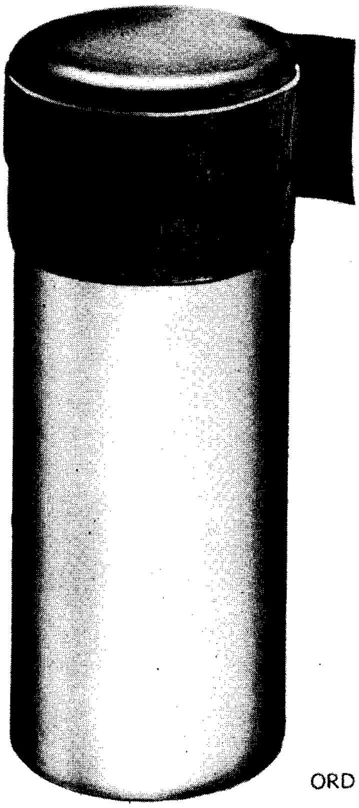


Figure 6-19. Starter, fire: M1.

7. SUMMARY. This lesson provided you with information relative to the types, characteristics, identification, packing, marking, and filler of representative types of military pyrotechnics. It is emphasized that military pyrotechnics are unique, compared to most other types of ammunition, in that they are unusually sensitive and quickly become unserviceable by absorption of moisture unless they are handled and stored under favorable conditions. Personnel under your supervision should be thoroughly informed regarding the peculiarities of this type of ammunition in order that all safety precautions are adhered to so as to prevent accidents, and that storage conditions are proper in order to insure that the munitions remain in a serviceable condition. No doubt you have heard the expression "keep your powder dry" as applied to propellants. It is equally important that you "keep your pyrotechnics dry." Unless you do, you will have unserviceable pyrotechnics on hand which are useless. Pyrotechnics, unlike most other types of ammunition, cannot be restored to serviceability once they become unserviceable, and must be destroyed. It is recommended that you refer to this lesson from time to time in order to refresh your memory on the subject of military pyrotechnics. In so doing you will be better able to perform your duties as an ammunition supervisor.

EXERCISES FOR LESSON 6

1. Which pyrotechnic item produces one hundred million candlepower?

   A. Photoflash bomb M122
   B. Gunflash simulator M110
   C. Photoflash cartridge M112A1
   D. Atomic simulator M142

2. What is the primary purpose of flares?

   A. Flash of light
   B. Illumination
   C. Trail of smoke
   D. Ignition

3. What does the marking WP designate on a ground signal?

   A. White phosphorus
   B. White star parachute
   C. With parachute
   D. Without parachute

4. Where is the emphasis placed in the specifications for manufacture of aircraft signal AN-M37A2?

   A. Increased production
   B. Star intensity
   C. Improved ballistics
   D. Moisture resistance

5. Which furnishes oxygen for pyrotechnic fillers?

   A. Aluminum
   B. Paraffin
   C. Chromate
   D. Sulfur

6. Which element relays the flame from the igniter to the priming composition in the M8A1 flare?

   A. Quickmatch
   B. Center tube
   C. First fire composition
   D. Friction wire

7. What is the purpose of the ignition pellet in the M49A1 surface flare?

   A. Actuates the prong
   B. Ignites the primer
   C. Ignites the first fire composition
   D. Blows off the cover

8. Which pyrotechnic is marked on the outer case to show when it was X-rayed to determine presence of defects?

A. Ground burst simulator
B. Rocket propelled signal
C. Photoflash cartridge
D. Railraod fusee

9. Which simulator can be installed as a safe boobytrap?

A. M117
B. M115A1
C. M116A1
D. M80

10. What color is generally used to mark pyrotechnics?

A. Blue
B. Black
C. Yellow
D. White

LESSON 7. BOMBS AND BOMB FUZES

Subcourse No. 621	Ammunition Materiel
Lesson Objective	To give the student a general knowledge of the types, characteristics, fillers, packing, marking and function of bombs and bomb fuzes.
Credit Hours	Three

TEXT

1. INTRODUCTION. This lesson provides general and technical information on bombs and bomb fuzes currently used by the Army, Navy and Air Force. Covered are general and specific characteristics, fillers, packing, marking and function of representative items in this category. The contents of this lesson should provide you with sufficient background material so that operations involving storage, shipping and handling will be conducted with greater safety and efficiency by you and the personnel under your supervision. In oversea theaters, under normal conditions, the Department of the Air Force will be responsible for this type of munition; however, Army ammunition personnel should always be prepared to receive, store, maintain, and issue these items in emergencies.

2. GENERAL.

a. A bomb is a particular kind of ammunition which is designed to be carried and dropped from an aircraft in flight. It usually consists of a metal container filled with explosives or chemicals, a device for stabilizing its flight so that it can be aimed accurately, a fuze(s) to cause the bomb to function at the target and safety devices to make it reasonably safe to carry. The metal container, called the bomb body, is usually streamlined with a rounded (ogival) nose and a tapered tail. The stabilizing device is attached to the tail end of the body and usually consists of a sheet metal fin assembly. A fuze is installed in the nose and/or in the tail end of the bomb body. To assure flexibility in use and functioning reliability, two fuzes are used in the same bomb. Safety wires are provided in fuzes and an arming wire is substituted for the safety wire when the bomb is readied for use.

b. Components of a complete bomb.

(1) A complete bomb assembly (figures 7-1, 7-2 and 7-3) consists of all the components and accessories necessary for the bomb to function in the manner intended. For safety in handling, sensitive or fragile components are packed separately and assembled to the bomb prior to its use. Components of a typical bomb are:

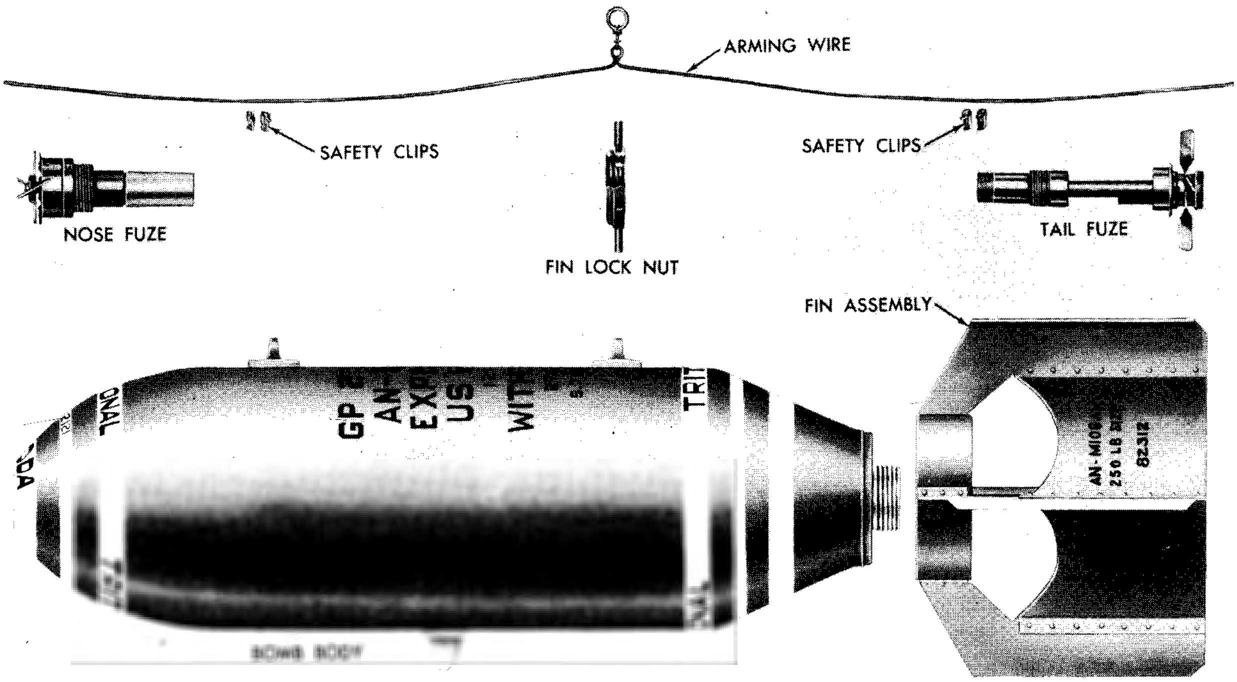


Figure 7-1. Components of a bomb complete round with box fin.

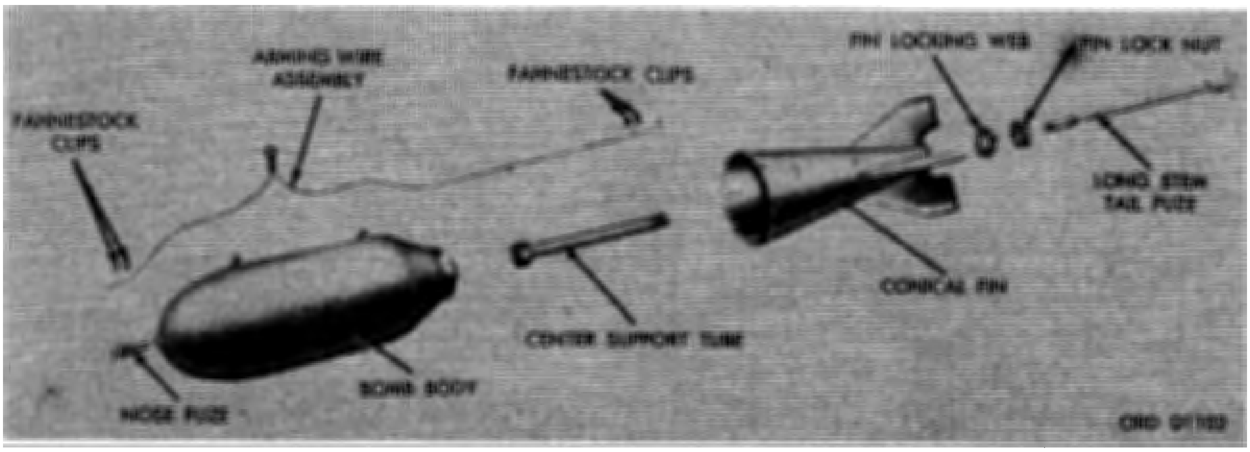


Figure 7-2. Components of a bomb complete round with conical or streamlined fin.

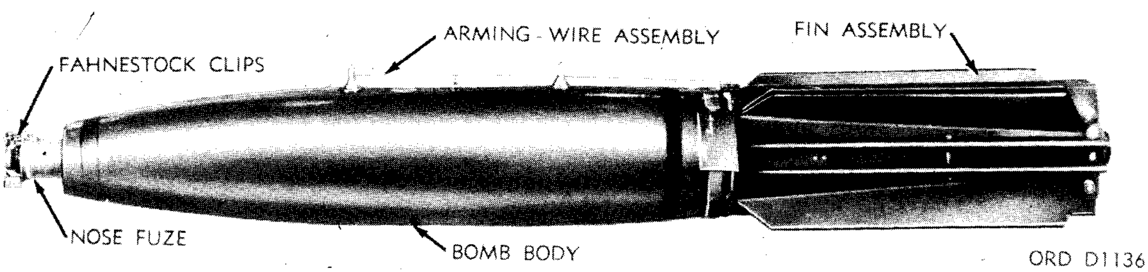


Figure 7-3. Components of a bomb complete round with retarding fin.

(a) Bomb body. The body is a metal container designed to hold an explosive, chemical or inert filler. The case may consist of a single piece of metal or several pieces welded or otherwise joined together.

(b) Fin assembly. There are three types of fin assemblies commonly used with bombs:

1. The box type consists of a fin sleeve which fits over the bomb tail, and sheet-metal blades which are joined to the fin sleeve and to each other to form a box-like assembly.

2. The conical or streamlined type consists of a cone-shaped body with metal blades attached to give a streamlined configuration.

3. The retarding type consists of streamlined folded blades which can open in an umbrella-like fashion to impart high drag.

(c) Fuzes are of the impact, mechanical time, variable time, hydrostatic and miscellaneous types designed to initiate bombs under desired circumstances.

1. Impact. This type fuze is one that functions when the bomb strikes a resistant material. Some impact fuzes contain both instantaneous and delay capabilities and are usually assembled with arming vanes. These fuzes, for nose and tail assembly, are similar in overall construction and function except that the length of the tail fuze varies because of differences in the length of the arming stem. These differences are necessary to locate the arming-vane assembly in the air stream so that the same type fuze can be used in various size bombs.

2. Mechanical time. This type fuze, both nose and tail, are combination vane, arming pin, time, or impact functioning. The impact feature, for insurance rather than deliberate selection, operates only when the time setting exceeds time of flight. Although varying in arming and explosive characteristics to meet specific use requirements, all mechanical-time fuzes are essentially of one type, that of common clockwork mechanism. Current models are detonator safe (i.e., detonator out of line with booster).

3. Proximity (VT). These fuzes are automatic time fuzes which, without setting or adjustment, detonate the bomb on approach to the target at the most effective point on its trajectory. They are essentially radio transmitting and receiving units and transmit a continuous radio signal in flight. When this signal is reflected from a target to the armed fuze, it interacts with the transmitted signal to produce ripples or beats. When the beat reaches a predetermined frequency, an electronic switch closes, permitting an electric charge to initiate a detonator. There are two types of proximity (VT) fuzes, the bar type and the ring type (figure 7-4). Both types derive their source of energy from arming vane assemblies connected to a generator in the fuze body.

4. Hydrostatic. These fuzes act under the influence of water pressure to explode a bomb at a predetermined depth. They are used in depth bombs for antisubmarine warfare. The depth at which detonation will occur can be controlled by setting a depth-setting knob.

5. Miscellaneous fuzes.

a. These fuzes, with physical and functional characteristics and specialized application, prohibit them from being classified as a standard series or type. For example, bomb fuzes, FMU-7/B or 7A/B are designed for use on later model fire bombs. They are electrically armed, Two identical fuzes are used on each bomb in the nose and tail. This fuze is provided with an all ways-functioning striker assembly which functions upon ground impact of the munition.

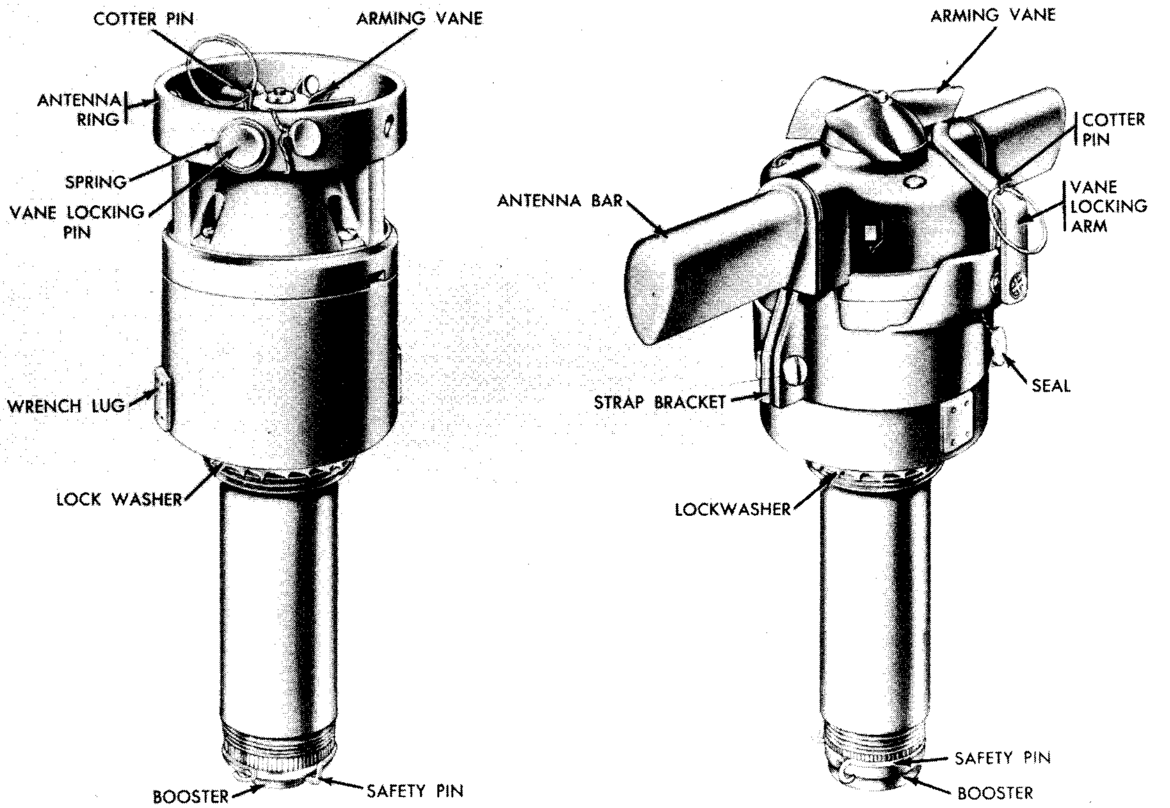


Figure 7-4. Proximity nose fuzes.

b. Four pound butterfly bombs may be assembled with three types of fuzes, the M129 fuze is set for AIR or GROUND at the time of manufacture. Fuze M130A1 is a mechanical time fuze and set so that detonations will occur 10, 20, 30, 40, 50 or 60 minutes after arming, depending upon the setting made at the time of manufacture. Fuze M131A1 is similar to the other two types except that it has an antidisturbance device which will cause the fuze to function after impact if subjected to handling, vibration, or shock. These three fuzes are installed in bombs and assembled in clusters which require mechanical time fuzes for cluster opening.

(d) Arming-vane assembly. This assembly is a small propeller device with sheet metal blades or vanes and is used on all fuzes with the exception of some fire bomb and miscellaneous fuzes. The arming vanes differ in pitch, shape and length of blades and are prevented from turning by a safety wire or pin.

(e) Arming wire assemblies. These components usually consist of either one or two strands of wire attached to a swivel loop. They are used to lock the fuze-arming mechanism in the unarmed position. Fahnestock (safety) clips are attached to the free ends of the wires after installation of fuzes in the bomb. This prevents accidental withdrawal of the wires while the aircraft is in flight.

(f) Igniters. An igniter is an explosive charge used to ignite the filler of incendiary and fire bombs. Igniters vary considerably in their shape, method of operation, and are filled with white phosphorus (WP) or sodium (Na).

(g) Adapter-boosters. This component is a bushing which is threaded on the outside for assembly in the bomb body and on the inside for assembly to the fuze. Adapter boosters, normally assembled to high-explosive and chemical bombs, are drilled for the insertion of lock pins which prevent their removal when antiwithdrawal fuzes are to be assembled in the bomb. Most of the larger bombs have a sealer (booster surround) cast in the nose and tail around the adapter boosters. The semi-armorpiercing-bombs have a booster surround of cast TNT and the general purpose bombs usually have an inert wax sealer.

(h) Auxiliary boosters. This component consists of a column of tetryl pellets in a suitable container which relay and amplify detonating waves to insure the explosion of the main charge. It may be cast within the explosive charge adjacent to the fuze seat liner or they may be issued separately for installation in fuze seat liners. Some of the large general purpose bombs require two auxiliary boosters to complete the explosive train between the fuze and the main charge of the bomb. They are approximately 1.75 inches in diameter and 3 inches long.

(i) Primer-detonators. This component is an interchangeable unit (composed of a primer delay element and a detonator) which is designed to provide delay in the action of older models of tail fuzes. Primer-detonators of various delay times are available, with the exact delay time of each painted on the head.

(j) Bursters. This component consists of a long plastic, fiber, aluminum or paper tube closed at both ends and usually filled with an explosive. The burster is used to burst the bomb body and release the filler or used to open bomb clusters allowing the contents to fall free.

(2) Complete round functioning. The bomb is carried either internally or externally on single or multiple racks, whichever is applicable to the particular aircraft. Hooks engage the suspension lugs welded to the bomb body. The arming wire replaces the safety wire which was initially installed through the arming vanes of the fuze. The arming wire is prevented from slipping back through the arming vane assembly by installing a Fahnestock clip on the protruding end of the arming wire providing safety prior to bomb release. If a bomb must be released over friendly territory the swivel ring or loop is released with the bomb and the arming wire stays in place as the bomb falls, thus preventing the fuze from arming. When the bomb is to be released armed, the arming wire and swivel is retained in the aircraft. As the bomb drops, the arming wire is withdrawn or pulled from the arming vane allowing the fuze to arm. The armed fuze then will cause the bomb to detonate on impact or at the appropriate time to fulfill the mission requirements.

3. TYPES, CHARACTERISTICS, AND CONSTRUCTION OF REPRESENTATIVE BOMBS.

a. Semi-armor-piercing (SAP), 1000 pound, AN-M59A1 (figure 7-5). These bombs, thick walled and normally tail fuzed are used to penetrate armor and hard targets. A solid metal nose plug is replaced with a nose fuze when penetration is not required. Approximately 30 percent of weight of the bomb is explosive filler which is amatol, picratol or TNT. This bomb is assembled with a box-type fin. Bombs loaded with amatol and picratol include an auxiliary booster.

b. General purpose (GP) bombs are divided into three distinct types: old series GP bombs (figures 7-6 and 7-7) which range in weight from 100 to 2000 pounds; the streamlined new series GP bombs (figure 7-8) which range in weight from 750 to 3000 pounds, and the low-drag GP bombs (figures 7-9 and 7-10) which range in weight from 250 to 2000 pounds. GP bombs will produce blast, fragmentation and deep-mining effects. Their functions are determined by the action of the fuzes with which they are armed.

(1) GP bombs, old series, 1000 pound, AN-M65A1. This bomb (figure 7-11) is relatively thin cased with an ogival nose, parallel side walls and a tapered aft section. Both nose and tail fuzes are used for a majority of operations. This bomb can be assembled with either the box-type or conical-type fin assembly. Approximately 50 percent of the total weight of the bomb is its

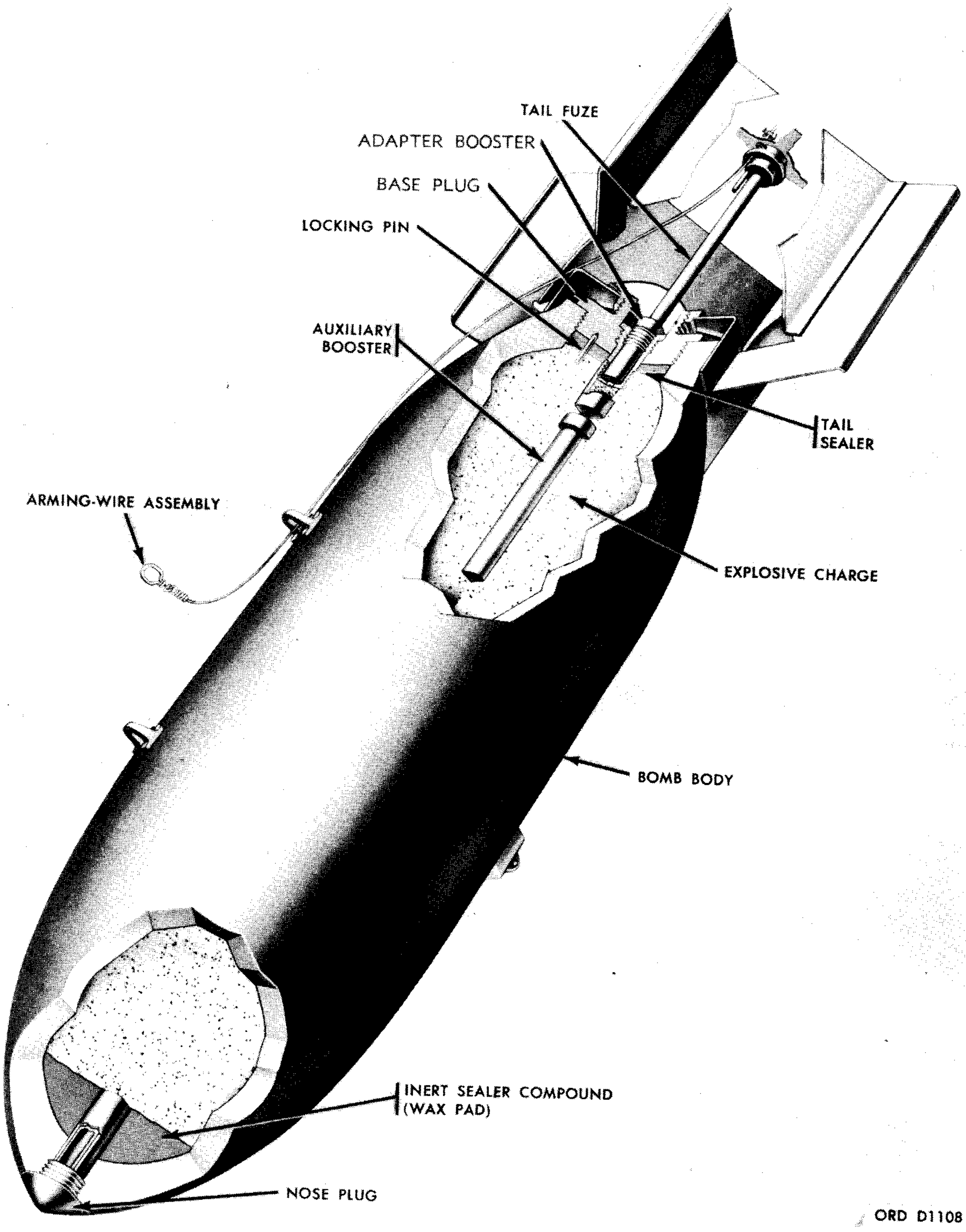


Figure 7-5. Bomb, semi-armor-piercing: 1,000-lb, AN-M59A1, cutaway view.

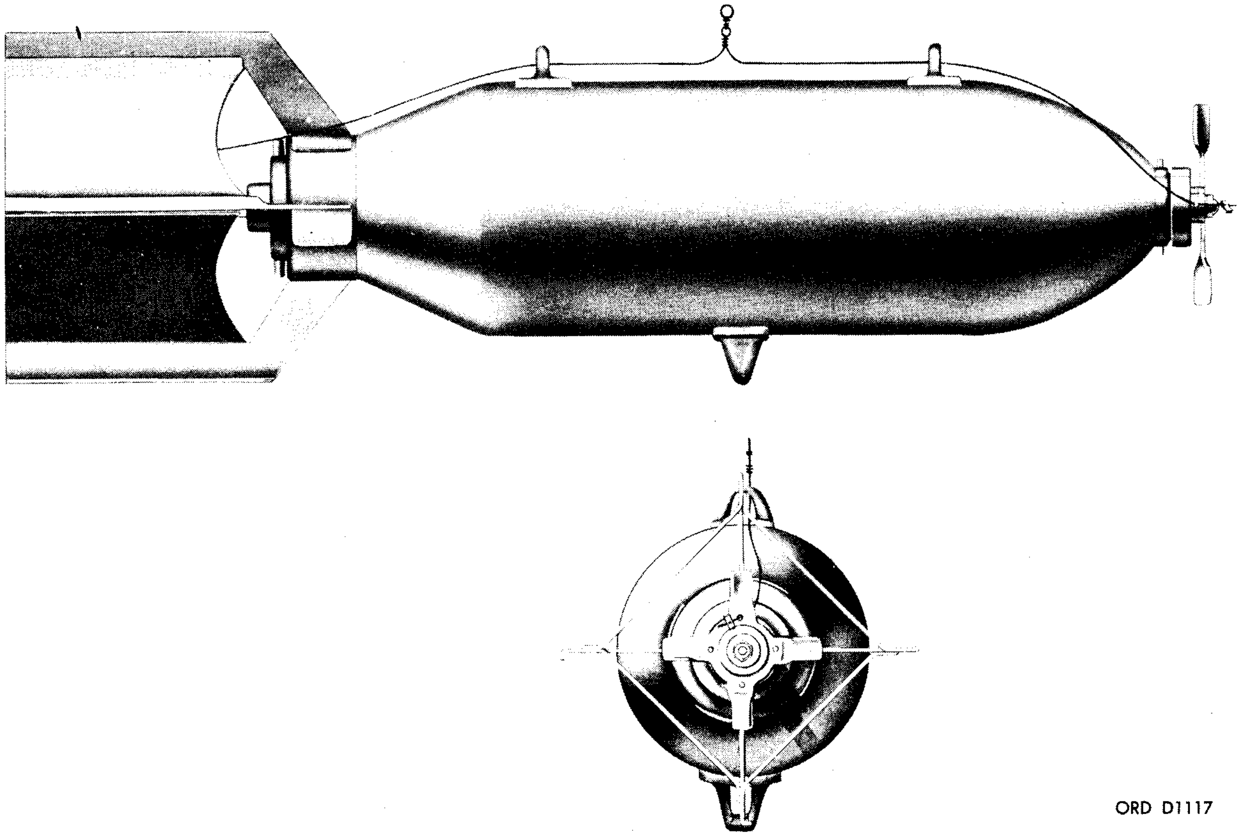


Figure 7-6. Old-series GP bomb with box fin assembly.

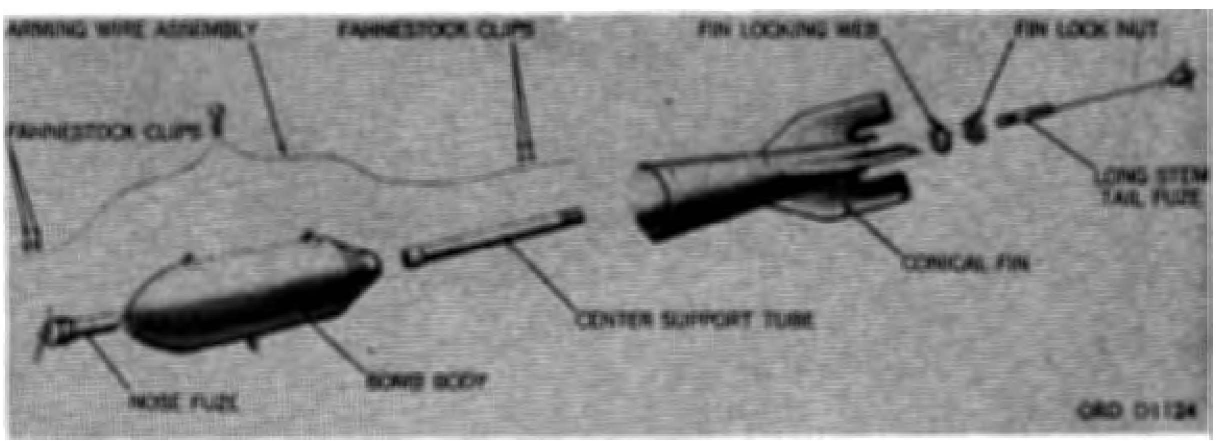


Figure 7-7. Old-series GP bomb with conical fin assembly, exploded view.

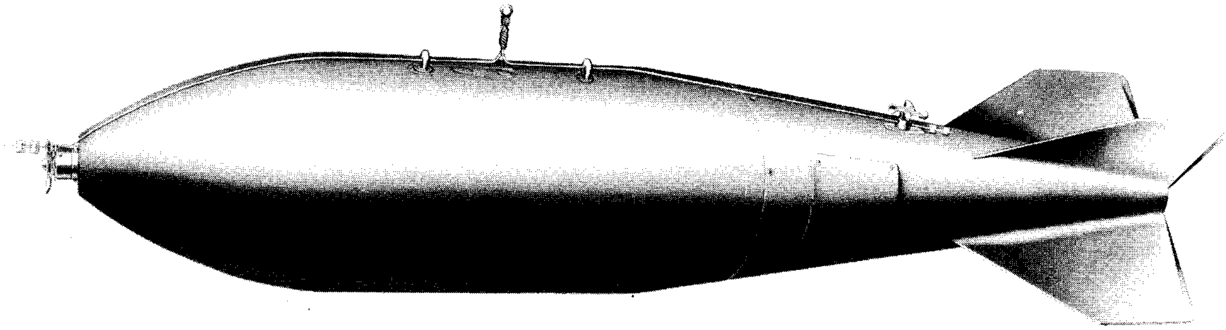


Figure 7-8. New-series GP bomb, typical.

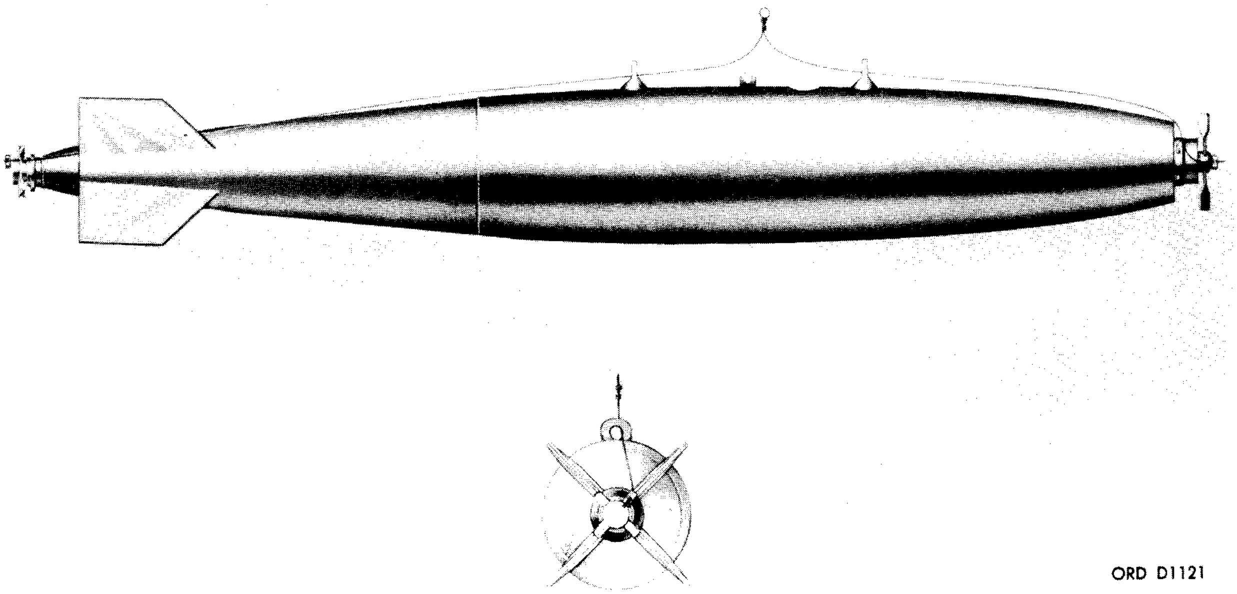


Figure 7-9. Low-drag GP bomb, typical.

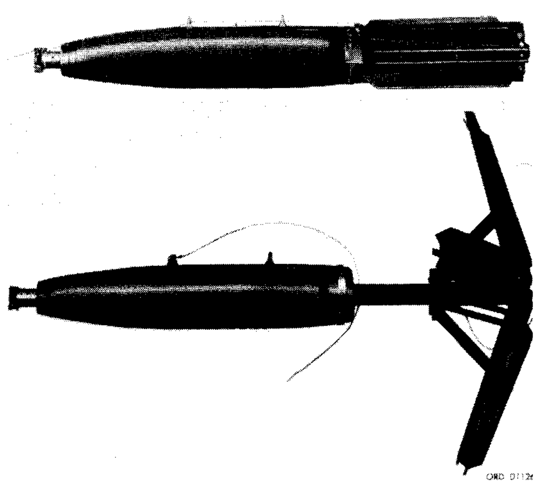


Figure 7-10. Low-drag GP Snakeye I-series bomb.

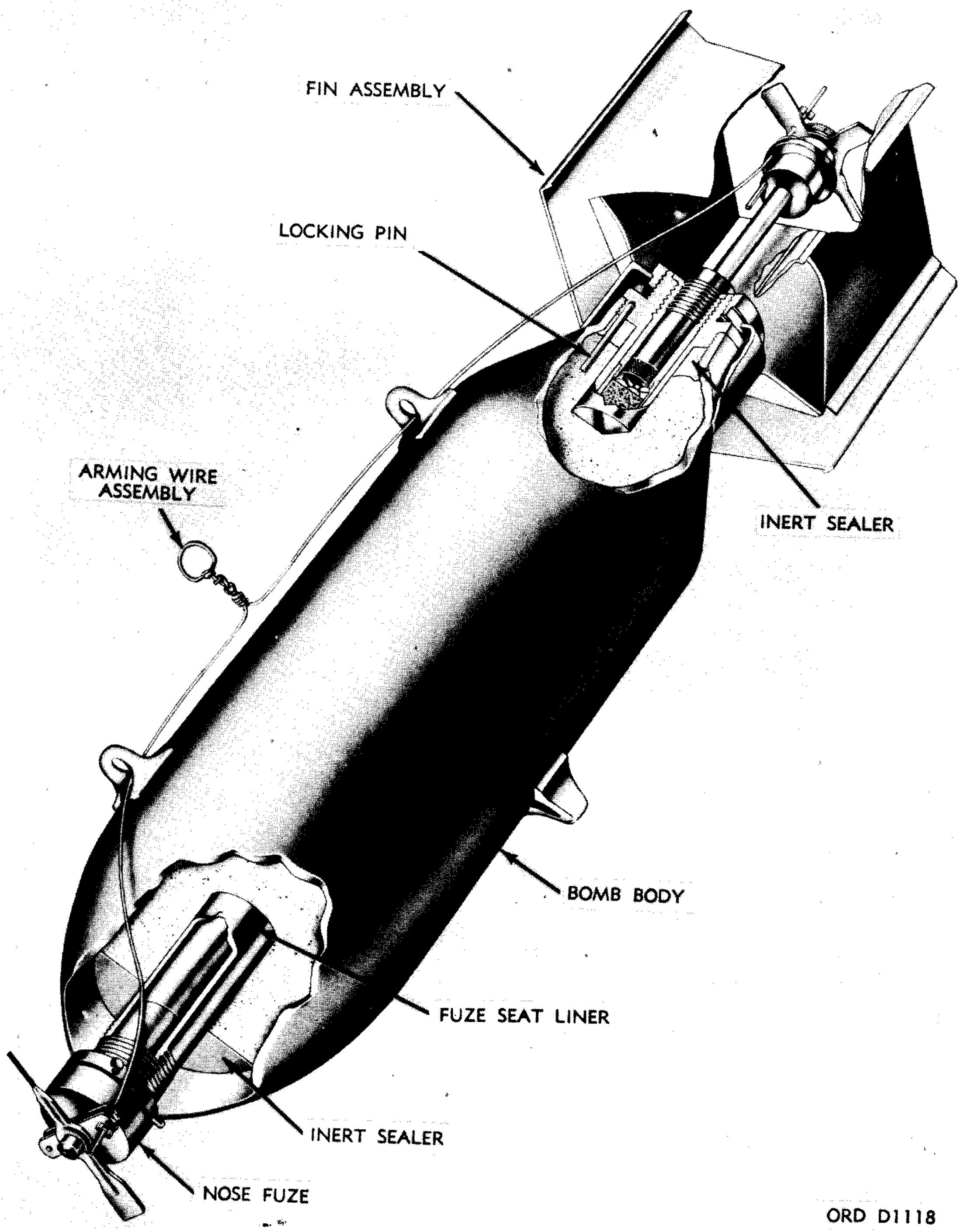


Figure 7-11. Old series GP bomb, cutaway view.

explosive filler of amatol 50-50, TNT, tritonal, or composition B. Loaded with tritonal, the assembled bomb weighs 1205.21 pounds.

(2) GP bomb, new series, 750 pound, M117. This bomb (figure 7-12) is designed for improved aerodynamic performance and accuracy in flight when released from most altitudes and air speeds. It has a cigar-shaped body, a conical fin assembly bolted to the rear, and is designed for either mechanical or electrical 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 well receptacle located between the suspension lugs. The new series have an adapter-booster capable of receiving tail fuzes with a 2 inch thread and may be assembled with a fuze adapter to accommodate fuzes with a 1½ inch thread. This bomb has a 14 inch span between lugs and a total assembled weight of 823 pounds. This bomb is loaded with tritonal.

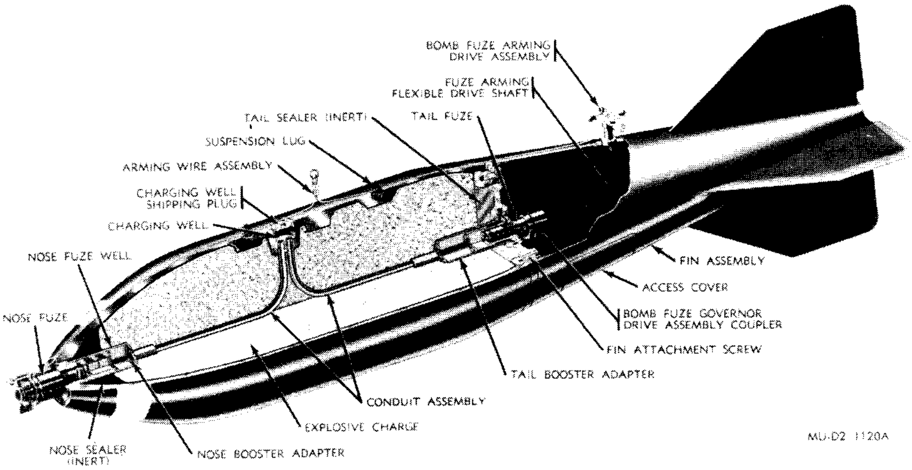


Figure 7-12. New-series general purpose bomb, cutaway view

(3) GP bomb, low drag, 500 pound, Mk82 Mod 1. This bomb (figure 7-13) has a long slender body, with a streamlined fin. It uses proximity (VT), mechanical, or electrical fuzes. When electric fuzes are not used a plug is threaded into the charging receptacle cavity. A hoisting lug is threaded into a lug insert at the center of gravity. This bomb assembled and filled with tritonal or H6 weighs 531 pounds.

(4) GP bomb, low drag, 250 pound, Mk81 Mod 1, Snakeye I. This bomb (figure 7-10) is characterized by a flight-retarding tail fin assembly attached by a quick attachment mechanism. The retarding fin provides the aircraft with a high-speed, low-altitude bombing capability. It 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 decelerates the bomb so that it impacts the ground at greater angles. Weight of assembled bomb is 300 pounds.

c. Fragmentation (FRAG) bombs, with the exception of the 4 pound M83 frag bomb body, consist of a thin tubular steel sleeve. A body of heavy steel bar stock, spirally wound, is assembled to the outside of the steel sleeve and provides a principal source of fragments when the bomb is detonated. Frag bombs, which weigh 220 pounds or more, are effective against materiel targets and are threaded to receive both nose and tail fuzes. Direct hits or near misses are required for this type of bomb to damage resistant targets.

(1) Frag bomb, 4 pound, M83. This bomb (figure 7-14) is a small barrel-shaped bomb. The fuze is assembled at the time of manufacture and is mounted in the center of the bomb case. Two

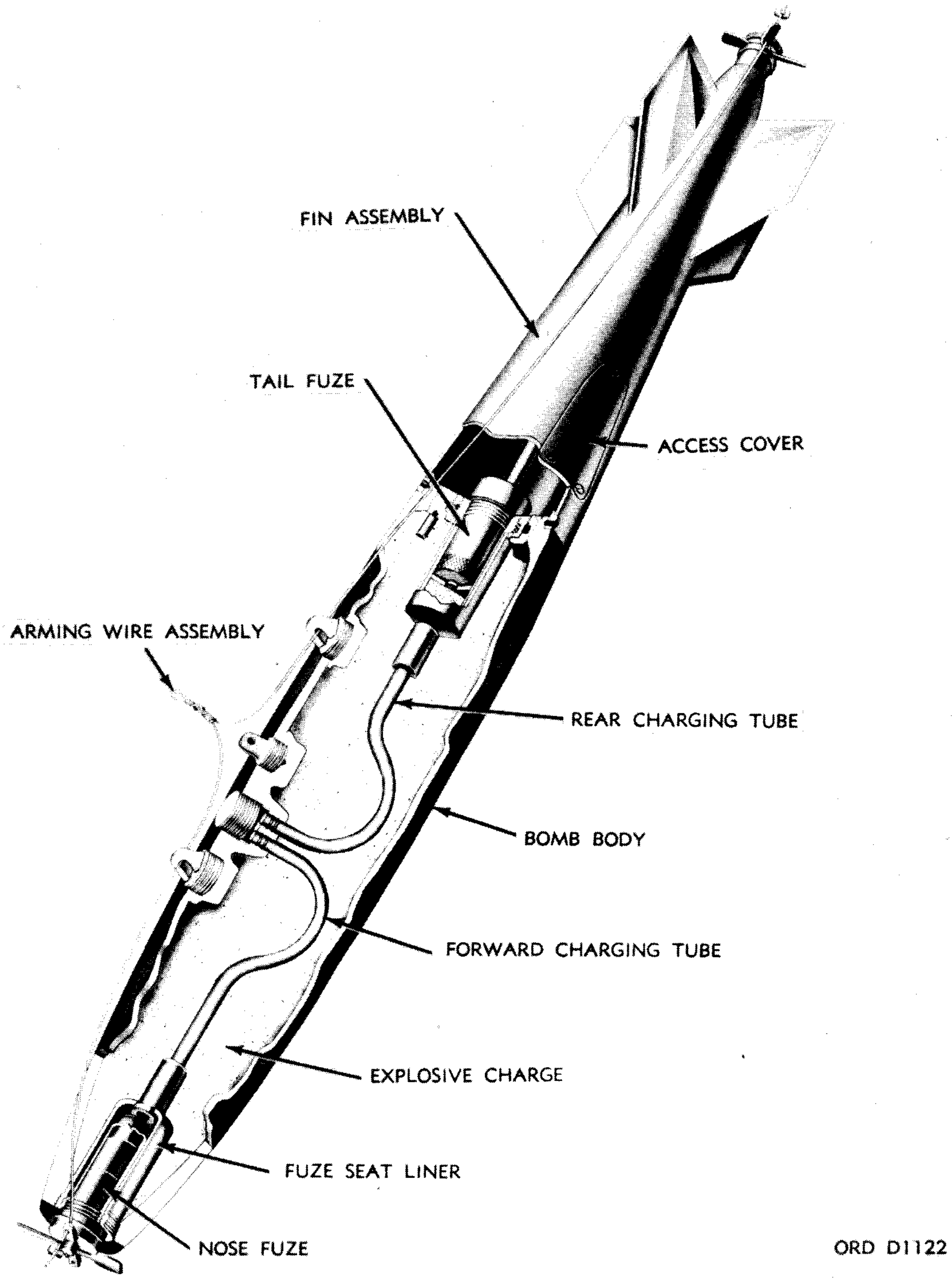


Figure 7-13. Low-drag general purpose bomb, cutaway view.

semicylindrical surfaces (butterfly wings) and two discs (propeller blades) are spring-hinged together independent of the bomb. When unarmed, these four pieces are folded about the bomb forming a cylindrical outer bomb casing. A cable extension projects from the fuze and acts as an arming shaft which rotates to arm the fuze. The M83 bombs are issued assembled in clusters. Impact, mechanical-time-delay and antidisturbance fuzes (para 2b(1)(c)5 b) with preselected setting action are selected in proportion when the cluster is assembled. Approximately 12 percent of the weight of the bomb is explosive filler consisting of composition B, ednatol or TNT.

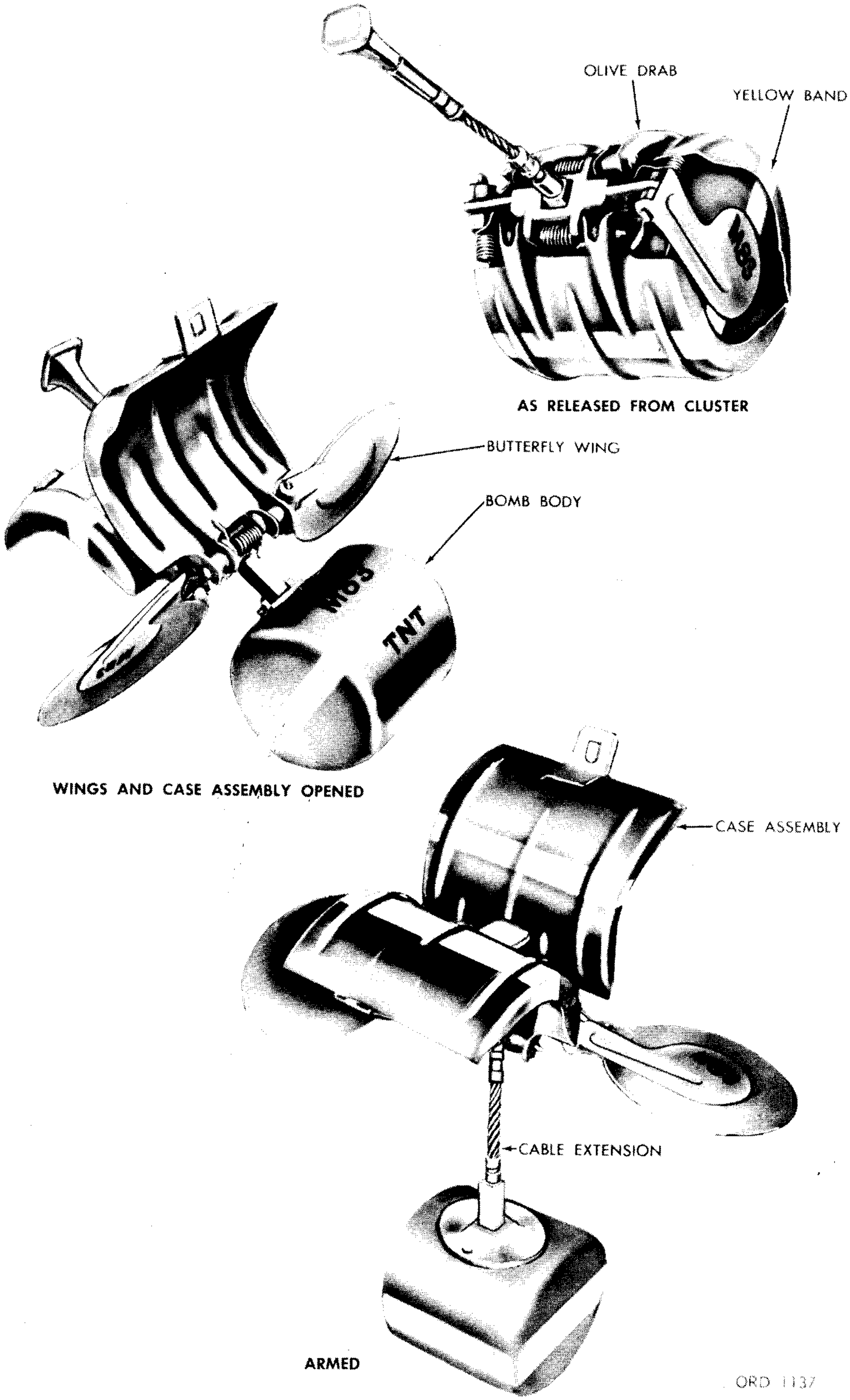


Figure 7-14. Bomb, fragmentation: 4-pound, M83, steps in operation.

(2) Frag bomb, M88 (220 pound); and M81 (260 pound). These bombs, (figure 7-15) are typical frag bombs. The M88 has a body constructed of spirally-wound 13/16 inch square steel wire over a seamless steel tube which forms the base for the spiral wrapping. The M81 is constructed of 1 inch square steel wire and contains 5 pounds less explosive than the M88 which is a modification of the M81. The M88 contains 19 percent of explosive by weight and the M81 contains 13 percent. Both bombs can be assembled with box or conical type fins and will accommodate both nose and tail fuzes.

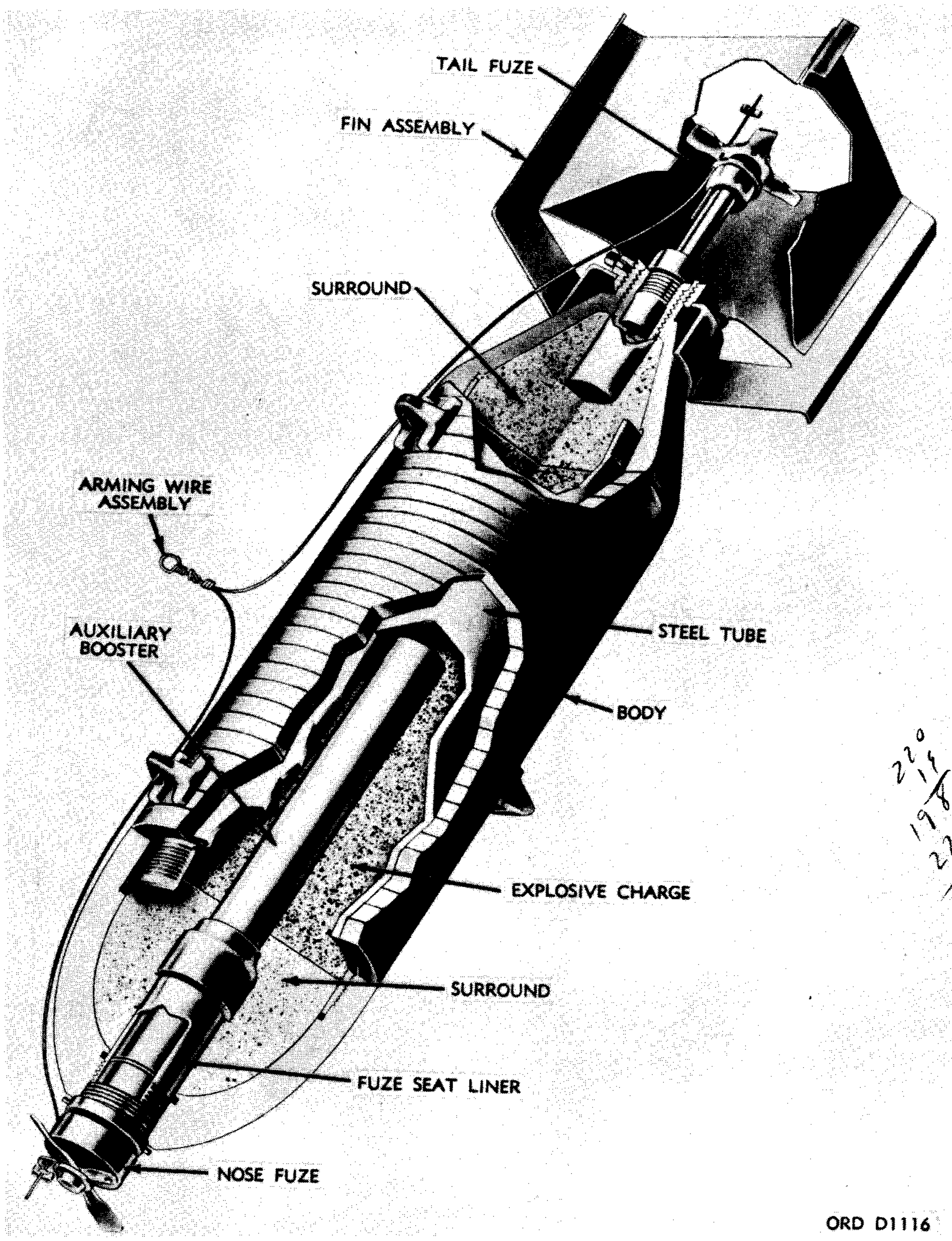


Figure 7-15. Bomb, fragmentation: typical AN-M88 and AN-M81 series, cutaway view

d. Incendiary bombs. These bombs are designed for use against combustible targets and are filled with 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 and containing a thermate filler which, when ignited, also burns the bomb body.

(1) Incendiary bomb, 100 pound, AN-M47A4. This bomb (figure 7-16) is made of sheet steel. A burster well, which is a metal tube closed at one end, extends the full length of the bomb. The bomb is threaded at the nose end to receive the fuze. The filling consists of approximately 40 pounds of napalm (NP) and the AN-M12 burster is filled with black powder and magnesium.

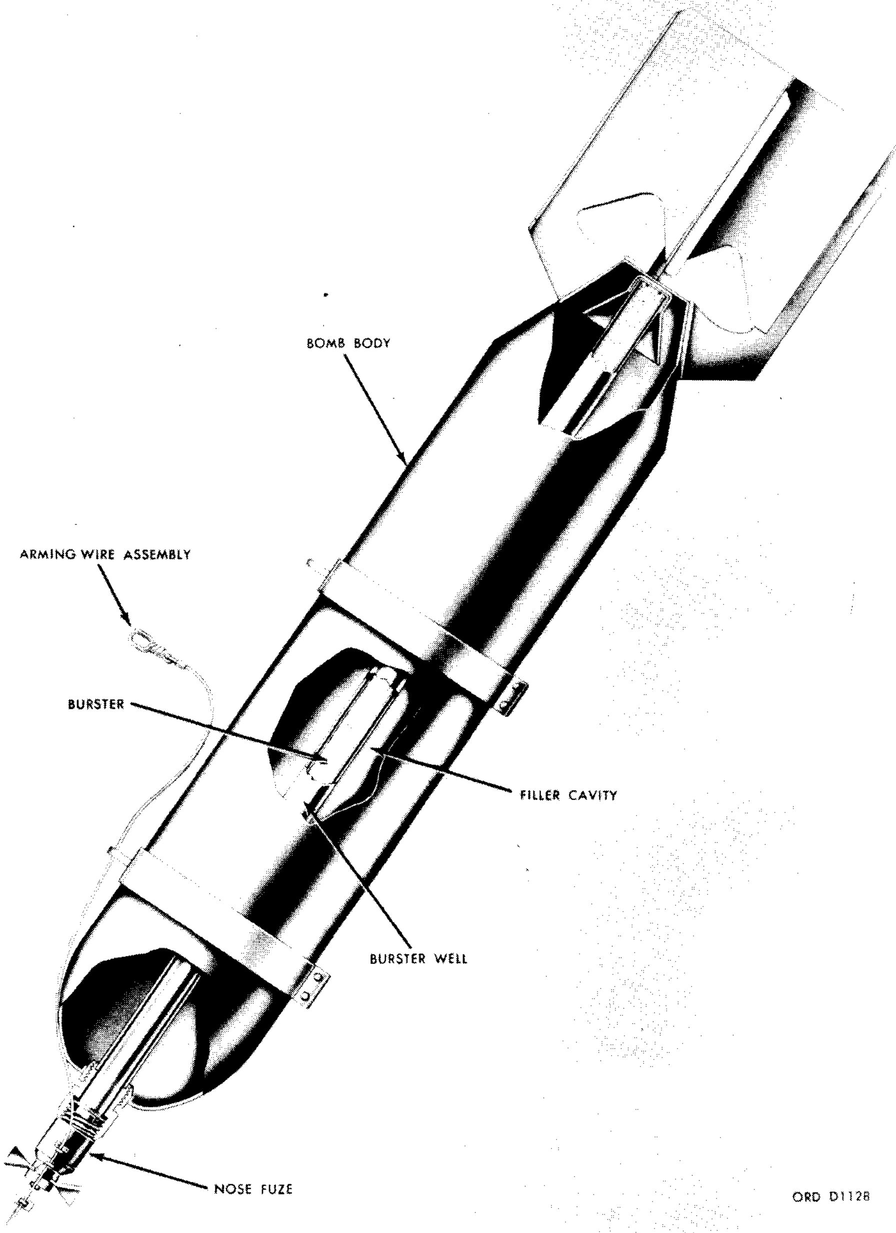


Figure 7-16. Bomb, incendiary: 100-pound, AN-M47A4, cutaway.

(2) Incendiary bomb, TH3, 4 pound AN-M 50A3. This bomb (figure 7-17) is used in an incendiary bomb cluster. The body of the bomb is hollow and made of magnesium alloy, which constitutes the main incendiary charge. The cavity of the bomb body is filled with a priming charge consisting of approximately 10 ounces of thermate, TH3, which is a mixture of TH1 (powdered aluminum and iron oxide), barium nitrate, and sulfur in an oil binder. It is a standard metallic filling used in incendiary bombs. The end of the body is closed with a solid, iron nose so that it falls nose downward and penetrates the target without crumpling on impact. This end of the bomb contains an inertial-type fuze which functions upon impact igniting the thermate filler. The burning thermate **ignites the magnesium section of the body which burns with high intensity for 5 to 8 minutes.**

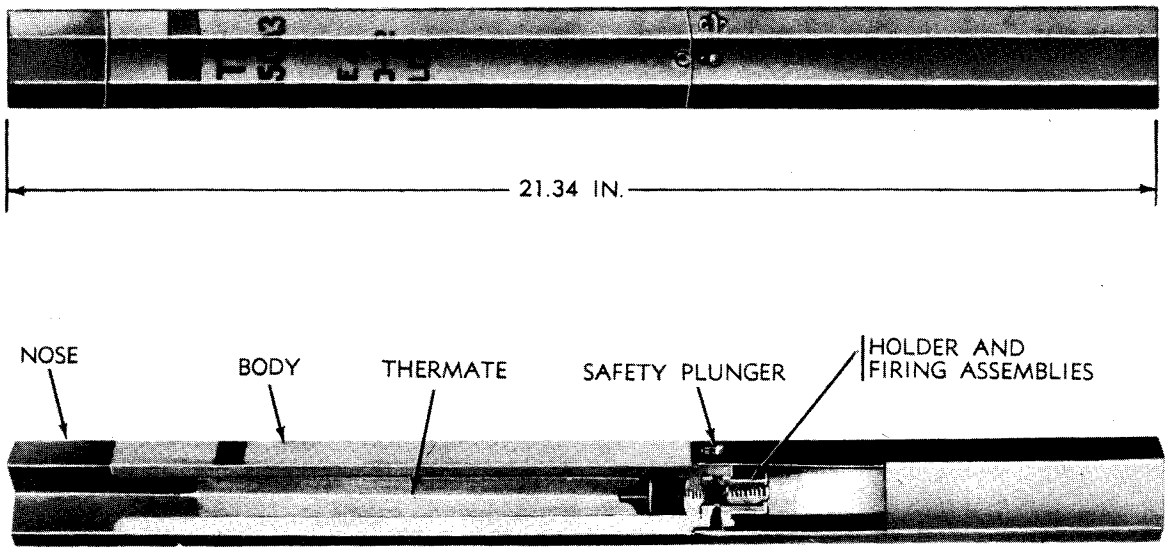


Figure 7-17. Bomb, incendiary: TH3, 4-pound, AN-M50A3.

e. Fire bombs.

(1) These bombs are usually thin-skinned containers of thickened fuel (gasoline gel) designed for use against dug-in troops, supply installations, wooden structures and materiel in tactical situations.

(2) Fire bomb, 750 pound, Mk77 Mod O. This bomb (figure 7-18) is a nonstabilized, cigar-shaped bomb constructed of aluminum and consists of three main and two end sections held together with a center tie rod. A 110 gallon mixture of gasoline and napalm fills the bomb body. Gaskets between the sections prevent leakage of the gasoline gel. The bomb uses two igniter and fuze combinations to ignite the gel upon impact. Metal tubes carry the arming and cone wires from the outside to the inside of the bomb. When the bomb is released from the aircraft, the arming and cone release wires are withdrawn causing the nose cap and the tail cone to be ejected by their respective springs. This exposes the nose and tail fuze arming vanes to the airstream, permitting them to arm. The force of impact initiates the fuze, bursts the bomb, and causes the thickened fuel to splatter and burn over the target area.

f. Smoke bomb, PWP or WP, 100 pound. AN-M47A4. These bombs have a threefold purpose. They are used for screening the movement of troops and ships in combat areas and for antipersonnel effect on troops in the open or in dug in positions and for marking targets. They also

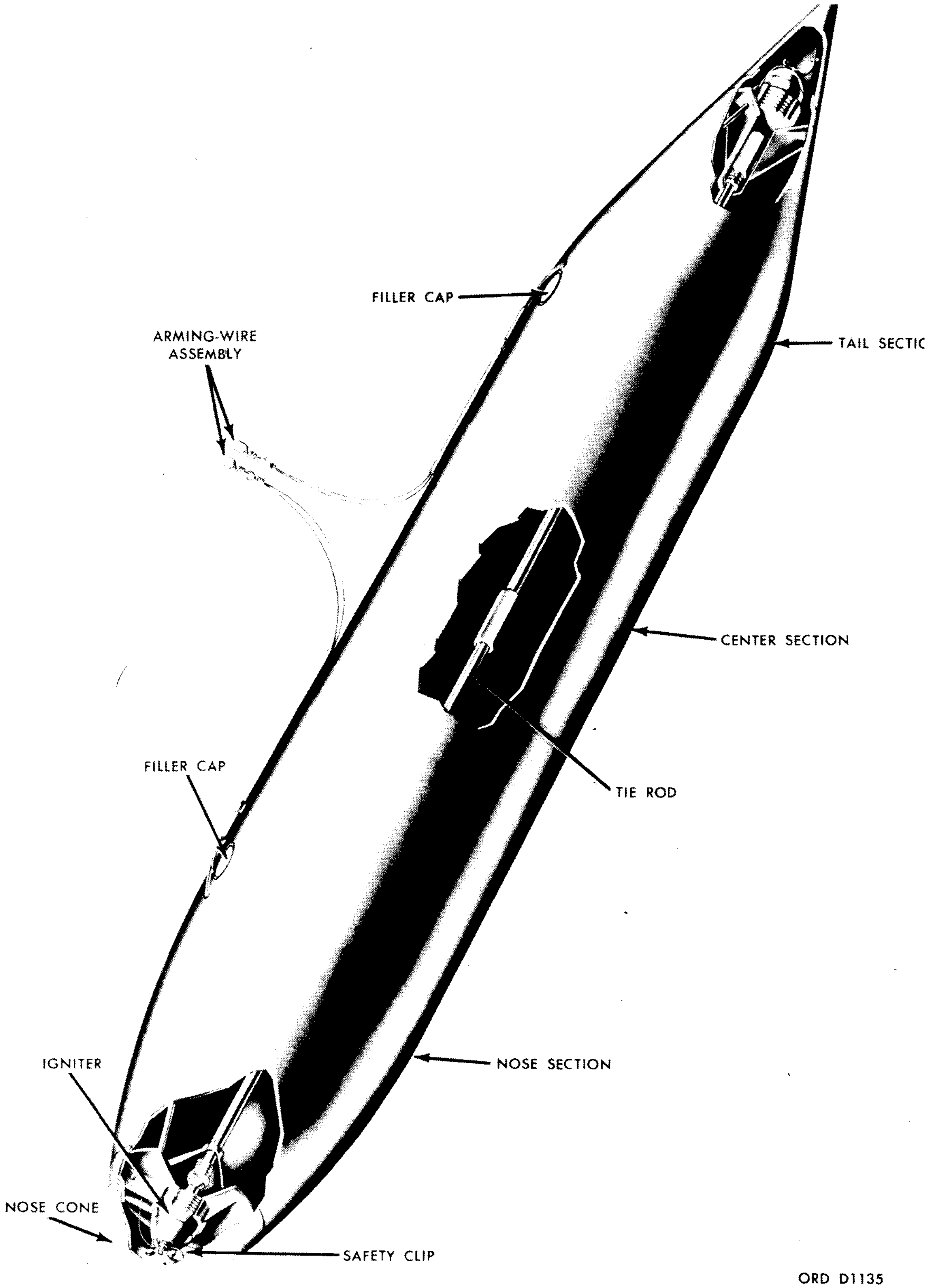


Figure 7-18. Bomb, fire: 750-pound, MK77 Mod O, cutaway view.

have an incendiary effect in that they will set fire to materials which are easily ignited such as clothing, dry brush, canvas, etc. The bomb bodies are filled with plasticized white phophorus (PWP) or white phosphorus (WP) which ignites spontaneously upon contact with air. This bomb (figure 7-19) is made of sheet steel. A burster well, which is a metal tube closed at one end, extends the full length of the bomb. It is installed in the bomb during manufacture. The bomb is filled with either 74 pounds of PWP or 100 pounds of WP. The bomb is fuzed with a vane operated, delay armed impact type. Functioning of the fuze and burster ruptures the bomb and disperses burning particles over a wide area.

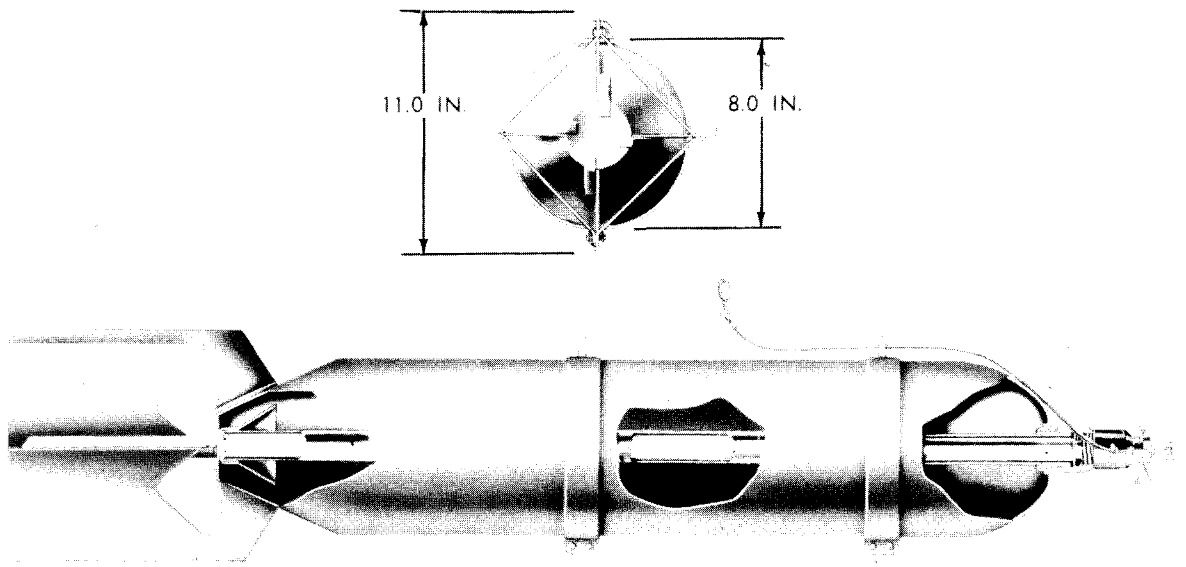


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Figure 7-19. Bomb, Smoke: PWP or WP, 100-pound, AN-M47A4.

g. Gas bomb, nonpersistent, GB, 750 pound, MC-1. This bomb (figures 7-20 and 7-21) is designed for internal or external carriage on bomber and fighter-bomber aircraft utilizing single or double lug suspension for release at altitudes up to 60,000 feet, and air speeds up to 600 knots. It may be released at low altitudes by fighter-bomber aircraft using low-altitude bombing systems. Gas bomb MC-1 is essentially a new-series, general-purpose bomb M117 modified to accommodate a liquid chemical filler and a burster. The bomb body is round in cross section. It has an ogival nose and truncated conical tail. A burster tube (15) is welded to the bomb body at the nose end and into a hole in a baseplate (10) which is welded to the tail end of the bomb body. The burster tube is internally threaded at each end and is fitted with fuze wells (11 and 16). The nose end of the

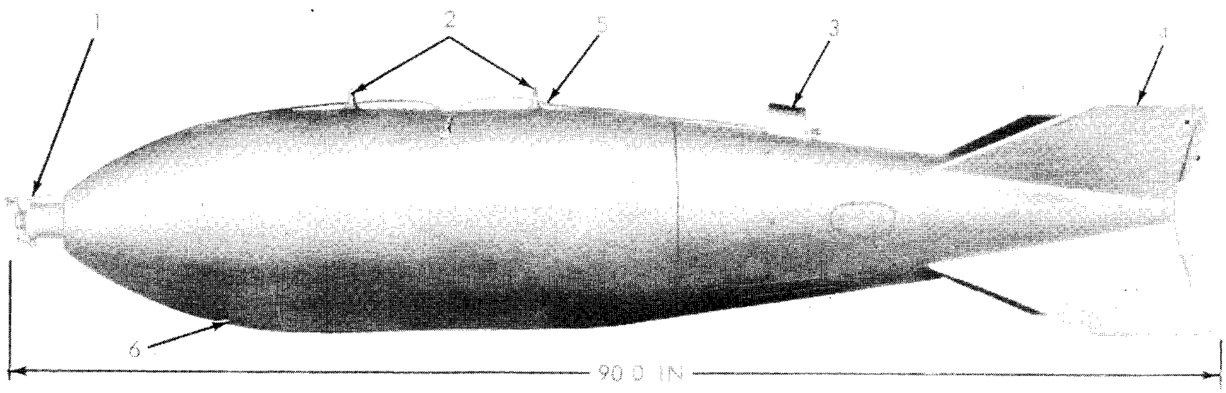


Figure 7-20. Bomb, gas: nonpersistent, GB, 750-pound, MC-1.

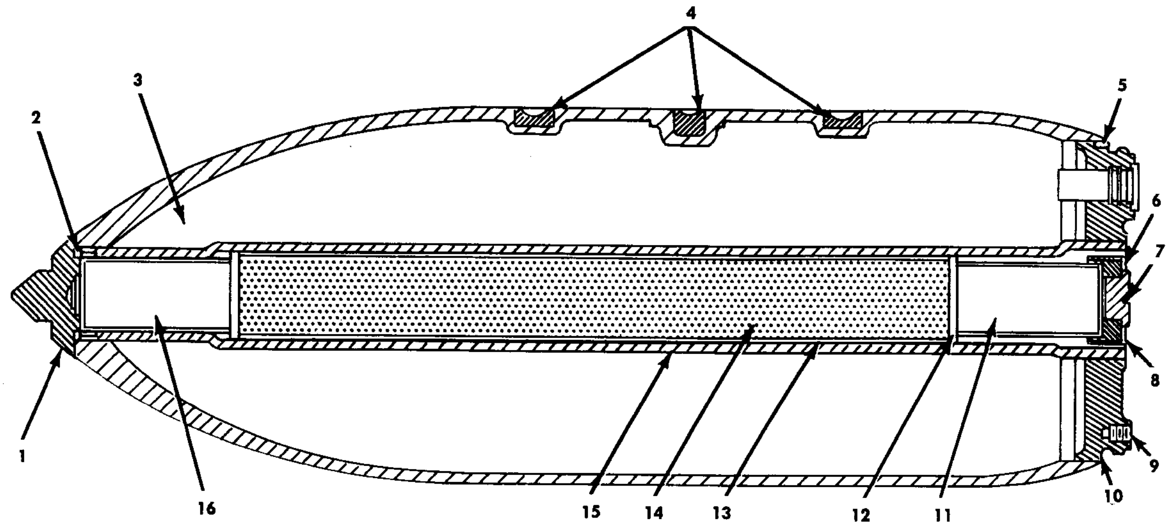


Figure 7-21. Bomb, gas: nonpersistent, GB, 750-pound, MC-1, cutaway view

burster tube is closed by a nose plug (1) which is fitted with a gasket (1), a retainer ring (8), a plug bushing (6), and a closing plug (7). These are used to close the tail end of the burster tube when the bomb is shipped. Three threaded suspension lug inserts (4) are welded into the bomb body. The suspension lug inserts are closed by shipping plugs during shipment. The rim of the baseplate is grooved to retain eight socket-head screws which hold the fin assembly to the bomb body. Two alignment pins (5) spaced 180°apart on the rim of the baseplate, fit into holes in the fin assembly. Four threaded holes (9) in the baseplate are used for bolting a shipping guard over the tail of the bomb body during shipment. Gas bomb MC-1 is filled with 24 gallons (220-lb) of GB gas (3). The burster (13) is a tubular fiberboard container filled with 14½ pounds of composition B(14) and closed by metal end caps (12). It is installed in the burster tube when the complete round is assembled. The fuzes arm when the bomb is realeased from the aircraft. When the bomb impacts, the fuzes function and detonate the adapter-boosters which in turn detonate the burster. The burster ruptures the bomb body and disseminates the filler.

h. Practice bombs.

(1) These bombs, which are used for target practice, vary in type and weight to simulate the variety of service bombs. Some practice bombs may have a fuze and a spotting charge; others are completely inert. Some practice bombs are filled with sand or water in the field while others are fabricated to the desired weight.

(2) Practice bomb, 25 pound, Mk 76 Mod 2 (figure 7-22) has a tear-drop shaped, cast metal body which is centrally bored. The tail tube assembly fits into the end of the bore. The conical afterbody covers the tail-tube assembly and is threaded to the body. The two sections are staked together to prevent unscrewing. The fin assembly is welded to the tail tube. A firing-pin assembly and the signal are assembled into the bore of the body and secured in place by a safety (cotter) pin. On impact, the firing-pin assembly fires the signal, discharging smoke rearward through the central tube.

i. Miscellaneous bombs.

(1) Missile cluster adapter, Mk44 (figure 7-23) is an antipersonnel munition containing solid missiles and physically resembles a 500 pound GP bomb. The body has 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 bomb is filled with small, solid fin stabilized missiles contained in paper bags. 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 an arming van type mechanical-time fuze. 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.

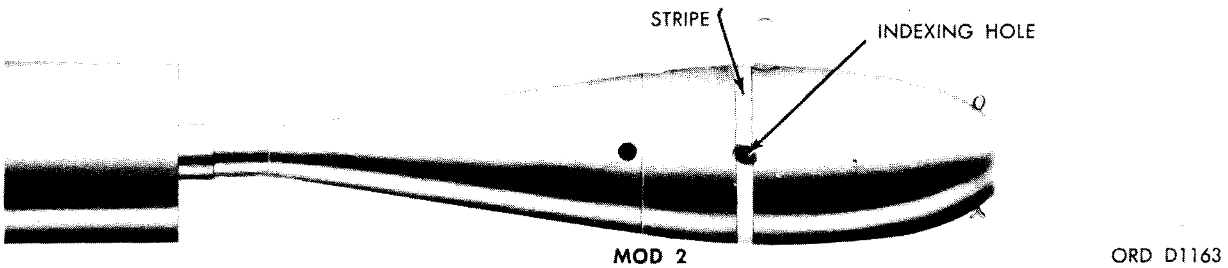


Figure 7-22. Bomb, practice: 25-pound MK76 Mod 2.

(2) Aircraft depth bomb (ADB) 300 pound, AN-Mk54 Mod 1 (figure 7-24) has a flat nose to reduce ricochet on impact and is generally used against underwater targets. The depth of detonation is determined by the setting of the hydrostatic (water pressure) tail fuze. It may also be nose fuzed for use against surface and land targets. Two suspension lugs are welded to the body 14 inches apart and a single suspension lug is located diametrically (180 degrees) opposite. Tapped holes are provided for attaching hoisting lugs which may be needed for handling the bomb. Approximately 70 percent of the weight of the bomb is high explosive filler consisting of HBX, HBX-l, or TNT. With both fuzes installed, the aircraft depth bomb may be selectively armed by releasing one of the arming wires with the bomb. Depth settings are made prior to flight.

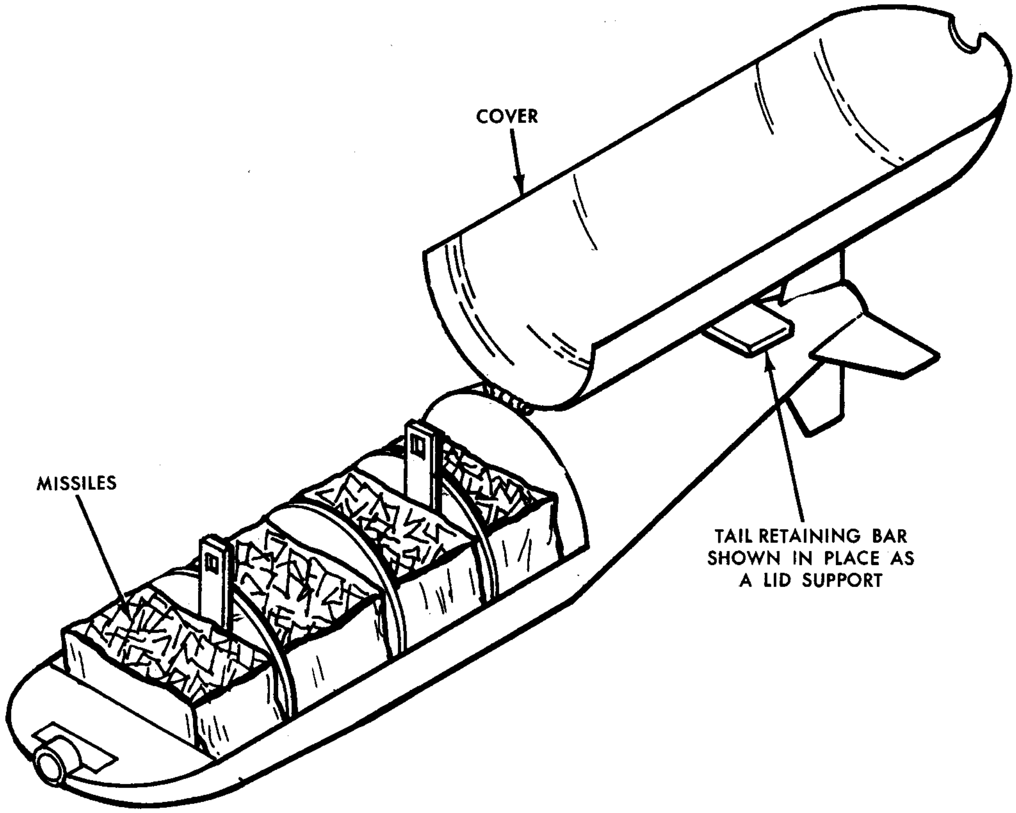


Figure 7-23. Adapter, cluster: missile, MK44, with lid turned back.

(3) Leaflet bomb, 750 pound, M129E1 (figure 7-25) is used to distribute literature and propaganda type material from an aircraft. They are issued empty and unfuzed and consist of fiberglass-reinforced material. They are split longitudinally into two sections which are held together by four latches on each side. The fuze well is located in the nose of the bomb. No provision is made for a tail fuze. The bomb is fuzed with a mechanical time fuze which causes the bomb to open before impact and disperse the leaflets.

(4) Photoflash bomb, 150 pound, M120A1 (figure 7-26) is thin walled, loaded with photoflash powder, and designed to burst in the air to produce a light of high intensity for night photography. This bomb develops approximately 4 billion candlepower. It is stabilized in flight by a box type tail fin. A trail plate and trail angle kit (figure 7-26) is used when a trajectory angle is desired other than that produced by the normal fin configuration. This bomb is fuzed with a mechanical time fuze and contains 82 pounds of photoflash powder.

j. Cluster bombs and cluster adapters. The cluster bombs and adapters described in this paragraph are of two general types, quick-opening and aimable:

(1) Quick-opening (frame) fragmentation bomb cluster and adapter. This type of cluster consists of a frame to which several bombs are attached by means of straps, forming an assembly which may be suspended and released as a unit. The straps are fastened with clamps which may be released by withdrawing the arming wire. The frame is also equipped with a fuze lock which prevents arming of the bomb fuzes until after they are released from the cluster. The 100 pound frag bomb cluster, AN-M1A2 (figure 7-27) consists of six 20 pound frag bombs AN-M41A1

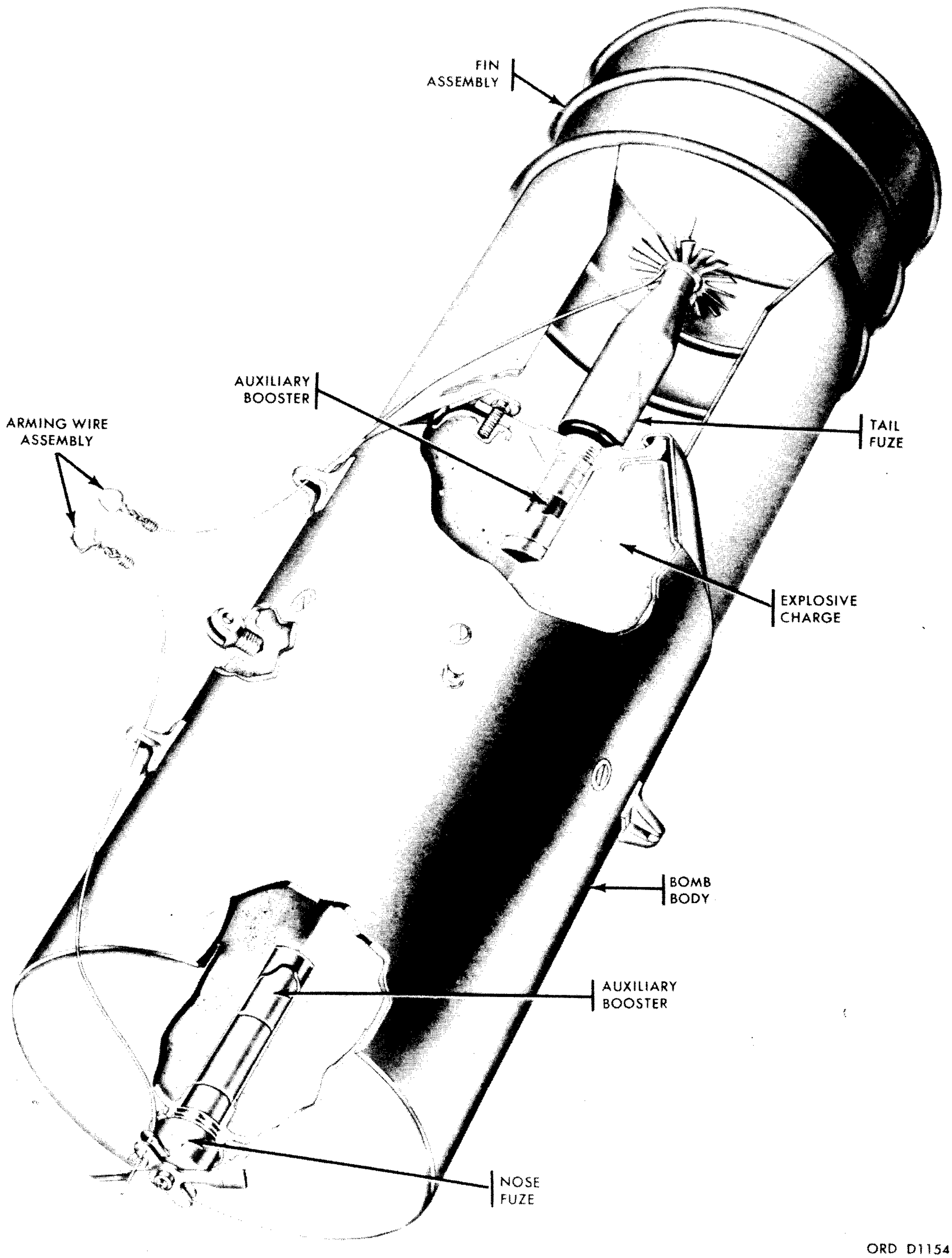


Figure 7-24. Bomb, depth: 300-pound AN-MK54 Mod 1, cutaway view.

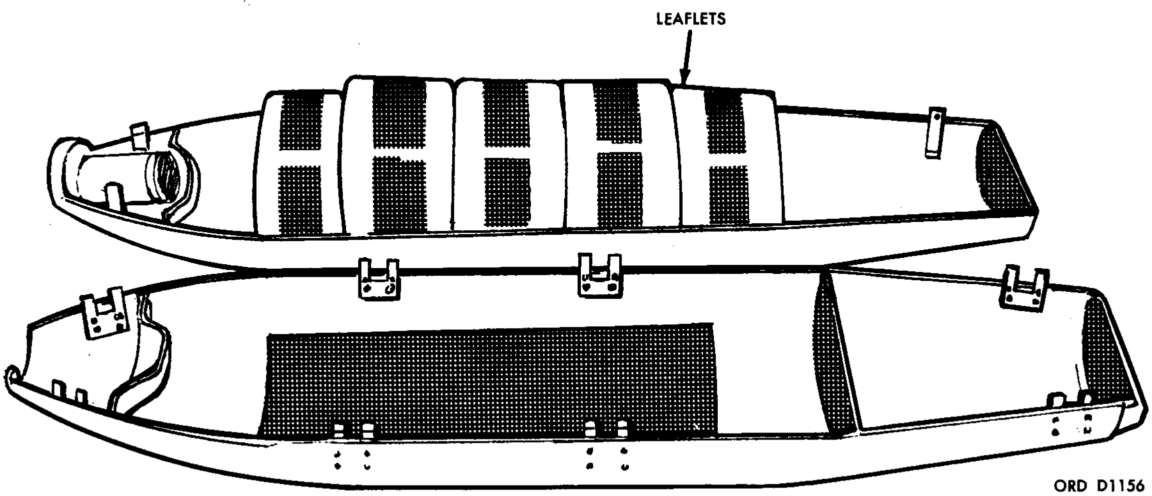
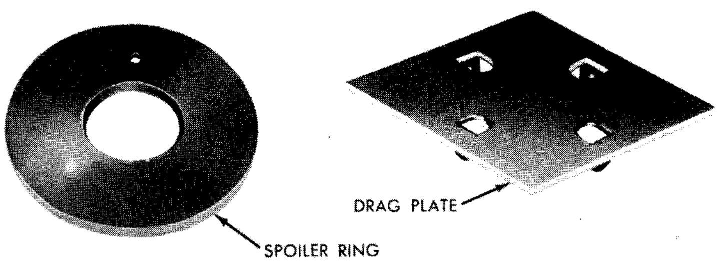


Figure 7-25. Bomb, leaflet: 750-pound, M129E1, w/lid removed.



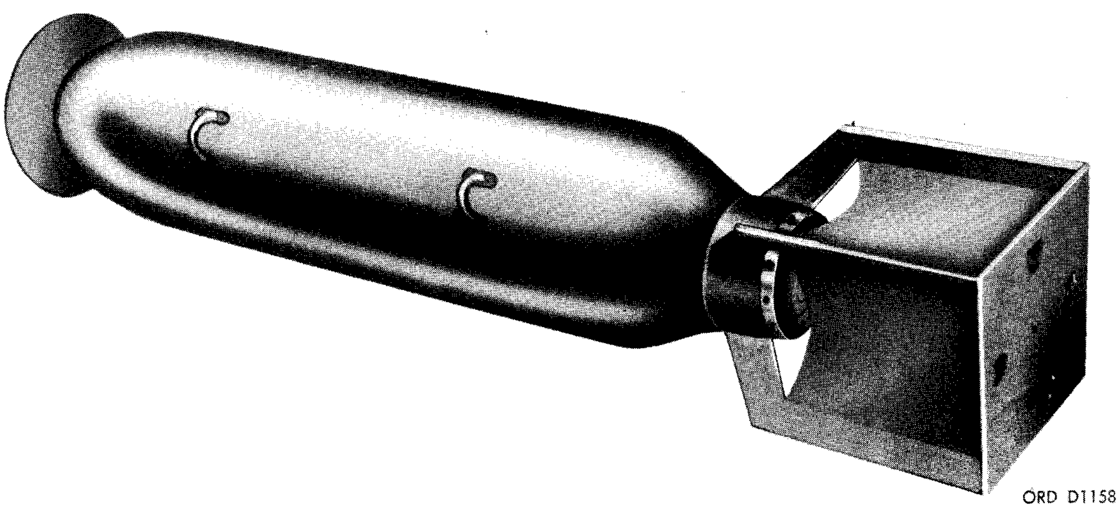


Figure 7-26. Typical photoflash bomb w/drag plate, spoiler ring, and trail plate.

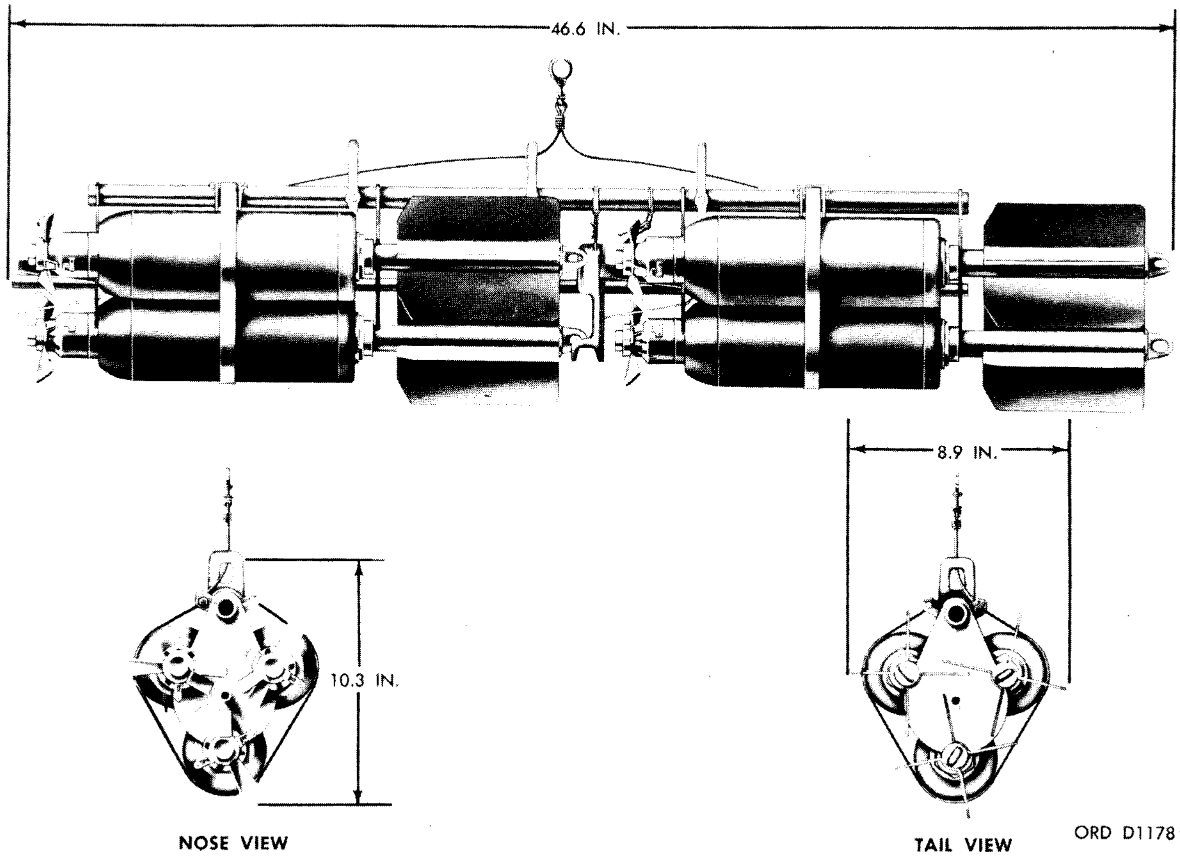


Figure 7-27. Cluster, fragmentation bomb: 100-pound, AN-M1A2.

assembled in cluster adapter AN-M1A3 (figure 7-28). This adapter is a "quick-opening frame," mechanical type holding two banks of three bombs each and releases them upon withdrawal of the arming wire. The bomb cluster is issued with individual bombs assembled but unfuzed; fuzing is accomplished before the cluster is installed in the aircraft. The bombs are held in place against the adapter by two metal straps and locked by strap clamps secured by the arming wire. When the cluster is released, the arming wire is pulled out, the strap clamp opens, and the bombs are freed from the adapter. Flat steel lugs, located on the upper tube provide for one or two point suspension. The fuze assembled to this bomb is vane operated, delay armed and detonates the bomb upon impact.

(2) Aimable fragmentation bomb cluster and adapter. This type of cluster consists of a streamlined metal body which holds the clustered bombs, a fin assembly or other such means of stabilization, and a time fuze to open the body and release the individual bombs at the time desired. The 750 pound M-35 cluster incendiary bomb, PT 1 (figures 7-29 and 7-30) consists of cluster adapter M30 filled with 57·M74A1 incendiary bombs and fitted with a burster, a fin assembly, two fuzes, and an arming wire. The cluster is approximately 90 inches long, 16 inches in diameter, and weighs approximately 690 pounds. The incendiary bombs are loaded into the cluster adapter in three bundles of 19 bombs each. The burster consists of 19 feet of detonating cord and is inserted in channels which parallel the sides of the adapter. The fin assembly consists of a fin blade assembly and a tie-rod assembly. The fin-blade assembly is made of sheet steel. It is in the shape of a truncated cone and has four fin blades welded to it. The tail of the assembly has a circular hole through which the tie-rod assembly is bolted. A sheet-steel cone welded to the front end of the fin blade assembly fits over the tail end of the cluster. The forward edge of the cone is marked with six

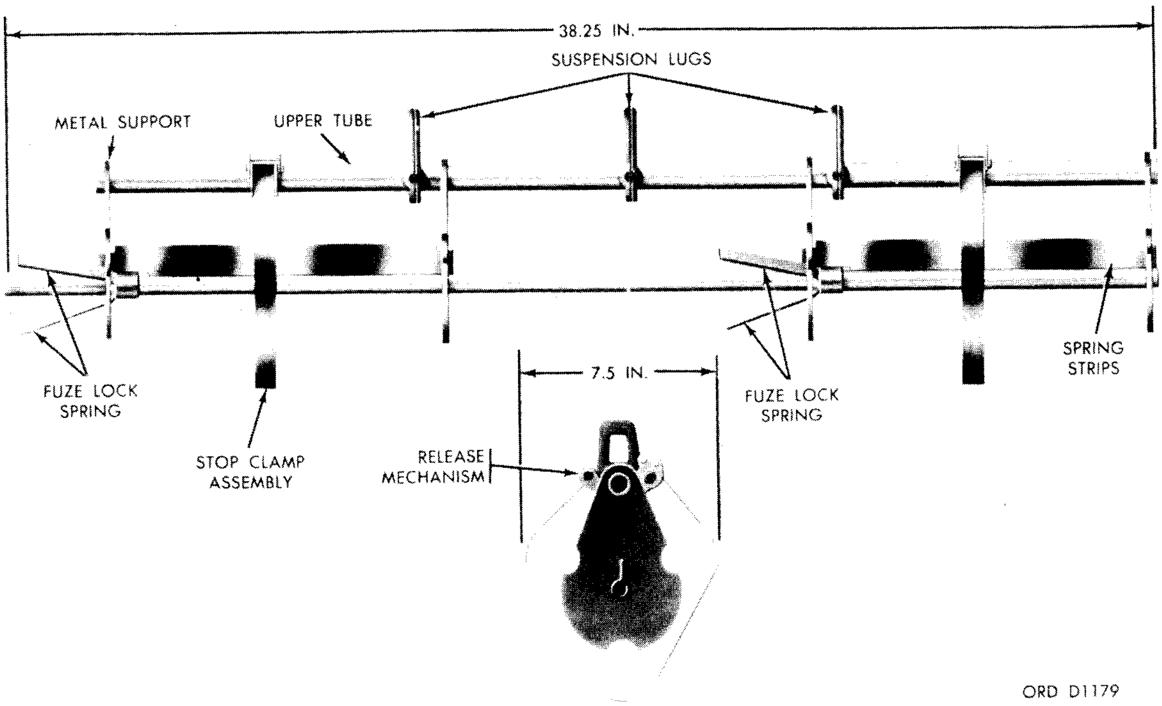


Figure 7-28. Adapter, cluster: AN-M1A3.

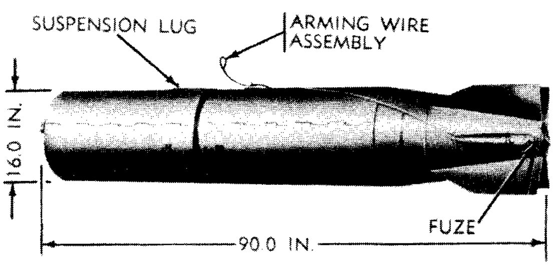


Figure 7-29. Cluster, incendiary bomb: PT1, 750-pound, M35.

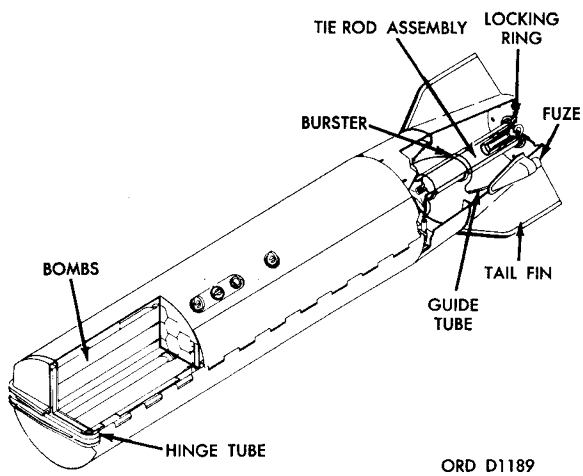


Figure 7-30. Cluster, incendiary bomb: PT1, 750-pound, M35, cutaway.

numbered stripes which are used as assembly marks when assembling the tail fin to a cluster. Two fuze holders in fairings are welded to the fin-blade assembly. Fuze adapters are installed in the fuze holders, and guide tubes lead from each fuze adapter to the interior of the tail fin. The tie rod assembly consists of a tubular steel body approximately 18 inches long and 3 inches in diameter, with threads at one end. The legs are fastened by spring steel connectors to the other end. The threaded end of the tie-rod has a locking ring screwed to it for use when fastening the fin-blade assembly in place. Two pairs of clips for the burster are welded to the outside of the body. A tie-rod foot, made of 7/16 inch steel tubing, is welded at right angles to the end of each leg. The feet are designed to engage the hooks at the tail end of the cluster adapter. A fuze receptacle for an electric fuze is located in the threaded end of the body, and a plug receptacle, covered by a plastic plug, is located at the opposite end. Two mechanical time tail bomb fuzes are installed in the tail fin. The fuzes are shipped separately from the cluster. When the cluster is released from an aircraft, the arming wire is withdrawn, the fuze arming vanes rotate in the airstream, and the fuzes arm. After the preset time has elapsed, one or both fuzes function and detonate the burster, which breaks the hinges holding the cluster together and breaks the feet and body of the tie-rod assembly. The cluster falls apart, allowing the bomblets to fall individually to the target.

4. BOMB FUZES.

a. Bomb fuze, nose, M904 series. These fuzes (figures 7-31 and 7-32) are designed for use with frag bombs; old-series, new-series, low-drag GP bombs; and chemical bombs. They provide a wider range of selective arming, and impact firing delays than older fuzes.

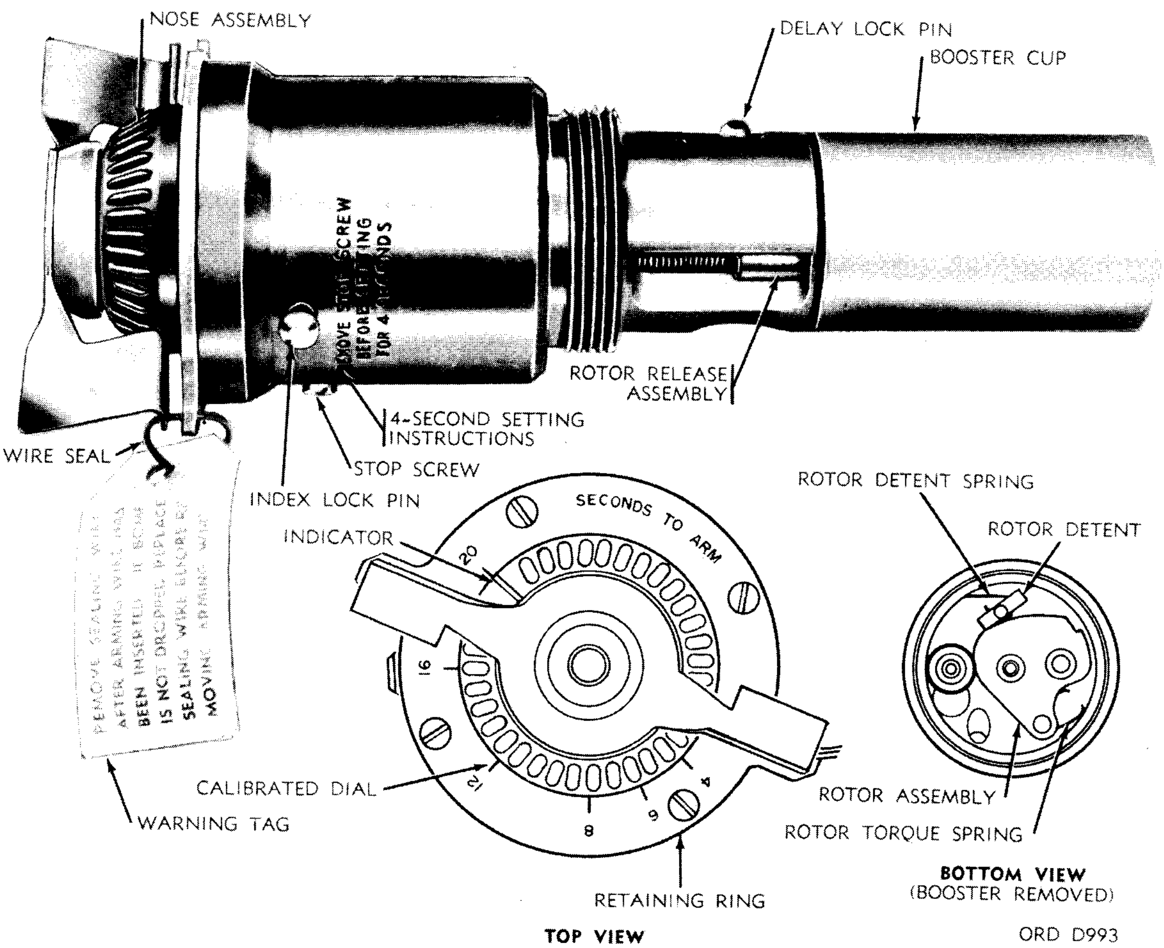


Figure 7-31. Nose fuze M904 series.

(1) Nose assembly. This assembly contains the following: housing and vane assembly, gear train and governor assembly, index ring, and arming stop. The vane assembly is secured to a spindle and drum assembly, thereby allowing the two assemblies to turn as one unit. The nose flange, when secured to the upper portion of the fuze body, holds the knurled nose assembly in place in the fuze body. An indicator on the nose assembly is used in conjunction with a calibrated dial stamped on

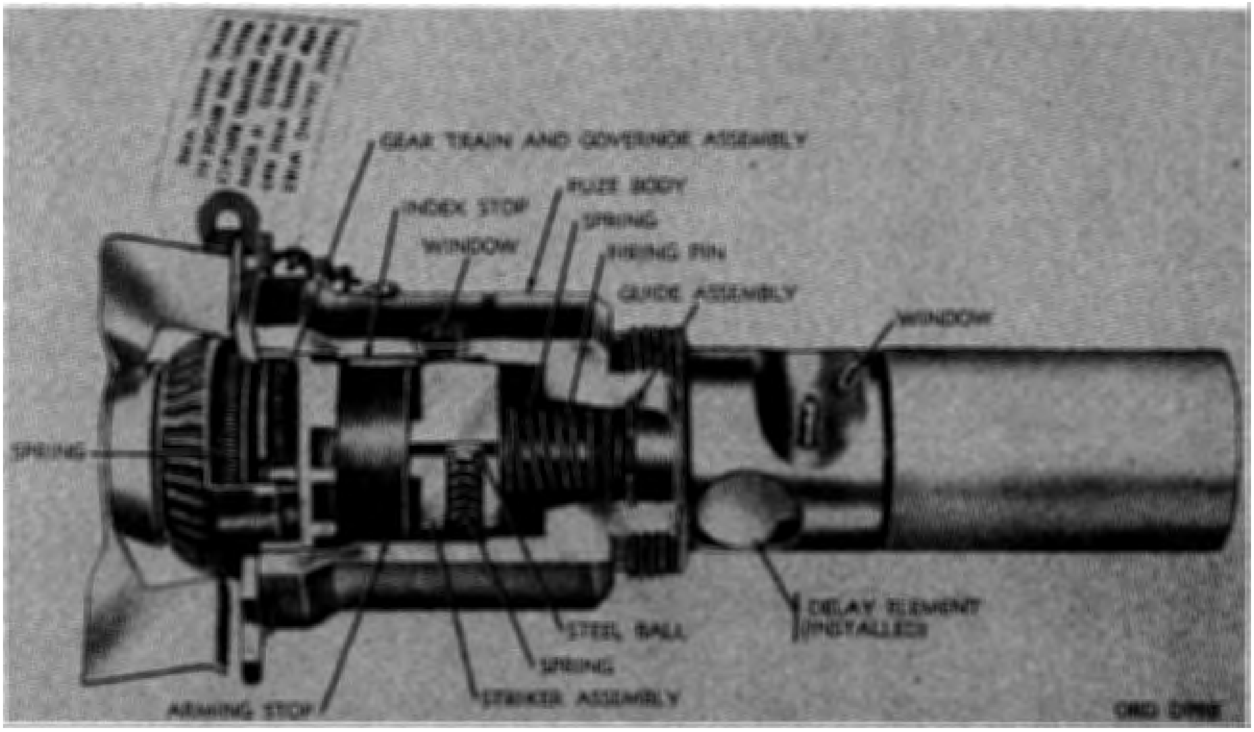


Figure 7-32. Fuze M904 series-cross section.

the flange for selecting arming delay time for the fuze. The vane is prevented from rotating by the wire seal until the fuze is prepared for use. The gear train and governor assembly, mechanically connected to the governor drum, is secured to the gear train which, in turn, is attached to the arming stop. The two drive pins of the arming stop are mechanically connected to the striker body assembly.

(2) Fuze body assembly. This assembly contains the following major components: index lock pin, stop screw, index stop, striker assembly, striker pin and guide assembly, rotor release assembly, delay lock pin relay XM9, rotor assembly containing detonator M35, and the fuze body. When the indicator is rotated, to a new arming delay mark or time, the index lock pin must be pushed inward in order to release the index ring. For fuzes M904E1 or E2, the stop screw must be removed to select an arming delay time of less than six seconds. The striker assembly, containing a steel ball, spring, and firing pin guide, is held in place by the index stop, which is secured to the fuze body. The firing pin assembly is fastened to the guide assembly with a shear pin. The guide assembly is held in place in the fuze body with a retaining ring. Relay element XM9 is located in the lower portion of the fuze body. Delay element M9, when installed in the cutout in the fuze body, is held in place by a spring and a lock pin. The lower portion of the rotor release assembly holds the rotor assembly (containing detonator M35) in an out-of-line position with other explosive train elements. The window in the middle of the fuze body is used to view the white stripes on the striker body; full red color indicates that the fuze is armed. The window in the lower portion of the fuze body is used for viewing the upper edge of the rotor assembly; full red indicates that the rotor assembly has been released and detonator M35 is in line with the other explosive train elements. The explosive train of the fuze consists of delay element M9 relay XM9 (2.31 grains of lead azide), detonator M35 and a tetryl booster assembly.

Note: White stripes showing through either of the windows mentioned above indicate the unarmed condition.

(3) Booster cup assembly. The major components of this assembly are a booster lead of 1.55 grains, tetryl, a booster pellet of approximately 1146 grains, tetryl, a filler disc, and an aluminum booster cup. The threaded end of the booster cup is used for attaching the booster cup to the lower portion of the fuze body.

(4) Functioning. The fuze starts to function when the bomb is released from the aircraft. The arming wire is withdrawn from the vane and the Fahnestock (safety) clips. The vane spins in airstreams of 150- to 650-knots. Airstreams of less than 150 knots will not produce sufficient torque for the vane to arm the fuze properly. Rotation of the vane provides the drive power for the governor spindle and drum assembly. The centrifugal-type clutch maintains the output speed from the governor at a constant 1800 (plus or minus 100) revolutions per minute. The governor output is transmitted through the gear train. This causes the arming stop to rotate through an angle corresponding to the selected arming time of approximately 11 degrees-per-second of arming delay. While the arming stop is rotating to the armed position, three other parts rotate with it: the striker body, the firing pin, and the firing-pin guide, driven by the drive pins and keyed to the arming stop. When the arming stop has moved to the armed position, a slot in the striker body aligns with a slot in the index stop. The helical spring forces the striker body forward until it rests against the index stop of the arming stop. Immediately, a helical spring forces the steel ball into the void above the firing pin. A cut-out in the firing pin guide aligns with the upper portion of the rotor release assembly allowing the assembly to be driven forward by its spring. On removal of the lower portion of the release assembly, the spring-loaded rotor rotates, thereby aligning the detonator M35 in the rotor assembly with the other explosive train elements. The rotor detent locks the rotor assembly in the firing train position, thus arming the fuze. When the bomb hits the target, the force of the impact drives the entire nose assembly rearward, thereby causing the three integral lugs attached to the nose housing to be sheared off. The striker body is forced against the firing pin, shearing the shear pin, which in turn, causes the explosive train components to be initiated.

b. Bomb fuze, tail, M123A1, M124A1 and M125A1. These fuzes (figures 7-33 and 7-34) differ in overall length so that the same type fuze can be used in various size bombs. The differences in length are necessary to locate the arming vanes properly in the airstream. They are vane operated and incorporate an antiwithdrawal device and are designed for special application. The fuze acts to detonate the bomb after a delay of 1, 2, 6, 12, 24, 36, 72 or 144 hours. Any attempt to unscrew these fuzes will result in the functioning of the antiwithdrawal (boobytrap) mechanism followed by instantaneous detonation. This type of fuze is particularly sensitive to changes in temperature. See table 7-1.

(1) Explosive Components. The detonator is the only explosive element used in these fuzes. It is contained in the detonator holder which screws into the base of the body extension, and is always in line with the spring-loaded firing pin. The detonator and detonator holder are shipped with but not assembled in the fuze as issued and must be installed prior to the bomb-fuzing operation.

(2) Safety Features. The detonator holder containing the detonator is not assembled in the fuze until immediately prior to assembling the fuze to the bomb. In place of the detonator holder, a shipping plug is seated in the fuze-body extension. This makes the fuze safe for handling. The fuze-body extension is prevented from unscrewing by a wire safety clip which locks the extension to the fuze body. This clip is not removed until the fuze is prepared for installation in a bomb. A safety pin, held in place by a sealed safety wire, locks the clip and stem disc and prevents the arming stem from rotating and arming the fuze. Four instruction tags are attached to the fuze. The packing box containing the fuzes has indicator vials which show the various temperature ranges to which the fuzes have been subjected during shipping and storage. This system prevents the use of fuzes which have experienced temperatures rendering them dangerous to handle. When the fuze is installed in the bomb, the arming wire prevents the arming stem from rotating and initiating the delay action. This is the only safety feature afforded these fuzes once they are installed. Attempted withdrawal or tampering with an installed fuze will cause the fuze to detonate the bomb. Severe shock may cause the glass ampoule to be broken prematurely and begin the delay action before desired.

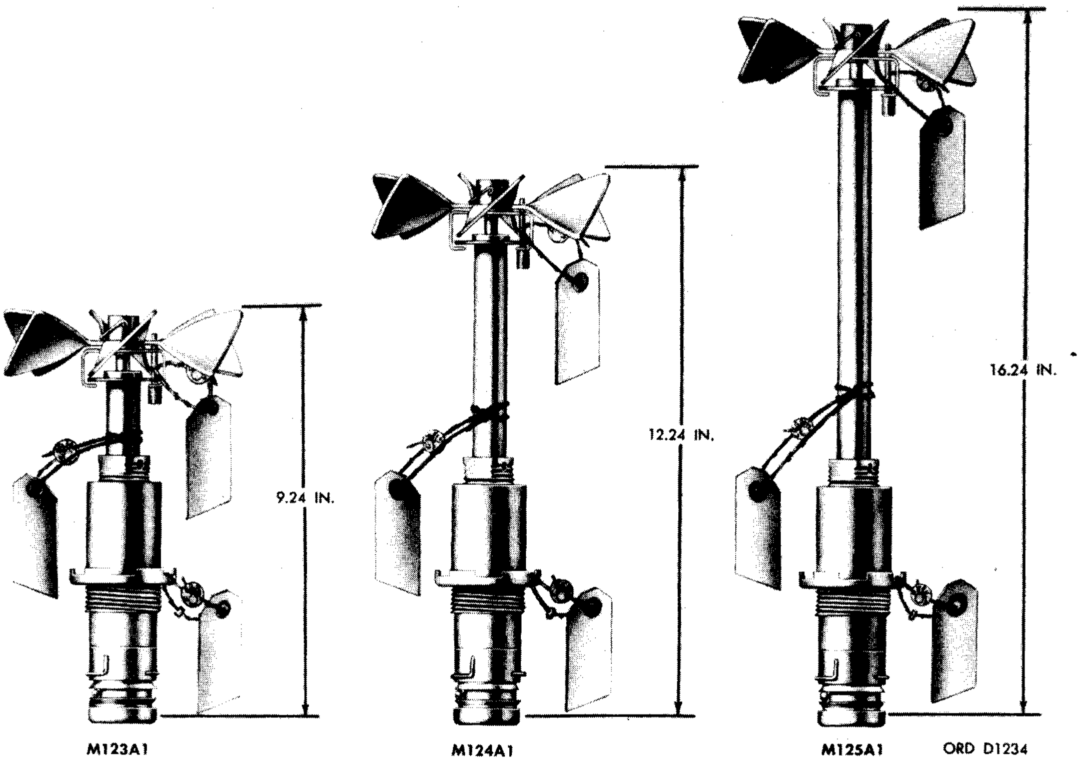


Figure 7-33. Tail fuzes M123A1, M124A1, and M125A1.

Temperature: (°F.)	Nominal Delay Time: 1 hr / Actual Delay Time: (Hrs:mins)	2 hr	6 hr	12 hr	24 hr	36 hr	72 hr	144 hr
115	0:15	0:20	1:00	1:15	1:30	2:30	----	----
90	0:20	0:50	1:30	2:30	6:00	11:00	37:00	52:00
80	----	----	----	----	8:00	15:00	38:00	70:00
75	0:30	1:00	2:00	3:50	12:00	20:00	53:00	90:00
55	0:45	1:30	3:00	9:00	24:00	37:30	96:00	135:00
25	2:10	3:15	11:20	30:00	----	62:30	----	----

Table 7-1. Effect of Temperature on Delay Action of Tail Fuzes M123A1, M124Al, M125A1.

(3) Safety Precautions. The following precautions must be observed in handling these fuzes: Do not assemble the fuze to the detonator holder nor to the bomb in anticipation of future needs. Take particular care to protect fuzes from extreme heat and shock. Examine the indicator vials when the fuze packing box is opened. If all fuzes in the box are not used, leave the vials in the box with the remaining fuzes and reinspect them when the box is reopened.

Warning: When engaging threads of mating parts in assembling the fuze to the bomb, do not turn one part back and forth until the threads engage. Use a screwing in motion only. The antiwithdrawal device will cause the fuze and bomb to detonate if the fuze is rotated counterclockwise while in the adapter-booster, even before the threads are engaged.

(4) Functioning. When the fuzed bomb is dropped, the arming wire is withdrawn from the arming-vane assembly, stem disc, and clip. The freed arming-vane assembly rotates in the airstream. After completion of less than 100 feet of air travel, the fuze is armed and sealed against the

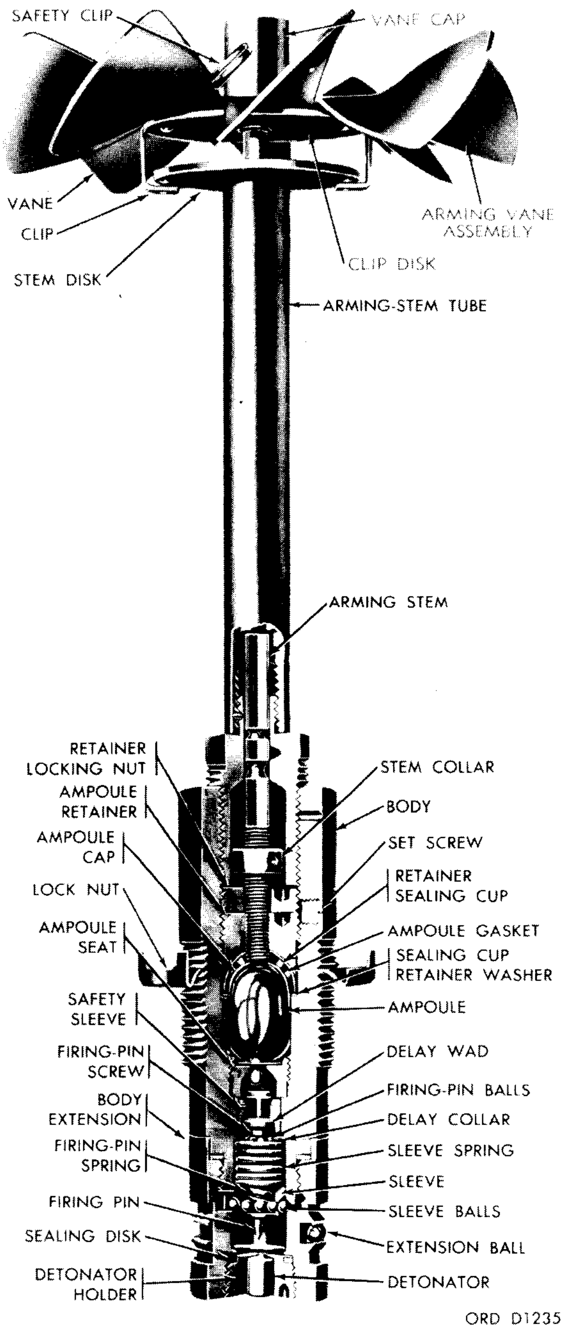


Figure 7-34. Tail fuze M123A1-cross section.

entrance of moisture and the escape of solvent. Impact produces no effect upon the armed fuze. The fuze does not act to explode the bomb until the delay time has expired or until someone attempts to defuze the bomb.

Note. A steel nose plug or an inert nose fuze must be used to reduce the possibility of the bomb detonating on impact.

(5) Arming. The arming-vane assembly (figure 7-34) is connected directly to the arming stem by means of the safety catch. At its lower end, the arming stem is threaded into the retainer locking nut and ampoule retainer. As the arming-vane assembly turns the arming stem, the stem is screwed into the ampoule retainer and ampoule-retainer nut. After a short air travel, the stem, moving into the fuze body, crushes the ampoule and frees the solvent. With additional air travel, the arming stem progresses far enough to force the stem collar against the retainer locking nut. This action seals the outer end of the fuze body to prevent the escape of solvent or the entrance of moisture.

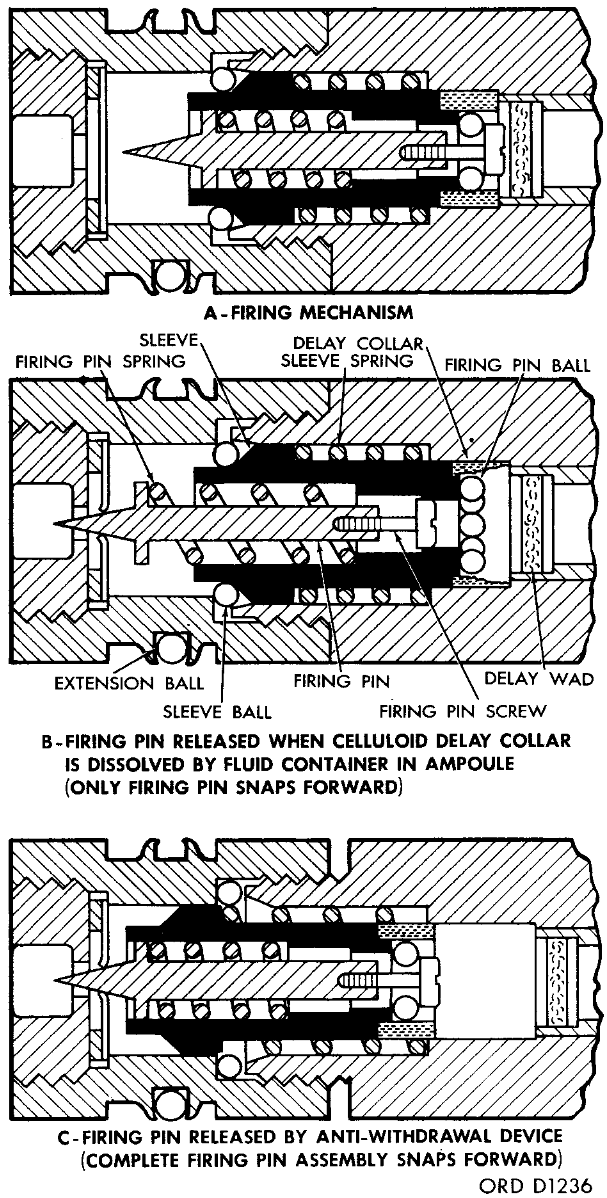


Figure 7-35. Tail fuse M123A1, Antiwithdrawal.

(6) Action. The solvent from the crushed ampoule filters through the delay wad to contact the celluloid delay collar. It is this celluloid delay collar that is the key to the lock arrangement of the spring-loaded firing pin. The firing pin balls are wedged between the head of the firing pin and the celluloid collar by the action of the firing pin spring. The celluloid delay collar prevents the firing pin balls from being forced outward until the culluloid delay collar is softened by the solvent.

Warning: If a fuze is suspected of having an acetone leak (odor or wetness at any joint or cavity), consider the fuze to be armed. Notify qualified and authorized munitions personnel immediately.

(7) Antiwithdrawal. If any attempt is made to remove the fuze from the bomb, the antiwithdrawal device will detonate the fuze. The following characteristics and mechanisms of the fuze are related to the antiwithdrawal feature (figure 7-35). The body assembly consists of two parts, the fuze body and the fuze-body extension. The fuze body contains the firing pin and sleeve assembly, the delay wad, and also the solvent-filled ampoule. The body extension contains the detonator holder which is screwed into the base. An off-center circumferential groove is machined into the outer surface of the body extension. This groove contains the locking ball, used in conjunction with the antiwithdrawal mechanism. The sleeve within the fuze body is held in place against the action of the compressed sleeve spring by the sleeve balls. These balls are wedged between the sleeve shoulder and the body-extension shoulder, and are held in place by the lips of the fuze body. Since the ball groove of the fuze-body extension is machined off-center, the locking ball is forced outward when the fuze is turned counterclockwise. This action wedges the ball between the adapter-booster wall and the fuze-body extension, thus locking the fuze-body extension in place. Any further counterclockwise rotation unscrews the fuze-body extension from the fuze body. When the fuze-body extension is unscrewed 3/64 inch, the sleeve balls are released and move outward. The sleeve and firing-pin assembly are driven forward as a unit by the sleeve spring, causing the firing pin to puncture the sealing disc and strike the detonator. For insurance against countermeasures, the adapter-booster of current design is drilled for the insertion of a metal locking pin supplied with the fuze. When this pin is in place, the adapter-booster is locked to the base plug of the bomb, thus preventing removal of the fuze by the unscrewing of the adapter-booster.

(8) Detonation.When the firing pin punctures the sealing disc and the detonator, the detonator explodes, setting off the adapter-booster and the bomb.

(9) Accidental arming. From outward appearances there is no way of determining definitely whether these fuzes are armed or are in a safe condition. The best policy is to regard any suspected fuze as being armed. Any fuze that has been dropped from a height of 10 feet or more, or has had its arming-vane assembly free to rotate, must be disposed of as quickly as possible by qualified and authorized munitions personnel.

Warning No. 1: **If the red-stoppered indicator vial in the fuze packing box shows that the fuzes have been subjected to temperatures over 170° F., notify qualified and authorized personnel immediately.**

Warning No. 2: **No attempt must be made to remove a fuze after it has been partially or completely installed in a bomb.**

Warning No. 3: **Return of bombs to air fields or carriers is prohibited. Bombs fuzed with fuzes M123A1, M124A1 or M125A1 cannot be released SAFE: Impact will cause the ampoule to shatter and to initiate the delay train, even with the arming wire in place. In the event of incomplete missions, these fuzed bombs are to be jettisoned over enemy territory or deep water.**

c. Proximity fuze (VT), nose, M914. This fuze (figure 7-36) is a bar-type and is designed for use over dense jungles where bomb burst is desired under the jungle canopy rather than in or above it. Fuze M914, electrically initiated upon coming into close proximity to foliage, allows an additional 46 to 67 feet of bomb travel prior to bomb burst.

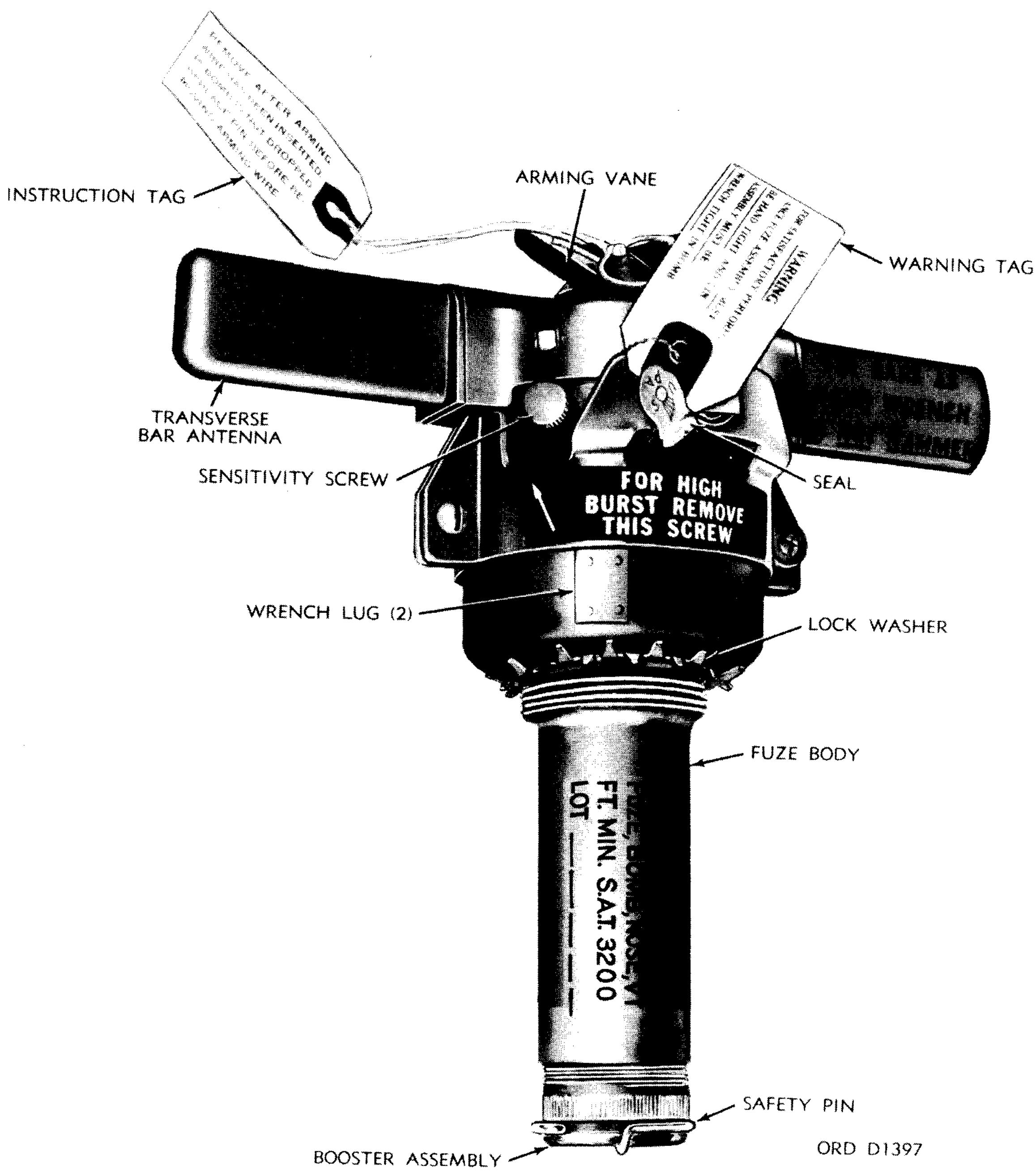


Figure 7-36. Proximity (VT) fuze M914 (XM914E1).

(1) Components of fuze M914 are listed as follows: transverse bar antenna, arming vane, sensitivity screw, vane locking arm, fuze body, booster assembly, and safety pin. The fuze body (figure 7-37) contains a radio transmitter and receiver, wind-driven generator power supply, and mechanical arming system. The sensitivity screw, used as a function height selector, provides the following: (LO-sens position) the fuze will operate with reduced sensitivity with the sensitivity screw removed; and (HI-sens position) the fuze will operate with normal sensitivity. Initiation of fuze M914 over jungles or normal terrain, will be at the approximate heights.

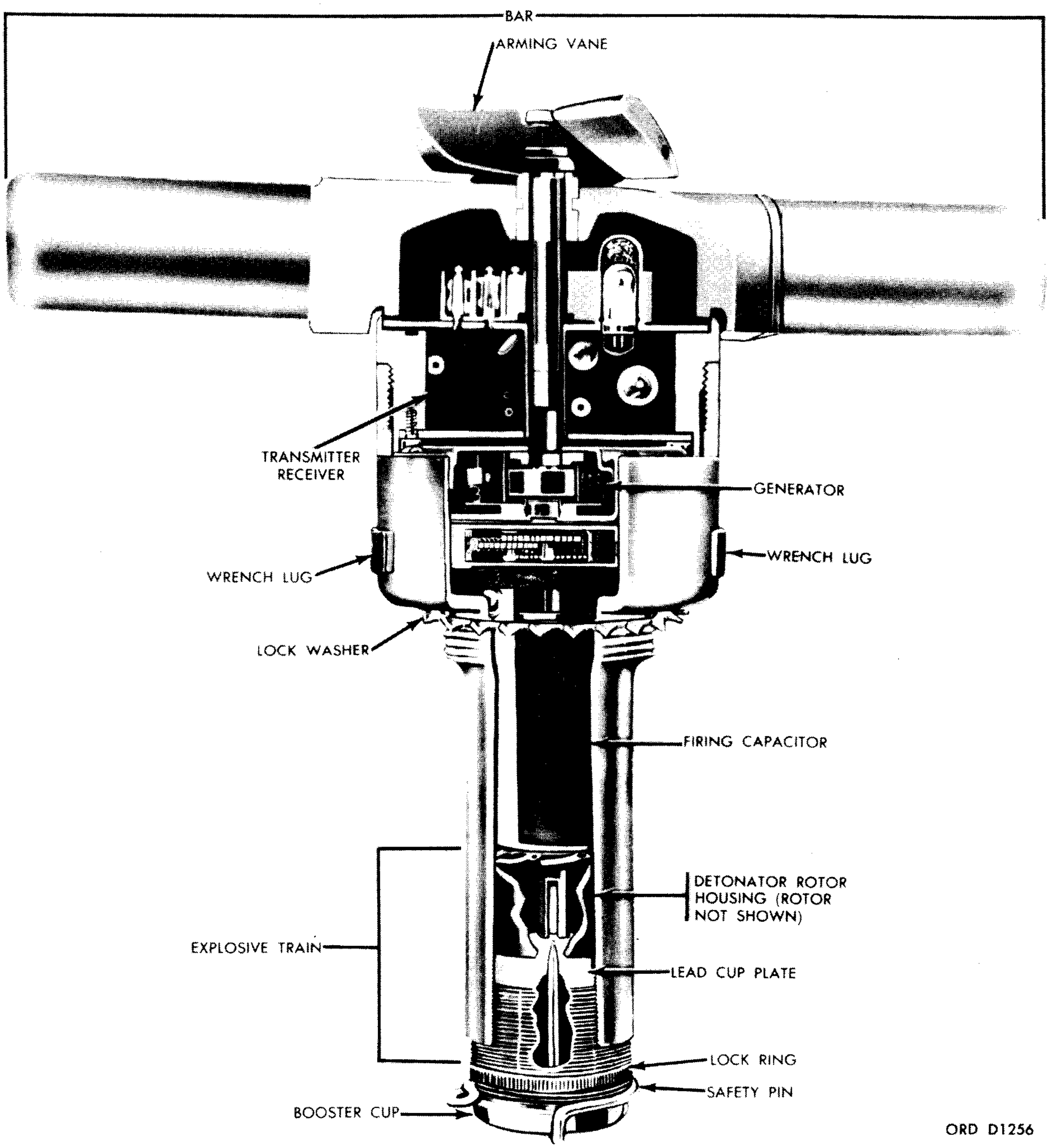


Figure 7-37. Proximity nose fuze.

Note: For tactical application, fuze M914 should be used in conjunction with an instantaneous impact fuze in the tail fuze well.

(2) Tall dense jungle bomb release. For bomb releases over tall (75-100 ft) dense jungles the sensitivity screw in side of the fuze should be left in place, thereby desensitizing the fuze to assure delay action starts at the top of the cover foliage. Bombs, with fuze M914 installed, function about 40 to 50 ft under the top of the foliage or about 30 ft from the ground. In the event fuze M914 fails to operate/function, the impact fuze in the bomb tail will provide ground function. If

the bomb strikes a sizeable limb during the 50-ft penetration, the impact fuze may cause the bomb to function. If a bomb-fuzed in the manner above is inadvertently released over open fields, low (40 ft) jungles or a low reflectivity area (very dry ground), the delay and the fuze function heights will not be compatible. The bomb will function on the ground as a result of the tail impact fuze.

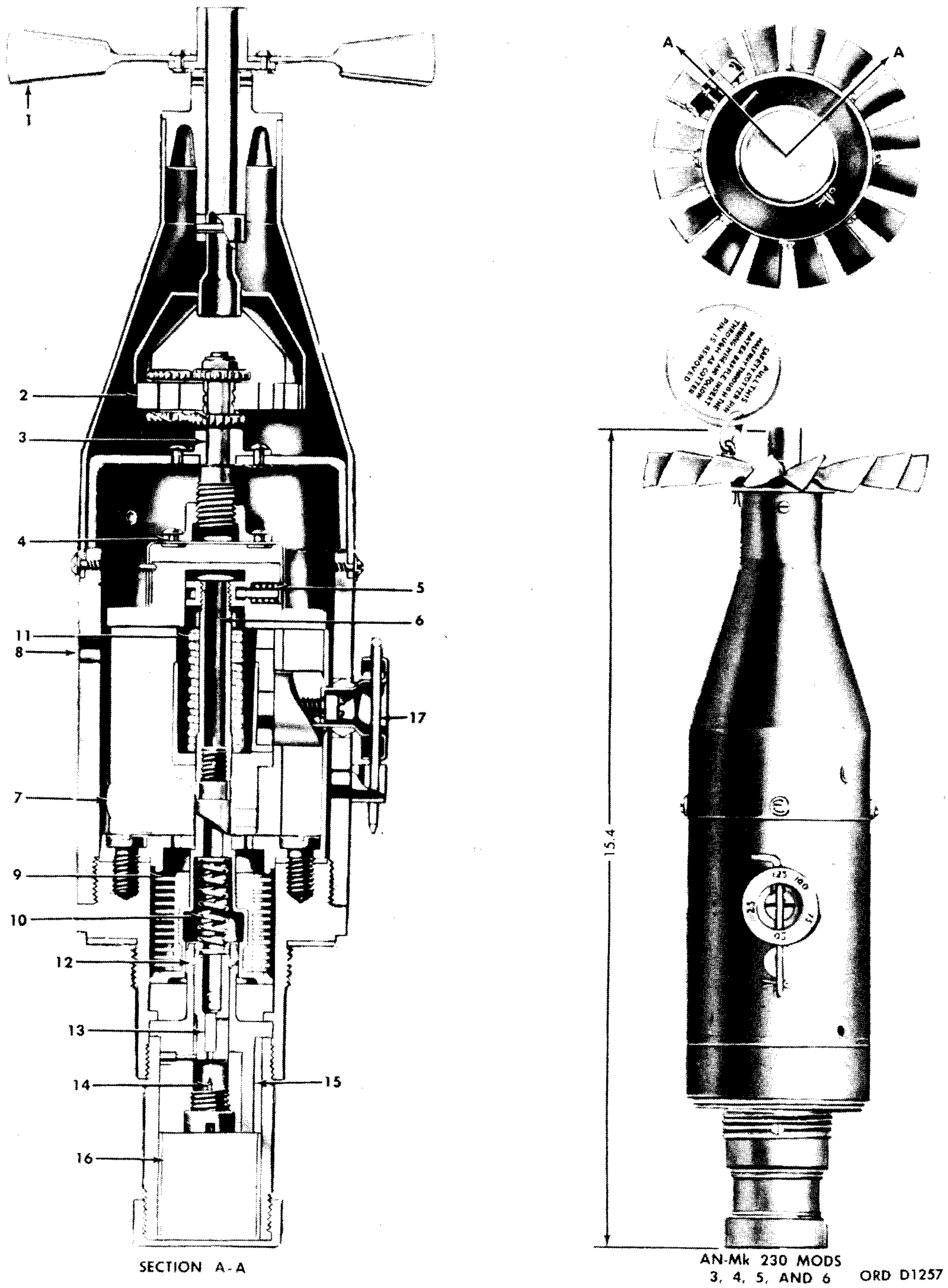
(3) Open field bomb release. For bomb releases over open fields, low (40 ft) jungles, rice paddies, or water, the sensitivity screw should be removed, thereby allowing the fuze to operate under normal sensitivity. This will result in a proximity fuze action from 50 to 90 ft above the ground or water. Delay detonator DD16A0 allows the bomb to fall an additional distance prior to bomb detonation (0 to 45 ft above the ground or water). In the event of a proximity fuze dud or too long a delay time, the impact fuze will cause the bomb to function on impact with the ground. If a bomb fuzed in the above manner is inadvertently used over high jungles, there is a possibility of the bomb functioning in the cover foliage rather than below it.

d. Hydrostatic tail fuze AN-Mk230. This fuze (figure 7-38) is vane operated and requires 400 to 500 feet of air travel to arm. It is bottle-shaped in appearance and has a 16 blade arming-vane assembly attached to its head. This type of fuze is sometimes used in conjunction with a nose fuze. Water pressure operates the hydrostatic mechanism that detonates the fuze. The depth at which detonation will occur can be controlled by presetting the depth-setting knob. This knob, located on the side of the fuze, is marked with depth settings of 25, 50, 75, 100, and 125 feet.

(1) Explosive Components. The explosive components of this fuze consist of the detonator, the lead-out charges, the lead-in charges, a relay, and a booster charge. The detonator and lead-out charges are in the firing plunger. The booster charge, the relay, and the lead-in charges consist of approximately 25.5 grams (0.9 ounce) of tetryl.

(2) Safety Features. Each fuze is individually packed in a sealed metal container. The fuze body, plunger housing, and firing plunger are locked by a safety rod to prevent operation of the hydrostatic mechanism and consequent premature functioning of the fuze. The safety rod is protected against accidental withdrawal by a safety (cotter) pin (18, figure 7-38) through a hole at the protruding end. A safety (cotter) pin, provided with a pull ring and instruction tag, locks the bushing and arming-vane assembly together to prevent the arming vane from rotating and arming the fuze. In all, four safety (cotter) pins are used externally on the fuze: one to prevent withdrawal of the setting rod, one to prevent withdrawal of the safety rod, one to lock the vane assembly in place, and a fourth to connect the arming-vane hub to the vane shaft. An arming bracket is used with fuzes of this type when they are assembled in bombs that are to be carried on the external racks of high-speed aircraft. The bracket assures that the arming wire will not shear and inadvertently allow the fuze to arm. When placed in a bomb, the fuze is in an unarmed condition as long as the arming wire is in position. It will not begin to function until the bomb is dropped and the arming wire is withdrawn from the arming-vane assembly and bushing. The fuze is detonator safe as well as shear safe.

(3) Arming. When the arming wire is withdrawn, the air stream rotates the arming vane (1). The rotation is transmitted through a reduction gear train (2) to the arming shaft (3) which is threaded into the arming spider assembly (4). The arming spider assembly progresses upward and, after 110 revolutions of the vane, clears the safety detents (5) which are ejected by their springs from the groove in the head of the firing spindle (6). Upon impact with the water, the inertia counterbalance weights (7) prevent function by set-forward. As the bomb sinks, the water enters the ports (8) in the body of the fuze and builds up hydrostatic pressure in the bellows (9). When sufficient pressure is built up to compress the firing spring (10) and depth spring (11), the firing spindle is forced downward so that the locking balls (12) fly into a recess and the firing spring forces the detonator (13) against the fixed firing pin (14). The resultant explosion is transmitted through the firing train leads (15) to the booster (16). Variation in depth setting is obtained by



1. Arming vane assembly
2. Reduction gear assembly
3. Arming shaft
4. Arming spider assembly
5. Safety detents
6. Firing spindle
7. Inertia counterbalance weights
8. Ports
9. Bellows assembly
10. Firing spring assembly
11. Depth spring assembly
12. Locking balls
13. Detonator
14. Firing pin
15. Firing train leads
16. Booster
17. Depth setting control
18. Safety cotter pin

Figure 7-38. Hydrostatic tail fuze AN-MK230.

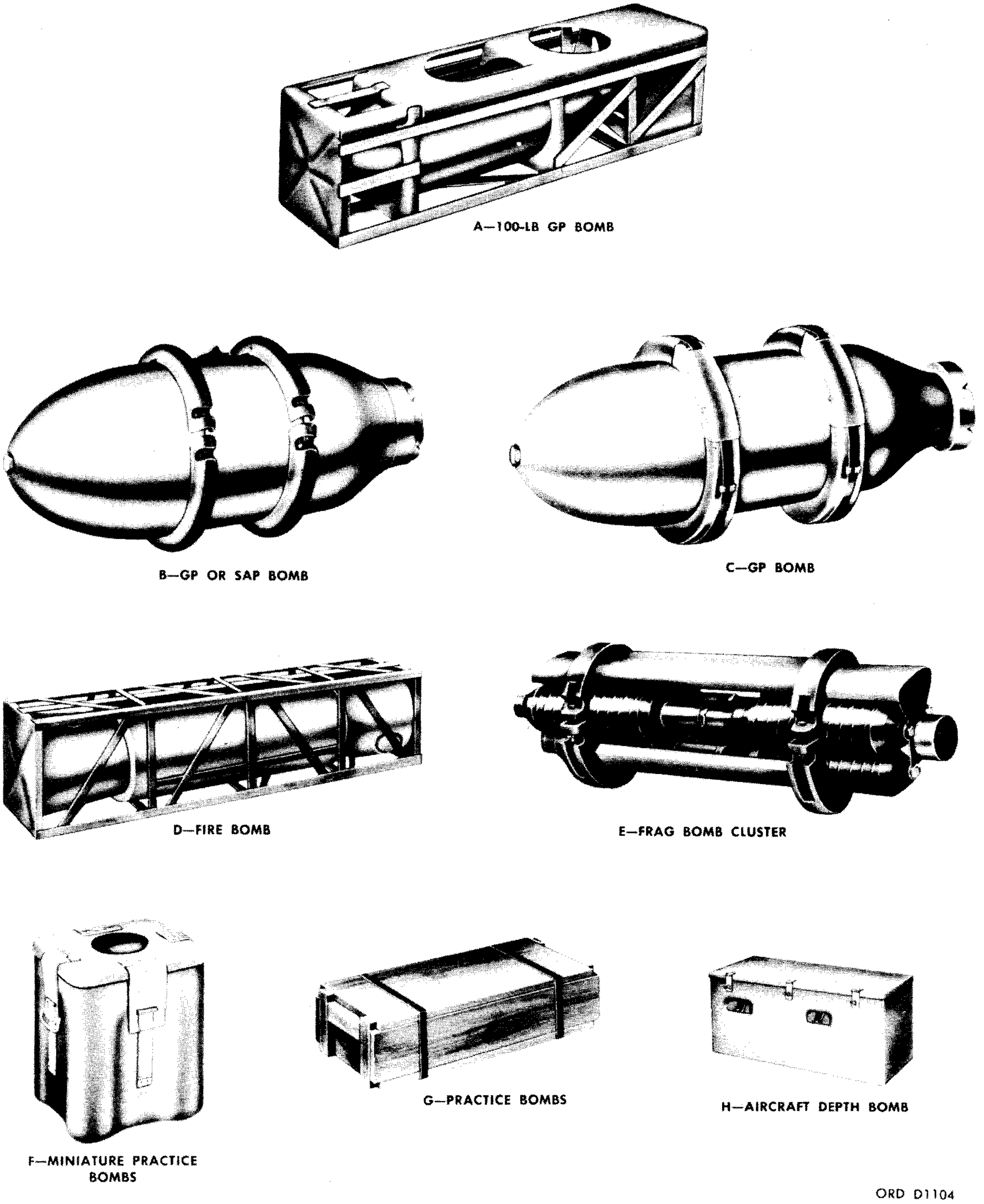


Figure 7-39. Shipping containers for bombs.

varying the compression of the depth spring by means of a cam on the inner end of the depth setting control (17). The difference between the number of teeth on the stationary and movable gears of reduction gear train causes the idler gear to force the movable gear one tooth ahead with each revolution of the planetary-gear cover. This gives a reduction ratio of one revolution of the arming shaft to 23 revolutions of the arming-vane assembly.

(4) Functioning. When the bomb is dropped, the arming wire is withdrawn and the arming-vane assembly is free to rotate in the airstream. After the bomb completes from 300 to 400 feet of air travel along its trajectory, the fuze is fully armed. The fuze begins functioning when water enters its body. Water pressure, increasing with depth, expands a bellows, causing alignment of the explosive elements and detonation of the fuze.

Table 7-2. Packing.

Bomb type	Bomb body	Fin assembly	Assembled bombs
Semi-Armor-Piercing (SAP)	Metal shipping rings; fuze cavities plugged.	Metal containers	
General Purpose (GP)	Metal or composition shipping rings; fuze cavities plugged.	Metal containers	Some GP 100-lb bombs are shipped as a unit in a metal container.
Fragmentation (Frag)	Metal shipping rings; fuze cavities plugged.	Metal containers	In clusters or wafers
Aircraft Depth Bomb (ADB)	Metal containers	Metal containers	
Miniature Practice Bombs (MPB)			Wood or metal containers
Practice Bombs (PB)	Fiberboard containers	Metal containers	Wood or metal containers
Fire Bomb*	Wood or metal containers		
Smoke and Incendiary Bombs (100-lb size).	Wood containers		Wood containers
Incendiary Bombs (500-lb size)	Metal shipping ring; fuze cavities plugged.	Metal containers	

*The center section of fire bomb MK79 Mod 1 is used as a shipping container for the bomb's four sections: fins, filling-hole covers, lock pins and a fiber pounding block.

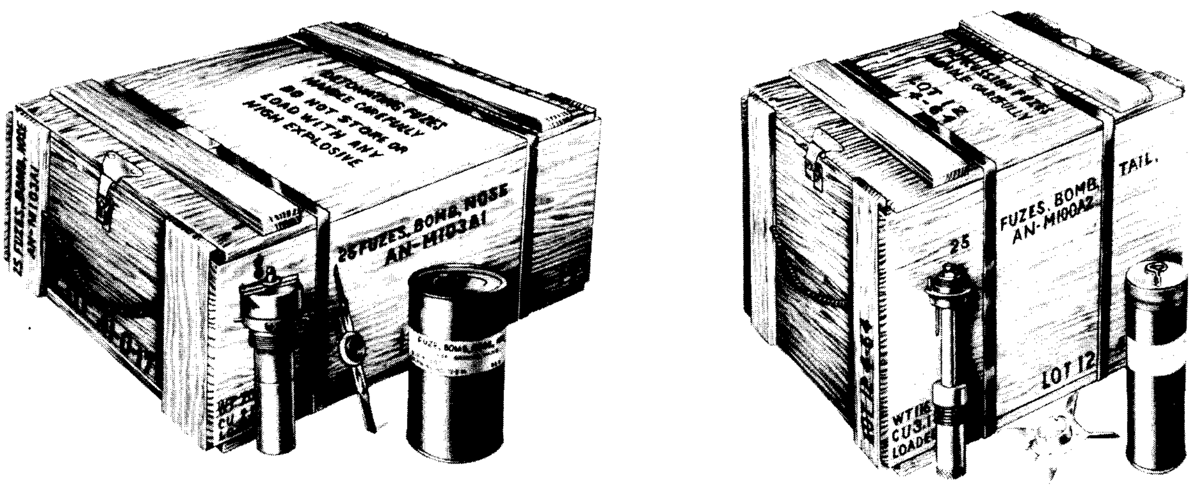


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Figure 7-40. Shipping containers for arming vanes and fuzes.

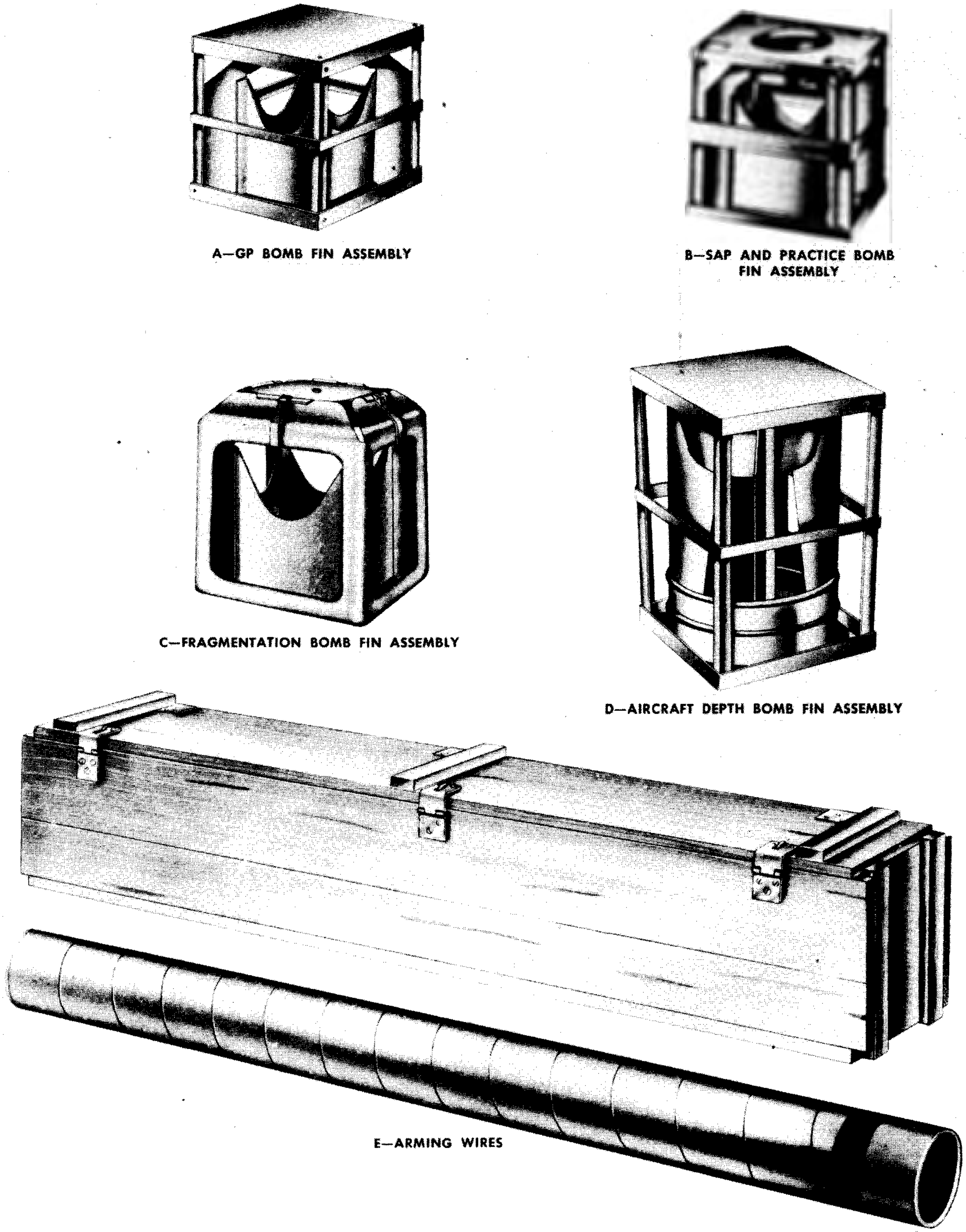


Figure 7-41. Shipping containers for bomb fins and arming wires.

Table 7-3. Bomb Color Coding

Bomb type	Body color	Band color		Marking color	
		Old marking	New marking	Old marking	New marking
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	Gray	Purple	Purple	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 frag 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 is unpainted.
[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.

5. **Packing, Marking and Color Coding.** Bombs and bomb components, for safety and convenience in handling, are not shipped or stored as complete rounds. The breakdown of the round is governed by the size of the bombs, the frailty of the components and the explosive hazards involved. Typical packaging for the components that make up a complete bomb are illustrated in figures 7-39, 7-40 and 7-41. Additional packing data is given in table 7-2. Information on bomb color coding and marking is given in table 7-3.

6. **SUMMARY.** This lesson has encompassed the components of a complete bomb, types of bombs and bomb fuzes. Representative types of bombs and bomb fuzes have been discussed in detail with reference made to appropriate illustrations. Although you may not have the responsibility of handling, storing and maintaining this type of munition, this being a normal function of the Air Force in oversea theaters, it will be to your advantage to acquire a comprehensive knowledge of this type of material. The size, weight, and configuration of bombs have created some exceptions in types of packing, for example: shipping bands as substitutes for containers. Another exception is the requirement for color coding of bombs which differs, in some respects, with other types of ammunition. Frequent reference to this lesson will enhance your ability in performing duties associated with ammunition activities.

EXERCISES FOR LESSON 7

1. What department of the defense establishment is responsible for the maintenance of bombs in emergencies?

   A. Army
   B. Navy
   C. Air Force
   D. Defense

2. Which bomb may be selectively armed by releasing one of the arming wires with the bomb?

   A. GP
   B. SAP
   C. Depth
   D. Frag

3. What is cast around the adapter boosters of SAP bombs?

   A. TNT
   B. Cyclotol
   C. Inert wax sealer
   D. Primer detonator surround

4. What action takes place when the M124A1 tail fuze is removed from a GP low drag bomb?

   A. Nose fuze functions
   B. Glass ampoule breaks
   C. Instantaneous detonation
   D. Ambient temperature increases

5. Which component remains in place when a bomb is dropped unarmed?

   A. Sealing wire
   B. Arming wire
   C. Safety wire
   D. Safety pin

6. Which munition carries its payload in paper bags but is stored and shipped empty?

   A. Fragmentation cluster bomb
   B. Incapacitating gas bomb cluster
   C. Leaflet bomb
   D. Missile cluster adapter

7. Which bombs used by the AF have unpainted bodies?

   A. Fire
   B. Incendiary
   C. Smoke
   D. Practice

8. Which fuze is provided with an all ways functioning striker assembly?

A. Hydrostatic
B. Miscellaneous FMU series
C. Proximity bar type
D. Point detonating

9. What is the purpose of the conduit assemblies in the new series GP bombs?

A. Drains excess exudation from filler
B. Equalizes pressure between nose and tail sealers.
C. Contains fuze cable harness
D. Provides protection for arming wires

10. What causes arming of hydrostatic fuzes?

A. Hydraulic pressure
B. Water travel
C. Water pressure
D. Air travel

11. How far (in inches) is the fuze body extension unscrewed to activate the withdrawal mechanism in the M125A1 tail fuze?

A. 3/64
B. 1/16
C. 1/8
D. 16/64

12. What component is shipped in the center section of the Mk79 Mod 1 bomb?

A. Rubber pounding block
B. Fin assembly
C. Nose and tail fuze assemblies
D. Fuze igniters

13. How many pounds of explosives are contained in frag bomb M88?

A. 28.0
B. 32.6
C. 41.8
D. 51.7

14. How is the M9 delay element held in place in the M904 series nose fuze?

A. Stake and index stop
B. Shear and safety pin
C. Arming wire and cotter pin
D. Spring and lock pin

15. What action is taken when a bomb (assembled with VT fuze M914) is to be released over open fields?

A. Increase launching angle
B. Remove sensitivity screw
C. Install arming delay M1A1
D. Install drag plate

LESSON 8. ROCKETS AND GUIDED MISSILES

MMS Subcourse No. 621 . . . . Ammunition Materiel

Lesson Objective . . . . To give the student a general knowledge of the types, identification, characteristics, use, and packing of representative rockets and guided missiles.

Credit Hours . . . . Four

TEXT

1. INTRODUCTION.

a. This lesson is designed to provide you with a general overall knowledge of rocketry beginning after World War II to include the types which have been developed and standardized for use in present tactical and scientific operations. The basic principles of rocketry were handed down by the Chinese. Scientists such as Oberth, Goddard, and Von Braun have refined the systems to the extent that rockets have launched man on a round trip to the moon.

b. A rocket may be defined as a missile which is propelled by the reaction of a burning propellant, producing a high velocity jet of gases forced through a venturi-type nozzle. When a gas is compressed in a closed vessel, pressure is transmitted equally in all directions (Pascal's law); hence, the force in one direction is counterbalanced by an equal force in the opposite direction with no resulting motion of the closed vessel. This is illustrated diagrammatically by figure 8-1, representing a closed tube. Note that although the equal and opposite forces on the side walls of the tube are represented in figure 8-1, they are omitted in figures 8-2 and 8-3 because they cancel each other, and therefore, are not necessary in the further discussion of the rocket principle. When an opening is made in one end of the tube (figure 8-2), the pressure at the open end drops to near atmospheric, while the pressure on the closed end remains greater than atmospheric. As a consequence, the tube tends to move in the direction of the closed end while a jet of gas is ejected from the open end. The burning of a propellant maintains high pressure at the closed end, while near atmospheric pressure prevails at the open end. Thus, the high pressure at the closed end, acting on a wall area equal to the area of the open end, results in a force or thrust in the direction of the closed end. Gas passing by the square corners near, and at, the open end (figure 8-2), would be subject to substantial frictional losses due to turbulence near the opening. These losses are largely overcome by using the shape shown in figure 8-3, which forms a nozzle. This type of opening has a smooth contour which provides for a nonturbulent, hence relatively frictionless flow of gases to the rear. The constricted opening, called the throat, limits the flow of gas and thereby maintains pressure within the tube while the propellant is burning. Pressures represented by (d) and (d') normal to the wall of the

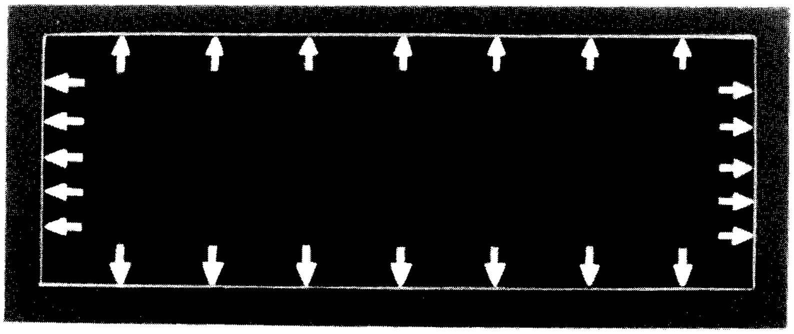


Figure 8-1. Rocket principle (pressure in closed tube).

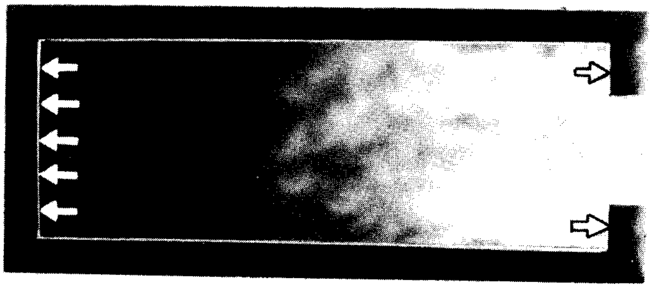


Figure 8-2. Rocket principle (movement of tube-opening in one end).

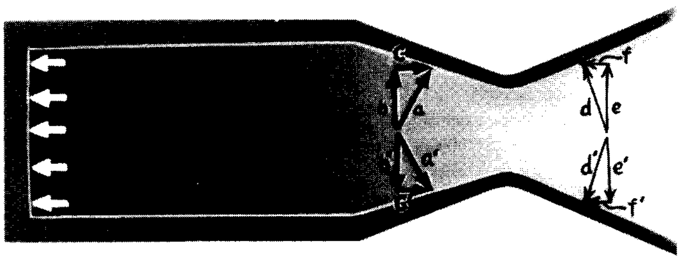


Figure 8-3. Rocket principle (movement of tube-nozzle in one end).

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 8-2, is converted to additional thrust by use of the nozzle. Thus, the principle forces producing motion of the tube consist of those resulting from the internal pressure acting at the closed end of the tube on an area equivalent to that of the throat, plus the axial forces (f) and (f') resulting from the pressure within the nozzle.

2. JATOS.

a. In discussing the subject of rockets and guided missiles, a short description of Jet Assisted Take-Off (JATO) is deemed appropriate, as the propulsion system is similar to that used in rockets and guided missiles in that it produces thrust of limited duration.

b. Advantage has been taken of the powerful thrust developed by JATOS to permit aircraft takeoff from small or emergency fields, the flight deck of aircraft carriers, to launch target aircraft, missiles, and to propel explosive "snakes" into position on mine fields for mine clearing purposes.

c. JATOS (figure 8-4) are completely identified by standard nomenclature which consists of three parts: the basic noun "JATO", the principle identifying characteristics (duration, type of propellant, and thrust), and the model designation. The characteristics (at 70 degrees F) appear as a numeral indicating duration of thrust in seconds, a two-letter symbol indicating the type and physical state of the propellant, followed by a numeral indicating the nominal thrust in pounds, separated by hyphens. Thus, 0.9–ES–800 indicates a JATO containing an extruded double base solid propellant that will produce a nominal thrust of 800 pounds for 0.9 second duration at 70 degrees F.

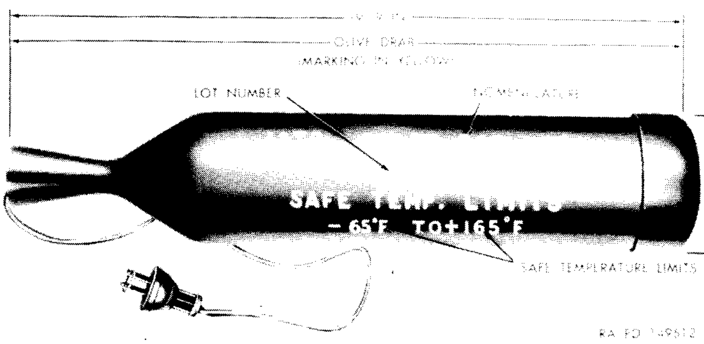


Figure 8-4. JATO,0.9-ES-800, T31.

d. Complete round (figure 8-5).

(1) The combustion chamber or body is a metal cylinder closed at the front end and fitted for a nozzle at the other end and houses the propellant and igniter. On some JATOS and rocket motors, threaded openings are provided for assembly of the igniter. However, during shipment, and for safety reasons, the igniter may be shipped unassembled and the threaded igniter openings are sealed against moisture by closing plugs or other suitable closures. On some thrust units, safety devices such as blowout plugs,, are provided to prevent rupture of the body should excessive pressures be built up within the motor during firing.

(2) Propelling charges of various compositions, shapes and number of propellant grains (figure 8-6) are used in different models of JATOS. The different configurations determine the burning characteristics of the propellant grain(s) which may be classified as illustrated in figure 8-6. "A" indicates an unrestricted-neutral burning type, "B" a semi-restricted progressive burning type, and "C" a restricted-degressive burning type. Generally, the grain is in some kind of a perforated configuration, with the perforation(s) running longitudinally through the grain. In any event, the grain is designed to permit a free flow of gases from the burning surface to the nozzle. To restrict burning to certain surfaces of the propellant grain, the remaining surfaces, usually the outside surfaces, are coated with an inhibitor in the form of a slow-burning substance such as cellulose acetate. In the case of some JATOS and motors, in which the propellant is in the form of grains with center perforations, the presence of a rod through the perforations improves functioning by eliminating pressure peaks. Such a rod is called a resonance rod. If the propellant is in the form of several grains, each with a center perforation, the grains are assembled on a cagelike support secured to a trap assembly (i.e., each grain is mounted on a rod). This assembly (figure 8-5) supports the propellant and prevents the propellants, or portions thereof, from blocking or restricting the flow of gases through the nozzle.

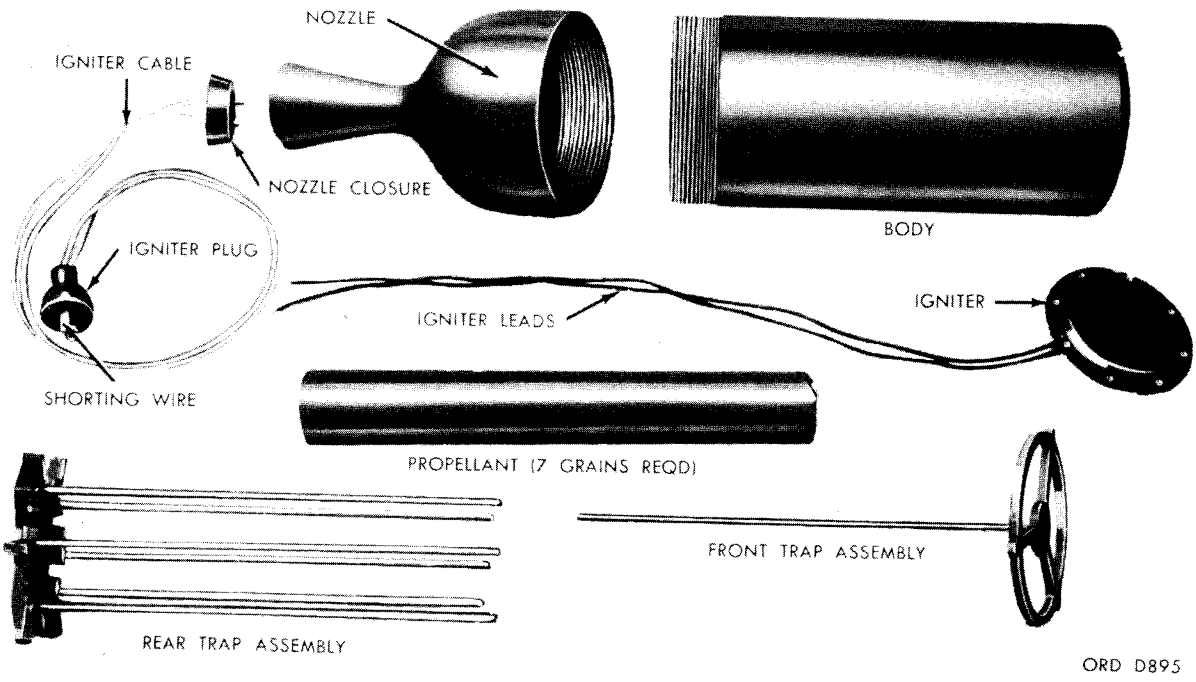


Figure 8-5. Components of typical JATO.

(3) The ignitor assembly usually consists of one or more electric squibs, and a charge of black powder housed in a plastic container. Leads from the squibs are passed from the igniter housing, through the nozzle closure, to some external point on the motor body, where they may be attached to the firing circuit. Two squibs are provided as insurance against misfires; should one squib fail when the firing switch is closed,, the other squib should fire the black powder charge which, in turn, ignites the propellant.

(4) The nozzle(s) assembled to or formed in the bodies of the JATOS described herein are of the convergent-divergent type. Where the body is not constricted to form a nozzle, a nozzle assembly is assembled to the JATO. To construct a complete rocket, a JATO unit could be modified by assembling a warhead and fuze to the fore end and a stabilizing assembly to the aft end of the thrust unit. These components will be discussed in subsequent paragraphs. (In view of the many types and modifications of rockets, the rockets discussed herein will be the current model HE types.)

3. REPRESENTATIVE ROCKETS. (2.75 inch, 3.5 inch and 4.5 inch).

a. Rocket, HEAT, 2.75 inch: Folding Fin Air Rocket (FFAR), M1. This rocket (figure 8-7) is a fin stabilized rocket designed for use by the U. S. Air Force for forward-firing from an aircraft rocket launcher. Stabilization in flight is accomplished by four pivoted folding fins which are actuated by pressure from propellant gases on a piston which pushes against the heels of the fins extending them at a 45 degree angle during flight. The rockets are fired from a launcher consisting of multiple nested tubes arranged in various configurations. Electrical energy to fire the rocket is provided by the aircraft. The rocket consists of a nose fuze, warhead, and motor. The warhead contains a shaped charge of composition B and is fuzed with a point initiating, base detonating (PIBD) type similar to figure 8-8, utilizing the piezoelectric crystal principle. The motors are internally threaded to receive the head and consist of an aluminum alloy tube containing a single grain of double base inhibited propellant. The rockets are packed as complete rounds (assembled or

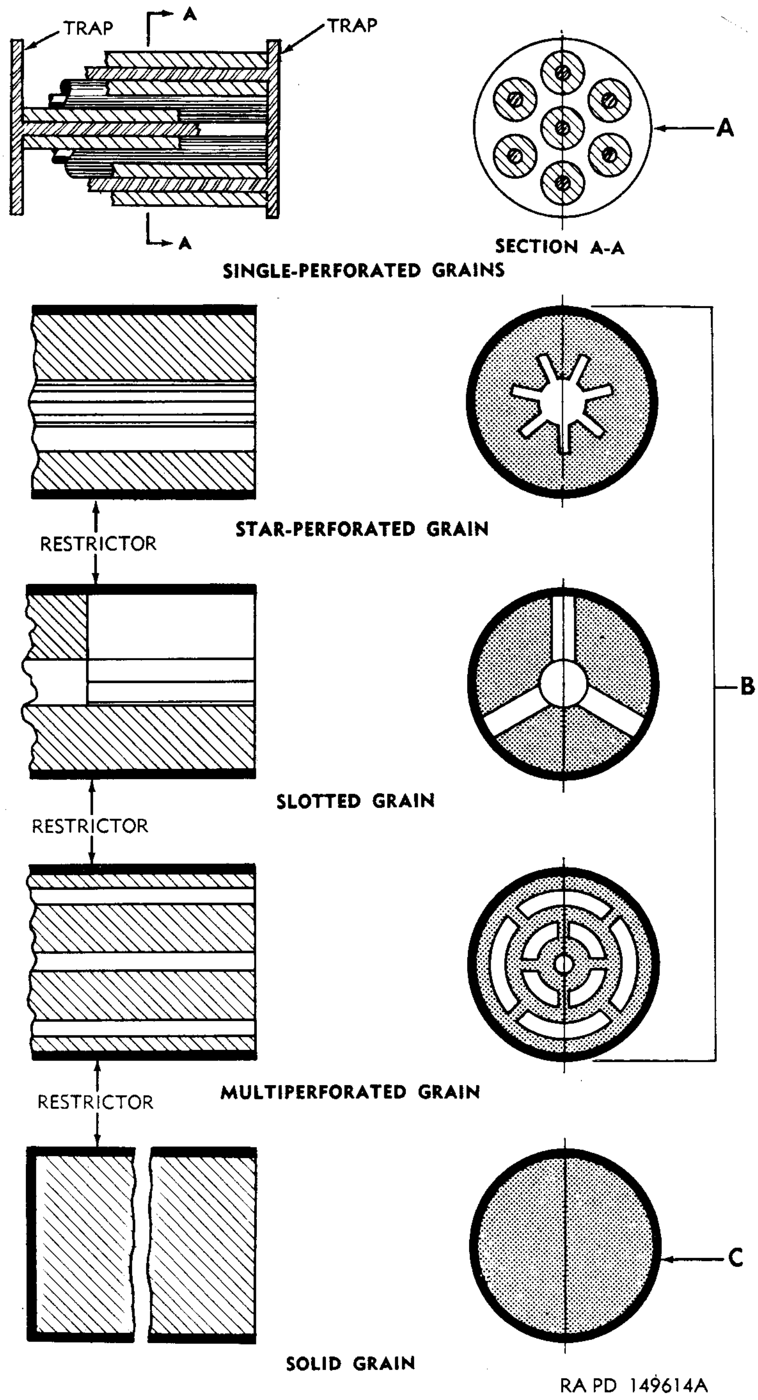


Figure 8-6. Typical JATO propellant grains.

unassembled) or with fuzed heads and motors separate. Packing and shipping data appear in SC 1340/98/IL.

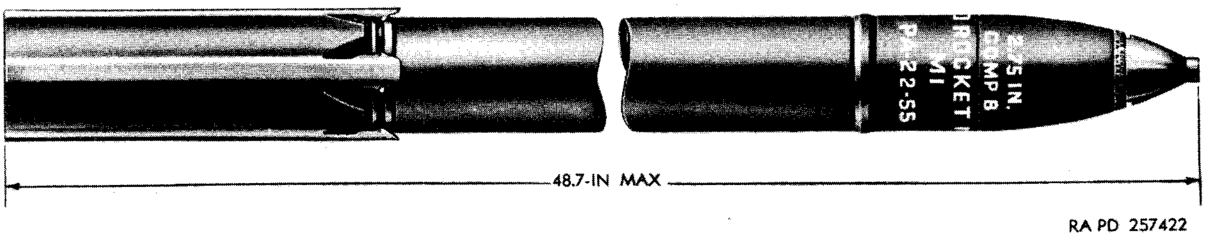


Figure 8-7. Rocket, high-explosive, 2.75-inch: FFAR, AT, M1.

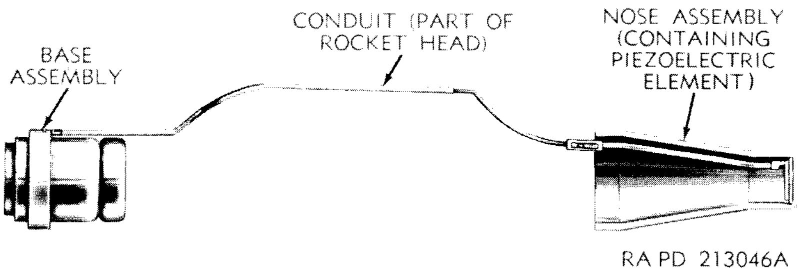


Figure 8-8. Fuze, PIBD: M408 (T2030E4).

b. Rocket, 3.5 inch series.

(1) These rockets (figures 8-9, 10, 11, 12 and 13), of the fixed-fin stabilized type, are fired from the shoulder or from a bipod. The rocket comprises two types--the M35 and M36 series have a velocity of approximately 485 fps, and the M28, M29, and M30 have a velocity of approximately 320 fps. The former series burn completely within the launcher at all operating temperatures. The latter series may continue to burn (after burning) at freezing temperatures after the rocket has been fired from the launcher. Rockets with high explosive heads are used against armored targets. Smoke rockets are used for screening, and rockets with inert head and subcaliber rockets are used for practice. Dependent on the type of head, these rockets are designated high-explosive antitank (HEAT), practice, and smoke (WP). Practice rockets of smaller caliber (figure 8-13) are designated subcaliber and are launched through the bore of the 3.5 inch rocket launcher, utilizing the 3.5 inch rocket launcher firing mechanism with a subcaliber device inserted in the bore. The 27-mm subcaliber rocket matches the M35 series ballistically and is used for economy reasons to save wear on the 3.5 inch launcher and to expend a cheaper rocket during practice. (See table 8-1 for additional 3.5 inch rocket data.)

(2) Rocket HEAT, 3.5 inch, M35 and M35A1 series. These rockets (figure 8-9) are the same except that the M35A1 contains 1.7 pounds of composition B and has a double angle copper cone. These rockets are fuzed with the M408 series PIBD fuze.

c. Rocket, 4.5 inch series.

(1) These rockets (figure 8-14) are characterized by spin stabilization and are similar to artillery projectiles, having cylindrical bodies, ogival noses, and front and rear bourrelets. Electrical contact to fire the rockets is made through contact rings in the base. The rocket is issued with motor and head assembled but unfuzed. The fuze cavity is sealed with a plastic closure, when issued.

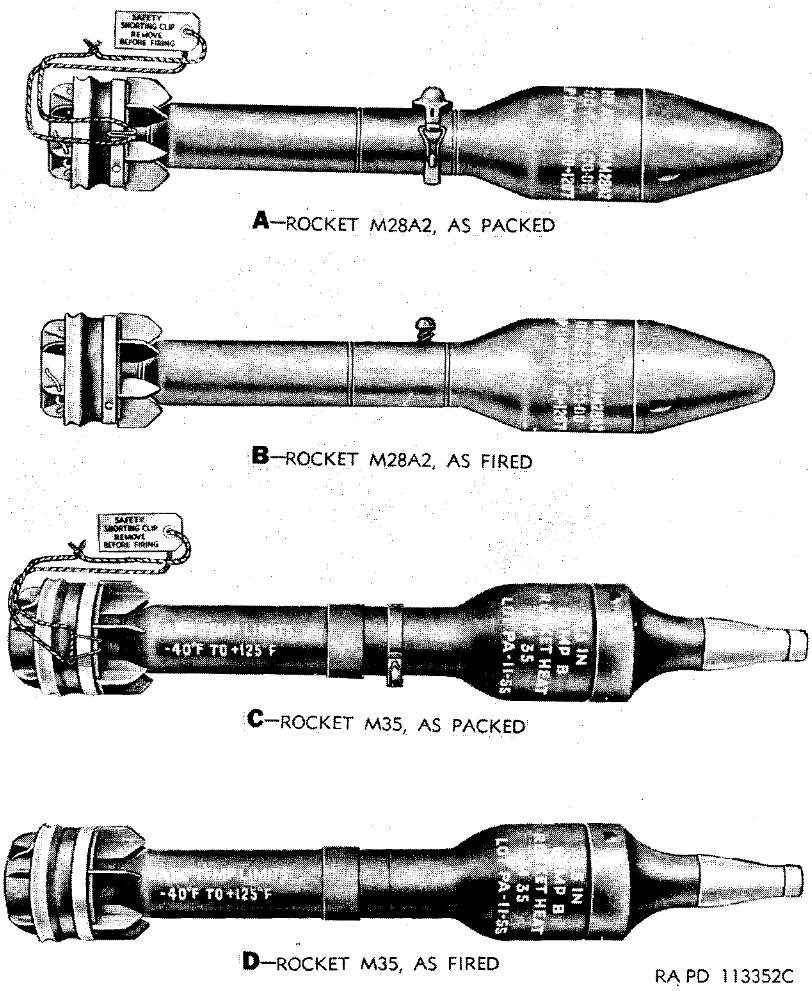


Figure 8-9. 3.5-inch rockets (as fired and packed).

(2) Dependent on the type of head, these rockets are high explosive (HE), practice, gas, or drill. The head is externally threaded at the base for assembly to the motor and internally threaded at the nose to receive the fuze. The HE heads have deep fuze cavities with a supplementary charge for the point detonating fuze. If a variable time (VT) fuze is used the supplementary charge is removed.

(3) The motor contains the propelling charge and the igniter. The nozzle plate-trap assembly for the M32 rocket (figure 8-15) is a thick steel plug having nine equally spaced nozzles and a trap attached to its forward surface. The nozzles are inclined at an angle to impart spin to the rocket in flight. In rockets of earlier manufacture (M16 and M17 series, figure 8-14) the nozzle plate has eight nozzles located near the outer edge and a controlled vent closed by a safety blowout plug designed to blow out when the motor pressure exceeds a safe limit. The propelling charge of the M16 and M17 series consists of 30 sticks of double base propellant mounted on the wires of a cage-like support. The propellant charge of the M32 rocket consists of seven single perforated cylindrical grains of double-base extruded propellant placed on seven plastic propellant rods and positioned against the trap assembly in the motor. The igniter of the M32 rocket consists of a sealed plastic tube containing 25 grams of black powder and an electric squib.

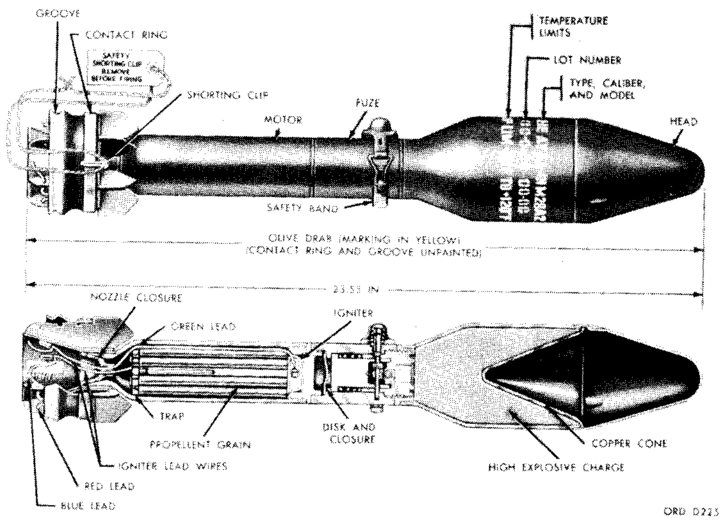


Figure 8-10. Rocket, high explosive, 3.5-inch: AT, M28A2.

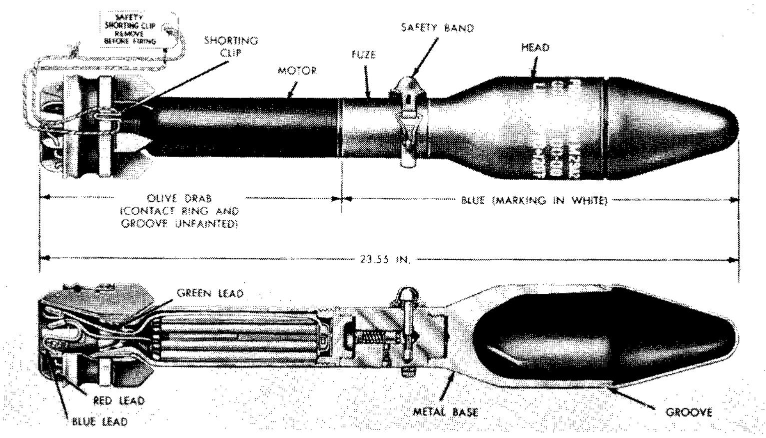


Figure 8-11. Rocket, practice, 3.5-inch: M29A2.

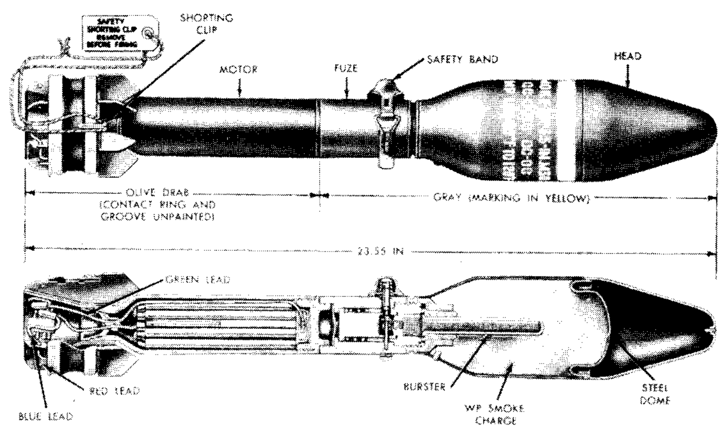


Figure 8-12. Rocket, smoke, 3.5-inch: WP, M30 (T127E3).

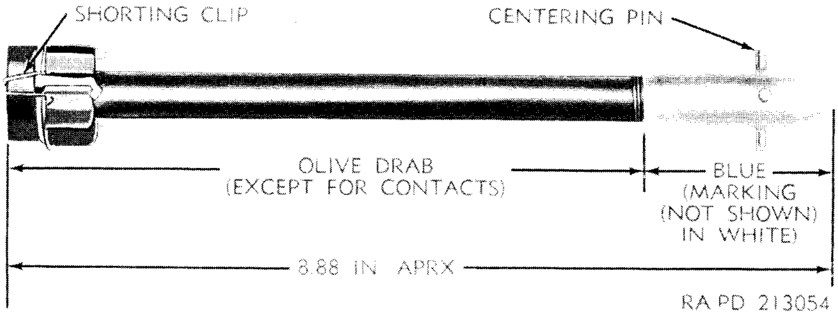


Figure 8-13. Rocket, subcaliber, 27 millimeter: practice, T265.

Table 8-1. 3.5-Inch Rocket Data.

Rocket nomenclature	Length (in.)	Weight (lb.)	Head filler		Weight of propellant (lb.)	Fuze	Velocity (fps)	Range (yds)	Temperature limits (°F)	Burning time (sec)	
			Type	Weight (lb.)						At lower limit	At higher limit
Rocket, high-explosive, 3.5-inch: AT, M28 (T80E2).	23.6	8.9	Comp B	1.93	0.36	M404 or M404A1	334	945	-20 to 120	0.035	0.015
Rocket, high-explosive, 3.5-inch: AT, M28A2	23.6	9.02	Comp B	1.90	0.35	M404A1 or M404A2	317	945	-30 to 120	0.045	0.015
Rocket, high-explosive, 3.5-inch: AT, M35 (T205E1).	23.5	7.3	Comp B	1.60	0.44	M408	485	1300	-40 to 125	0.024	0.009
Rocket, high-explosive, 3.5-inch: AT, M35A1 (T205E3)	23.5	7.6	Comp B	1.70	0.44	M408E1	---	---	-40 to 125	---	---
Rocket, practice, 3.5-inch: M29A1	23.6	8.9	Inert	Empty[1]	0.36	M405	334	945	-20 to 120	0.035	0.015
Rocket, practice, 3.5-inch: M29A2.	23.6	8.96[2]	Inert	Empty[1]	0.35	M405	317	945	-30 to 120	0.045	0.015
Rocket, practice, 3.5-inch: M36 (T206E1).	23.5	7.3	([3])	([3])	0.44[3]	([3])	485	1300	-40 to 125	0.024	0.009
Rocket, smoke, 3.5-inch: T127E2.	23.6	8.98	Smoke (WP)	2.23	0.36	M404A1	317	945	-20 to 120	0.035	0.015
Rocket, smoke, 3.5-inch: M30 (T127E3).	23.6	8.89	Smoke (WP)	2.23	0.35	M404A1 or M404A2	317	945	-30 to 120	0.045	0.015
Rocket, subcaliber, 27-mm: Practice, T265.[4]	8.88	0.32	---	---	---	---	485	---	---	---	---

[1] A manufacturing alternative head consists of the HE head metal parts inert loaded with plaster of paris.
[2] Rockets with alternative head weight 9.02 pounds.
[3] The head of the practice rocket M36 has no filler or fuze. It is hollow and of cast iron.
[4] This rocket authorized practice ammunition for 3.5-inch launchers.

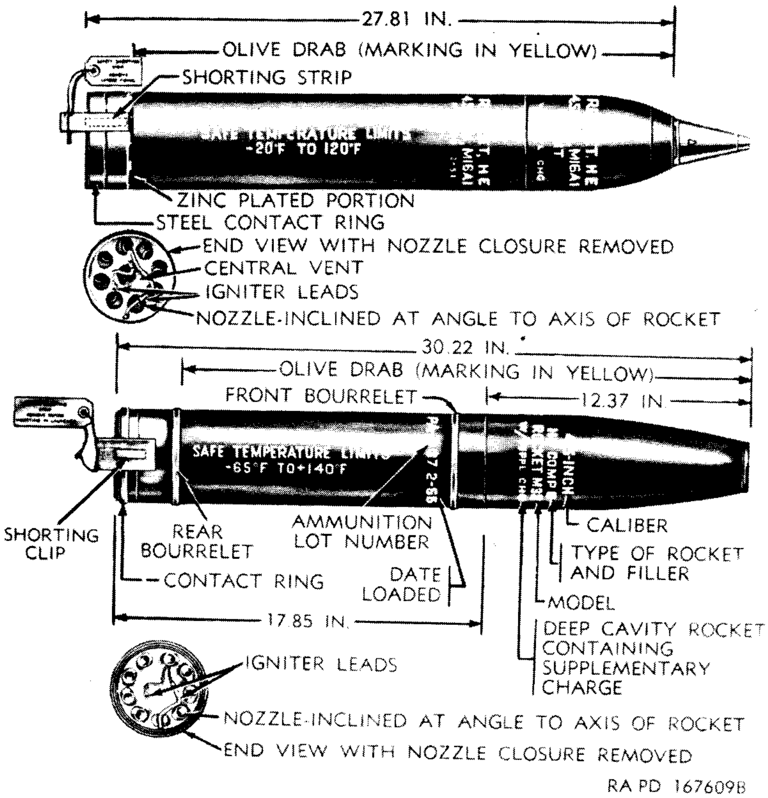


Figure 8-14. 4.5-inch rockets.

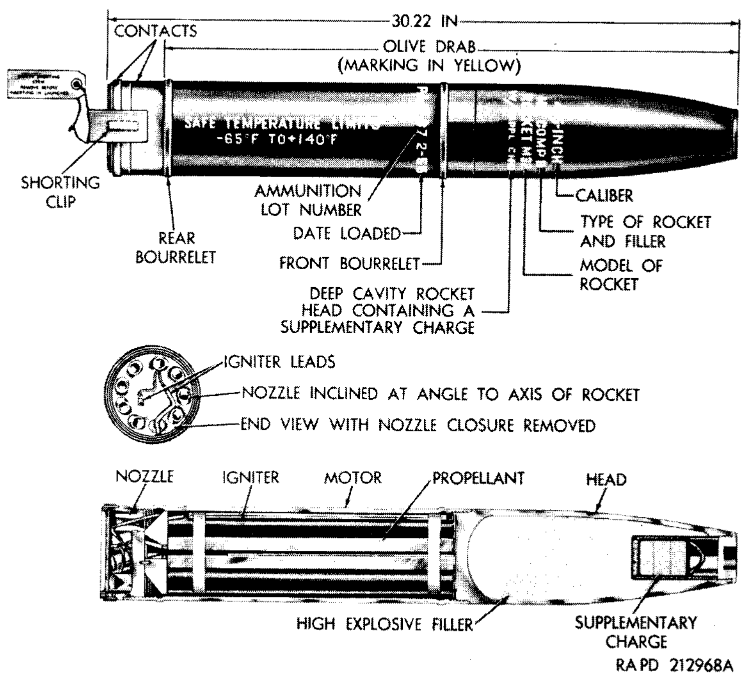


Figure 8-15. Rocket, high-explosive, 4.5-inch: M32.

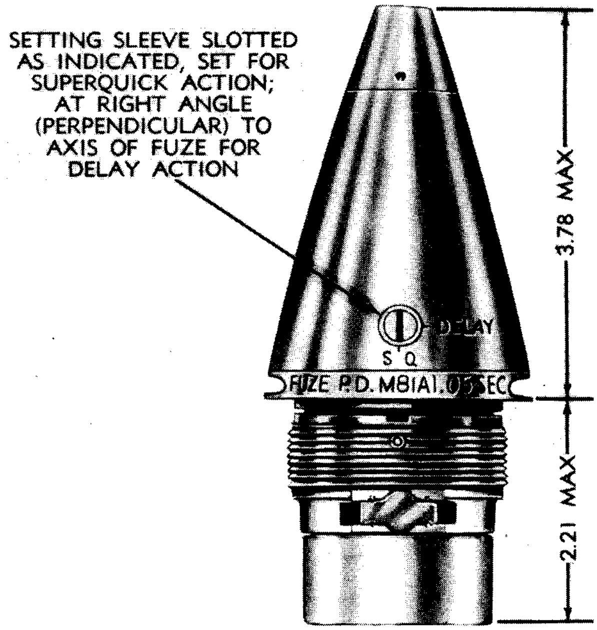


Figure 8-16. Fuze, PD: M81A1.

(4) The artillery type PD fuze M81 series (figure 8-16) and the VT fuze M402 series (figure 8-17) are approved for use in the 4.5 inch HE rockets.

(5) Rocket, HE, 4.5 inch, M32. This rocket (figure 8-15) provides greater maximum range, improved accuracy, and greater lethality than the earlier HE rockets of the M16 series. The rocket is spin stabilized (9 canted nozzles) and has a relatively thin-walled HE head containing 6.1 pounds of composition B designed for blast effect. Front and rear bourrelets on the rocket motor provide bearing surfaces for the travel of the rocket through the launcher. This rocket has a velocity of 1250 fps with a range of 9100 yards at 45 degrees elevation. This rocket is fuzed with the PD M81A1 artillery-type nose fuze with booster assembled. It is a selective superquick or delay type and arms by centrifugal force. The VT fuze M402 (figure 8-17) is a proximity fuze for ground to ground use in the spin-stabilized 4.5 inch HE rockets. This fuze is, in effect, an automatically set time fuze. Without field adjustment, it produces an air burst at a height to cause greatest lethal fragmentation effect against personnel without top cover, such as men in fox holes. The VT fuze M402 can only be assembled to rockets having a deep fuze cavity (figure 8-15) due to the fact that its added length to the rear of the fuze threads requires more space. These rockets are packed individually in fiber containers, either one fiber container per metal container or two fiber containers per wooden box. These rockets are also packed and shipped in the expendable launcher (fig 8-18). The fuze, in a separate fiber container, is packed with the rocket in its launcher in a wooden box.

4. ROCKET, 5.0 INCH SERIES.

a. The 5.0 inch, fin stabilized aircraft rocket (figure 8-19) is a Navy type used by the U. S. Air Force. The Department of the Army stores 5.0 inch base fuzed, rocket heads, nose fuzes, VT fuzes, and rocket motors separately. These components are assembled to make up various complete High Velocity Aircraft Rockets (HVAR) with Navy and Army nomenclature as listed in table 8-2.

b. The various HVAR heads and fuze combinations assembled to the 5.0 inch rocket motors are the MK 6 and Mods, TNT loaded, assembled with permanently installed base fuze of the MK 159 and MK 164 series. The MK6 Mod 4 head may be assembled with the MK 159 and MK 164

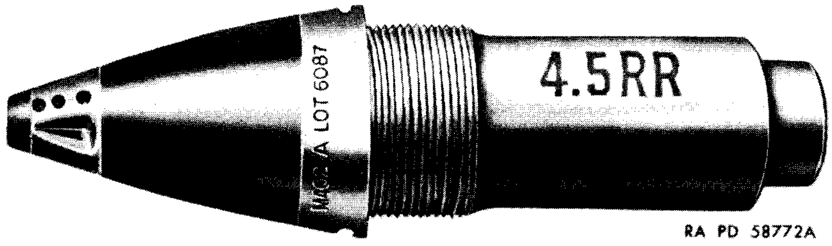


Figure 8-17. Fuze, rocket, VT: M402.

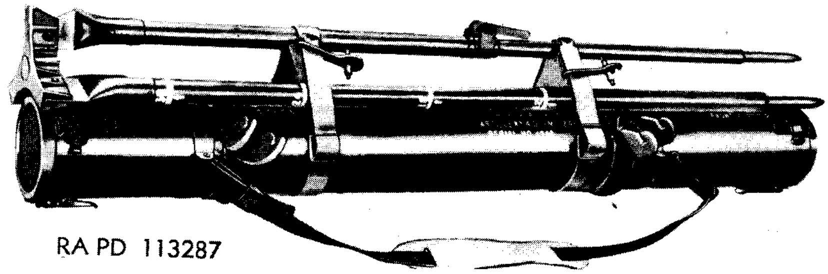


Figure 8-18. 4.5-inch rocket in expendable launcher.

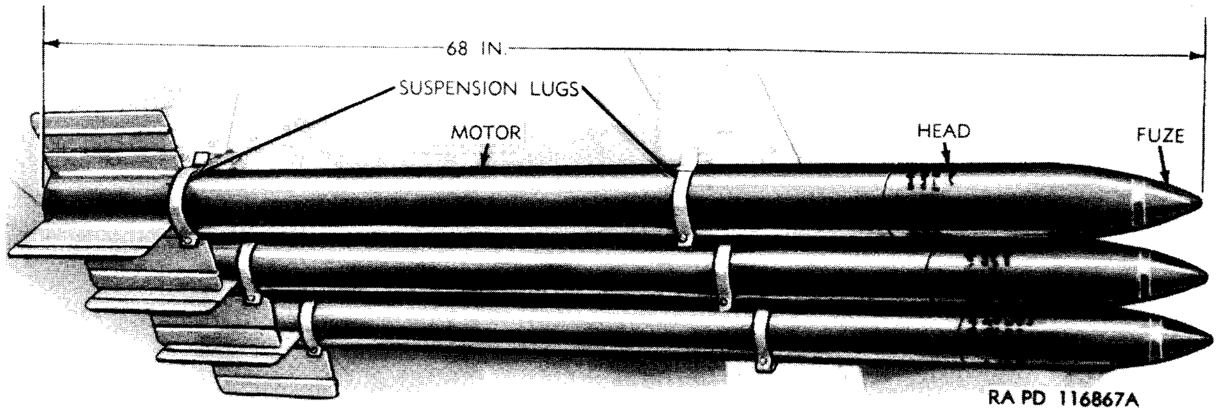


Figure 8-19. Rocket, high-explosive, 5.0-inch: HVAR.

series base fuzes and the VT fuzes M403 series. The MK 25 Mod 1, composition B loaded head, receives the MK 149 series fuze modified for the shaped charge application.

c. The 5.0-inch rocket motors are assembled with the 5.0-inch HVAR heads to form complete rockets. The MK 10 differs from the MK 2 principally in having an Army igniter plug instead of the Navy (bayonet-type) plug. The 5.0-inch motor consists of the motor tube, front closure disk, igniter, propellant, nozzle plate, suspension lugs, and fin assembly. The fin assembly, which is clamped to the aft end of the motor, is a sleeve with 4 equally spaced rectangular fins extending radially (figure 8-20). The propellant is a single, solid, inhibited, double-base cruciform grain (figure 8-21). The igniter is a metal can containing 55 grains of black powder and an electric squib.

d. 5.0-inch rocket, base, nose, and VT fuzes.

Table 8-2. Physical Data for Aircraft Type Rockets.

Size of rocket	5.0-inch (HVAR)			
Army Complete Round Nomenclature.	ROCKET, HIGH-EXPLOSIVE, 5.0-INCH: HVAR	ROCKET, HIGH-EXPLOSIVE, 5.0-INCH: HVAR	ROCKET, HIGH-EXPLOSIVE, 5.0-INCH: HVAR, AT	ROCKET, PRACTICE, 5.0-INCH: HVAR
Navy Complete Round Nomenclature.	5.0-inch Rocket, Mk 4 Mod 0 (aircraft general purpose).	5.0-inch Rocket, Mk 28 Mod 4 (aircraft general purpose).	5.0-inch Rocket, Mk 32 Mod 1 (aircraft, heat).	5.0-inch Rocket, Mk 5 Mod 0 (aircraft practice).
HEAD—Mark and Mod	Mk 6 Mod 4	Mk 6 Mods	Mk 25 Mod 1	Mk 6 Mods
Length (in.)	16.73	16.73	----------------	16.73
Diameter (in.)	5.0	5.0	----------------	5.0
Weight (lb)	45.5	45.5	----------------	45.5
Weight of filler (lb)	7.5 TNT	7.50 TNT	7.50 COMP B	7.50 plaster
MOTOR—Mark and Mod	Mk 10 Mod 6	Mk 10 Mod 6	Mk 10 Mods	Mk 10 Mod 6
Length (in.)	----------------	52.0	52.0	52.0
Diameter (in.)	5.0	5.0	5.0	5.0
Weight (lb)	----------------	89.3	89.3	89.3.
Model of propellant	Mk 18 Mod 0	Mk 18 Mod 0	Mk 18 Mod 0	Mk 18 Mod 0
Weight of propellant (lb)	23.9	23.9	23.9	23.9
FUZE—type, Mark and Mod	Nose VT Fuze M403 or M403E2 Base Mk 164 Mods	Nose Mk 149 Mod 0 or 1 Base Mk 164 Mod 0	Nose Mk 149 Mod 0 Base None	None
ROCKET (assembled)				
Length (in.)	68.6	68.6	68.6	68.6
Weight (lb)	----------------	134.0	134.0	134.0
Velocity (max) (fps)	1360	1325	1325	1325
Temperature limits (°F.)	—20 to 120	—20 to 120	----------------	—20 to 120
Burning time (static) (sec)				
Burning time (effective) (sec).				

(1) The base fuze MK 159 Mod 1 (figure 8-22) screws into the base of the rocket head. The base of the fuze (the exterior surface of the plug) is exposed to the front end of the rocket motor. This fuze is armed by gas pressure from the motor at time of firing. The base of the fuze contains a gas pressure chamber located between the diaphragm and the closing plug. When the rocket fires, gases from the burning propellant slowly enter the pressure chamber in the base of the fuze (figure 8-22) through a small orifice in the inlet screw. Debris from the motor is filtered out by the inlet washer. When the pressure in the chamber has reached between 325 and 375 psi, which is delayed by the small orifice in the inlet screw until half the burning time is consumed, the diaphragm collapses, forcing the arming plunger down and shearing the wire which holds the plunger in place. Movement of the plunger releases the locking ball, which, in the unarmed position, locks the firing pin body in place, and allows the latter to move toward the rear under the force of the firing pin spring and the inertia of the firing pin body due to acceleration. The firing pin, attached to the firing pin body, is withdrawn from the delay-detonator shutter which it normally locks in the safe position. After acceleration, the shutter spring swings the shutter into the armed

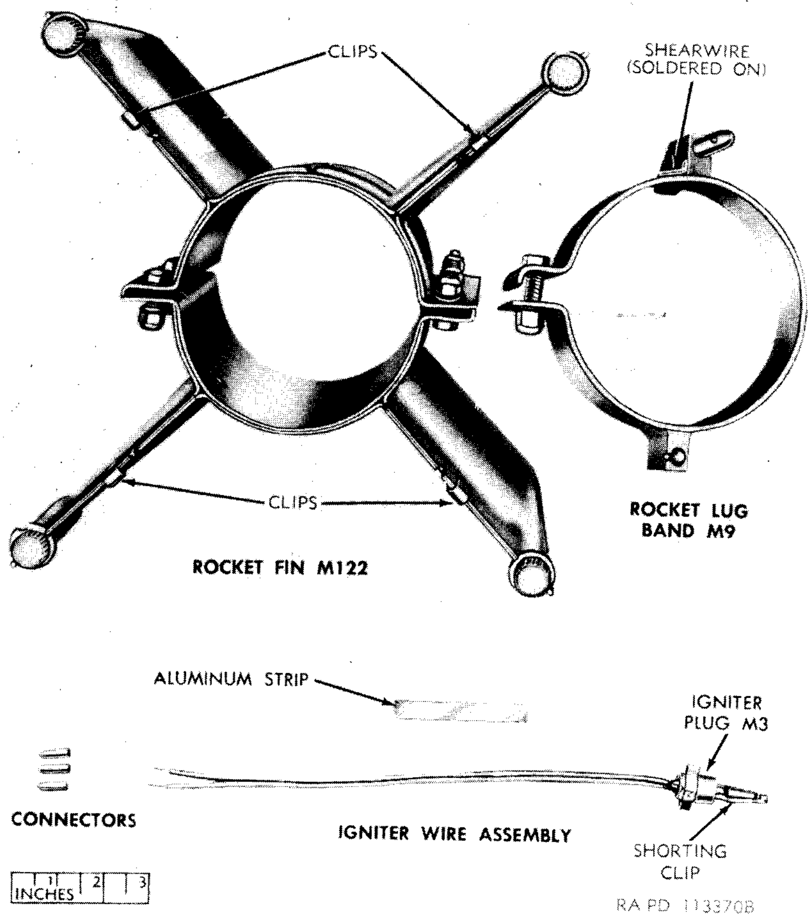


Figure 8-20. Fin assembly kit, 5.0-inch rocket: M34 (T38) for 5.0-inch high-velocity aircraft rocket (Navy).

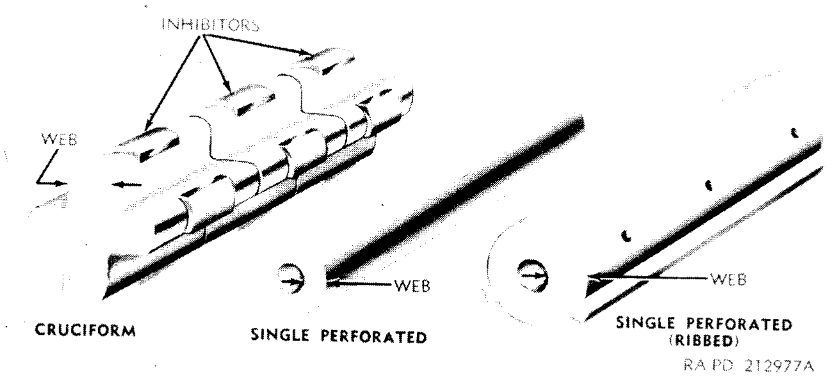


Figure 8-21. Rocket propellant grains.

position (delay-detonator in line with the firing pin and the lead-in) where it is locked in place. The other base fuze models MK 164 and MK 165 are essentially the same as MK 159 Mod 1 except for certain internal modifications.

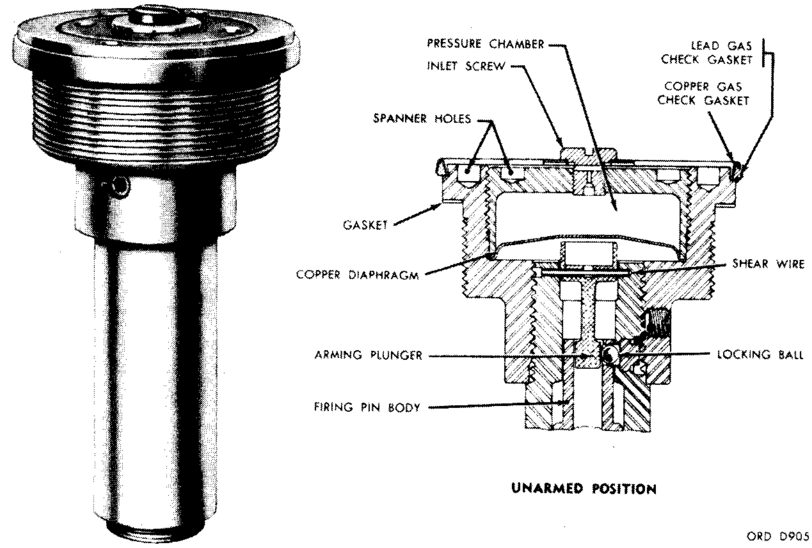


Figure 8-22. Fuze, rocket: base, Mk 159 Mod 1.

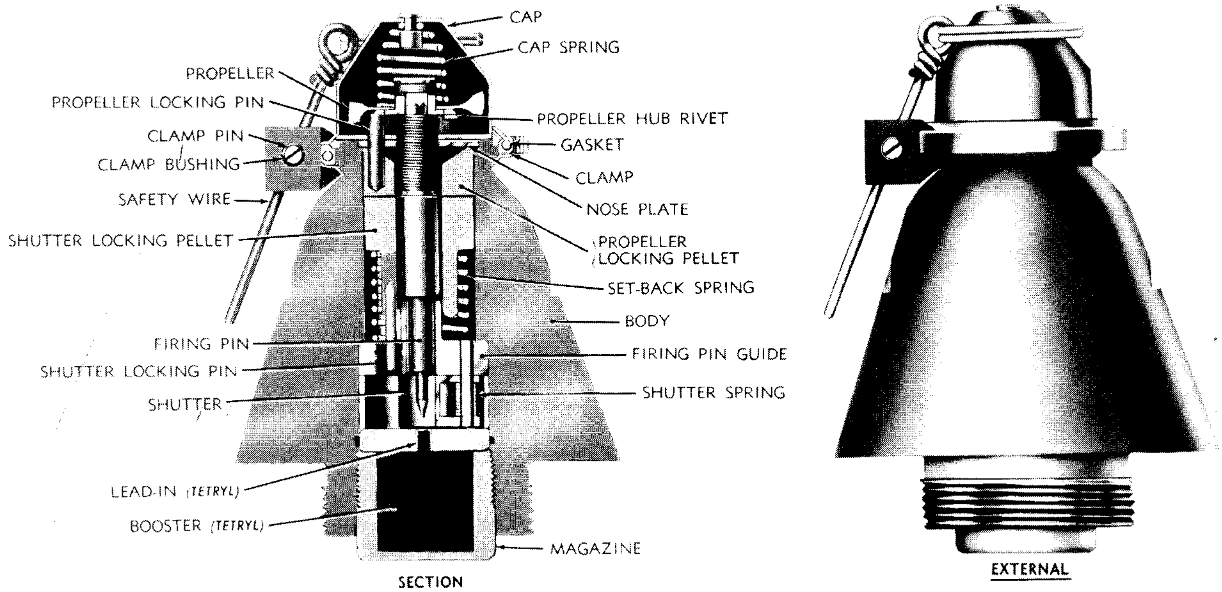
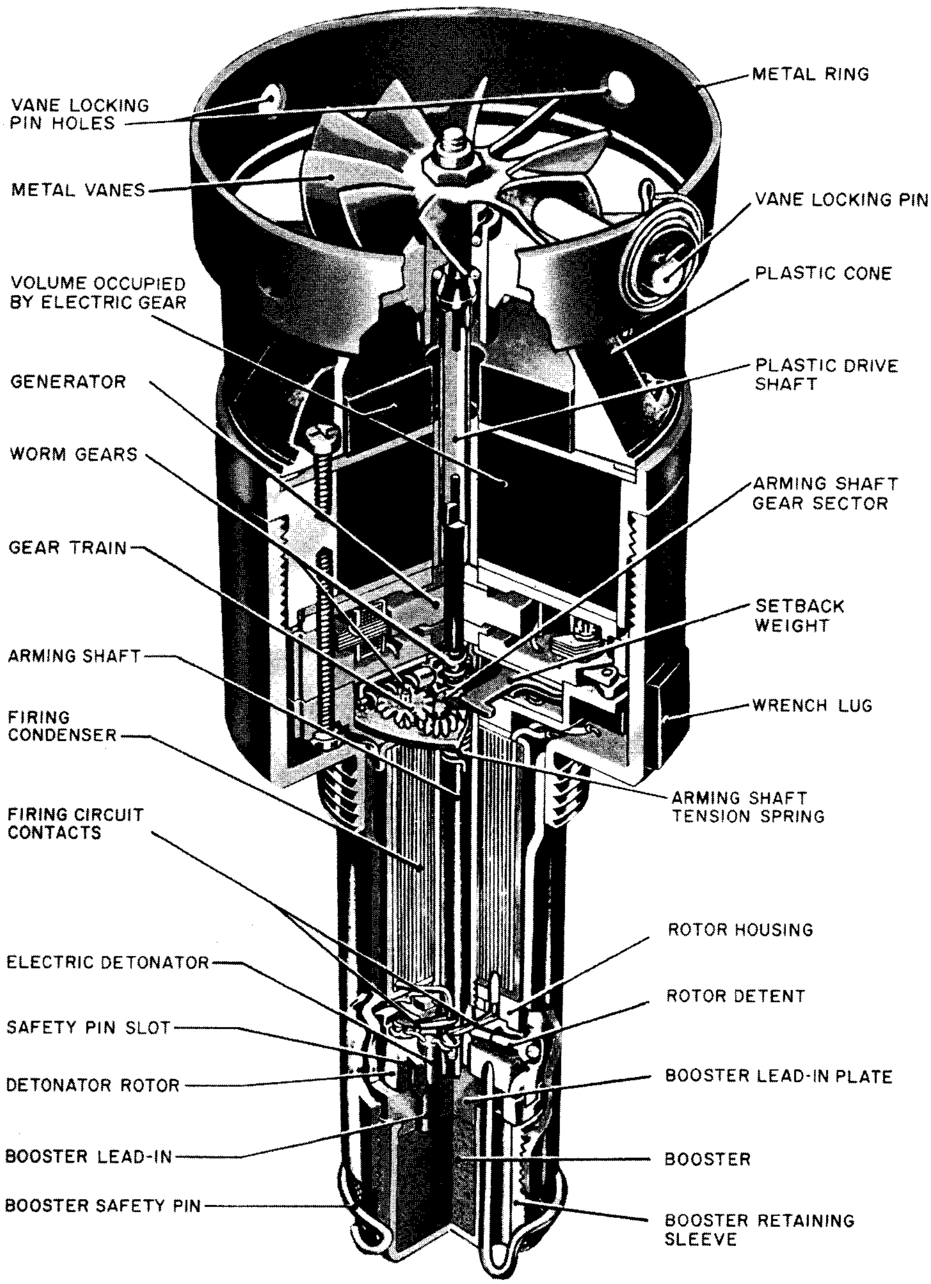


Figure 8-23. Fuze, rocket: nose, Mk 149 Mods.

(2) The nose fuze MK 149 Mod 0 is an air-arming fuze used on the 5.0-inch aircraft rockets. It is detonator safe and functions with superquick action on impact with ground, water, or plate. It requires the use of an arming wire. This fuze (figure 8-23) is streamlined and has a spring-loaded protective cap which protects the propeller and seals the fuze against weather. The cap is held in position by a split clamp which is held together by a collar and pin through which the arming wire and safety wire are assembled. This fuze is detonator safe as the detonator shutter is held in the safe position by a locking pin controlled by a setback sleeve. Thus the detonator can not move to the armed position until acceleration stops, even if the firing pin has been retracted by propeller action.

(3) The VT fuze M 403 (Army) or MK 172 Mod 0 (Navy) (figure 8-24) are proximity fuzes



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

Figure 8-24. Fuze, rocket: VT, M403--detonator in armed position.

used for air to ground firing of the 5.0-inch HVAR rockets. This fuze is, in effect, an automatically set time fuze. Without any field adjustment it functions automatically upon approach to the target, rather than by impact or time action, thereby causing an airburst to occur at a height determined by the fuze mechanism. Normally, functioning occurs at distances between 10 and 40 feet from the target causing greatest lethal fragmentation against personnel in foxholes, slit trenches, and gun crews on shipboard. This fuze requires a deep cavitized rocket head, as available in a 5.0-inch MK 6

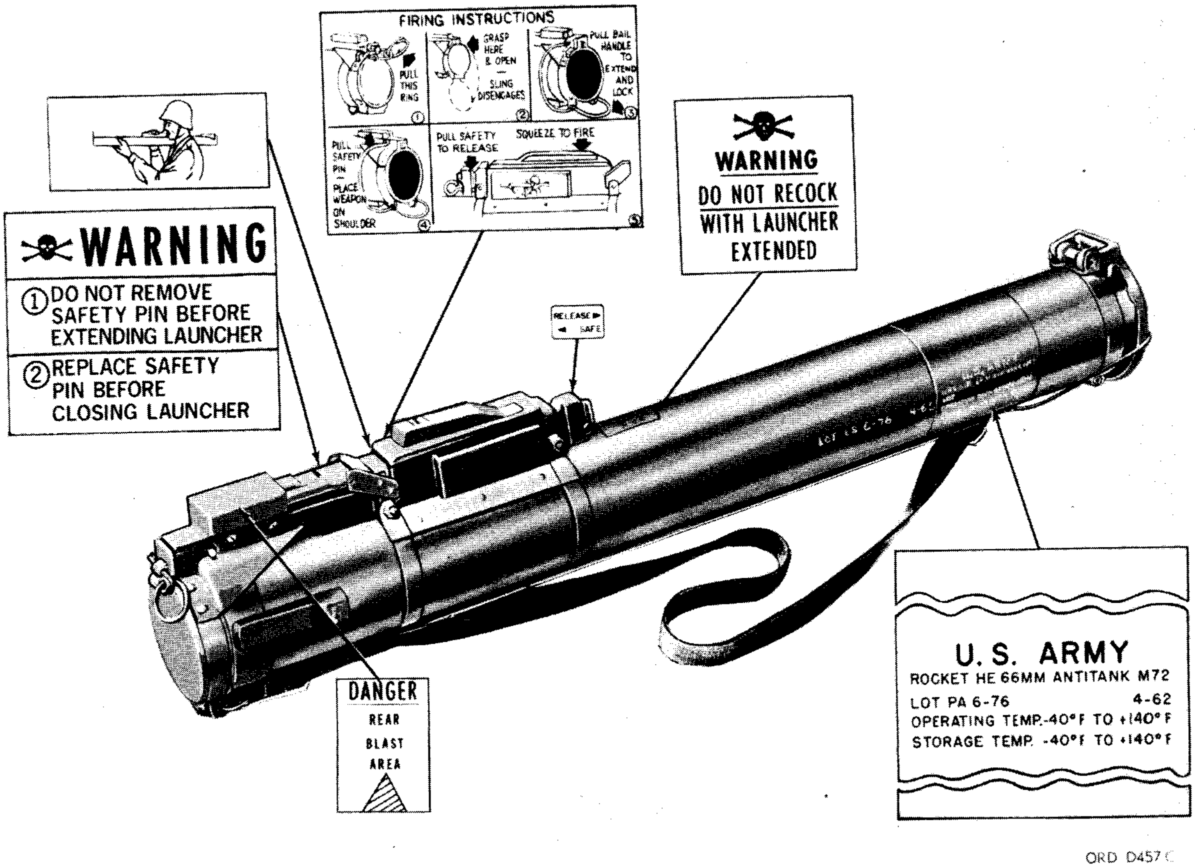


Figure 8-25. Identifying labels.

Mod 4 rocket head. Both mechanical and electrical safety measures (figure 8-24) are embodied in the VT M403 fuze. Safety is provided by an interrupted explosive train, an electrical delay system, and a setback weight in the gear mechanism.

(4) Packing. Normally, 5.0-inch rocket warheads are packed two per wooden box or 48 per pallet. Rocket motors are packed one per wooden box. For additional packing data refer to SC 1340/98-IL.

5. 66MM LIGHT ANTITANK WEAPON (LAW) SYSTEM, M72.

a. General. The LAW system (figure 8-25), consists of a lightweight, shoulder-fired, rocket launcher and a high explosive antitank (HEAT) rocket. The weapon may be fired from either shoulder in the standing, kneeling, sitting, or prone positions. The weapon is issued as a preloaded, single shot disposable launcher. It is compact, portable, completely sealed, and watertight. After the launcher has been extended (figure 8-26) and the rocket fired, the launcher is discarded.

b. The main assemblies of the weapons system are the rocket launcher, the 66MM high explosive antitank rocket, and the sling assembly. The total weight of the weapons system is approximately 4-3/4 pounds; the rocket weighs 2-1/4 pounds and the launcher weighs 2-1/2 pounds. The rocket (figure 8-27) is intended for use against armored targets. The warhead contains a shaped charge of 0.666 pounds of Octol (70% HMX and 30% TNT) cast around a copper cone.

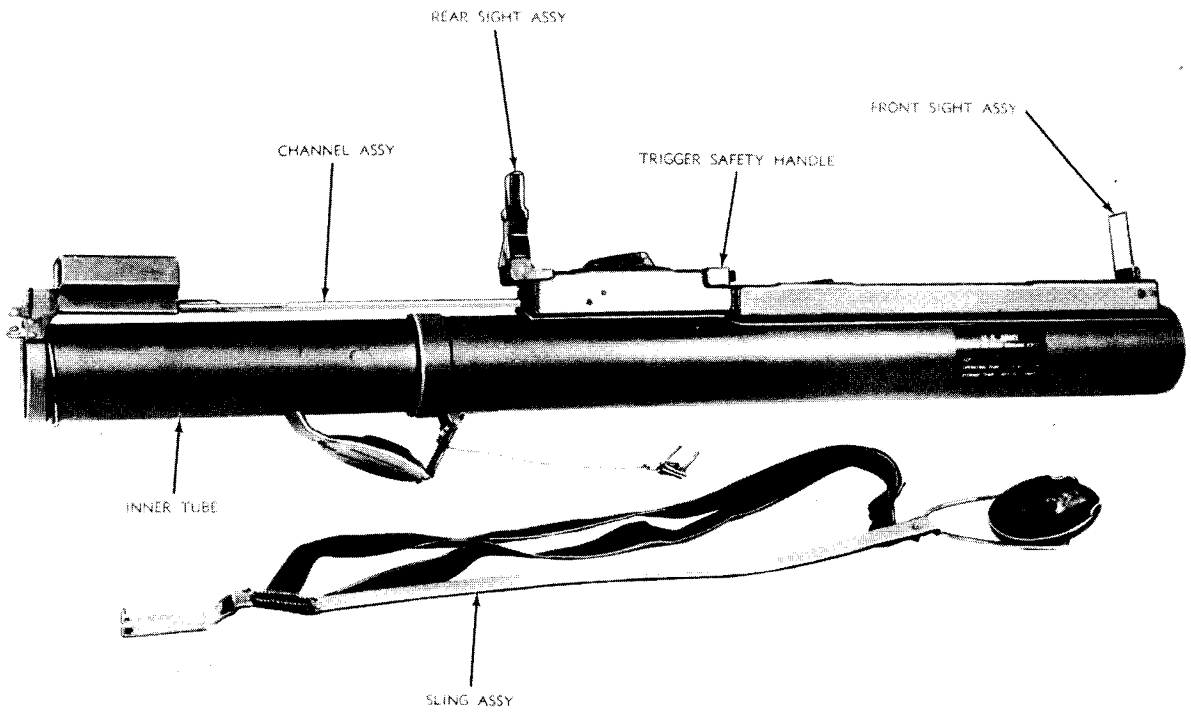


Figure 8-26. 66-mm light antitank weapon system M72--extended position.

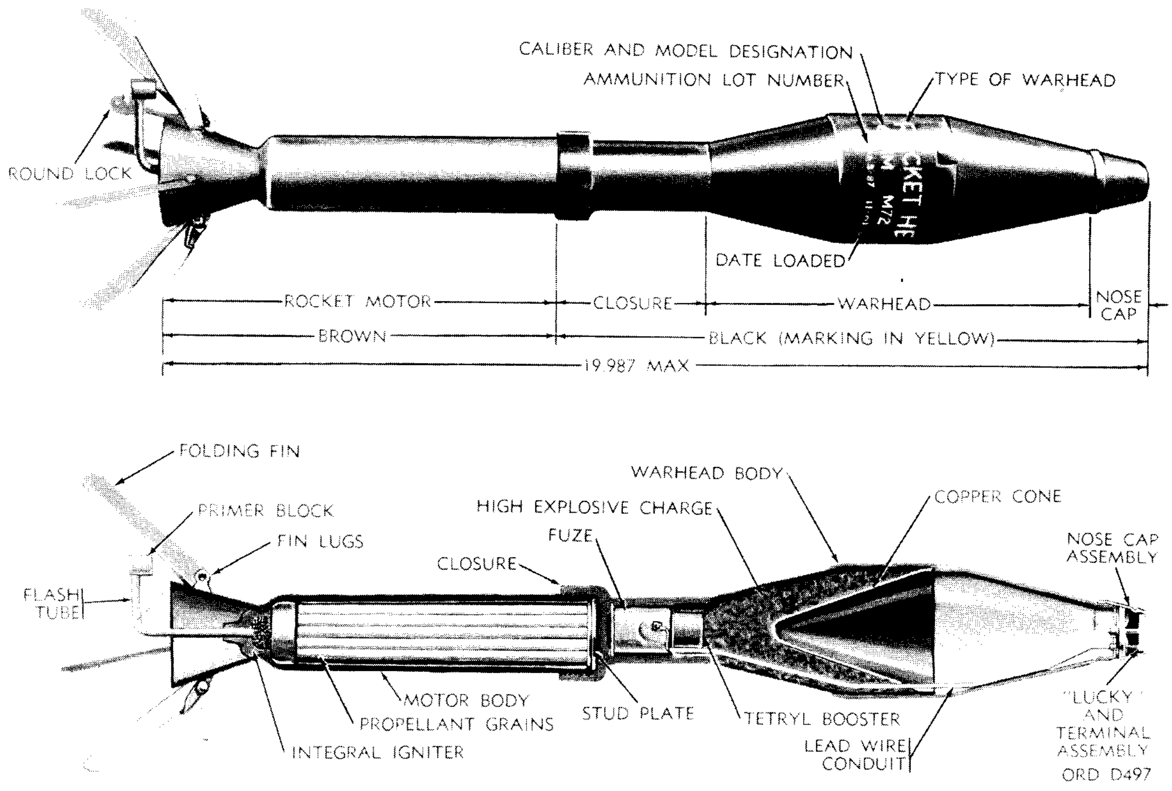


Figure 8-27. 66-mm High-Explosive Antitank Rocket M72.

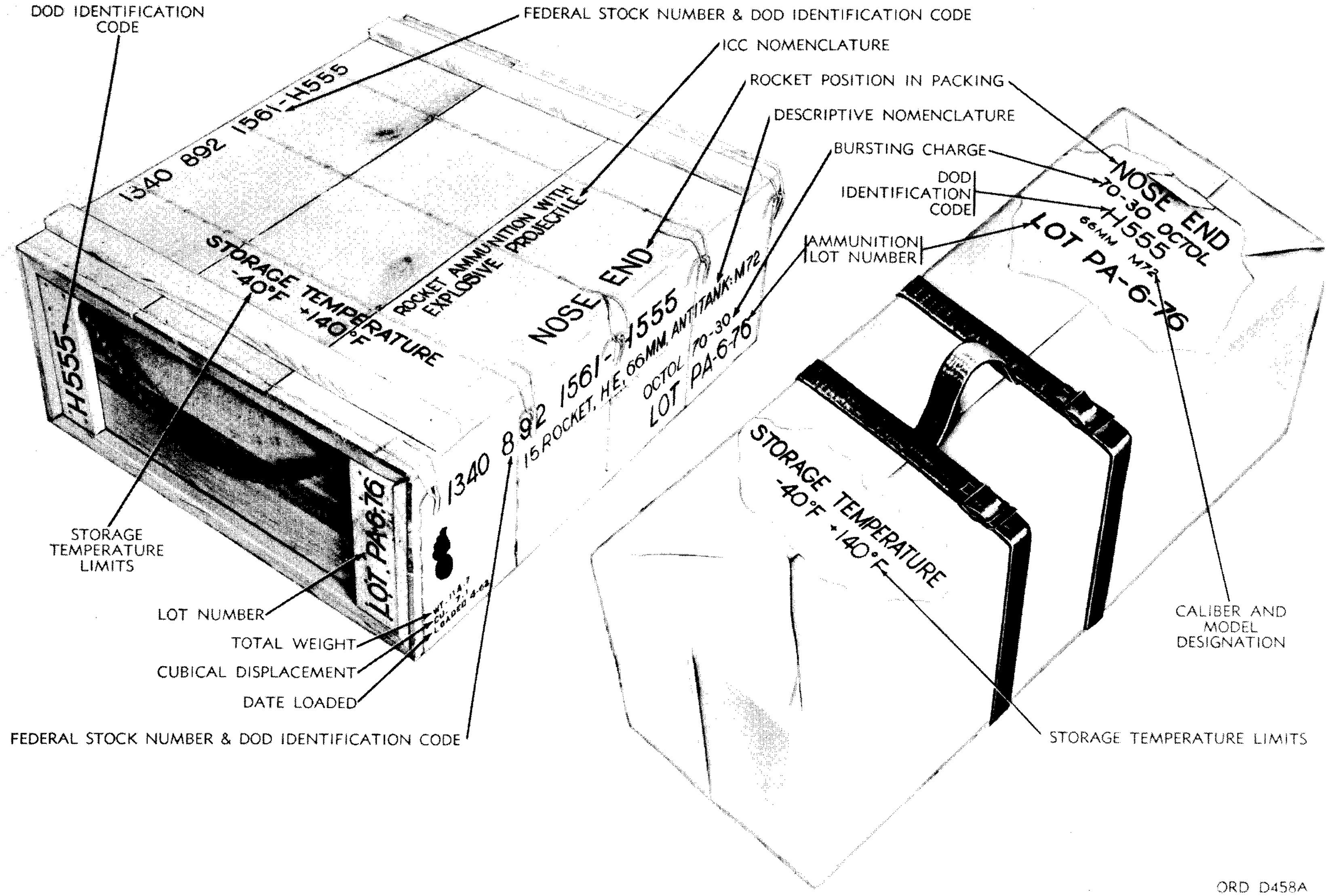


Figure 8-28. Barrier bag and wirebound wooden box.

The fuze M412 is a point-initiating, base-detonating type (PIBD) and incorporates a graze functioning element. Electrical energy required to initiate the fuze is developed by a piezoelectric element (Lucky) located in the rocket nose. It functions with superquick action in less than 100 microseconds on impact. The fuze is dropsafe and boresafe and arms after approximately 30 feet of rocket travel. The rocket has a muzzle velocity of 479 fps and a maximum range of 325 meters.

c. The motor assembly consists of a tube with external threads at the forward end for assembly to the warhead and formed into a cone-shaped nozzle at the rear end. Six equally-spaced spring-activated fins are attached to the nozzle end of the motor body. The propellant charge consists of 19 single perforated cylindrical grains of double-base propellant. The rocket motor igniter is a one piece polyethylene plastic body containing 1.6 grains of grade A4 black powder, a flash tube 2.23 inches long containing an ignition train of black powder impregnated cotton, and a primer block containing a percussion primer loaded with 60 milligrams of grade A5 black powder. The warheads are painted black with markings in yellow, and the motors and closures are painted brown. Five rocket launcher assemblies are packed in a fiberboard container. This container, in turn, is placed in a barrier bag, three barrier bags (15 launcher assemblies) per wirebound wooden box (figure 8-28).

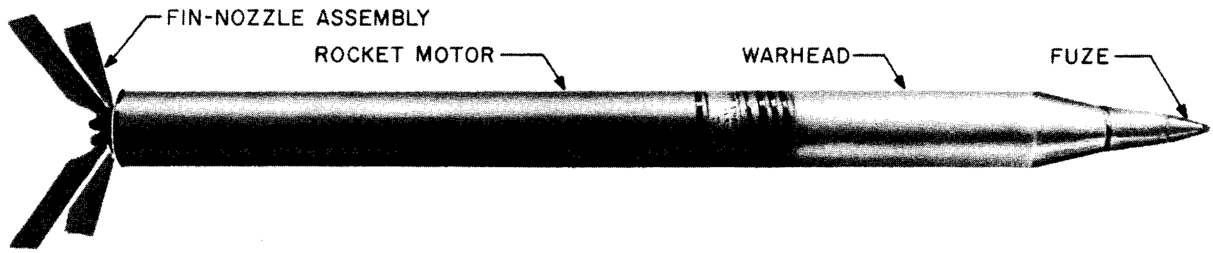


Figure 8-29. 115mm Rocket

6. ROCKET. CHEMICAL, 115mm.

a. The 115mm rocket (figure 8-29) is fired from the 45 round multiple launcher, M91. It is 78 inches long, weighs 58 pounds, and has a maximum range of 12,000 meters. The rocket consists of a warhead, rocket motor, and fin-nozzle assembly. The 115mm rocket system includes the M55 loaded with GB for nonpersistent effect or VX for persistent effect, the M60 dummy training rocket which is used for training personnel in the techniques of loading rockets into the M91 launcher in preparation for firing, and the M61 simulant (EG) practice rocket which is used for training personnel in firing the rockets from the multiple launcher.

b. The warhead is an extruded aluminum cylinder with an ogival nose. A central burster tube, closed at the bottom and at the nose end, is welded into the body of the warhead. The warhead is internally threaded to receive the fuze. The burster tube contains composition B. The fuze, PD, M417 is screwed into the fuze adapter of the warhead.

c. The rocket motor is a cylindrical steel tube containing a double-base solid propellant and an igniter. The tube is threaded at each end to receive the warhead and the nozzle plate of the fin-nozzle assembly. The propellant is designed so as not to present a high explosive problem.

d. The fin-nozzle assembly consists of a nozzle plate containing four nozzles. Four spring-loaded aluminum fins are attached to the nozzle plate. Lead wires from an electric squib in the igniter of the rocket motor project from one of the nozzles in the nozzle plate where they are readily available to the loader when the rear cap of the shipping-and-firing container is removed.

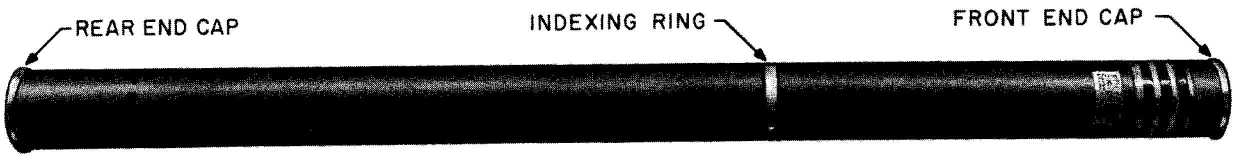


Figure 8-30. Shipping and Firing Container.

e. Each rocket is placed in a shipping-and-firing container (figure 8-30) which is made of fiberglass reinforced with plastic. The container is closed at each end with a removable cap (1 and 3, figure 8-30). Each cap (figure 8-31) is of one piece construction with a sampling plug and handle.

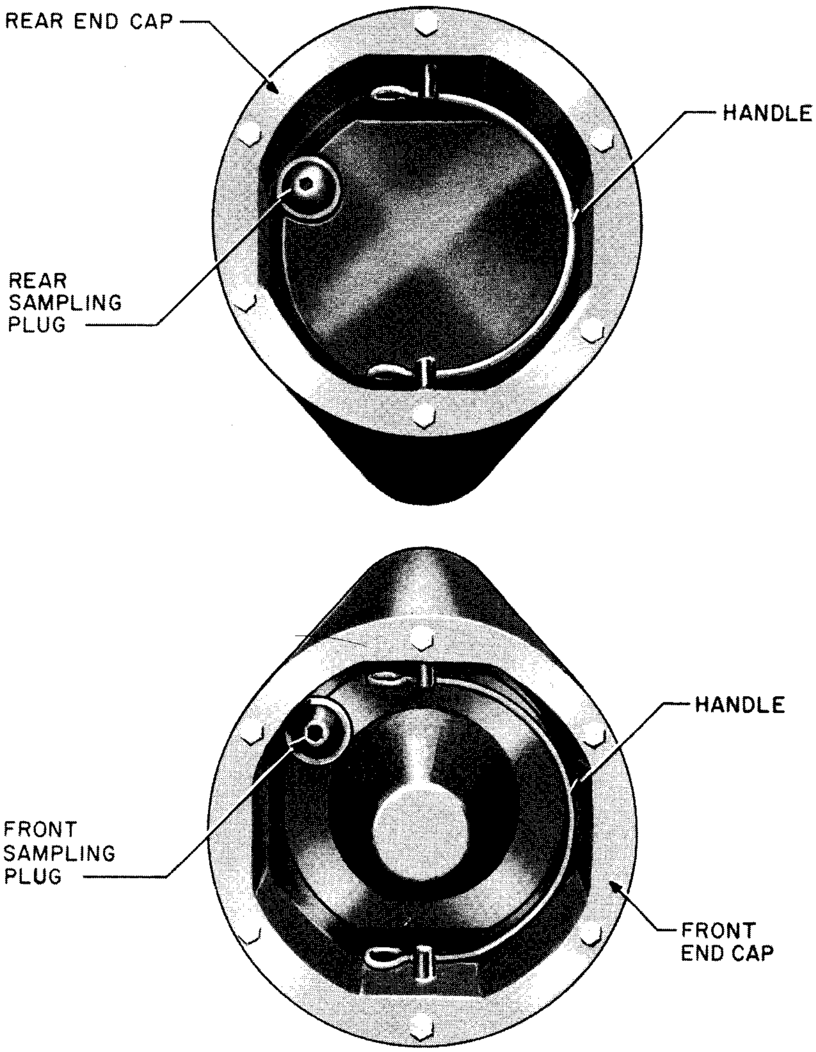


Figure 8-31. Removable Cap.

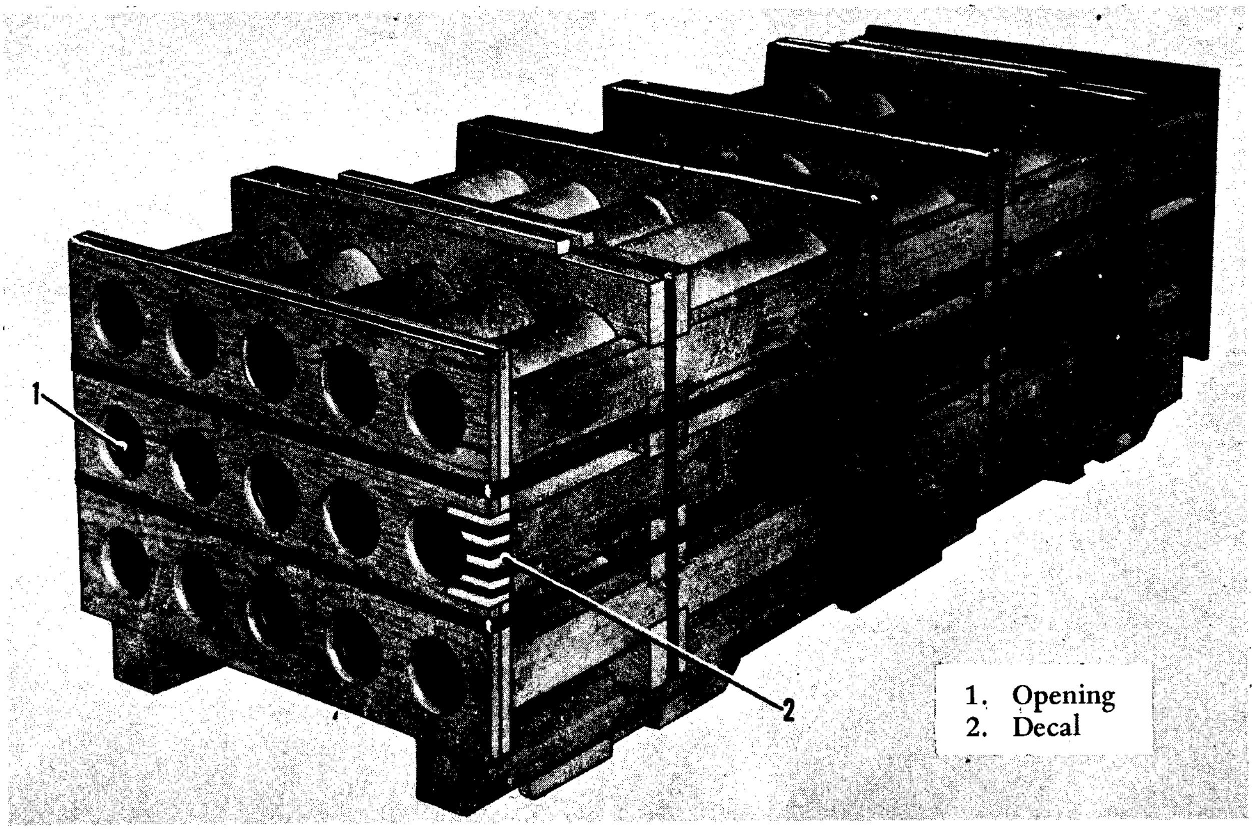


Figure 8-32. Wooden Crate.

The caps are removed by raising the handle to an upright position, rotating the cap 90 degrees, and then pulling the cap from the container. The purpose of the sampling plug is for testing during surveillance. An indexing ring (2, figure 8-30) is used to lock the shipping-and-firing container in the multiple rocket launcher. Fifteen rockets in their shipping-and-firing containers are placed in a wood crate (figure 8-32). The end panels of the crate are provided with openings (1) to permit removal of the sampling plugs in the end caps of each shipping-and-firing container, and a decal (2) containing a 1/4 inch yellow band and three 3/8 inch green bands on a gray background.

f. The M55 rocket (figure 8-33) is filled with either GB or VX. An identification decal is affixed to the warhead of each rocket and to the forward end of the shipping-and-firing container. The M60 dummy training rocket is readily identified by a blue decal and the M61 practice rocket is identified by a yellow band and white letters on a decal with blue background.

7. 762MM ROCKET (HONEST JOHN) SYSTEM.

a. General. The 762-mm rocket is a free flight, surface-to-surface, fin and spin-stabilized, solid propellant, field artillery rocket and is fired from a rail-type launcher. The rocket follows a ballistic trajectory and is designed to carry a 1,500 pound warhead. To reduce the effects of thrust malalinement, the rocket is assembled with small spin rockets which cause the rocket to rotate after it leaves the launcher. The igniter is activated by electric current from an external power source and ignites the rocket motor propellant. Holding pins, secured to the launcher rail by a lanyard, are withdrawn from two percussion primer thermal activated batteries (M31 rocket) when the rocket starts moving. This action activates the batteries, which supply the current required to ignite the spin rockets. As the rocket moves up the launcher rail, a striker rod protruding from the rail shears

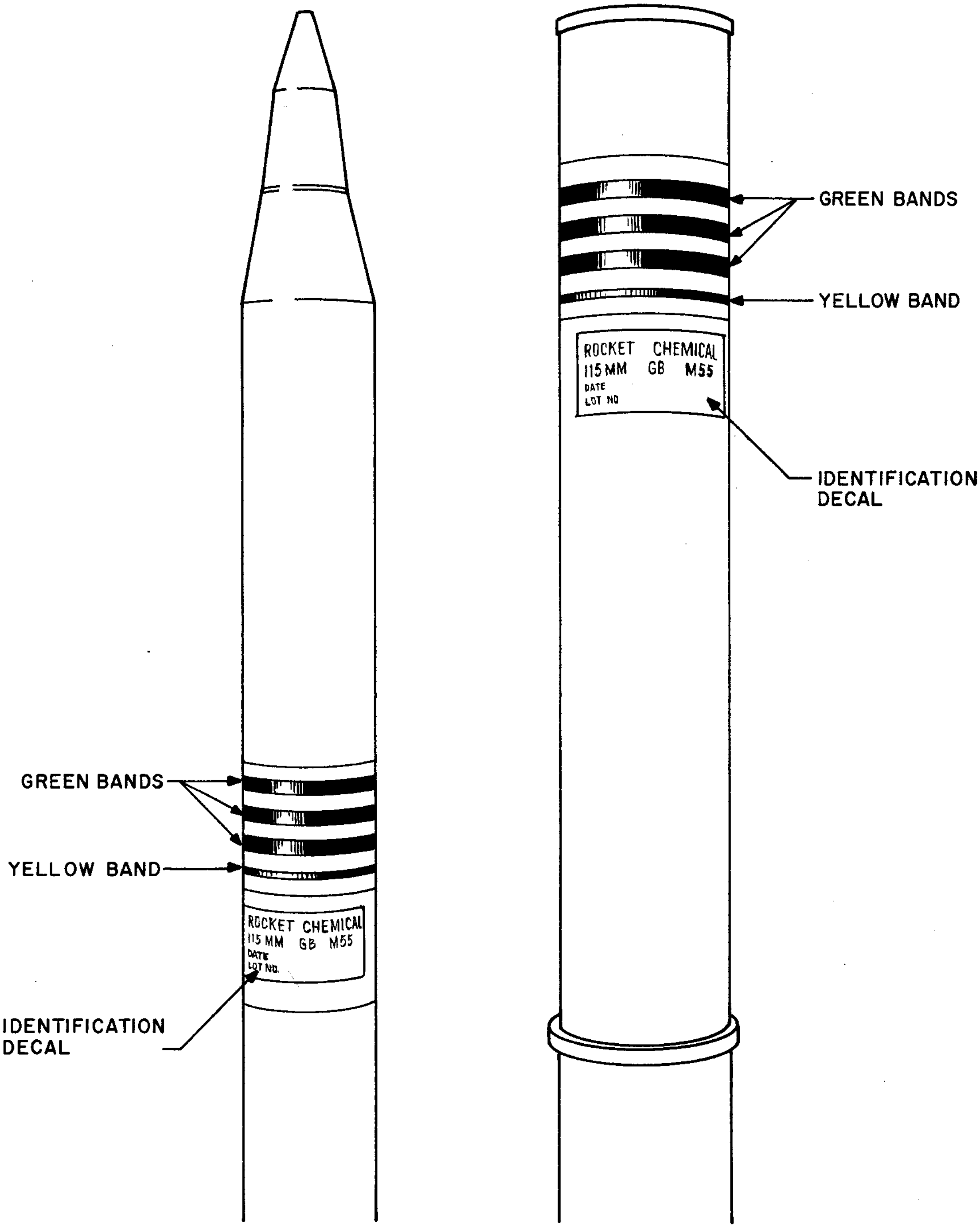


Figure 8-33. M55 Rocket.

the spin rocket ignition switch handle, closing the circuit from the batteries to the spin rockets and igniting them. The spin rockets and the igniter of the M50 rocket are initiated at the same time by batteries which are activated by electric current from an external source. Specific location on the

Table 8-3. Authorized Components for Rocket M31A2.

Warhead section [1]	Rocket motor assembly M3A2			Fins
Practice warhead section M38 with fuze MT M421 or High-explosive warhead section M57 with interval timer M12 or Chemical warhead section M190 with fuze MT M421	Pedestal M2A1 (with eight spin rockets M7A2 or M7A2B1)	Rocket motor M6A2 (with igniter M35A2)	Nozzle fairing M1A1	Four fins M136A1 or Four fins M136A2 or Four fins M136A2B1

[1] Not including certain special warheads.

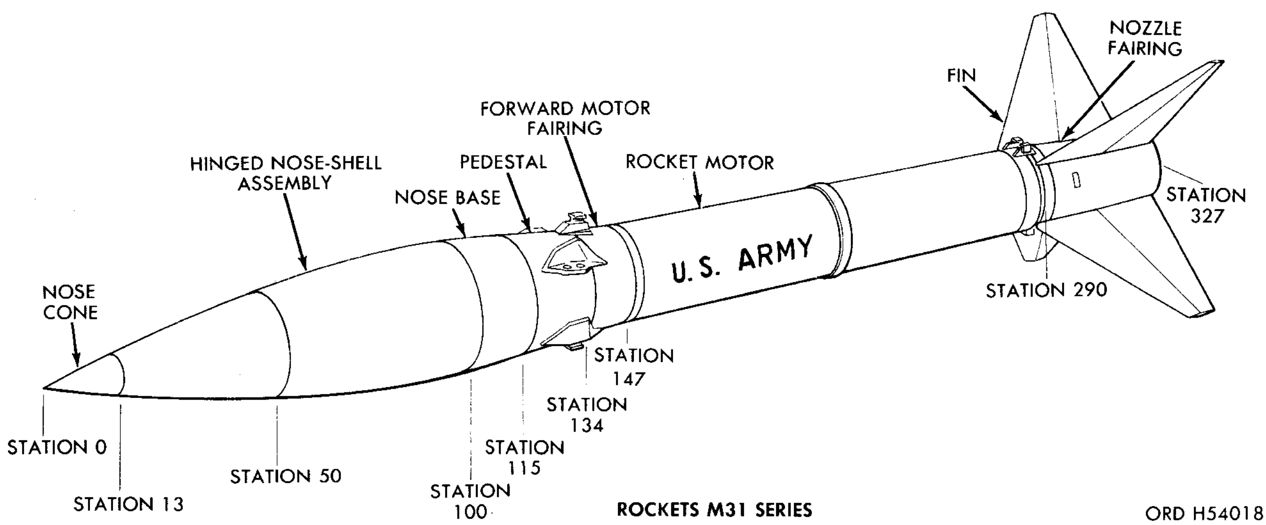


Figure 8-34. 762mm rocket MGR-1A (M31 series), with station locations.

rockets (figures 8-34 and 8-35) are expressed as "station." A station number indicates the distance (in inches) from the foremost point on the nose tip to that particular station.

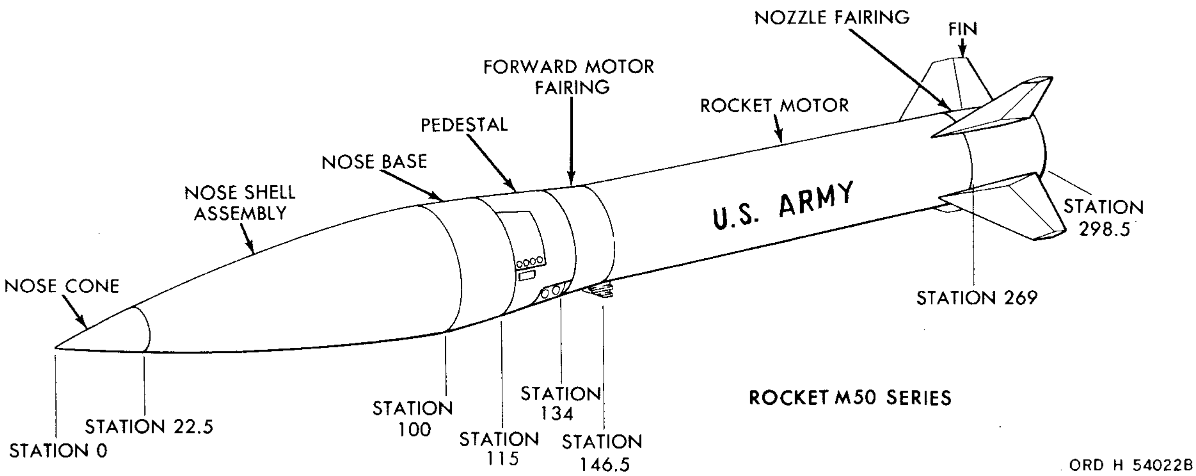


Figure 8-35. 762mm rocket MGR-1B (M50 series), with station locations.

b. Rocket, MGR-1A (Mobile Surface Rocket) (M31 Series).

(1) The components (table 8-3) of this system are the warhead, rocket motor and the fin assembly. The practice warhead M38 consists of a shell assembly, a ballast assembly, two spotting charges, and fuzing components. The nose cone assembly (figure 8-36) houses the mechanical time fuze (figure 8-37). This assembly is opened by two push button latches. The ballast assembly consists of a series of steel plates welded to a pipe and provides the warhead section with the proper weight and center of gravity. Two spotting charges are housed in the nose base skin and retained by two ring assemblies. Each charge consists of 1-1/2 pounds of spotting composition. The fuze contains two identical timer units which function independently of each other and is capable of initiating the explosive train. The fuze can be set from 0.1 seconds to 120 seconds by use of a fuze setting wrench.

(2) The HE warhead M57 is used with Rocket, MGR-1A only. It consists of the warhead shell (figure 8-38), warhead M57, and fuzing components. The nose shell is hinged at station 50 to provide access to the warhead and fuzing components. The warhead is bolted to a ring assembly at station 100 and consists of 170,000 spherical steel fragments contained between two aluminum shells mounted one within the other and interconnected by a steel end plate which provides rigidity to the warhead, supports the adapter booster, and confines an explosive charge of 412 pounds of composition B within the inner aluminum shell. The fuzing system consists of an interval timer M12, safety-and-arming device M43, power supply Y155, inertia switch M6, electrical-contact (crush switch) assemblies M65, M66, M67, and M68, an explosive harness assembly, and the wiring necessary for electrical connection of these items. The inertia switch and the crush switch

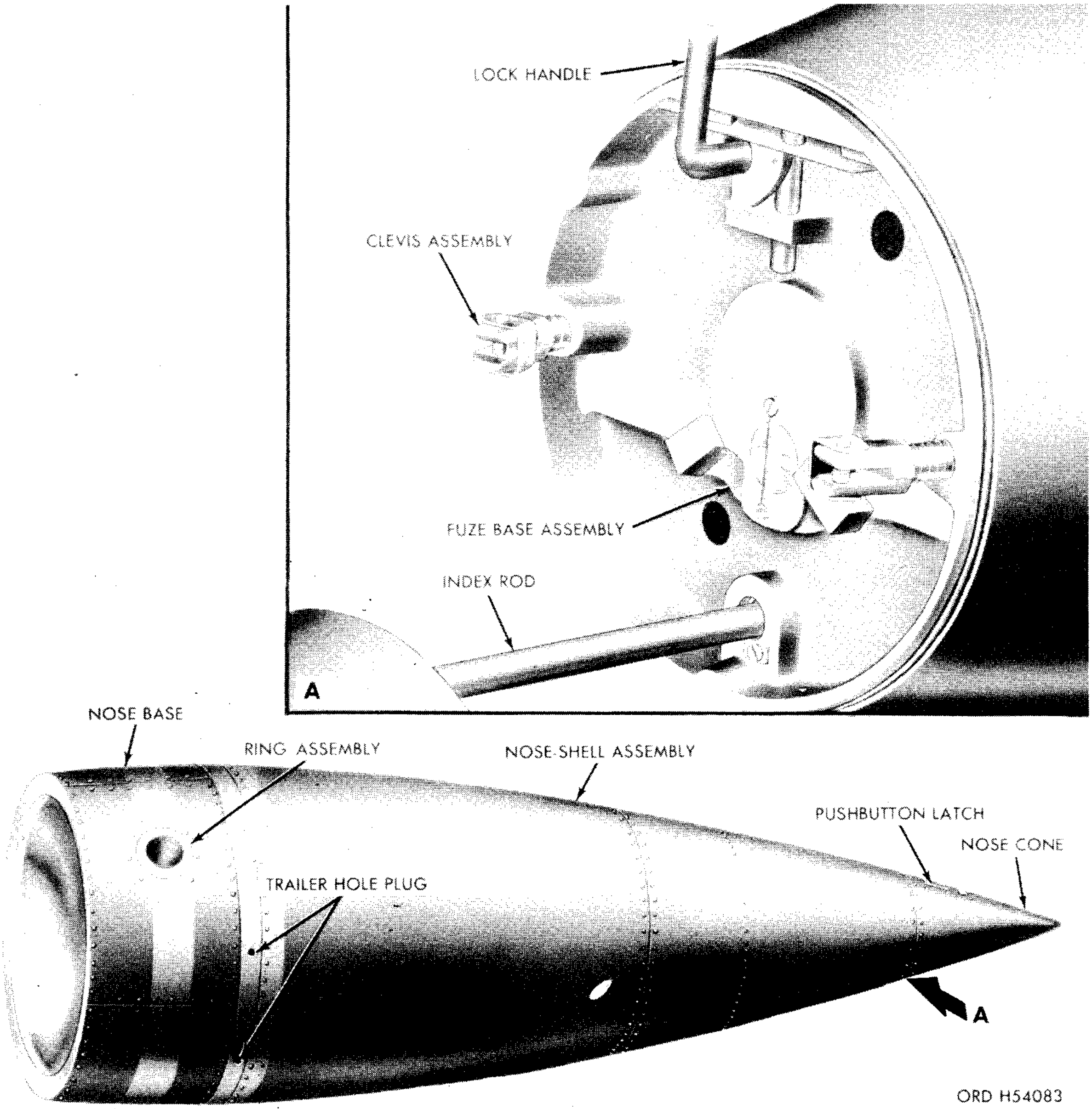


Figure 8-36. Practice warhead section M38.

assemblies are parallel-connected with one another and series-connected with the safety-and-arming device, the interval timer, and the power supply. All of these items, except the explosive harness and the electrical contact assemblies, are mounted on a control panel (figure 8-38C) just to the rear of the hinged joint in the warhead section. The explosive harness consists of a length of detonating cord equipped with threaded connectors. One end of the harness is connected to the safety-and-arming device and the other end to the adapter booster assembled in the base of the warhead. The interval timer M12 contains no explosive components and is essentially an inertia-activated, mechanical time device used as an electrical switch between the power supply and

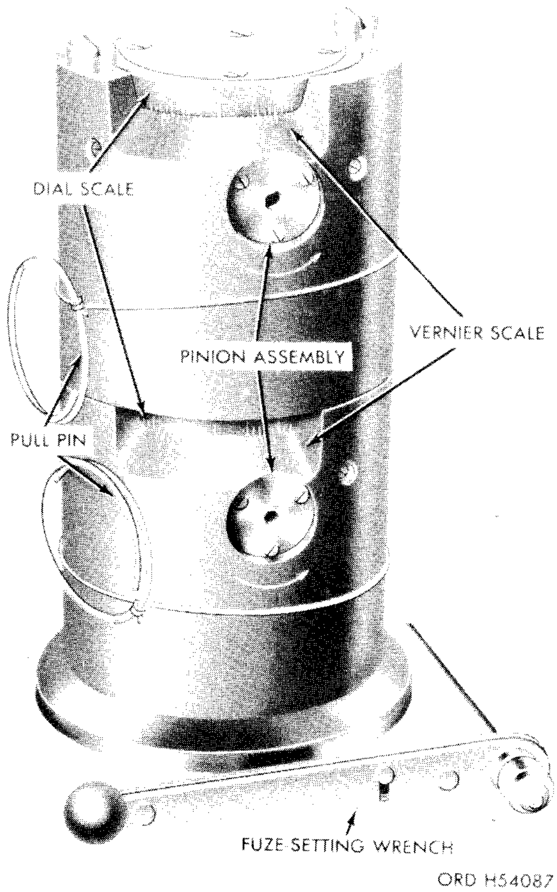


Figure 8-37. Fuze MT M421.

the safety-and-arming device. The safety-and-arming device M43 consists of a detonator, a G-weight, and two sets of electrical contacts. One set of contacts maintains a short across the detonator when the device is unarmed; the other set completes the internal circuit to the detonator when the device is armed. When the rocket is fired, the G-weight arms the device by removing the short from the detonator, thus completing the internal circuit and aligning the detonator with the explosive harness. Upon impact of the warhead section and deformation of any of the crush switches or the inertia switch M6 completing the fuzing circuit, current supplied through the electrical contacts initiates the detonator, which in turn, initiates the explosive harness, the booster, and the high explosive charge.

(3) The chemical warhead section M190 (figure 8-39) consists of a warhead casing filled with 368 nonpersistent GB gas bomblets M139 (figure 8-40). The warhead is fuzed with the MT fuze M421 (figure 8-37). The GB gas bomblet M139 is a 4.5-inch hollow aluminum sphere consisting of two halves held together by a lightweight steel band. An all-ways fuze, enclosed in a composition B burster with an RDX booster, is located in the center of the sphere between the halves of the bomblet. External driving vanes on the bomblet cause the bomblet to spin and disperse. The spinning of the bomblet arms the fuze, which functions when the bomblet impacts.

(4) Rocket motor assembly M3 series is for the M31 series system. The current M3 series rocket motor assembly (figure 8-41) consists of the pedestal M2A1 (figure 8-42), the rocket motor

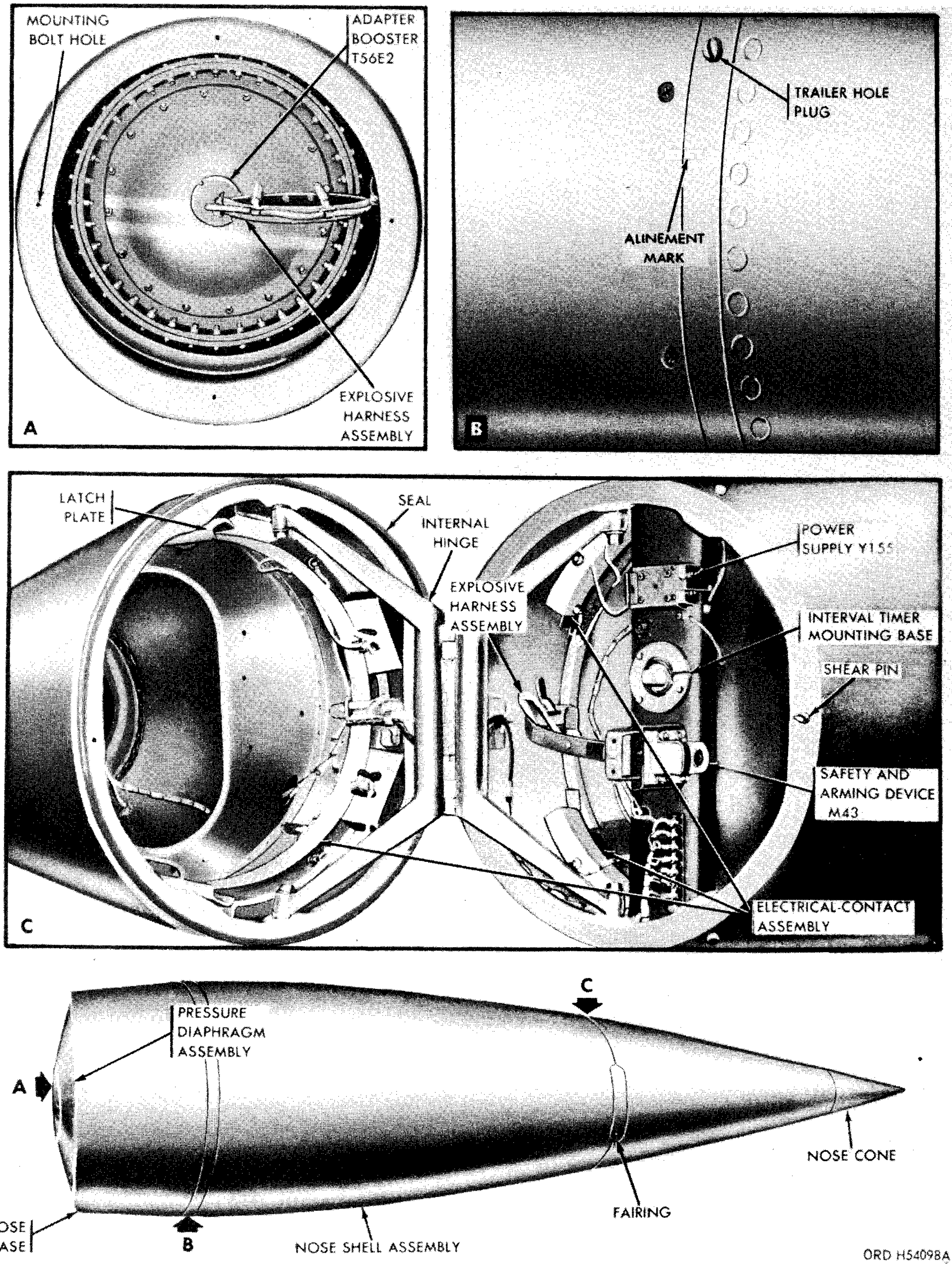


Figure 8-38. High-explosive warhead section M57.

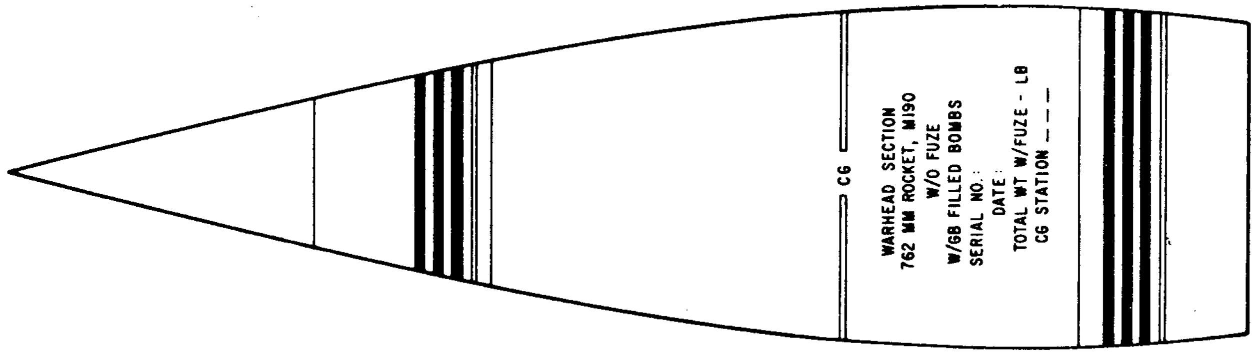


Figure 8-39. Chemical warhead section M190--marking and color-coding.

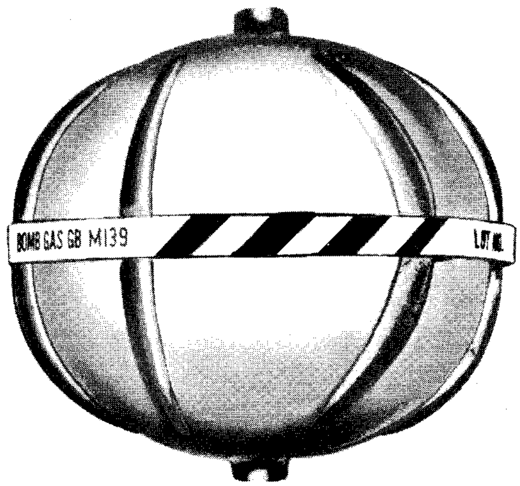


Figure 8-40. Gas bomb M139 (warhead M190)--marking and color-coding.

M6A2, the nozzle fairing M1A1, and the igniter M35A2 (figure 8-43) which is an integral part of the closure plug. The pedestal assembly is that part of the motor assembly from station 115 to 134 (figure 8-34) which houses eight spin rockets, the spin rocket manifold, and the spin rocket electrical system. It also provides a base for mounting the warhead section. The electrical system consists of two BA605/U thermal batteries mounted in the battery support assembly, a spin rocket cable assembly, and a spin rocket ignition switch (figure 8-44) which is mounted on the nozzle fairing. The motor igniter contains 3.3 pounds of black powder and four electric squibs. The motor M6A2 contains four double-base multiperforated, solid propellant grains weighing 2,063 pounds. Two launching shoes serve to hold the rocket on the launcher rail and two identical shoes serve as brackets for the lifting beam.

(5) The M136 series fin assembly (figure 8-45) consists of four fins and are attached to fin base fittings located 90 degrees apart around the nozzle. The fins are canted (angled) one half a degree to maintain rotation of the rocket in flight.

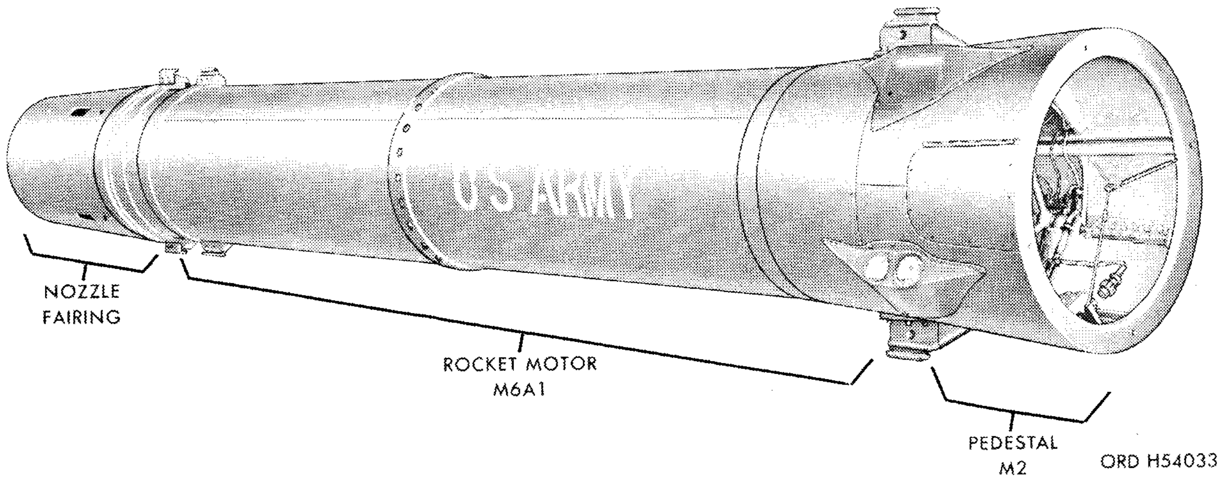


Figure 8-41. Rocket motor assembly M3A1.

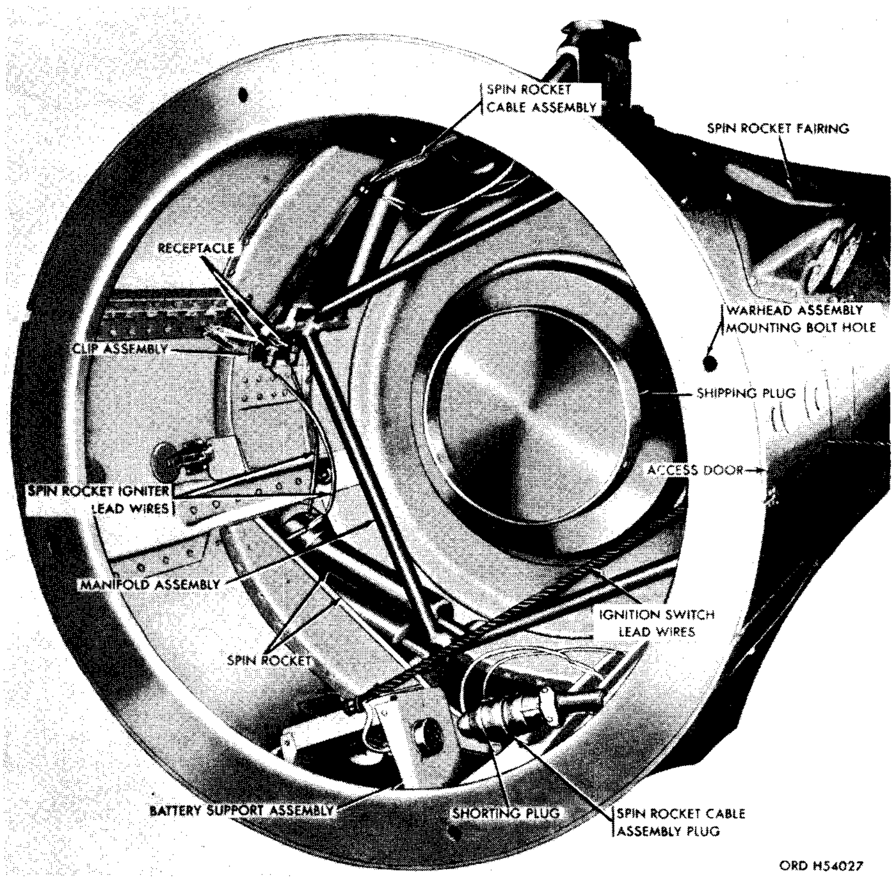


Figure 8-42. Pedestal M2A1--interior view.

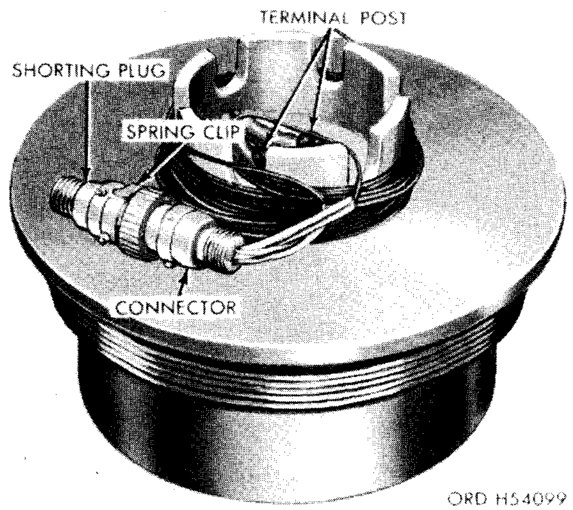


Figure 8-43. Igniter M35A2.

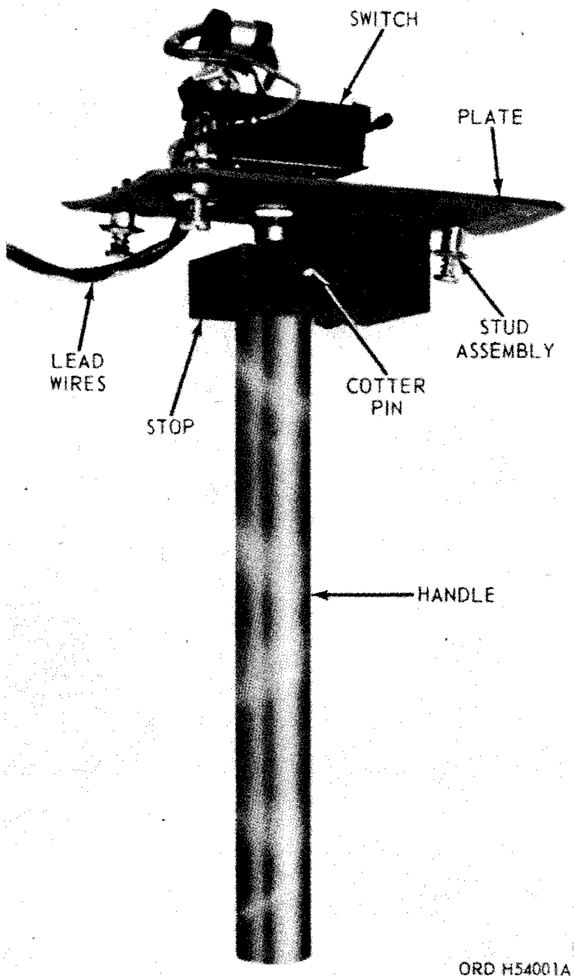


Figure 8-44. Ignition switch (rocket motor assemblies M3A1 and M3A1C).

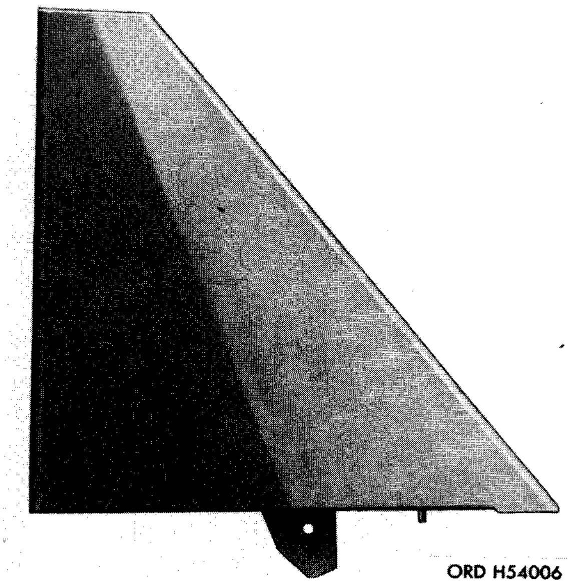


Figure 8-45. Fin M136A2B1.

c. Rocket, MGR-1B (Mobile Surface Rocket) (M50 Series).

(1) The general description of the MGR-1A rocket (paragraphs 7a and b above) is also applicable to the MGR-1B M50 system except, of course, the model designations are different. (See figure 8-35 for the overall configuration and station locations of the MGR-1B.) The complete round, M50 series, consists of a rocket motor and a warhead section; the fins are a part of the rocket motor assembly. See table 8-4 for authorized components. All warheads discussed in paragraph 7 above are applicable to both rocket systems (MGR-1A and MGR-1B), except the M57 HE warhead which is not included in the MGR-1B system. The M50 series rocket is 28.5 inches shorter and approximately 1,212 pounds lighter than the M31 series rocket. The weight of the M31

Table 8-4. Authorized Components for Rocket M50 Series.

Rocket	Warhead section [1]	Rocket motor assembly
M50	Practice warhead section M38 with fuze MT M421 or Chemical warhead section M190 with fuze MT M421	M66 Pedestal M3 (with four spin rockets M37) Rocket motor M31 Nozzle fairing M3 Four fins M17
M50A1	Practice warhead section M38 with fuze MT M421 or Chemical warhead section M190 with fuze MT M421	M66A1 Pedestal M3A1 (with four spin rockets M37A1) Rocket motor M31A1 Nozzle fairing M3A1 Four fins M17

[1] Not including certain special warheads.

series rocket, as fired, is 5,931 pounds; the weight of the M50 series rocket, as fired, is 4,719 pounds. The M50 series rocket has four spin rockets (eight in the M31 series) mounted in pairs 180 degrees apart, smaller fin assemblies and is more streamlined than the M31 series. The rocket motor assembly (M66 series) for the M50 rocket consists of the pedestal M3 (figure 8-46), rocket motor

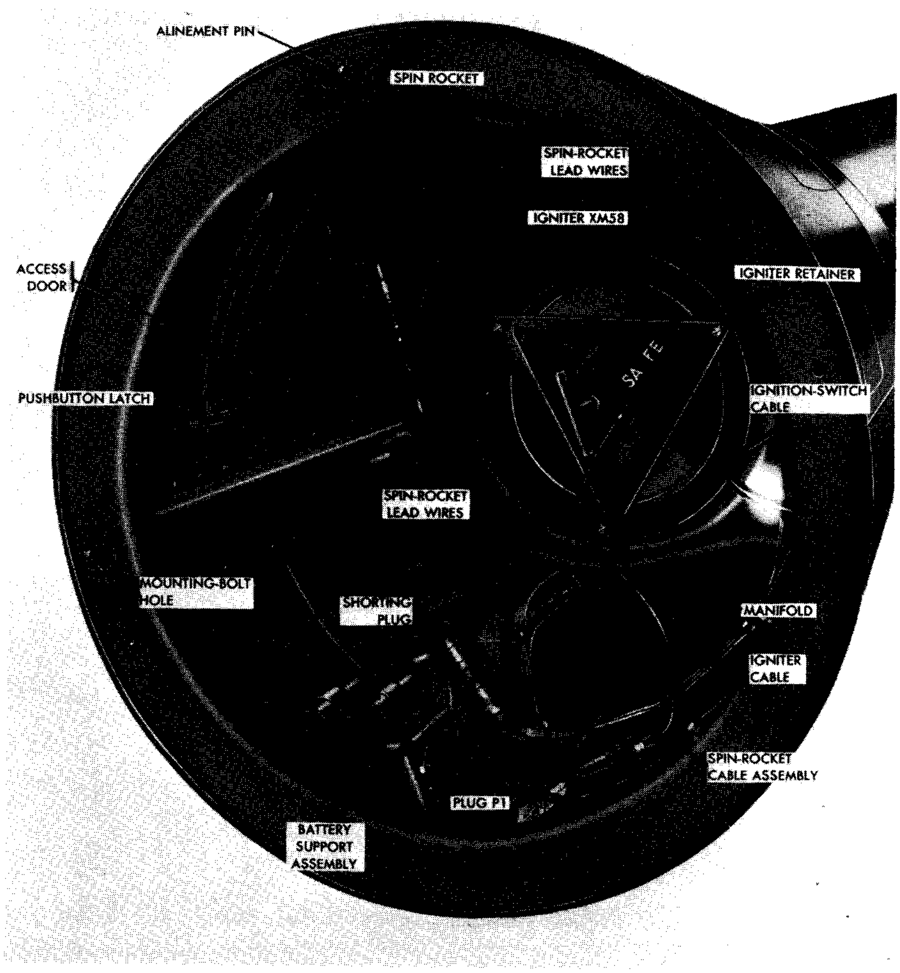


Figure 8-46. Pedestal M3--interior view.

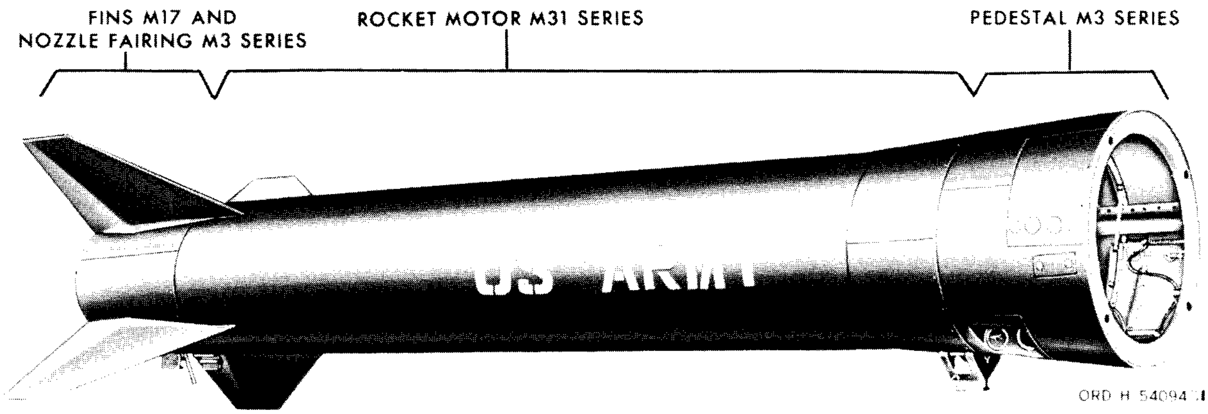


Figure 8-47. Rocket motor assembly M66 series.

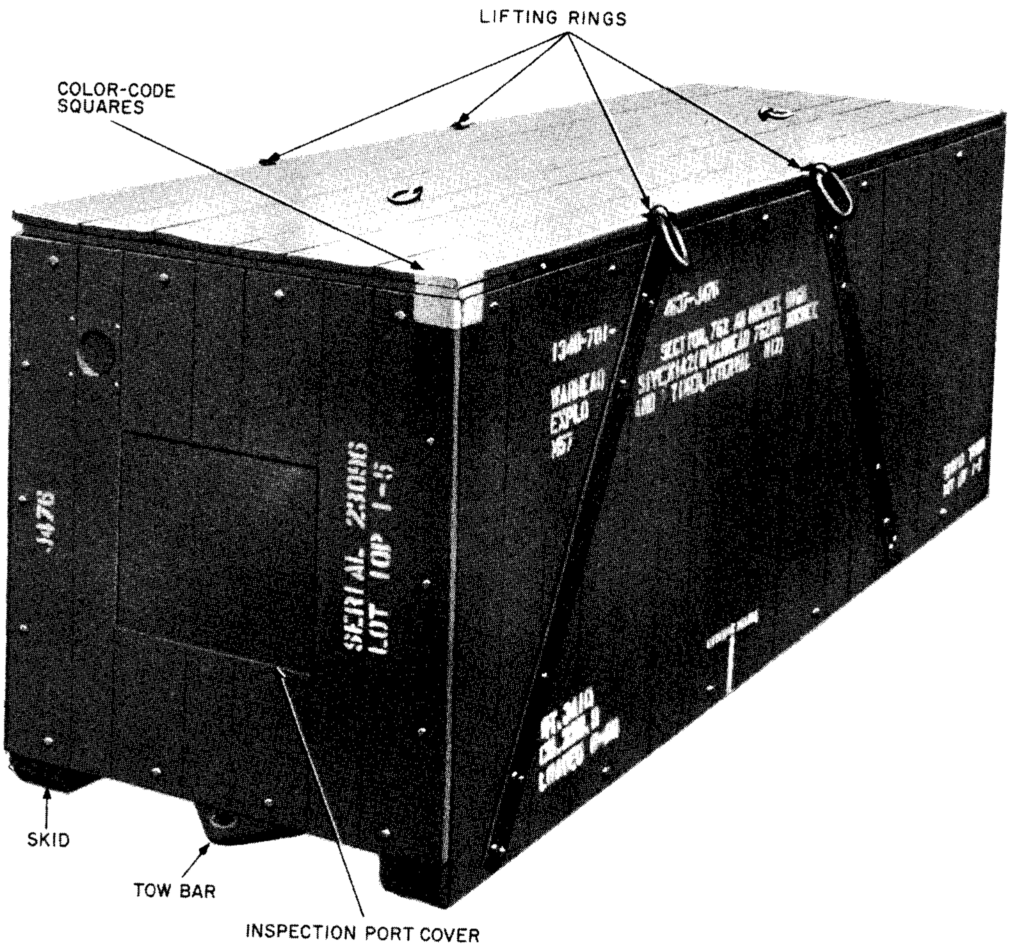


Figure 8-48. Wooden shipping container for warhead section.

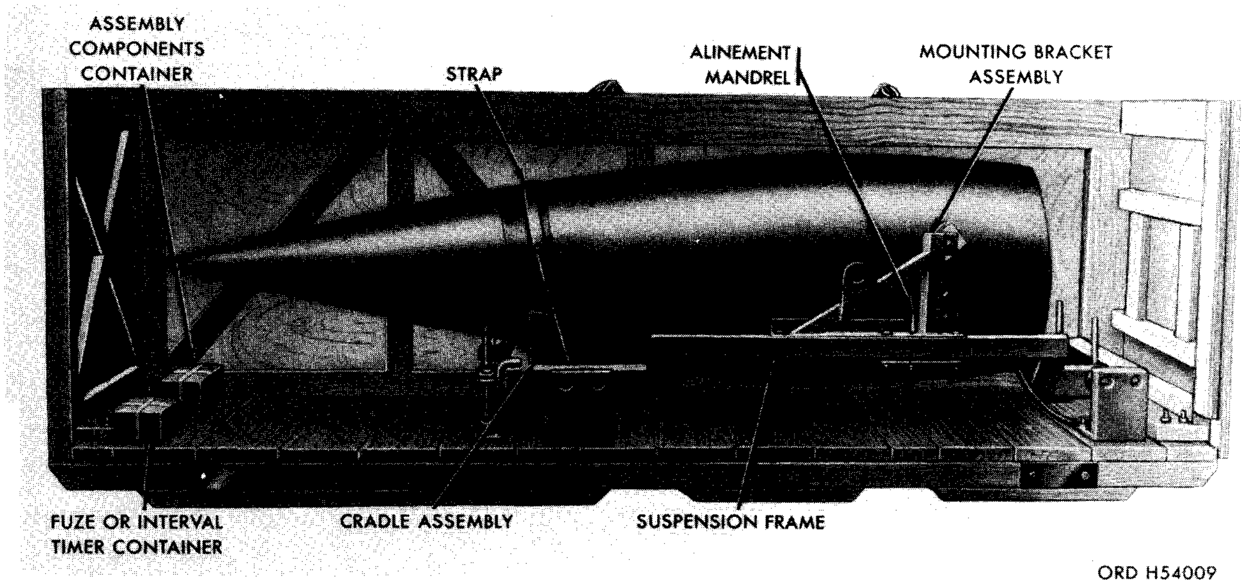


Figure 8-49. Warhead section in wooden container.

M31 (not to be confused with the M31 rocket system), four fins M17, and nozzle fairing M3 (figure 8-47) Other modifications on the M66 motor assembly, as compared to the M31 rocket system, are that the hoist adapter plates are flush with the surface of the motor, and the fore and aft launching shoes are ejected when the rocket leaves the launcher. In addition, an exterior source of electricity activates the thermal-type batteries which, in turn, initiates both the igniter and the four spin rockets. The motor of the M50 rocket system contains a single perforated grain, star configuration of composite propellant bonded to the motor casing.

(2) The following package and shipping configurations apply to the Honest John rocket components. The container for the M57HE warhead (figures 8-48 and 8-49) weighs 1,776 pounds empty and 3,410 pounds loaded. The plywood container for practice warhead M38 (figure 8-50), which is applicable to both rocket series, weighs 1,270 pounds empty and 2,898 pounds loaded. The fin assembly container for the M136 fins (figure 8-51) weighs 188 pounds empty and 361 pounds loaded. The steel container M480E2 for the chemical warhead M190 (applicable to both series) is illustrated in figure 8-52. A cutaway of the M31 rocket motor M3 container is illustrated in figure 8-53. It weighs 2,429 pounds empty and 6,538 pounds loaded. The M50 rocket motor M66 series container (figures 8-54 and 8-55) weighs 1,786 pounds empty and 4,800 pounds loaded. The four fins for this rocket are packed in two plywood boxes secured to the base of the motor container. Auxiliary equipment associated with the 762-mm rocket system is shown in figure 8-56.

8. REDEYE GUIDED MISSILE SYSTEM, XM41E2.

a. General. The Redeye weapon consists of a missile sealed inside its expendable launcher. Redeye is a man-transportable, shoulder-fired, all-arms, air defense system designed to provide combat units with the capability of destroying low-altitude hostile aircraft. Because it is man-transportable, it can be deployed easily and flexibly throughout the forward area. The weapon is capable of engaging a wide variety of aerial targets, including jet and propeller aircraft, helicopters, and reconnaissance drones. Redeye, in the hands of well-trained gunners, is an effective and lethal air defense system.

b. Redeye weapon. The Redeye weapon consists of three major components--launcher, missile, and battery/gas unit.

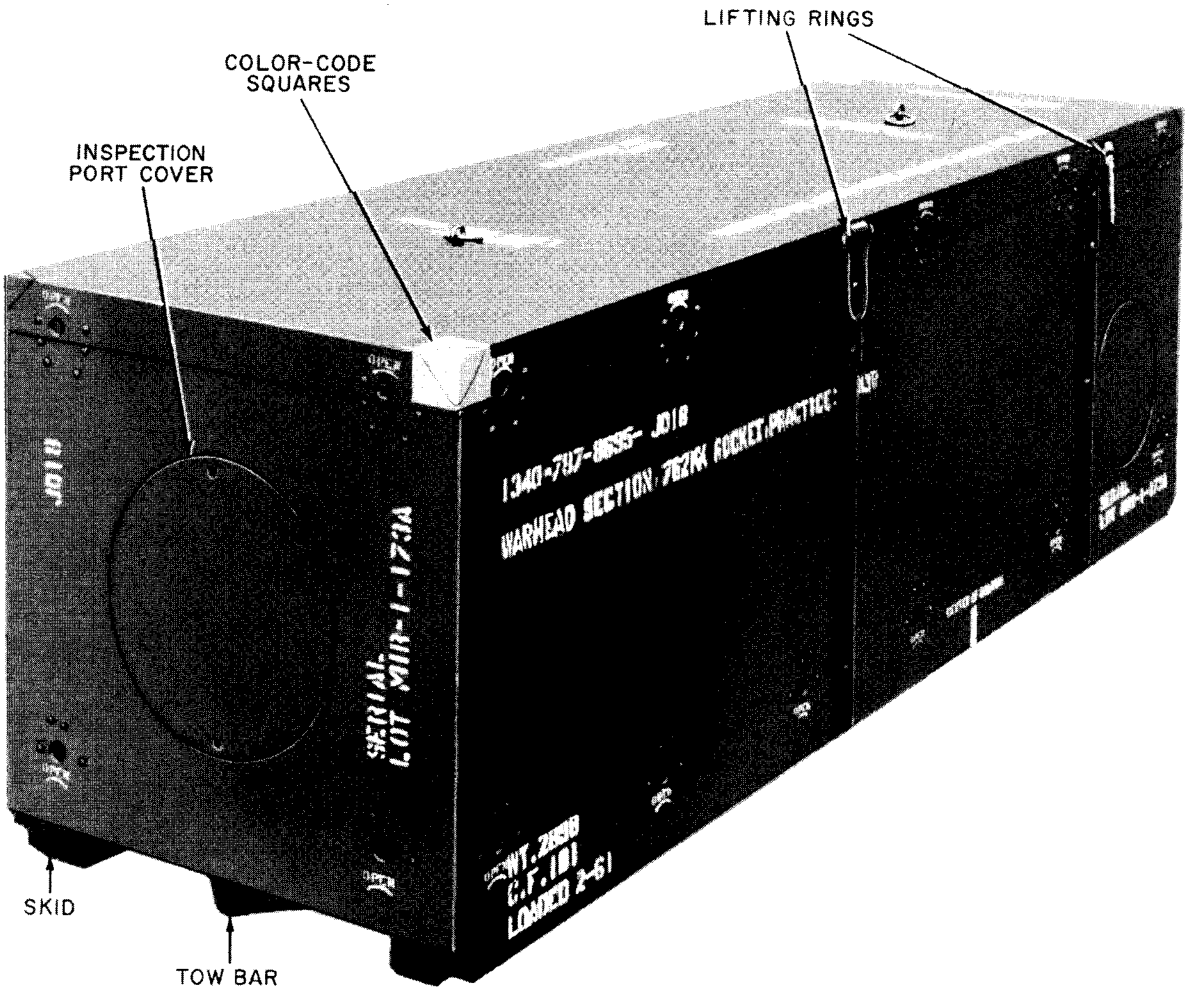


Figure 8-50. Plywood shipping container for warhead section.

(1) The launcher (figure 8-57), of molded fiber-glass construction, seals the missile from moisture and foreign matter. The front end is closed with a frangible (fragile), infrared-transparent window which allows the missile to "see" the target while still sealed in the launcher tube, and the rear end is closed with a frangible disk. The missile is secured within the launcher by a friction screw and an electrical, umbilical connector. The sight assembly provides a means for the gunner to aim the weapon, track the target, perform range estimation, and insert superelevation and lead. An audible signal from the acquisition indicator informs the gunner when he has the missile locked on the target. A transparent plastic eyeshield is attached to the sight to protect the gunner's left eye from blast effects. The launcher is provided with a humidity indicator plug and a receptacle cap. The safety and actuator device is a manually operated mechanism which, when activated, produces the electrical pulse that energizes the launcher battery/ gas unit. This, in turn, provides electrical power to prepare the weapon for firing and gas coolant to the detector cell. The launcher is discarded after the weapon has been fired. In a training environment, used launchers are recovered after firing, reconditioned, and reloaded at depot level.

(2) The launcher battery/gas unit (figure 8-57) is in a cylindrical case with an insulated plastic cap at the bottom. It consists of a thermal battery which energizes the launcher electrical

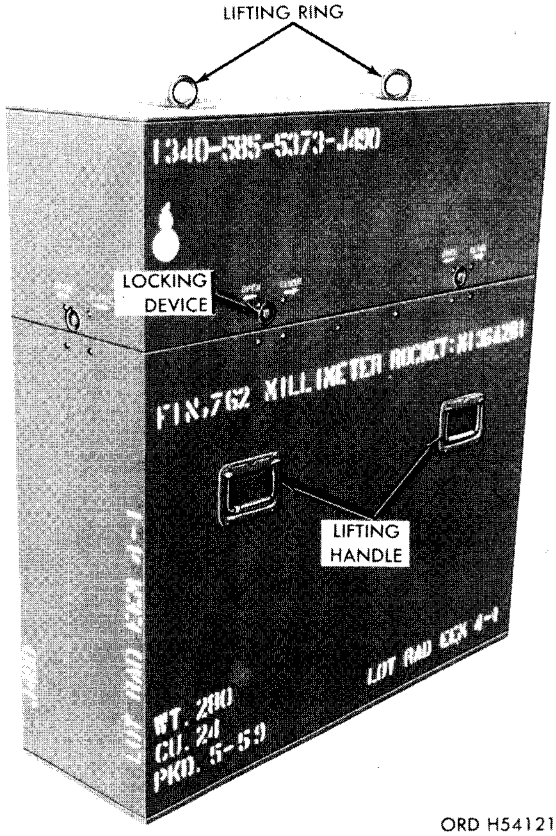


Figure 8-51. Plywood shipping container for fins.

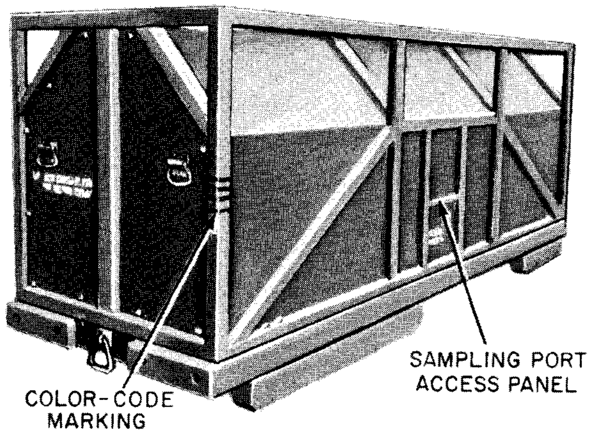


Figure 8-52. Chemical warhead shipping and storage container M480E2.

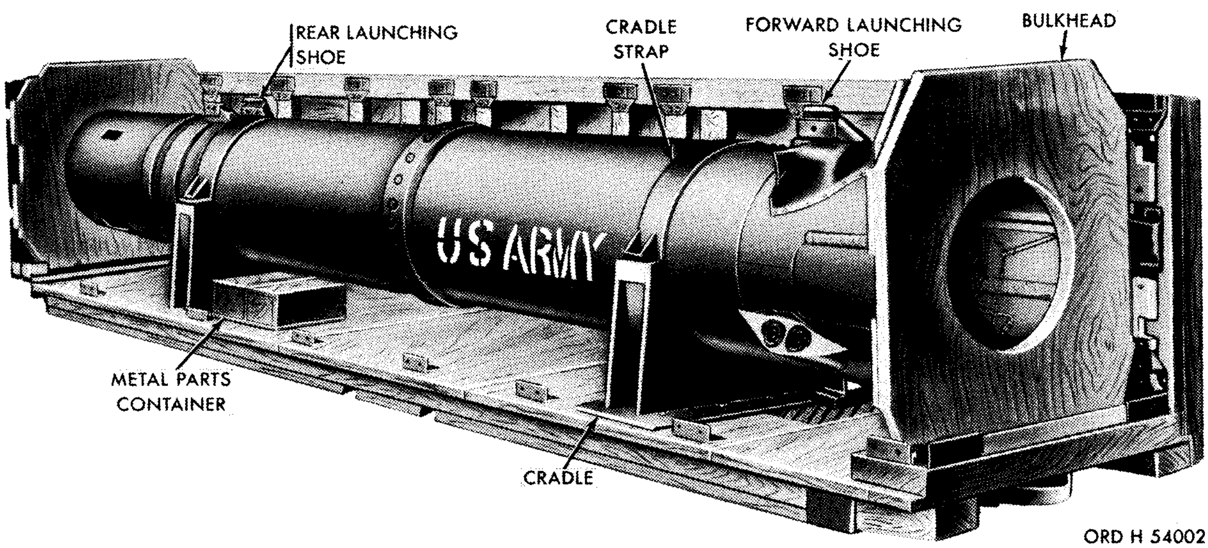


Figure 8-53. Rocket motor assembly M3 series in plywood shipping container.

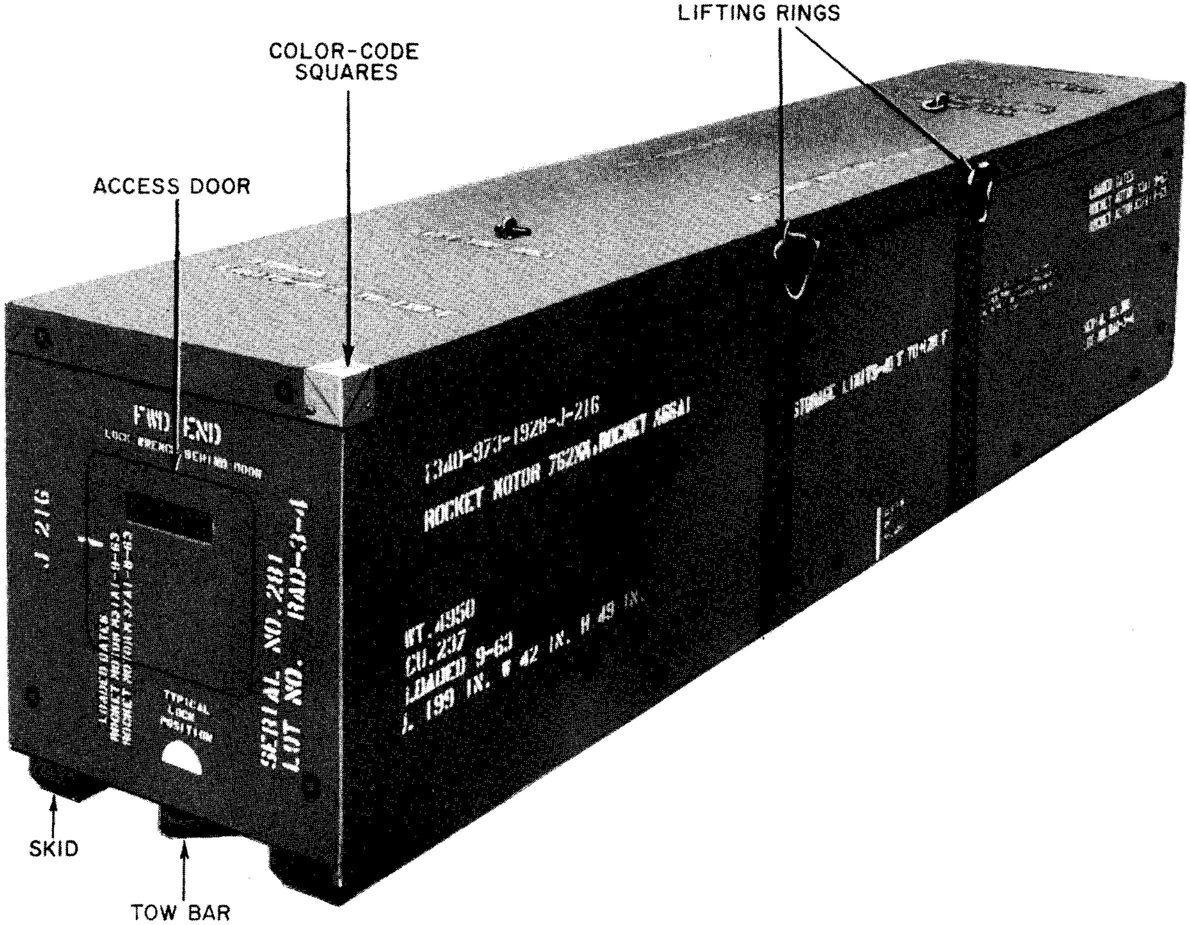


Figure 8-54. Plywood shipping container for rocket motor assembly.

circuits during the prelaunch sequence and a coolant gas supply unit which cools the infrared detector in the missile seeker to the required temperature. The battery/gas unit is inserted in the battery/gas unit receptacle in the launcher prior to activation of the weapon. A hollow needle on the battery/gas unit punctures a seal on the launcher coolant supply line when the unit is inserted in its receptacle. The gas is released simultaneously with activation of the battery. Freon gas flows through a supply tube to the infrared cell, cools it to minus 100 degrees fahrenheit making it more sensitive to target energy. **Once activated, the battery will supply power for at least 30 seconds and, used once, it is discarded.**

(3) The guided missile (figure 8-58) is an infrared (heat seeking) homing missile and is propelled by a two stage rocket motor. The missile consists of six major sections--seeker, control, missile battery, fuze and warhead, rocket motor, and tail assembly. Redeye functional description series is indicated in figure 8-59, sheets 1 through 5.

(a) The seeker section receives infrared energy from the target and provides acquisition signals which inform the gunner that the target has been acquired after he has activated the safety and actuator device. After launch, the seeker generates steering signals for use in the

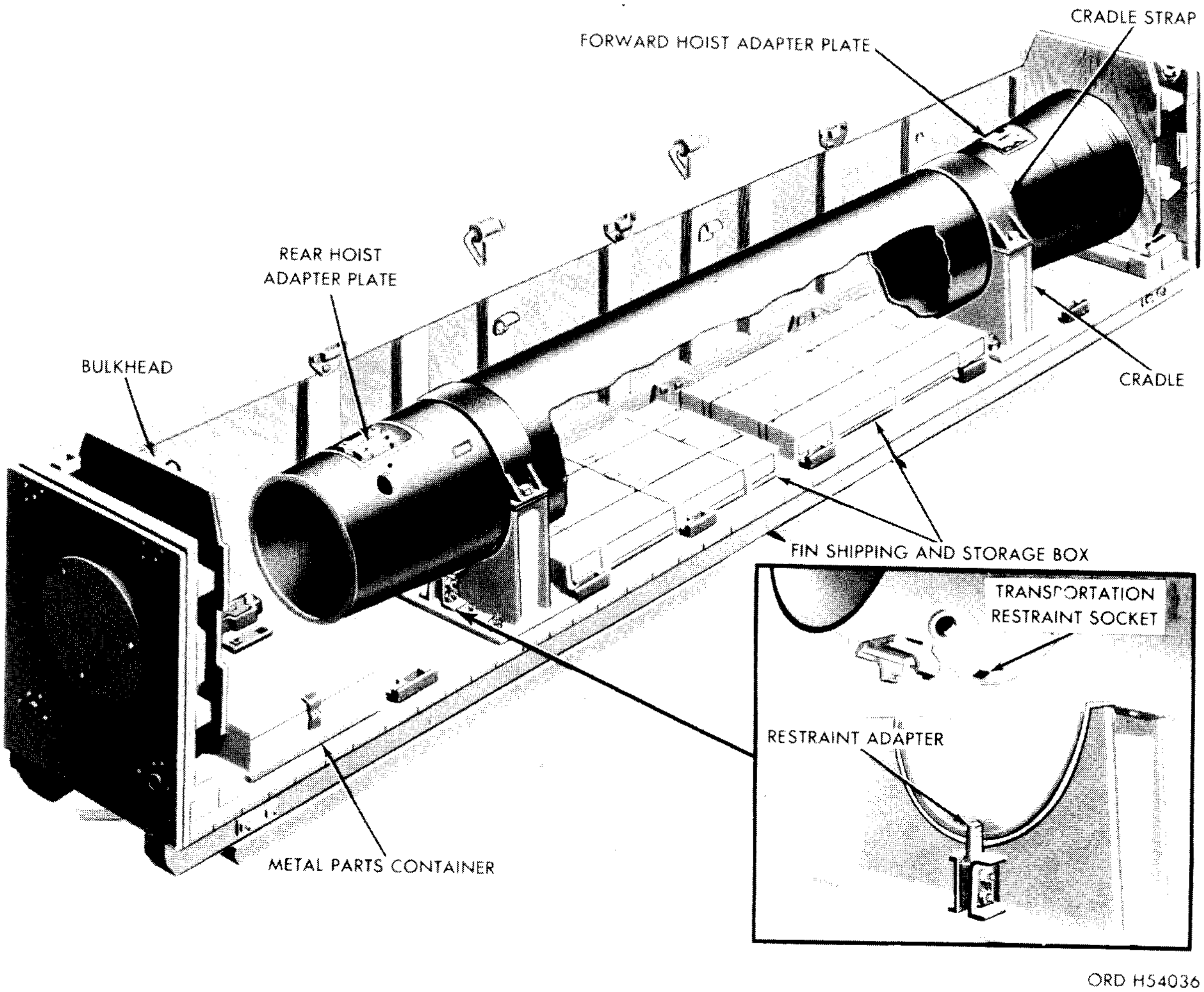
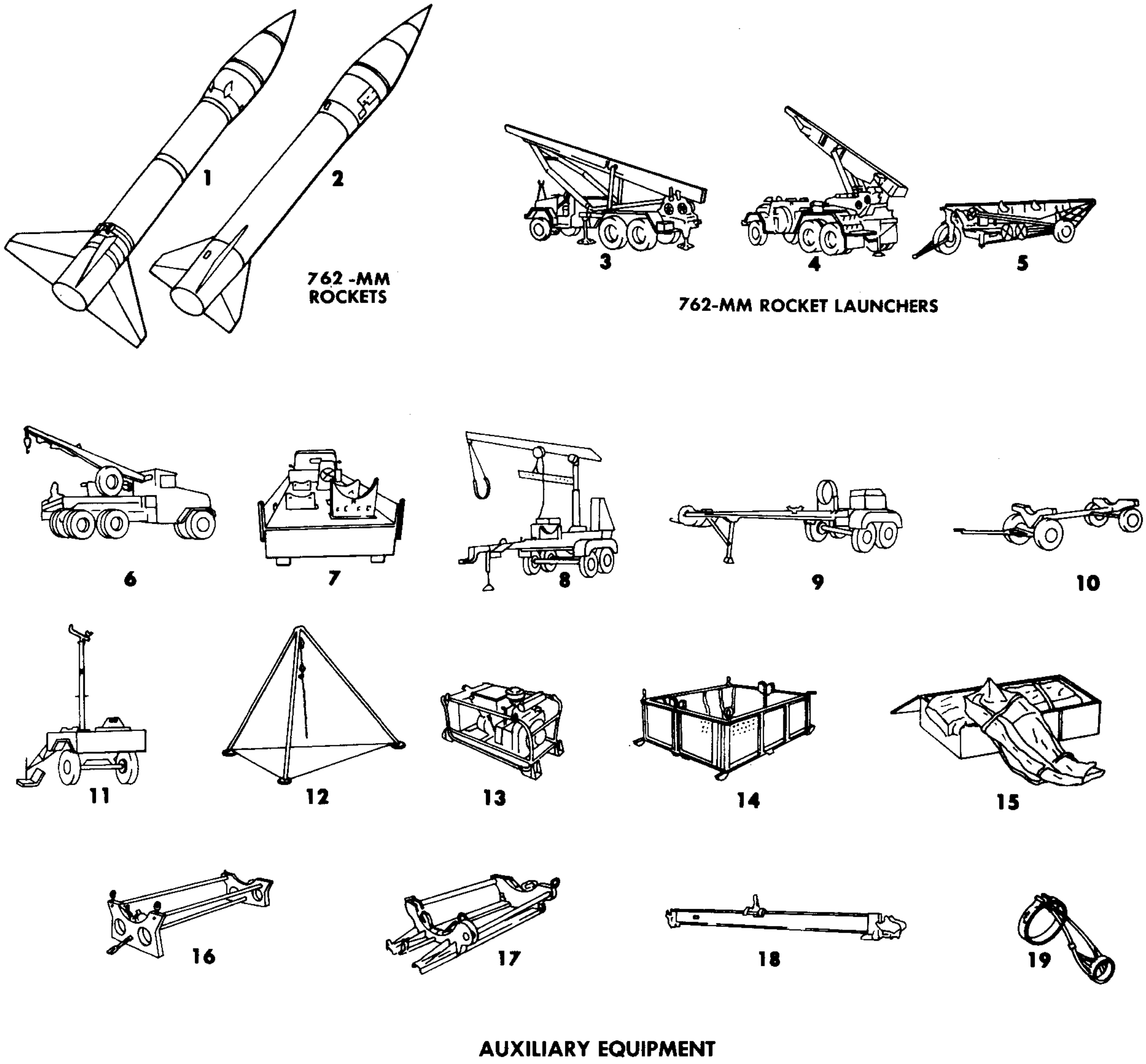


Figure 8-55. Rocket motor assembly M66 series in plywood shipping container.

control section. A detector cell within the seeker detects the infrared radiation from the target and converts it into electrical signals which are used to keep the seeker locked on the target. Automatic seeker tracking of the target infrared radiation occurs when the gyro is activated prior to launch and during missile flight.

(b) The control section (figure 8-58) consists of an electronic unit and motor-driven control surfaces. Two pairs of control surfaces, folded when the missile is in the launch tube, unfold when the missile is fired. One pair locks in place while the other pair, moved by a set of gears and an electric steering motor, steers the missile in flight. The error steering signals are converted to steering commands which steer the missile to the target. An umbilical assembly is connected to the control section and after the missile battery has been activated by the firing trigger, the umbilical plug is retracted by a squib and the missile battery then provides power to the seeker and control sections.

(c) The missile battery section (figure 8-59) (firing sequence) provides electrical power for the missile during flight. The battery contains an electrolyte which is a solid at normal temperature, but becomes active when melted by the heat produced by ignition of fuse strips (pyrotechnic paper) placed between the battery cells. Battery activation, initiated by pressing the firing trigger, produces a 40-volt output within 0.25 to 0.5 of a second.



AUXILIARY EQUIPMENT

1—762-MM ROCKET M31 SERIES
2—762-MM ROCKET M50 SERIES
3—LAUNCHER M289
4—LAUNCHER M386
5—LAUNCHER M33
6—WRECKER M62 OR M543
7—HEATING AND TIE-DOWN UNIT M78A1
8—HANDLING UNIT M405E1
9—TRANSPORTER TRAILER M329A1
10—TRANSPORT CART ASSEMBLY XM465
11—WIND MEASURING SET AN/MMQ-1 (AN/PMQ-6 NOT SHOWN)
12—HOISTING UNIT TRIPOD XM26
13—GENERATOR SET M25C
14—EQUIPMENT DELIVERY BASKET M2
15—ELECTRIC BLANKET M2E2
16—ROCKET MOTOR CRADLE M5
17—WARHEAD CRADLE M4
18—HANDLING BEAM M4E2
19—WARHEAD HANDLING SLING M6

Figure 8-56. 762mm rocket system.

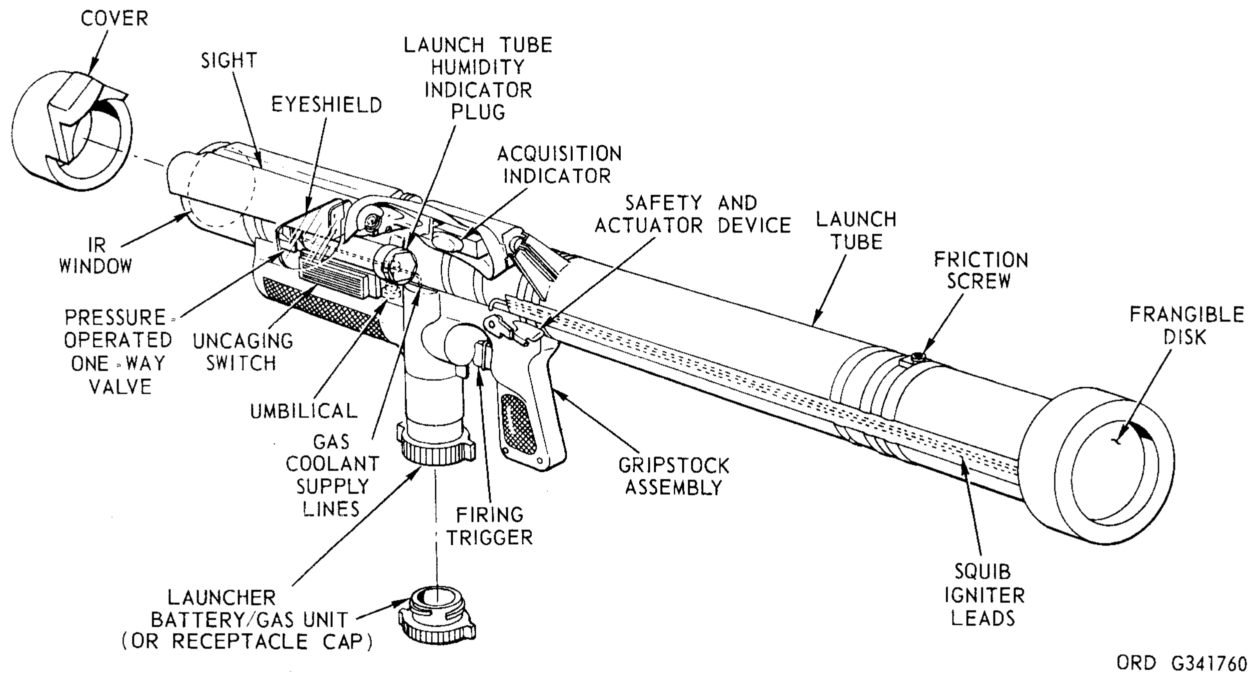


Figure 8-57. Launcher, battery/gas unit, and receptacle cap.

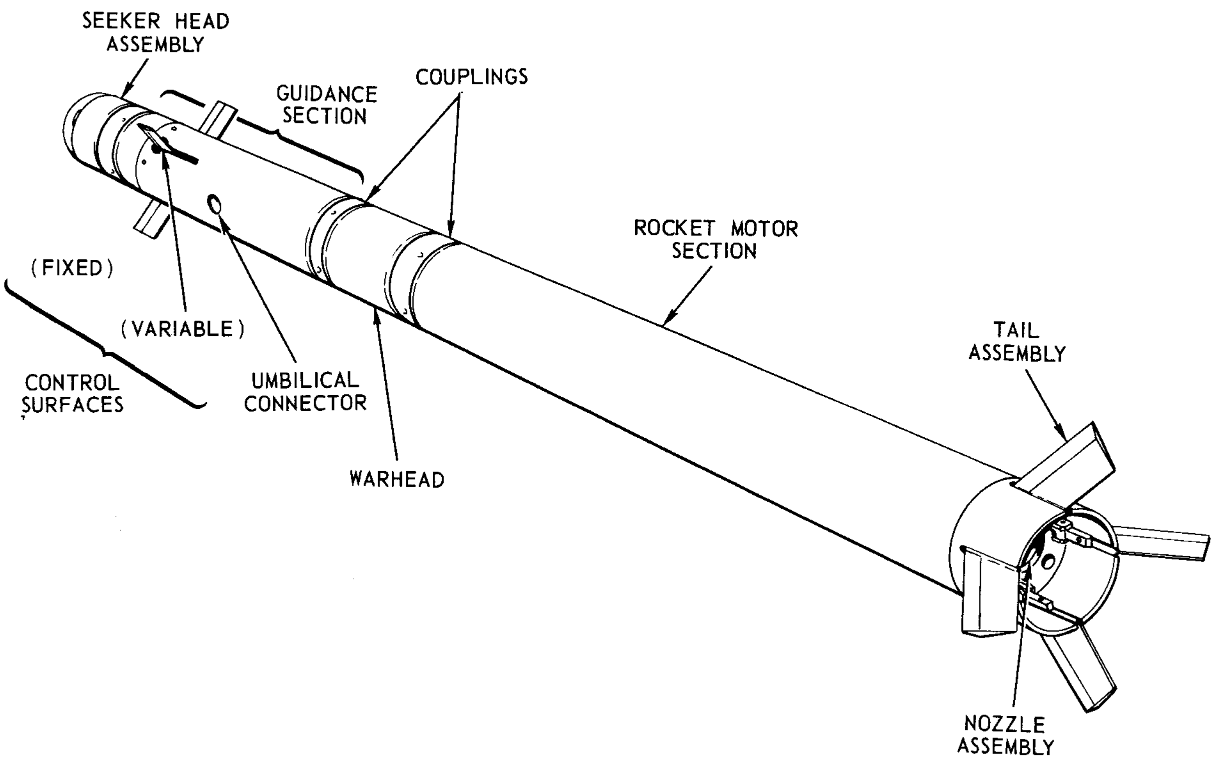
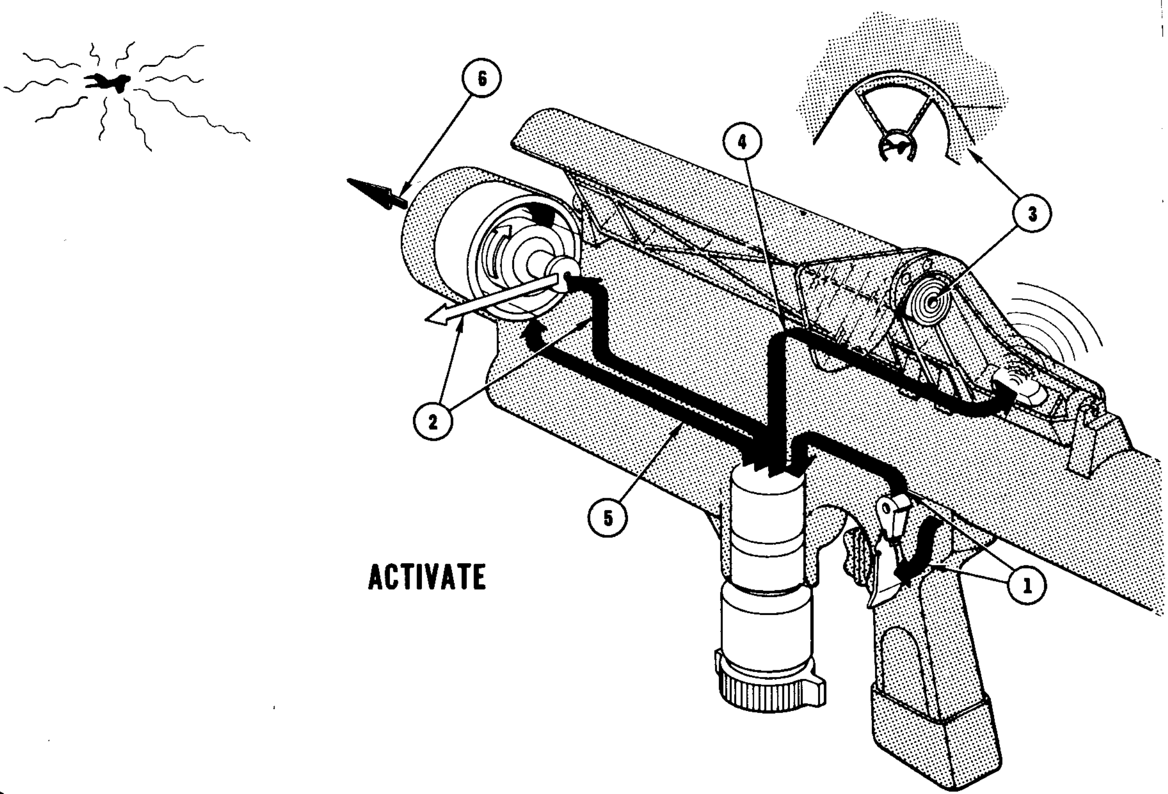


Figure 8-58. Guided Missile.



(1) **LAUNCHER BATTERY/GAS UNIT IS ACTIVATED**

OPERATION OF THE SAFETY AND ACTUATOR DEVICE ACTIVATES LAUNCHER BATTERY/GAS UNIT (BATTERY LIFE 30 SECONDS MINIMUM). BATTERY ENERGIZES LAUNCHER AND MISSILE, AND GAS BOTTLE RELEASES FREON COOLANT.

(2) **GAS COOLANT FLOWS**

FREON GAS FLOWS THROUGH SUPPLY TUBE TO IR CELL, COOLS IR CELL TO -80°C WITHIN 5 SECONDS, AND GOES OUT THROUGH EXHAUST VALVE. (GAS SUPPLY LASTS 35 SECONDS).

(3) **WEAPON ROUND IS AIMED**

GUNNER POSITIONS WEAPON ROUND SO THAT TARGET IMAGE APPEARS IN THE CENTER OF SIGHT RANGE RING.

(4) **INDICATOR CIRCUITS ENERGIZED**

ACQUISITION INDICATOR CIRCUIT IS ENERGIZED BY LAUNCHER BATTERY AND IS READY TO INDICATE WHEN THE SEEKER ACQUIRES AND TRACKS THE TARGET IR SIGNAL.

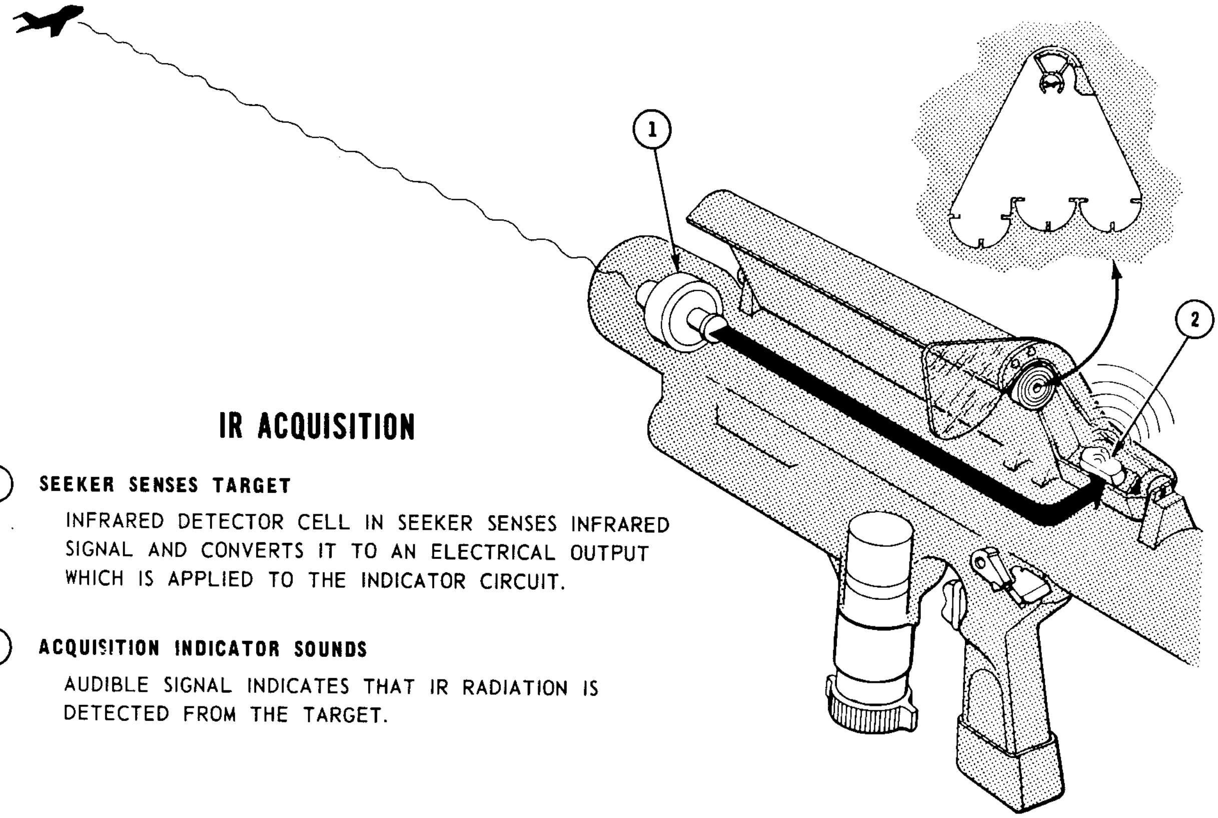
(5) **GYRO SPIN MOTOR ENERGIZED**

GYRO SPIN MOTOR IS ENERGIZED BY LAUNCHER BATTERY AND GYRO STARTS TO SPIN UP TO FULL SPEED. THE ACQUISITION INDICATOR PROVIDES AN AUDIBLE SIGNAL INDICATING GYRO SPINUP.

(6) **GYRO IS CAGED**

LAUNCHER BATTERY ENERGIZES THE GYRO CAGE CIRCUIT SO THAT THE GYRO IS ORIENTED TO THE WEAPON ROUND LINE OF SIGHT.

Figure 8-59. REDEYE functional description series (sheet 1 of 5).



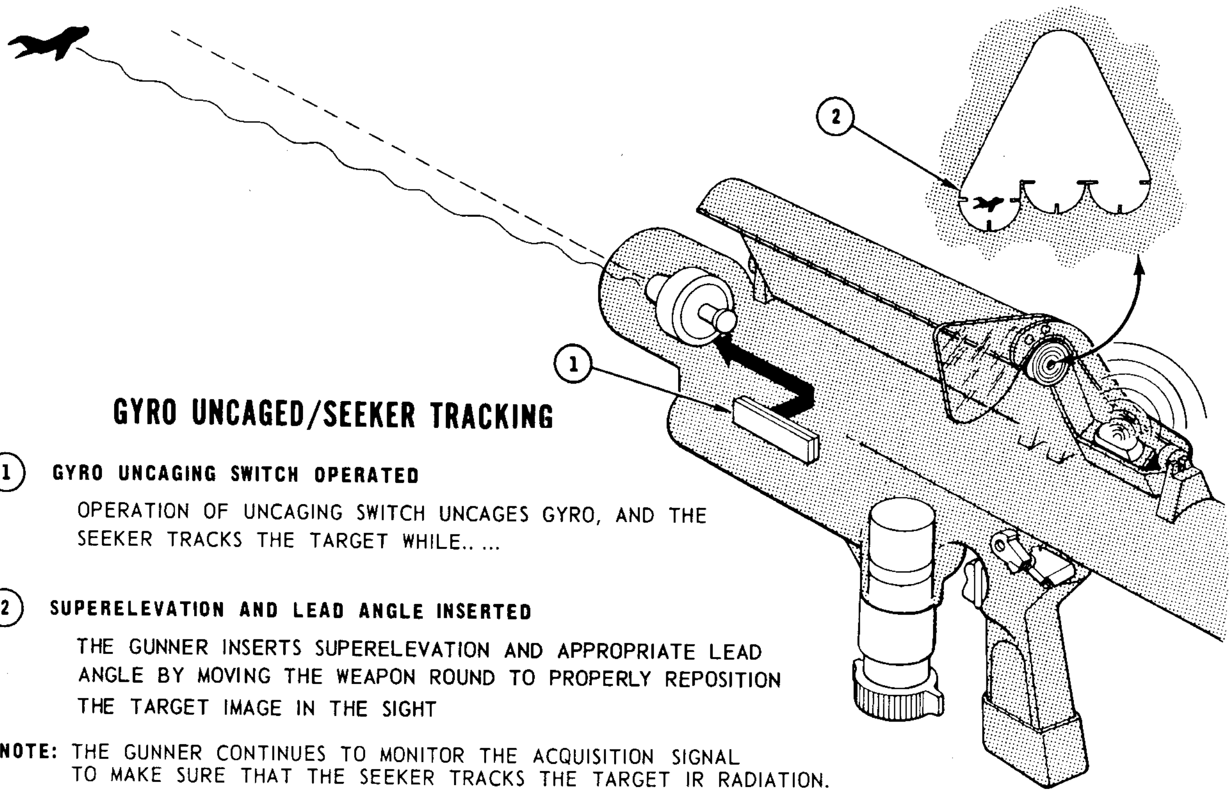
IR ACQUISITION

(1) **SEEKER SENSES TARGET**

INFRARED DETECTOR CELL IN SEEKER SENSES INFRARED SIGNAL AND CONVERTS IT TO AN ELECTRICAL OUTPUT WHICH IS APPLIED TO THE INDICATOR CIRCUIT.

(2) **ACQUISITION INDICATOR SOUNDS**

AUDIBLE SIGNAL INDICATES THAT IR RADIATION IS DETECTED FROM THE TARGET.



GYRO UNCAGED/SEEKER TRACKING

(1) **GYRO UNCAGING SWITCH OPERATED**

OPERATION OF UNCAGING SWITCH UNCAGES GYRO, AND THE SEEKER TRACKS THE TARGET WHILE.. ...

(2) **SUPERELEVATION AND LEAD ANGLE INSERTED**

THE GUNNER INSERTS SUPERELEVATION AND APPROPRIATE LEAD ANGLE BY MOVING THE WEAPON ROUND TO PROPERLY REPOSITION THE TARGET IMAGE IN THE SIGHT

NOTE: THE GUNNER CONTINUES TO MONITOR THE ACQUISITION SIGNAL TO MAKE SURE THAT THE SEEKER TRACKS THE TARGET IR RADIATION.

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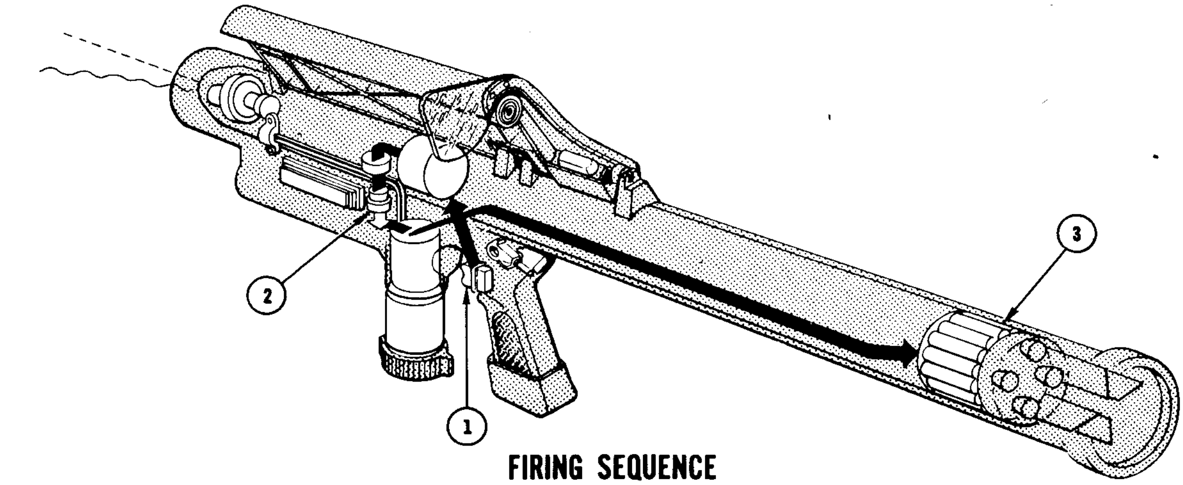
Figure 8-59. REDEYE functional description series (sheet 2 of 5).



FIRING SEQUENCE

(1) **MISSILE BATTERY ACTIVATED**

OPERATION OF THE FIRING TRIGGER ACTIVATES MISSILE BATTERY.

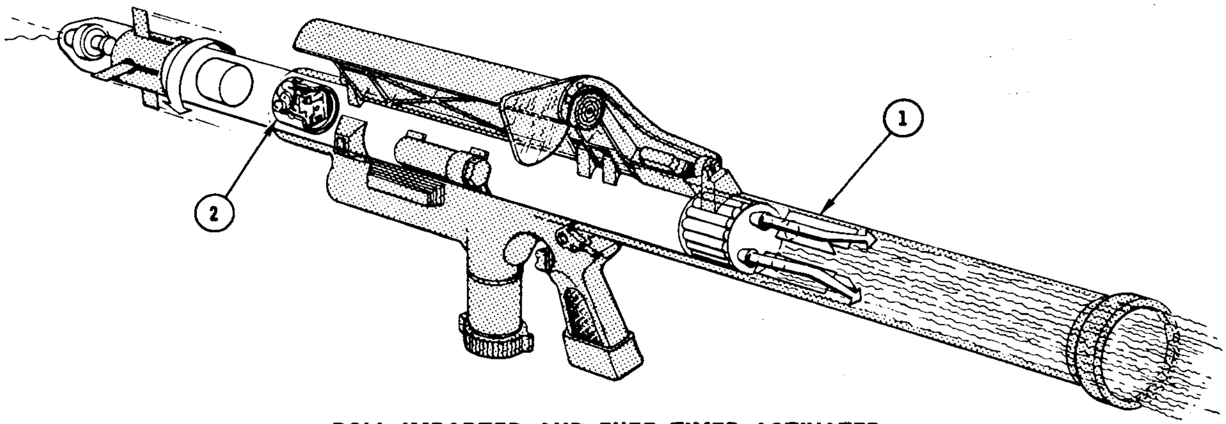
(2) **UMBILICAL RETRACTED**

UMBILICAL IS RETRACTED FROM THE MISSILE BY A SQUIB ACTIVATED BY THE MISSILE BATTERY AFTER OPERATION OF FIRING TRIGGER, AND . . . .

(3) **EJECTOR FIRES**

RETRACTION OF THE UMBILICAL CAUSES THE EJECTOR TO BE FIRED BY THE LAUNCHER BATTERY, AND THE MISSILE STARTS FROM THE LAUNCH TUBE.

NOTE: THE COOLANT GAS LINES BETWEEN THE LAUNCHER AND MISSILE ARE SHEARED AT LAUNCH.



ROLL IMPARTED AND FUZE TIMER ACTIVATED

(1) **MISSILE ROLL**

BEFORE IT LEAVES THE LAUNCH TUBE THE MISSILE IS SET TO ROLLING AT THE FULL FLIGHT RATE BY THE FORCE OF THE EJECTOR EXHAUST AGAINST THE (STILL FOLDED) CANTED TAILS.

(2) **FUZE TIMER STARTS**

WHEN THE EJECTOR PRODUCES A MISSILE LONGITUDINAL ACCELERATION OF 28 G's, AN INERTIAL SWITCH IN THE FUZE TIMER CLOSES AND THE FUZE TIMER STARTS.

NOTE: THE EJECTOR IS COMPLETLY EXPENDED BEFORE THE MISSILE IS ENTIRELY OUT OF THE LAUNCH TUBE.

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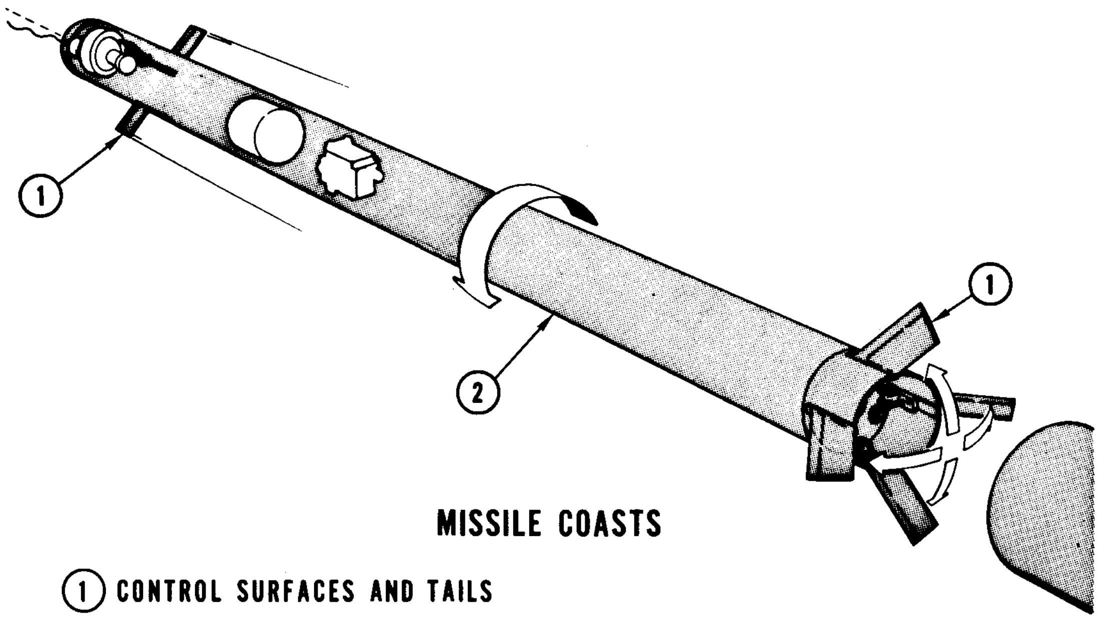
Figure 8-59. REDEYE functional description series (sheet 3 of 5).



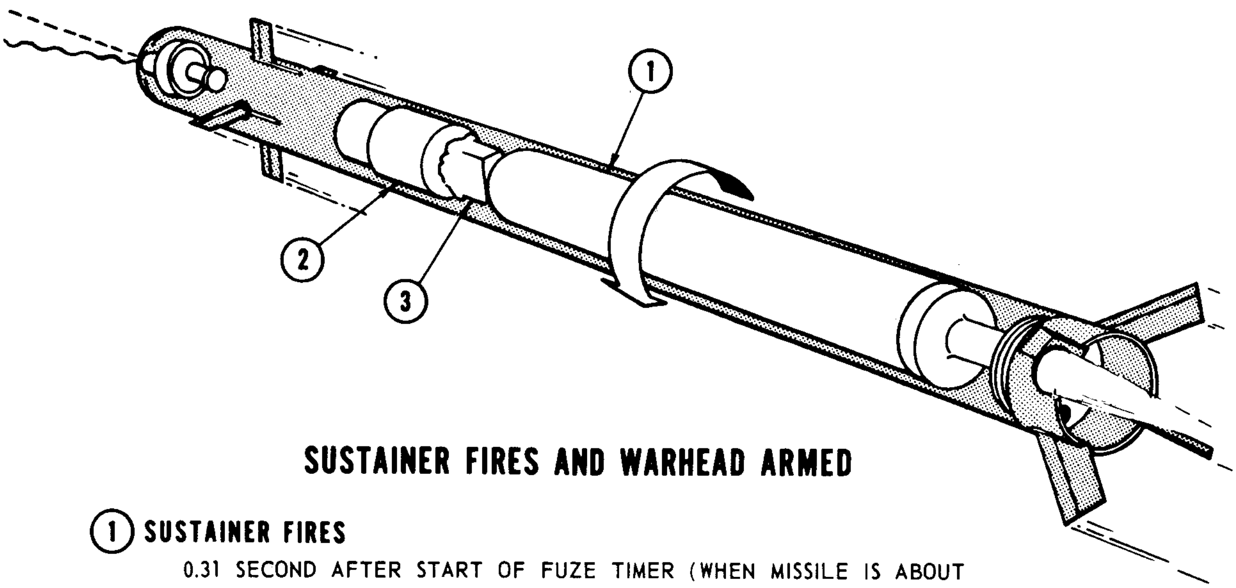
MISSILE COASTS

① **CONTROL SURFACES AND TAILS**

AS THE CONTROL SURFACES AND TAILS CLEAR THE LAUNCH TUBE, THEY SNAP OUT AND LOCK IN PLACE.

② **MISSILE COASTS**

UNDER THE FORCE IMPARTED TO IT BY THE EJECTOR, THE MISSILE COASTS FOR APPROXIMATELY 24 FEET.



SUSTAINER FIRES AND WARHEAD ARMED

① **SUSTAINER FIRES**

0.31 SECOND AFTER START OF FUZE TIMER (WHEN MISSILE IS ABOUT 24 FEET FROM GUNNER) THE FUZE COMPLETES THE SUSTAINER FIRING CIRCUIT AND THE SUSTAINER IGNITES.

② **WARHEAD ARMED**

THE FUZE ARMS THE WARHEAD 1.6 SECONDS AFTER FUZE TIMER STARTS (PROVIDED THAT THE MISSILE SUSTAINER ACCELERATION EXCEEDS 7 TO 12 G'S).

③ **SELF-DESTRUCT CYCLE BEGINS**

AT THE SAME TIME THAT THE WARHEAD IS ARMED, THE MISSILE SELF-DESTRUCT/TIME CYCLE IS STARTED.

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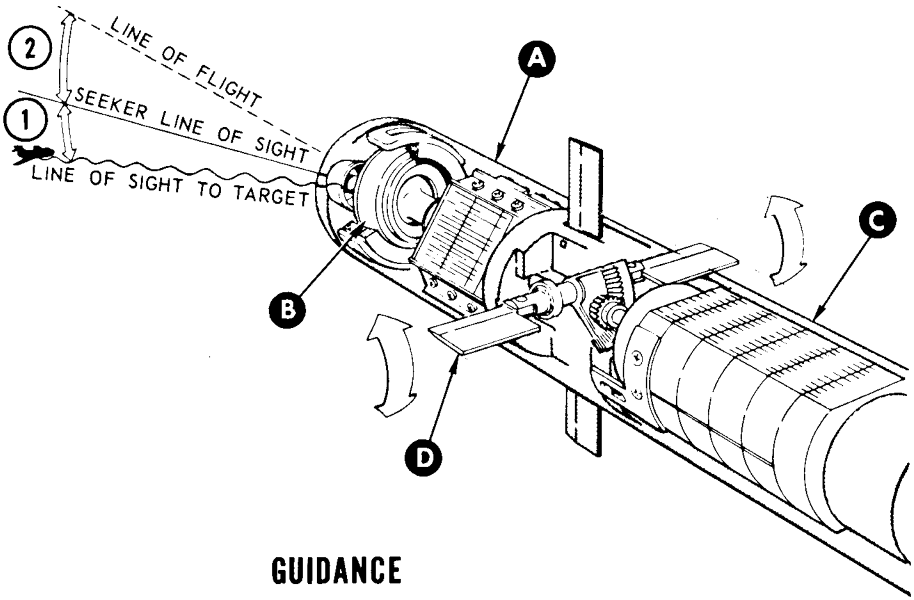
Figure 8-59. REDEYE functional description series (sheet 4 of 5).



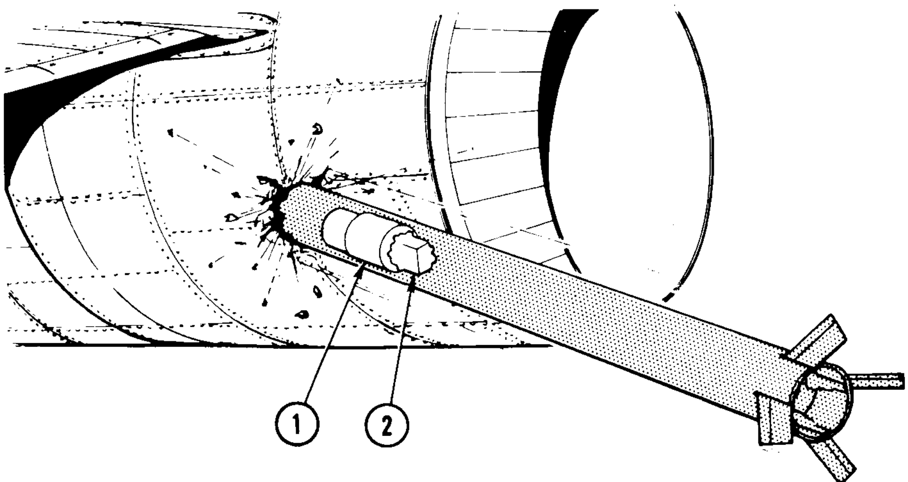
GUIDANCE

(1) TRACKING THE TARGET

THE SEEKER SECTION (A) DETECTS ANY DIFFERENCE BETWEEN THE SEEKER LINE OF SIGHT AND THE LINE OF SIGHT TO THE TARGET, AND CORRECTS THE POSITION OF THE SEEKER (B) SO THAT THE SEEKER AND TARGET LINES OF SIGHT COINCIDE.

(2) GUIDING THE MISSILE

THE CONTROL SECTION (C) DETECTS ANY CHANGE IN THE ANGLE BETWEEN THE MISSILE LINE OF FLIGHT AND THE SEEKER LINE OF SIGHT, AND CORRECTS THE LINE OF FLIGHT BY CHANGING THE ANGULAR POSITION OF THE CONTROL SURFACES (D)



IMPACT OR SELF-DESTRUCT

(1) TARGET HIT

WHEN THE MISSILE HITS (OR PENETRATES) THE TARGET, THE WARHEAD IS DETONATED BY (A) AN INERTIA SENSING SWITCH, OR (B) A METALLIC PENETRATION SENSING DEVICE.

(2) SELF-DESTRUCT

THE FUZE TIMER SETS OFF THE WARHEAD AT THE END OF APPROXIMATELY 15 SECONDS IF THE MISSILE DOES NOT HIT A TARGET.

Figure 8-59. REDEYE functional description series (sheet 5 of 5).

(d) The fuze, in the fuze and warhead section (figure 8-59) (warhead armed (2), functions to ignite the sustainer rocket motor at the proper time and to arm and detonate the warhead. The fuze also includes safety features to insure that Redeye is safe to ship and handle. The fuze timer is activated when the missile has reached sufficient acceleration. The timer controls sustainer ignition, arming, and self-destruct. The HE warhead is not armed and cannot be detonated until the missile is launched and is a safe distance from the gunner. The warhead, when armed, can be detonated in any one of three ways--when the fuze penetrates the metal surface of the target; by impact of the missile striking the target; or by self-destruct after approximately 15 seconds of flight.

(e) The rocket-motor section consists of the EJECT MOTOR (figure 8-59 (3)) (firing sequence) and the sustainer motor (figure 8-59 (1)) (sustainer fires). The eject motor consists of a solid propellant which provides the thrust to eject the missile from the launch tube. The propellant, which is completely expended while the missile is in the launch tube, also provides the initial missile spin. When the firing trigger is squeezed, power from the launcher battery/gas unit fires the ejector motor squibs which ignite the eject motor. Following eject motor burnout, the missile coasts for approximately seven meters prior to activation of the sustainer motor. The SUSTAINER MOTOR contains a solid propellant which provides thrust to accelerate and maintain the missile in flight. Following the coast phase, the sustainer motor fires and then burns for approximately 5.6 seconds.

(f) The tail assembly section (figure 8-59 (1)) (missile coasts) consists of four folding, stabilizing fins. Prior to firing, the fins are in the launch tube in a folded position. When the missile is fired, the ejector motor gases strike the folded, canted tail fins, causing the missile to spin counterclockwise. After the missile leaves the launch tube, the tail fins snap out and are locked in flight position. The fins maintain the counterclockwise spin, a necessary part of missile guidance, throughout missile flight.

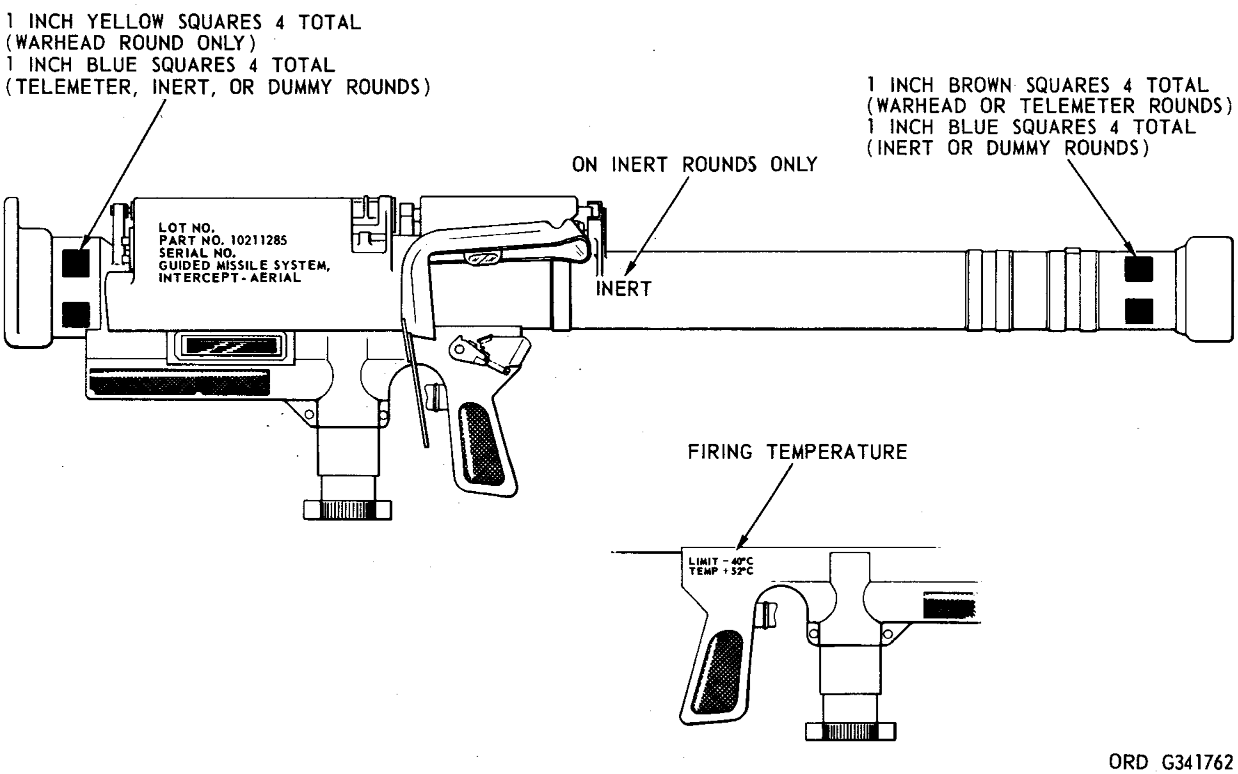


Figure 8-60. Weapon identification markings.

(4) Weapon identification, markings, and data are indicated in figure 8-60 and table 8-5.

Table 8-5. Data.

Item	Length (inches)	Width (inches)	Height (inches)	Case Diameter (inches)	Weight (pounds)
Weapon (complete with cover and battery/gas unit)	50.08	—	14.3	—	28.9
Launcher Battery/Gas Unit	6.015	—	—	1.865	1.20
Shipping and Storage Container	56	15.52	12.54	—	42.5 (empty) 75 (loaded)

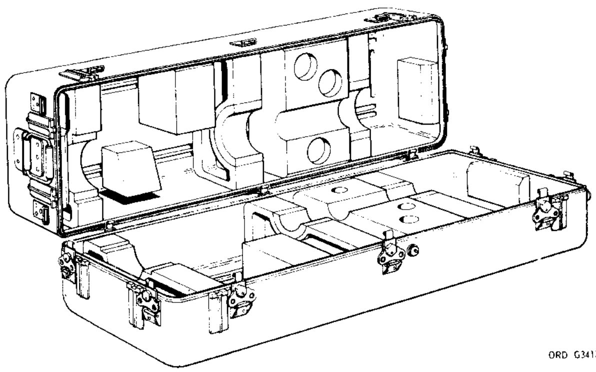


Figure 8-61. Shipping and storage container.

(5) The shipping and storage container is shown in figure 8-61. The Redeye missile is 47.5 inches long, 2.75 inches in diameter and weighs 18 pounds. It is packed in an aluminum, two-piece container with a capacity of one weapon and three launcher battery/gas units. The container is fungus and moisture resistant. A depressurization valve is provided to equalize internal pressure with the atmosphere before the container is opened.

9. SHILLELAGH GUIDED MISSILE SYSTEM.

a. General. This system was designed for use against tanks, armored vehicles and field fortifications. The Shillelagh was originally designed to be the major armament of the Sheridan M551 armored reconnaissance vehicle. The Shillelagh system has proven so effective and reliable that it has more recently been adapted to the M60A1E2 tank. The Shillelagh system is a highly mobile, easily maintained, antitank, weapons system. Some of the most important and most interesting characteristics of the system are: the missile is command guided by an infrared (IR) data link; the launch tube can fire either the MGM51 series missiles or the 152-mm conventional HEAT-T-MP cartridge discussed in lesson 3, paragraph 4o (figure 3-16). After the missile is fired, all the gunner has to do is establish and maintain the missile reticle on the target until the missile impacts.

b. The Shillelagh missile (figure 8-62) is a solid propellant guided missile and consists of two major sections, the warhead section and the missile body section. It is issued and handled as a complete round of ammunition.

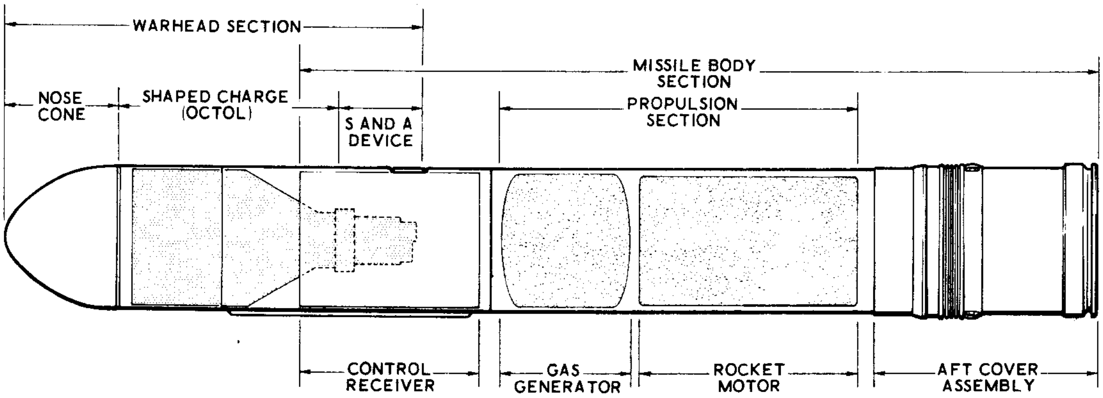


Figure 8-62. SHILLELAGH missile MGM-51A, MGM-51B, or MGM-51C - cutaway view.

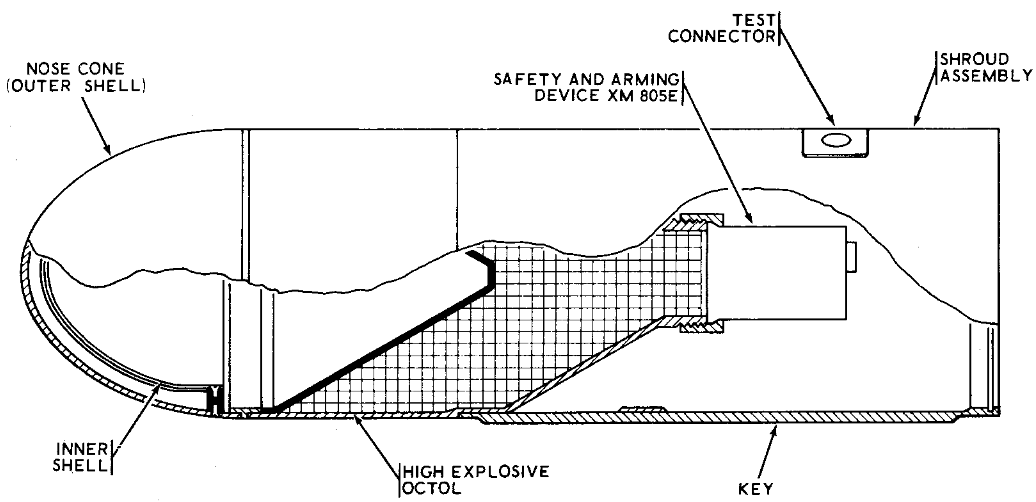


Figure 8-63. Warhead section GM HEAT XM-131.

(1) The warhead section (figure 8-63) consists of the nose cone assembly, the warhead body, the safety and arming device, and the shroud assembly. The warhead is designated GM HEAT XM31.

(a) The nose cone assembly consists of an electrically isolated (1/4 inch) inner and outer shell which functions as the crush switch for the safety and arming device. When the arming sequence is completed and the two shells are crushed together on impact, the electrical firing circuit to the warhead detonator is completed.

(b) The warhead body is of aluminum construction and contains a shaped-charge of high explosive (octol).

(c) The safety and arming device is assembled to the rear of the warhead. The S&A device consists of an electric detonator, an explosive train, and the arming mechanism. The arming sequence begins when the missile is fired and the on-board missile batteries are activated. The sustained acceleration of the missile causes a mechanical gear train to rotate and place the lead charge into alignment with the electrical detonator. The fuze is now armed and detonation of the warhead will occur when the crush switch is closed (by impact) completing the circuit to the detonator. Dropping the missile, though crushing the nose cone, will not arm the warhead (since the explosive train is not aligned), but will probably cause a malfunction in the missile when fired.

(d) The shroud assembly houses the safety and arming device and the control receiver package. The shroud has a longitudinal KEY along its lower centerline. The key engages a keyway cut along the length of the 152-mm gun/launcher tube and serves to orient and maintain the proper missile position in the gun/launcher.

(e) The control receiver, mounted on the forward bulkhead of the body section, consists of the electronic receiver and the flight control subassemblies. These subassemblies process the missile guidance signals from the vehicle-mounted guidance and control set into steering commands used to correct the flight path of the missile.

(2) The missile body section (figure 8-62) consists of the propellant section, the aft body section, and the aft cover assembly.

(a) The propellant section incorporates the gas generator and rocket motor which share a common bulkhead. A blast tube, which carries the gas generator exhaust gases, extends from the forward gas generator chamber through the aft motor chamber and closure to the jet reaction control assembly in the aft section. The forward closure to the gas generator chamber also serves as the bulkhead to which the control receiver is attached.

(b) The aft body section includes the aft shroud housing assembly, the aft bulkhead, jet reaction control solenoid valve assembly, exhaust tube set, optical receiver assembly, and missile source assembly. The machined cast-magnesium shroud housing provides support for the fin system and the flight control components. The shroud housing surface is recessed below the basic missile diameter to provide stowage for the four aluminum fins. The aft cover holds the fins in position until the missile is fired, then springs erect the fins. The optical receiver, located at the end of the missile, detects the infrared signals transmitted from the launching vehicle and converts them into electrical signals. An infrared energy source also mounted at the aft end, projects infrared energy from the missile back to the launching vehicle. The missile signal is used to determine the missile's deviation from the gunner's line of sight.

(c) The aft cover assembly (figure 8-62) is a cylindrical cover which fits over the aft body section. A tapered adapter stop positions the missile in the gun/launcher prior to breech closure. Cushioning pads (rubber and metal spacer rings) fit between the adapter stop and the shear screws to reduce the shock to missile components when the missile is loaded. Six aluminum shear screws secure the aft cover to the aft body section. When internal pressure from discharge of the rocket motor and gas generator reaches 250 psi, the screws shear, thus releasing the missile from the aft cap. The firing contactor, mounted in the base of the aft cover, mates with the electrical firing probe on the gun breech assembly. When the breech is closed, the probe punctures the protective cover and completes the circuit to the missile. The two windows in the base of the aft cover permit test of the missile source and optical receiver (figure 8-64). Upon completion of firing, the aft cover assembly is removed from the breech of the launcher tube and stored in the tank turret to be disposed of at a later time.

(d) Color code and data markings on Shillelagh missile are as shown on figure 8-65.

(e) The Shillelagh missile is stored and shipped in the M555 container (figure 8-66). The weight of the container, with missile, is 116 pounds. The Shillelagh missile weighs 61.5 pounds

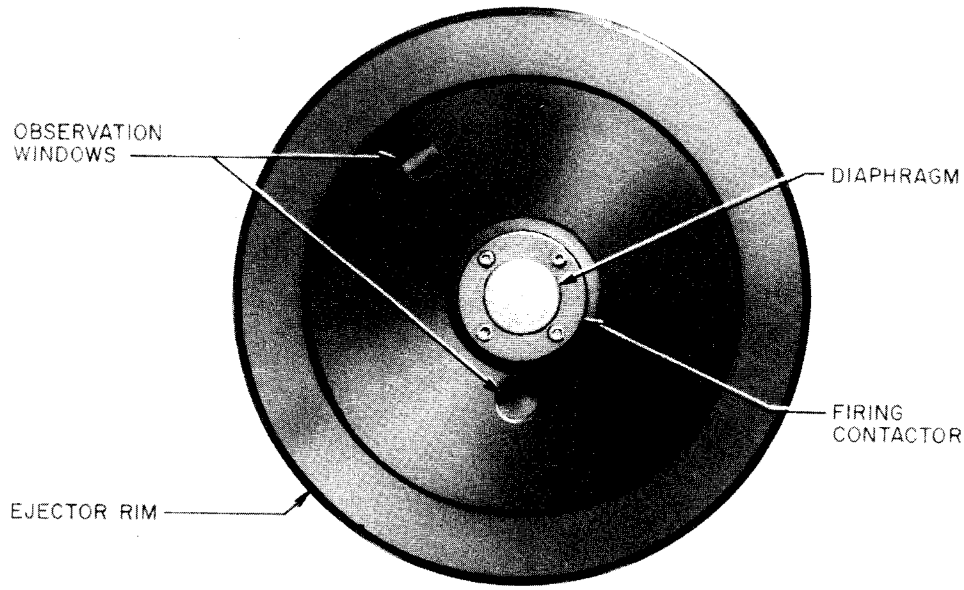


Figure 8-64. Aft cover-end view.

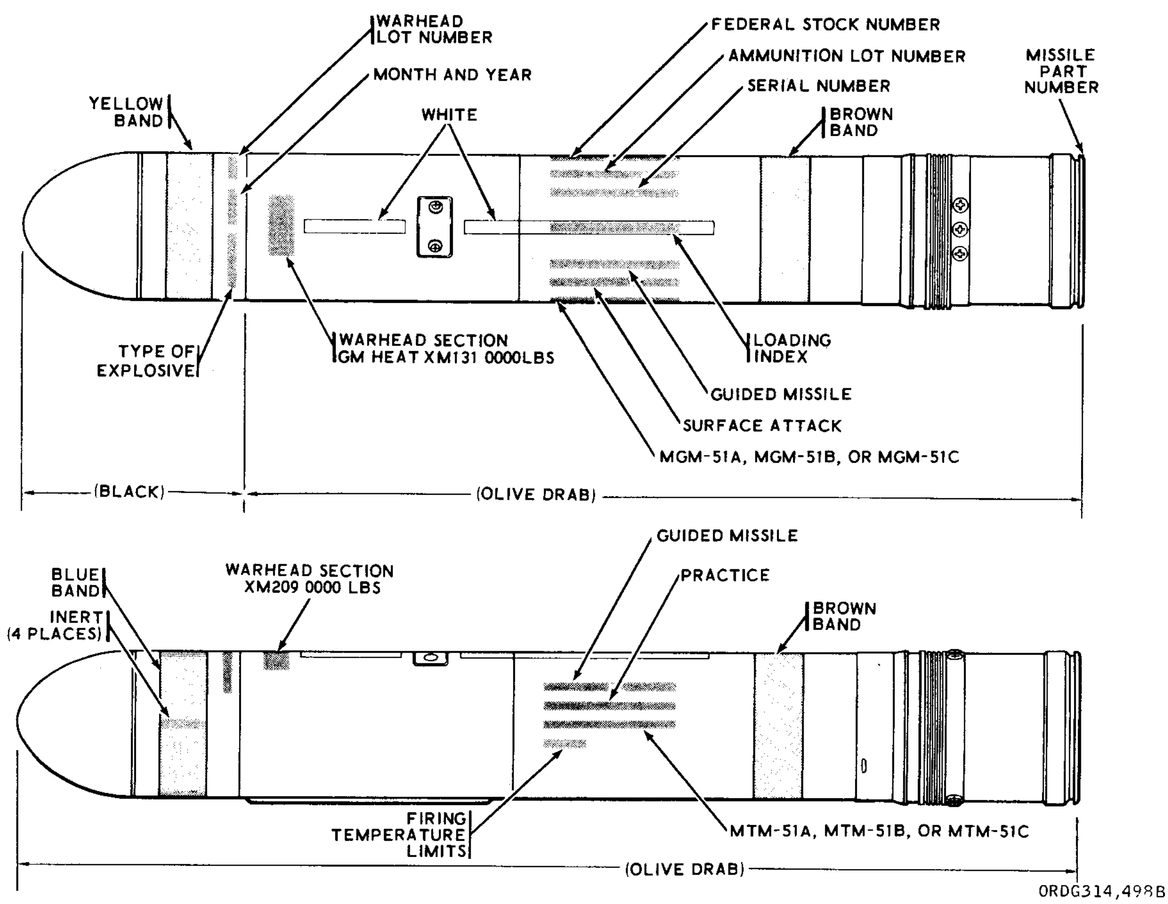


Figure 8-65. Location of color code and data markings on SHILLELAGH missiles.

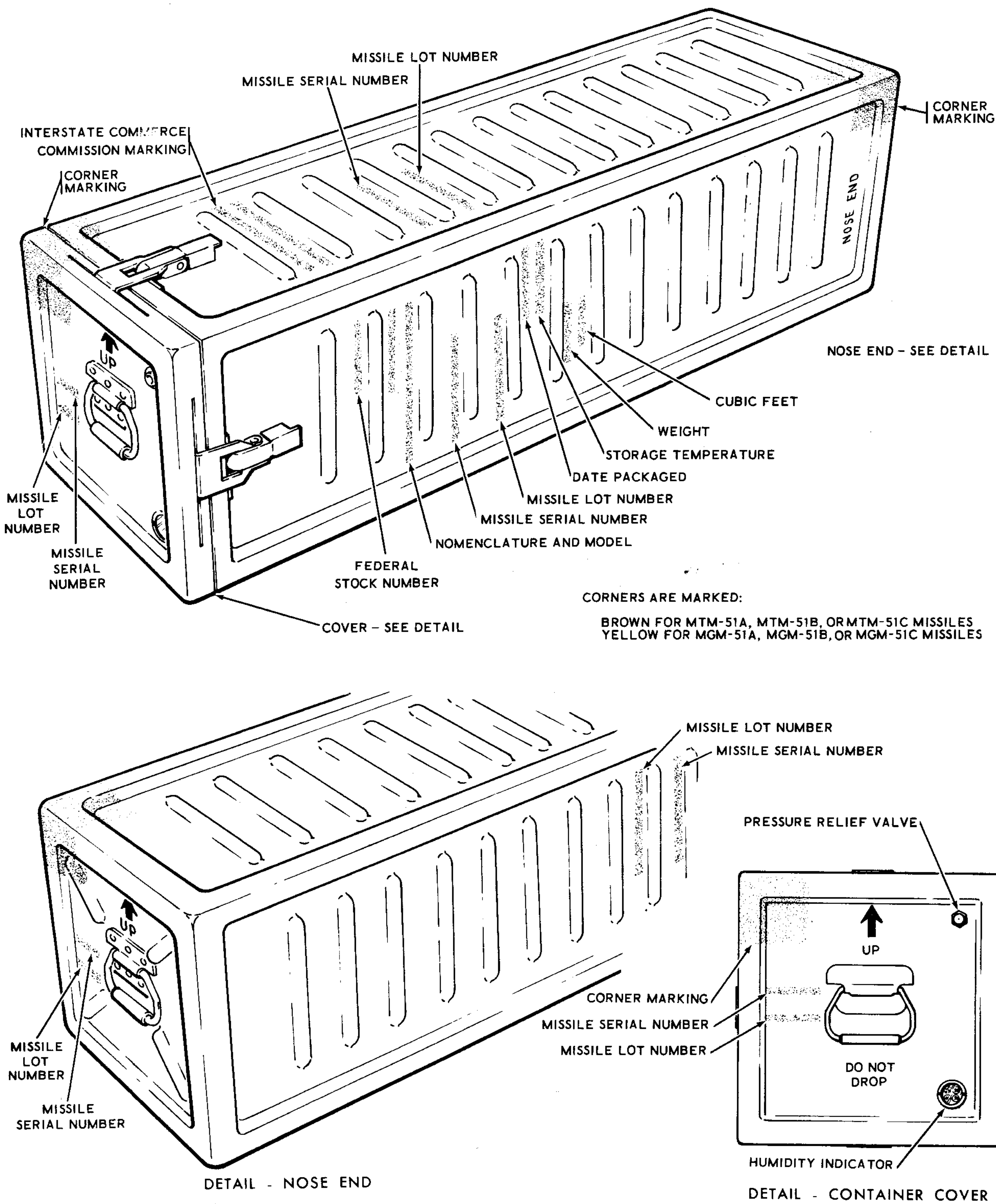


Figure 8-66. Missile container identification marking.

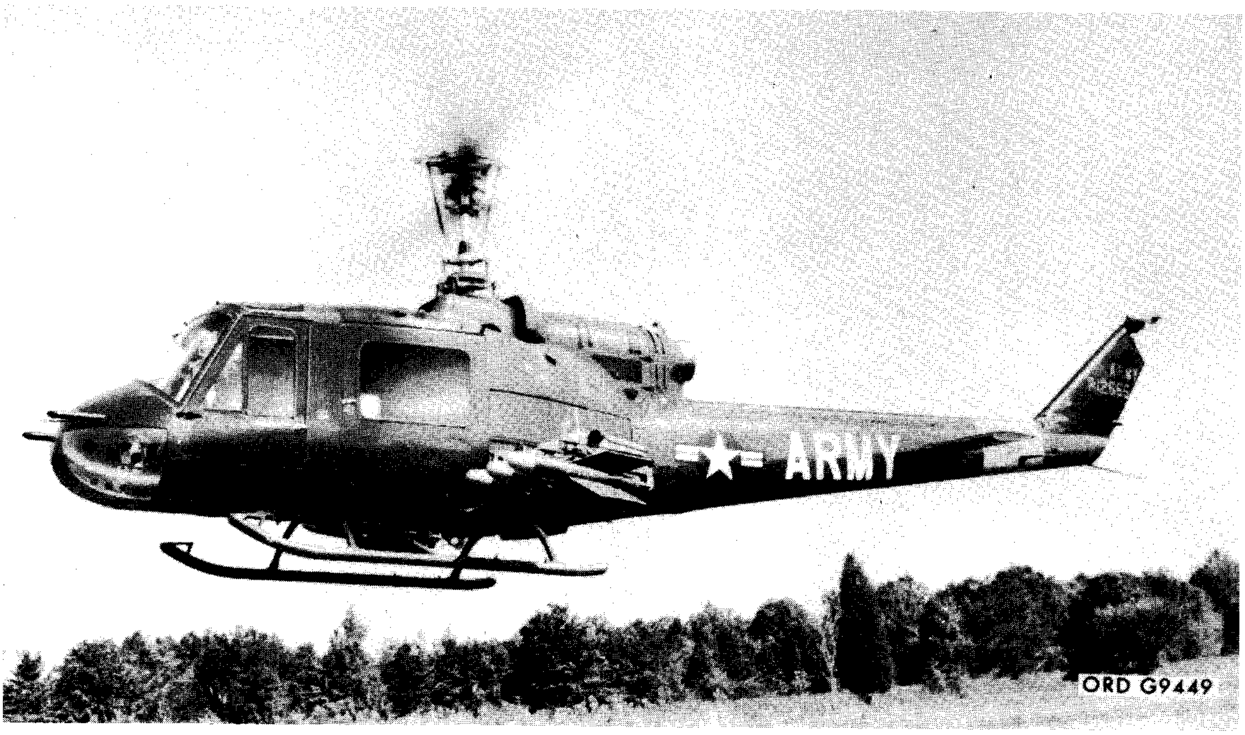


Figure 8-67. M22 armament sybsystem.

as fired; the length is 45.4 inches, with a diameter of 6 inches, and contains 22 pounds of explosive.

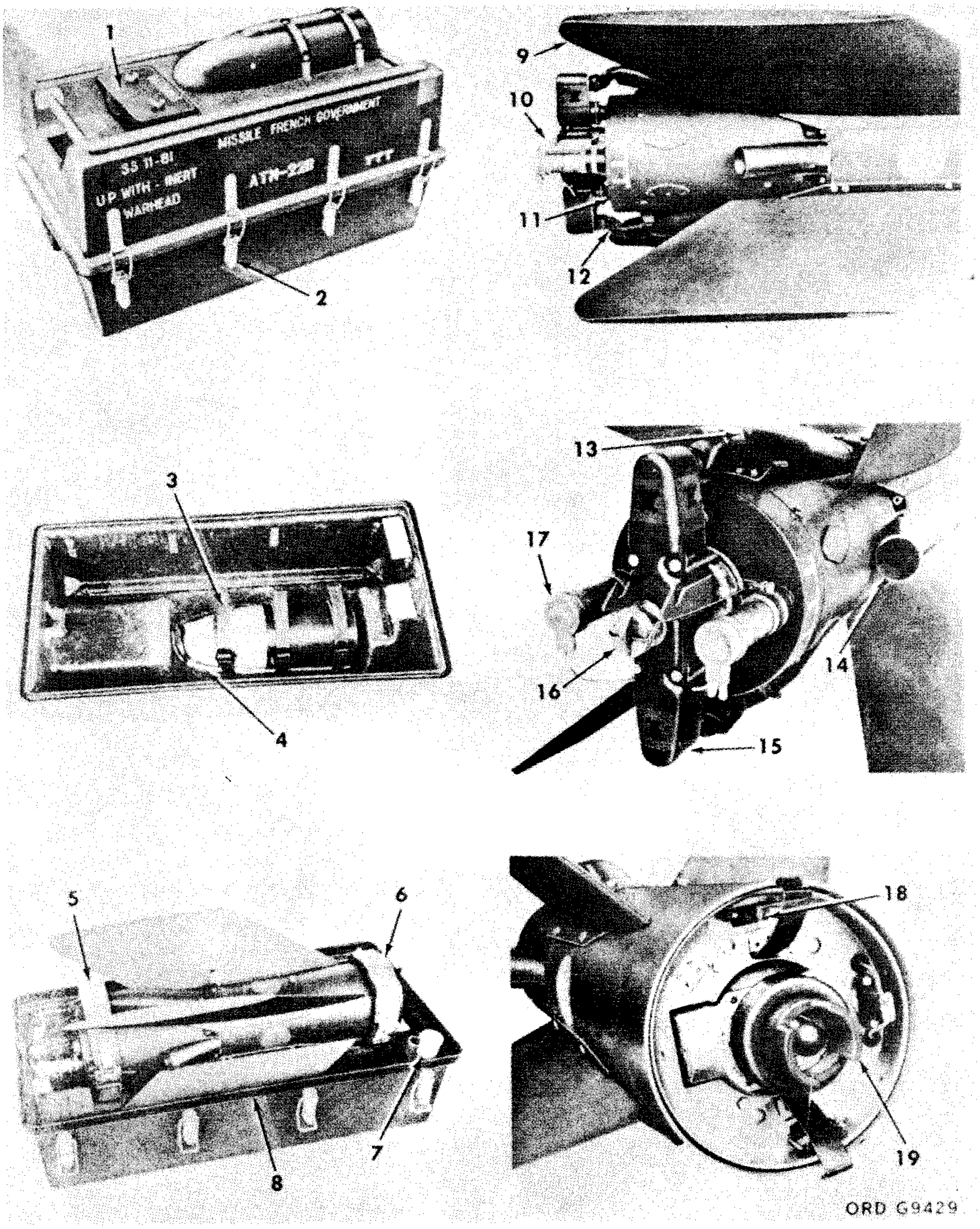
10. GUIDED MISSILE LAUNCHER HELICOPTER ARMAMENT SUBSYSTEM M22 (SS11).

a. General. The M22 is a helicopter-mounted guided missile armament subsystem used on the UH-1B helicopter (figure 8-67). It is primarily an antitank weapon, but can be used effectively against such targets as fortified gun emplacements and bunkers. A system consists of six AGM 22B missiles, which are transported on and fired from launcher assemblies attached to the helicopter. The gunner, sitting in the copilot's seat, fires and guides the missiles by remote control. The basic guidance commands from the gunner's control stick are converted to coded guidance signals by an electronic coder. These signals travel to the missile through two wires which unwind from the missile while it is in flight. After the signals reach the missile, they are decoded and routed to control devices that alter the in-flight missile direction.

b. There are two types of missiles (figure 8-68) used with the M22 subsystem: the AGM 22B is assembled with a HEAT warhead, and an ATM 22B is assembled with an inert-loaded, nonexplosive warhead containing an orange-colored powder to mark the spot of impact during practice firing. The warheads are NOT interchangeable.

c. The missile body section (figure 8-69) consists of the on-board guidance package, the booster and sustainer motors, and the warhead fuzing system. The warhead fuze forms the forward end of the body section and contains mechanical and explosive components that arm the warhead.

d. Four diagonally opposed wings provide lift for the missile and cause it to spin during its flight. The spin results from the way the wings are mounted in an offset position to the centerline



1 Attaching hardware box
2 Latches and pins
3 Straps
4 Warhead cushioning material
5 Aft clamp
6 Forward clamp
7 Cartridge holder
8 Container seal
9 Wings
10 Hooks
11 Rear cover
12 Guide-wire sleeves
13 Spool housing
14 Exhaust ports
15 Junction box
16 Junction-box container
17 Flares
18 Battery-electrical connector
19 Protector plug

Figure 8-68. Missile Components.

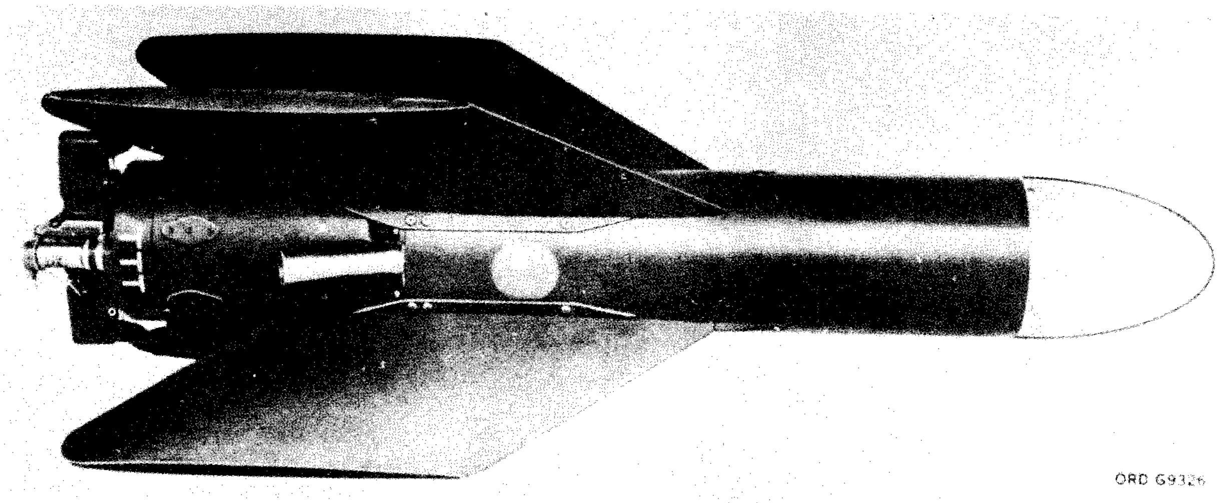


Figure 8-69. M22 missile.

of the missile. Two pyrotechnic flares, mounted on the rear of the missile, ignite when it is fired and help the gunner track its flight. The source of energy for the missile is from batteries mounted in the body section.

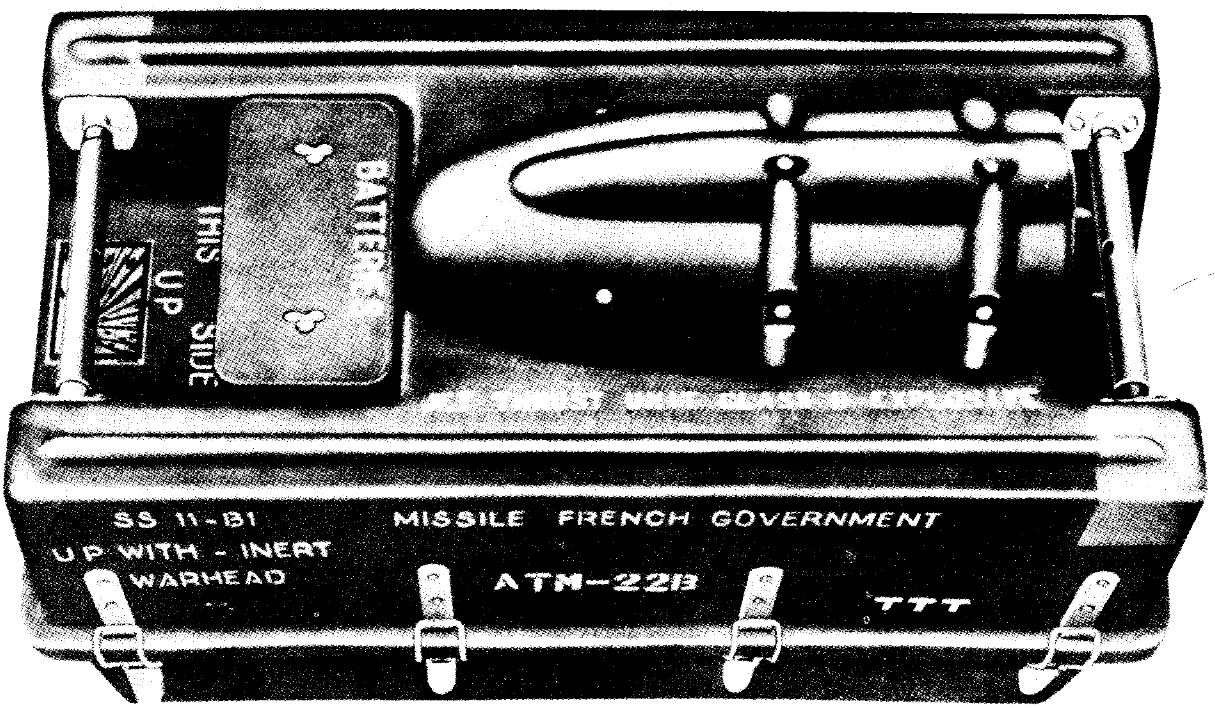


Figure 8-70. M22 shipping container.

e. Missiles are shipped disassembled in a two section container (figure 8-70). The top half of the container holds the warhead. The missile body section is stored in the bottom half of the container. The containers are also identified by color code and data markings to indicate their contents.

Figure 8-71. CW Acquisition Radar.

11. HAWK AIR DEFENSE GUIDED MISSILE SYSTEM.

a. General. This system must be able to perform four basic functions: detection, identification, tracking, and destroying hostile aircraft. The HAWK missile system has the capability of performing these functions against extremely low-altitude targets while retaining a high degree of mobility for rapid movement in the Field Army area.

(1) Detection. To detect targets, the HAWK system uses two acquisition radars. The first of these, a continuous-wave acquisition radar (CWAR) (figure 8-71), covers the low altitude zone. This radar utilizes the doppler effect to detect low flying targets. The doppler effect is produced by a change or shift in frequency due to the movement of the object reflecting that frequency. If the transmitted energy strikes a stationary object, such as a hill or building, it is returned to the radar unchanged in frequency. Within the radars, a comparison is made between the transmitted and received frequencies, and if there is no change, no indication is presented on the radar display indicator. However, if the transmitted energy strikes a moving object, such as an aircraft, there will be a change in frequency due to the movement of the aircraft. The amount of this change, the doppler effect, is directly proportional to the speed of the aircraft. Again, a comparison is made with the transmitted frequency and this time the radar will detect the change in frequency and an indication will be presented on the radar display indicator representative of the speed of the target. The indication will appear at an azimuth determined by the radar's antenna position at the time of detection. Thus, low-altitude targets are readily detected since reflection from stationary objects on the ground will not be presented on the radar display indicator. The second acquisition radar, the pulse acquisition radar (PAR) (figure 8-72) complements the CWAR and provides medium-altitude and medium-range capability for the system. Normally, the two radars are synchronized in rotation and rotate at approximately 20 rpm and scan each point on the radar coverage area once every three seconds. The PAR has a limited capability at very low altitudes due to the reflection of its energy by slow-moving and stationary objects on the ground; otherwise, the reflections would clutter the radar screen which could obscure low-altitude targets from the operators. The synchronized rotation of the two acquisition radars permits coordinated, continual search for targets. Target information from both radars is automatically relayed to the battery control central (BCC) by means of data cabling. Within the BCC, all operations of the battery are integrated and controlled during an engagement.

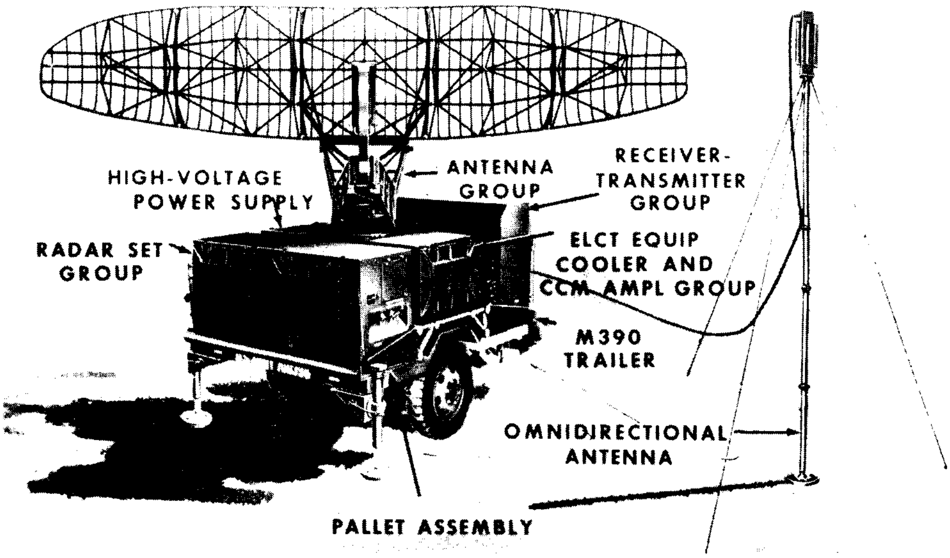


Figure 8-72. Pulse Acquisition Radar.

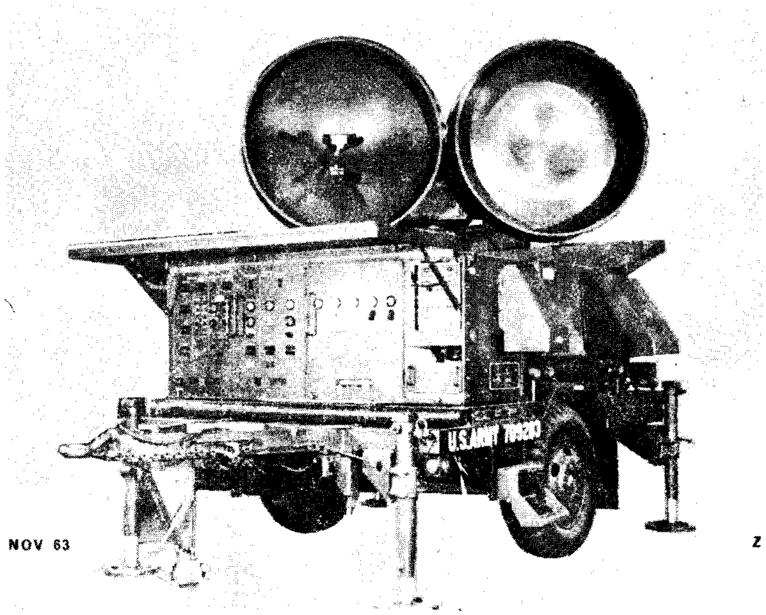


Figure 8-73. High-Power Illuminator Radar.

(2) Identification. Identification of targets is accomplished in the HAWK missile battery by use of selective identification feature (SIF) equipment. This organic means of identification is supplemented by information originating at the Army Air Defense Command Post (AADCP) and will be transmitted to the battery by voice or data cabling.

(3) Tracking. Tracking is accomplished by a high-power illuminator radar (HPIR) (figure 8-73). The firing battery contains two sections. A firing section consists of one HPIR and three missile launchers with three missiles for each launcher (figure 8-74). Upon receiving a target assignment, the illuminator radar in the assigned section is oriented to the azimuth of the detected target. When a reflected signal bearing a change in frequency is received by the radar, it will lock on

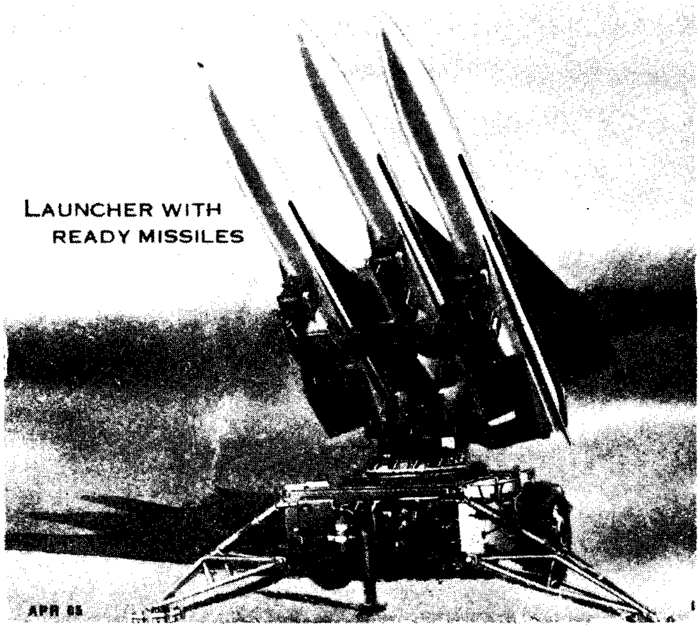


Figure 8-74. Launcher.

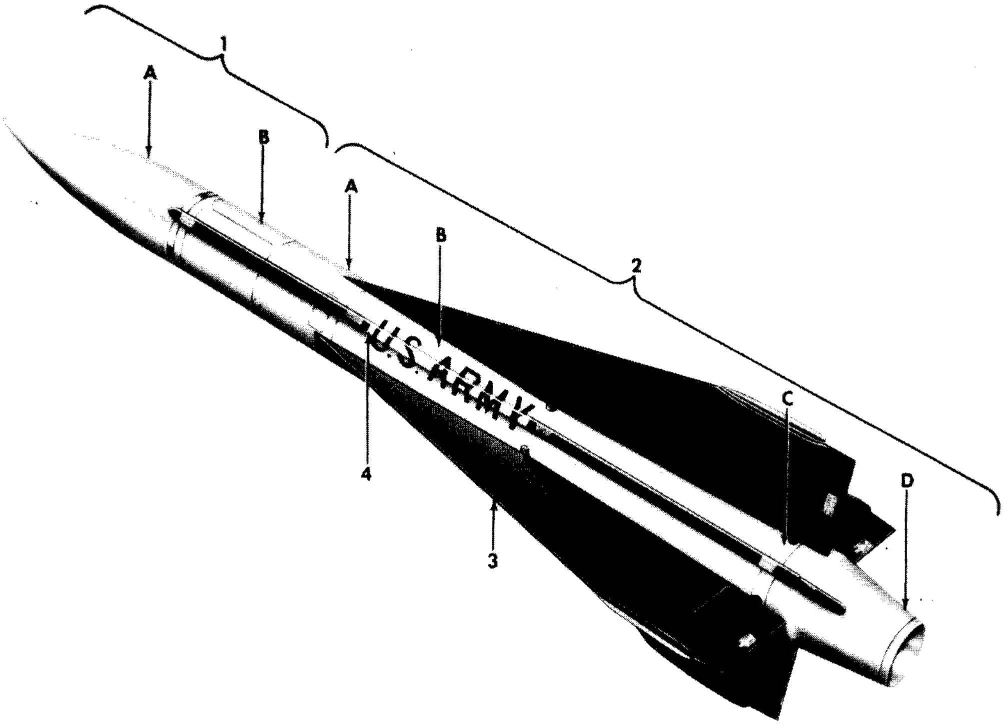
the reflecting source, the target, and automatically track the target during the remainder of engagement. Since this radar also uses the Doppler effect, it can track targets even though they are flying at treetop level. Once the HPIR is locked on the target, a selected launcher in that section will be assigned to this radar. Each missile on the selected launcher is aimed directly at the target. In the battery control center (BCC), the firing control operator (FCO) monitors the progress of these actions closely, and the tactical control officer (TCO) also monitors the engagement to insure the exercise of his command and control responsibilities. When all conditions for firing have been met, the FCO presses the firing button and the HAWK missile is launched toward an intercept point ahead of the target. Additional missiles may be fired with only a few seconds separation.

(4) Target intercept. The HAWK missile homes on energy reflected by the target. The missile will continually track its target through an on-board tracking antenna. The missile's semi-active homing guidance system will continually adjust the missile's course to insure successful intercept. Target speed is determined by the guidance package by continuous comparison of the transmitted energy of the HPIR with the reflected energy from the target. Target maneuver is determined by the position of the missile's target tracking antenna. Utilizing this information to make continuous adjustments in its course, the HAWK missile flies the most direct route to the intercept point.

b. The HAWK missile.

(1) General. The HAWK missile (figure 8-75) is propelled by a dual-thrust, solid propellant motor and uses semiactive homing guidance. The missile is 16.5 feet in length, 14 inches in diameter and weighs approximately 1,295 pounds. It has three basic functional systems: propulsion, guidance, and warhead.

(a) The propulsion system is a solid-fuel rocket motor which develops the thrust required to launch the missile, boosts it to operating speed, and provides the sustaining thrust to maintain this speed throughout flight.



1	Forward body section			B	Rocket motor
	A	Radome		C	Actuator section
	B	Guidance section		D	Tailcone
2	Aft body section		3	Wing assembly	
	A	Warhead	4	Tunnel section	

Figure 8-75. Basic components of the Hawk guided-missile.

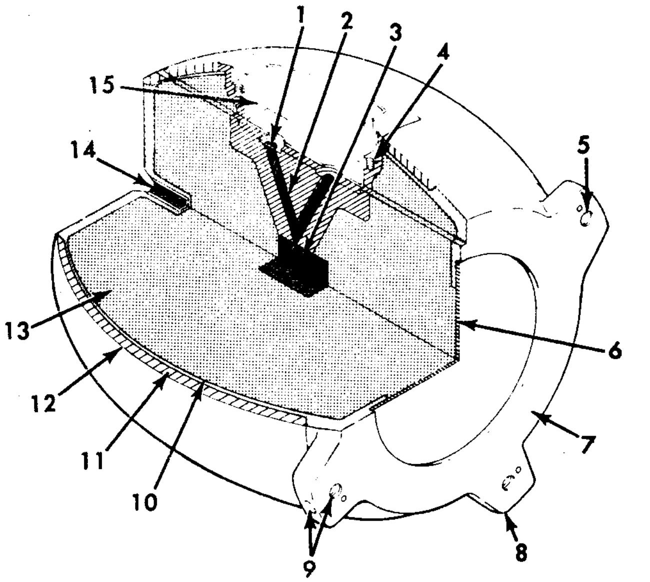
(b) The guidance system is a semiactive homing system which uses reference information transmitted by the illuminator and target information reflected from the target to continuously track and intercept the target.

(c) The warhead system is designed to detonate at the closest approach to the target. For safety purposes, self-destruct circuits will also detonate the warhead in the event of loss of missile control.

(2) Physical description. The missile has a dart-shaped body which is structurally divided into two parts; the forward body section and the aft body section. The wing assembly and tunnel section are components of the aft body section (figure 8-75).

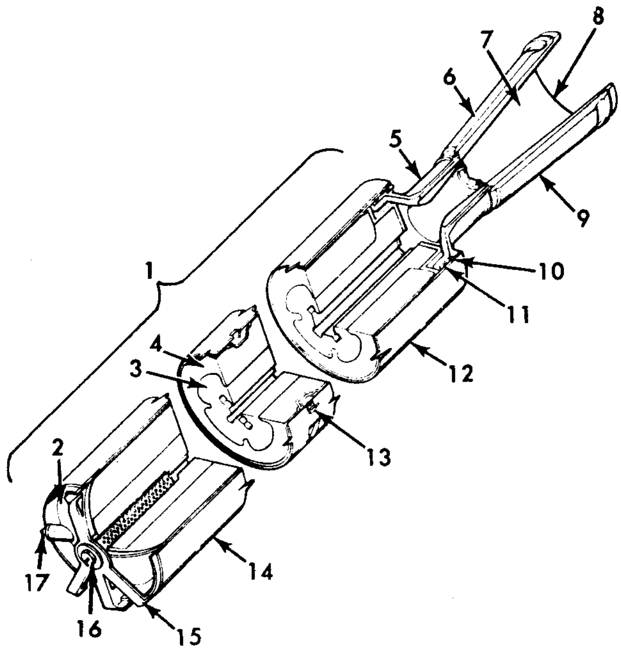
(a) The radome (figure 8-75,1-A) is a molded fiberglass structure with interrupted threads for fastening it to the gimbal ring. The radome serves many purposes, i.e., it minimizes air resistance at supersonic speeds, it permits maximum passage of microwave energy with a minimum of distortion, and it serves as a protective cover and front seal for the guidance section.

(b) The guidance section (figure 8-75,1-B) consists of an outer shell, a gimbal ring, an antenna and hydraulic assembly, an accumulator, an electronic guidance and control assembly, and a power plant. This equipment constitutes all the necessary equipment to receive electronic guidance intelligence and convert it to necessary commands to change the direction of missile flight. The radome fastens to the gimbal ring on the forward end, and the guidance section is joined to the warhead section on the aft end.



1 Aluminum cup
2 Lead charge
3 Booster
4 S & A insert and pin
5 Handling insert
6 Closing plug
7 Mounting plate
8 Mounting lug
9 Mounting insert and pin
10 Inner liner
11 Fragments
12 Outer cover
13 Bursting charge
14 Locator pin well
15 S & A liner

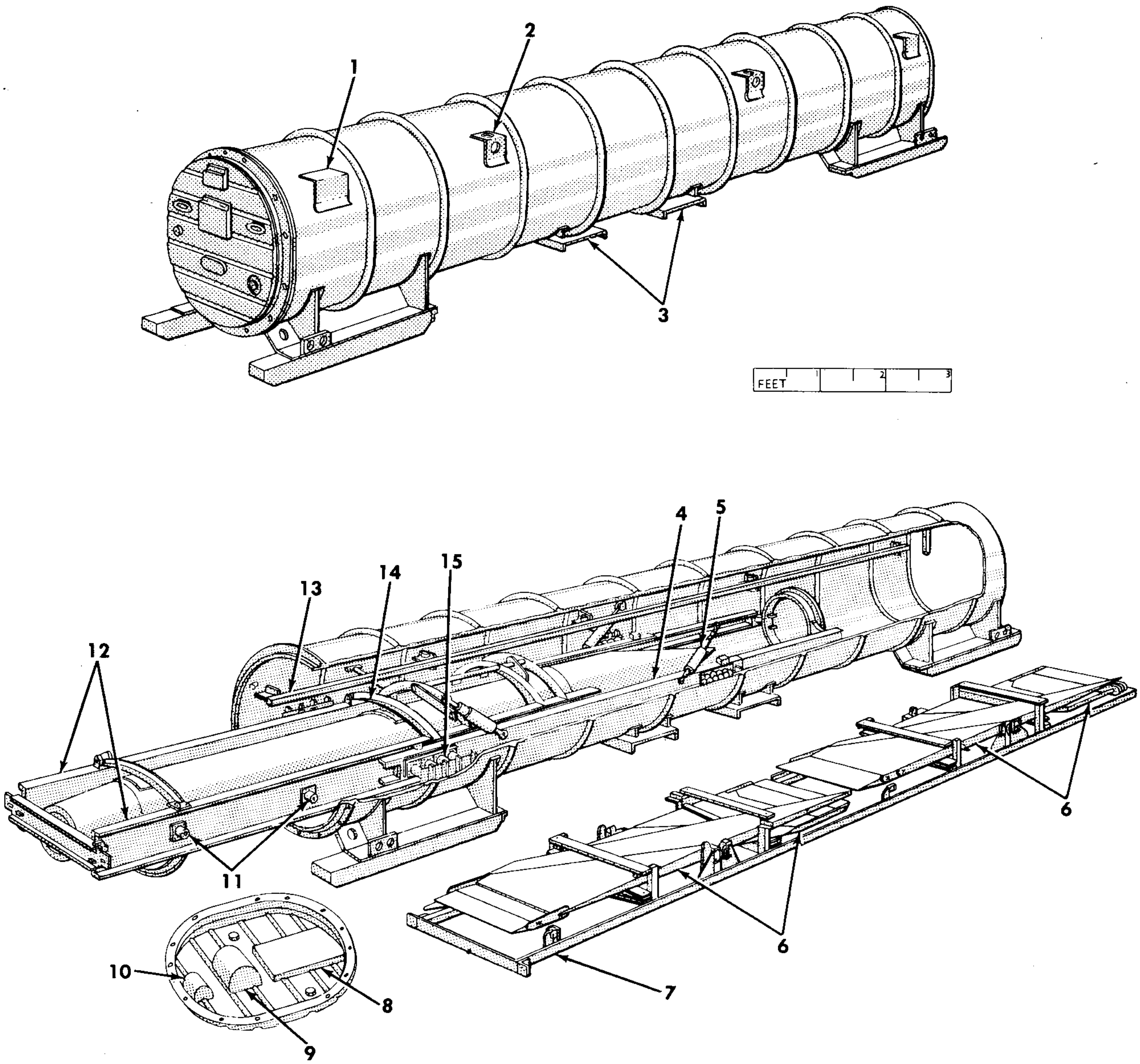
Figure 8-76. Tactical warhead.



1 Chamber assembly
2 Head closure
3 Booster propellant
4 Sustainer propellant
5 Aft closure assembly
6 Sleeve
7 Exit nozzle
8 Closure assembly
9 Exit nozzle assembly
10 Lock wire
11 Packing
12 Aft chamber
13 Wing attach ring
14 Forward chamber
15 Stiffener assembly
16 Igniter boss
17 Initiator boss

Figure 8-77. Rocket motor, XM22 series.

(c) The warhead section (figure 8-75,2-A) consists of an outer shell, the gyro and accelerometer assemblies, the safety and arming device, and warhead. The tactical warhead (figure 8-76) is an HE fragmentation type weighing 110 pounds and containing a bursting charge of 73 pounds of H6. The outer shell and an inner liner are made from cloth laminate, impregnated with an epoxy resin. Between the two shells is a layer of steel fragments set in epoxy resin. The S & A device is assembled in a cavity of the warhead which also contains two RDX lead charges and an RDX booster.



1	Tie-down bracket	6	Wing assemblies	11	Rollers
2	Hoisting bracket	7	Wing section mounting frame	12	Main loading frame
3	Fork lifting rail	8	Record storage compartment	13	Guide rail for wing rack
4	Stationary frame	9	S & A device storage compartment	14	Holding clamp
5	Hydraulic damper	10	Initiator storage compartment	15	Shock mounts

Figure 8-78. Missile container.

(d) The rocket motor (figure 8-75,2-B) forms a major part of the HAWK missile. When assembled for flight, the rocket motor contains the rocket motor igniter and the rocket motor igniter initiator and provides a base for the wing assemblies. The motor (figure 8-77) weighs 885 pounds and contains 620 pounds of propellant. The propellant consists of the booster and sustainer propellant (figure 8-77(3)(4)) and are concentrically cast within the motor chamber.

(e) The actuator section (figure 8-75,2-C) contains the control valves and assemblies for positioning the elevons during flight. The tail cone (2-D) is a fiberglass or aluminum structure and provides a protective cover over the actuator valves, and streamlines the rocket motor nozzle. The four wing assemblies consist of the wing panels and elevons. The fixed wing panels stabilize the missile during flight and the movable elevons deflect to provide guidance. The two tunnel assemblies, one mounted on each side of the missile, provide a streamlined protective cover for the reference antenna, interconnecting cables, and hydraulic lines which connect the guidance package to the actuator section.

c. The HAWK missile container (figure 8-78) is of steel construction with wooden skids. The complete missile is packed within the container in a partially disassembled state. The missile body, wings, and elevons are stored on shock-mounted loading frames. To provide protection from ambient conditions, the container is pressurized (2-3 psi) and humidity controlled. The color codes used in color coding the missile and its container follow the standard color coding system.

12. NIKE-HERCULES GUIDED MISSILE M6.

a. General. The Nike Hercules is an aerodynamic, supersonic, air defense missile (figure 8-79) with a symmetrical cruciform configuration. It is the prime air defense weapons system used against medium and high altitude targets. This system is primarily designed to combat fast, high altitude formations of modern bombers capable of taking evasive action during precision bombing missions. It is most effectively employed to defend military installations, industrial centers, large cities, and as a first line of defense in areas such as distant early warning (DEW) Line, and the eastern and western seaboards of CONUS. The Nike Hercules battery can operate independently or in combination with other air defense units in an integrated air defense system. A number of batteries can be controlled and monitored by a Missile Master System in CONUS or by a Missile Monitor System (in field army applications).

b. Functional operation. The overall system includes three tactical missions, surface-to-air and surface-to-air low altitude, surface-to-surface, and a radar bomb scoring mission. In the surface-to-air mission described herein, figure 8-80, targets are detected, identified, and located by the Nike acquisition radar (NAR) or an auxiliary acquisition radar (AAR). Designated target azimuth and range data are supplied to the target tracking radar (TTR) system by either of the acquisition radar systems. This data enables the TTR system to acquire the target rapidly. When tracking the target, the TTR system continuously supplies accurate target position data (range, azimuth and elevation), to the computer system. From this data, the computer system continuously calculates the predicted intercept point. The azimuth of the predicted intercept point is sent as gyro azimuth preset data to the selected missile on a launcher. This data orients a gyro in the missile guidance set. The missile tracking radar (MTR) system acquires the selected missile on the launcher so that the missile can be tracked continuously from launch to intercept. The computer system continuously supplies data to two automatic plotting boards from which can be determined the optimum time to launch the missile. After launch, the plotting boards record the paths of both the missile and the target. When the missile is launched, a rocket motor cluster (booster) (figure 8-81) provides the initial thrust. When the rocket motor cluster has burned out, the cluster separates from the missile and the missile rocket motor (sustainer) is ignited. The missile rolls to the reference attitude established by the preset gyro and begins to maneuver in response to guidance commands transmitted by the MTR system. The computer system, using the missile and target position data supplied by the MTR and the TTR system, computes the missile trajectory necessary for the missile to intercept the target and supplies the appropriate steering orders to the MTR system. The MTR system then transmits guidance commands to the missile. At a predetermined time before intercept, the computer system automatically sends a burst order to the missile by way of the MTR system. The burst order is timed to detonate the missile warhead just prior to intercept and within lethal range of the target. Identification of objects may be made by means of an identification friend or foe (IFF) system. An IFF system is associated with each acquisition radar system. The IFF transmits coded IFF interrogation pulses to an unidentified object. A friendly aircraft with properly coded IFF equipment responds automatically to the interrogation pulses by transmitting coded IFF

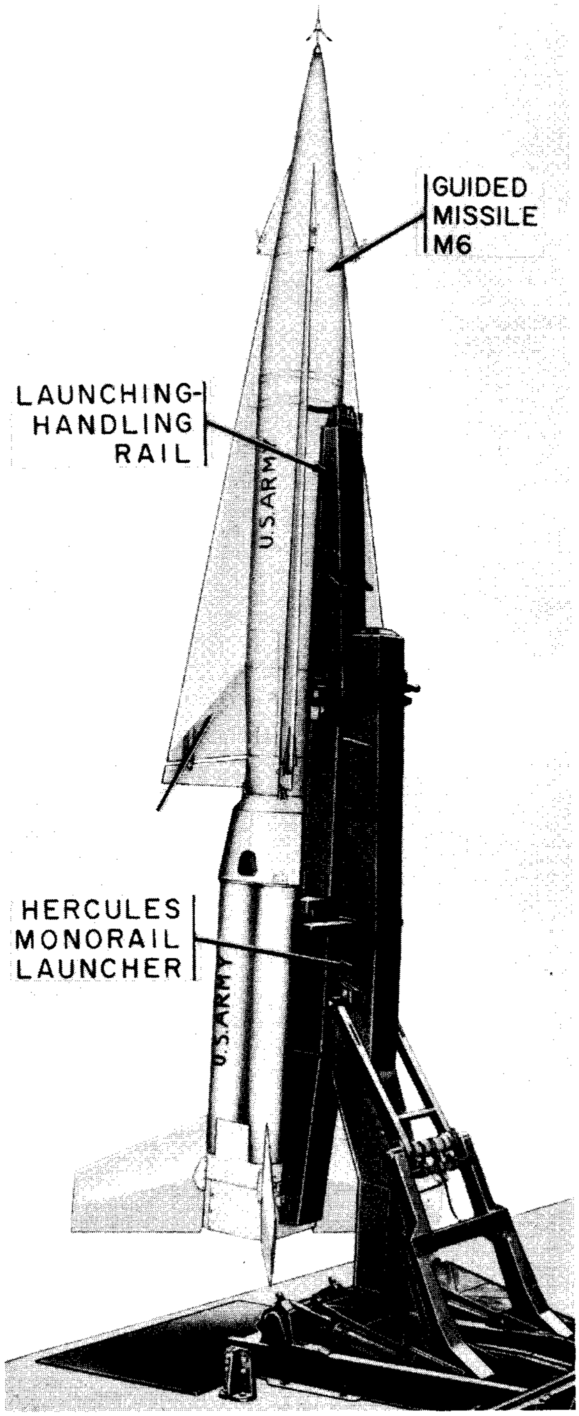


Figure 8-79. M6 Missile on launcher.

response pulses. These response pulses are converted into IFF video for scope presentations. Identification of objects may also be provided by the Army Air Defense Command Post (AADCP) through the fire unit integration facility (FUIF).

c. Physical description. The missile is assembled and mounted on a launching-handling rail and is shown erected on a Hercules monorail launcher (figure 8-79). The overall length of the missile

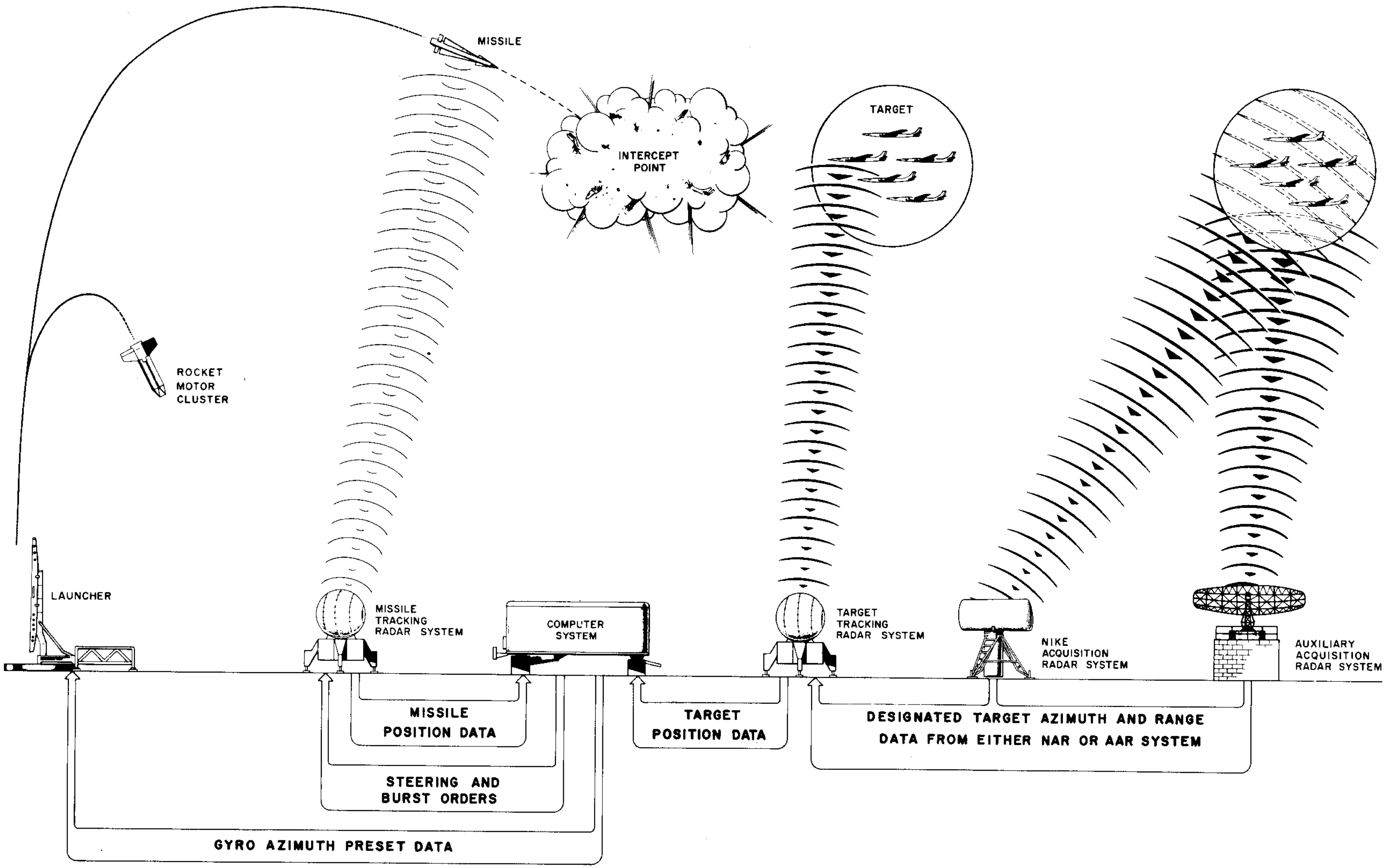


Figure 8-80. Surface-to-air mission.

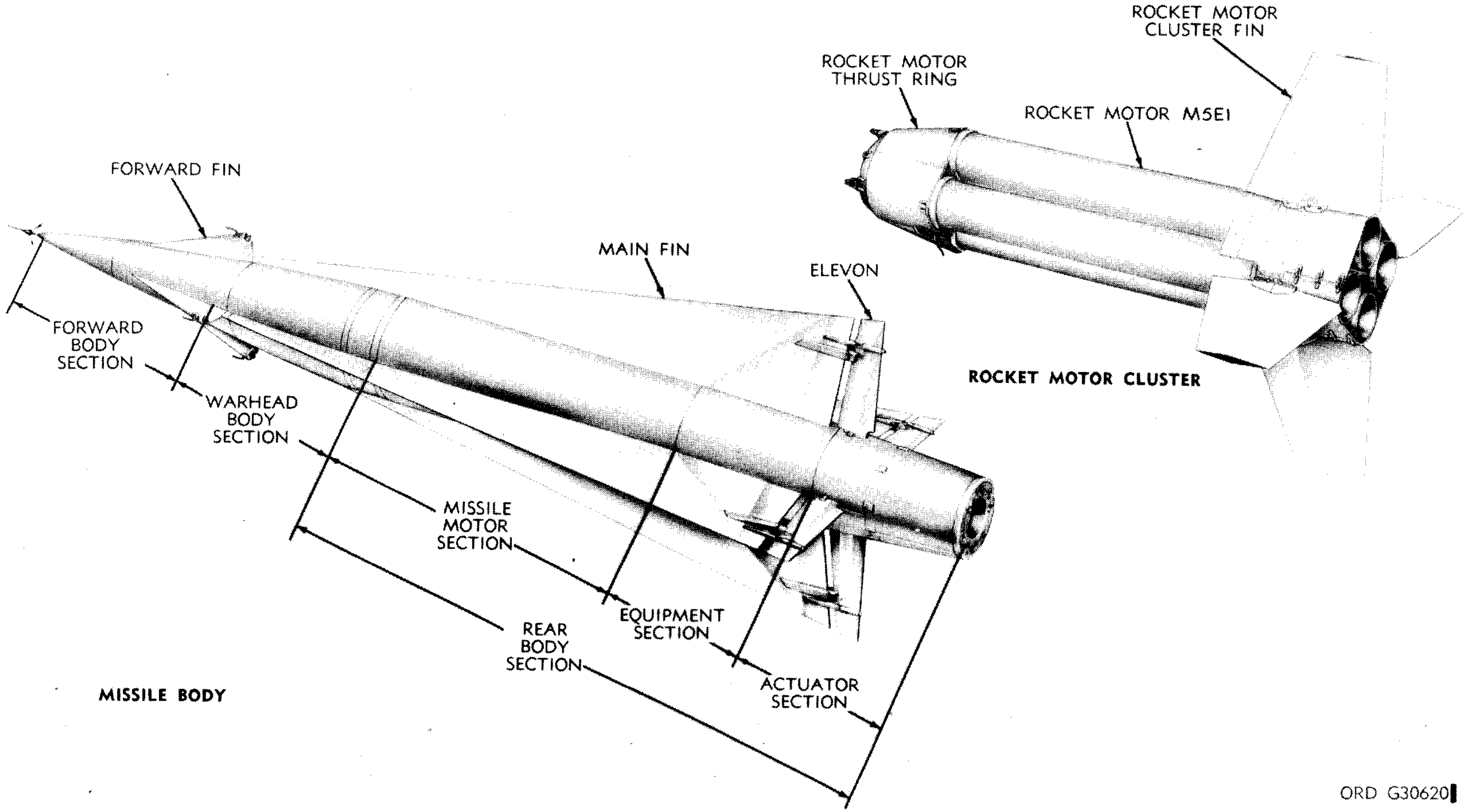


Figure 8-81. Main components of missile.

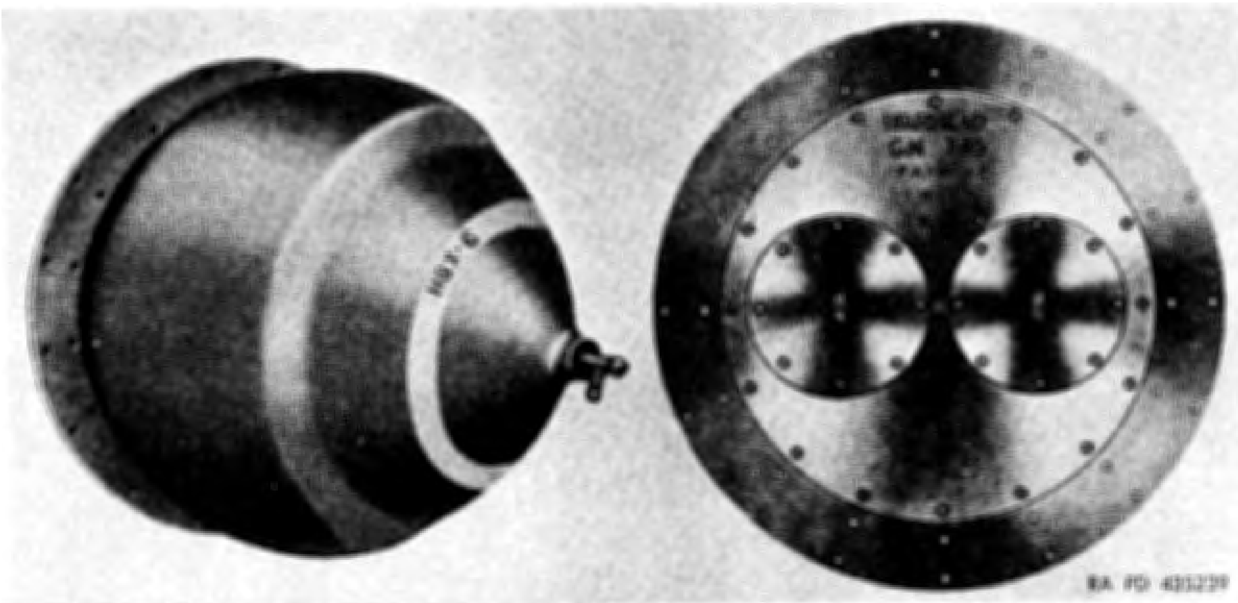


Figure 8-82. Warhead M17 (T45).

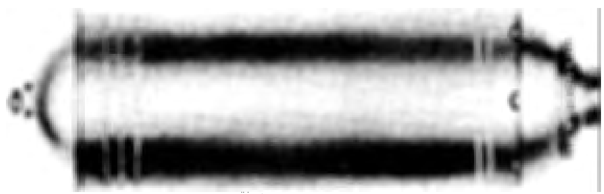


Figure 8-83. Rocket motor M30 series.

M6 is approximately 39 feet, the maximum body diameter is 31.5 inches, a fin span of 90 inches, and has a gross weight of approximately 10,550 pounds. The missile body (figure 8-81) consists of a forward body section, a warhead body section, a rear body section, and four main fins. The forward body section contains the transponder-control group, the major component of the missile guidance set. Four forward main fins are positioned at 90 degree intervals around the circumference of the forward body section. The antenna horns of the missile guidance set are mounted in the forward fins. The warhead body section (figure 8-81) contains the M17(T45) high-explosive, fragmentation warhead (figure 8-82), an S and A device and explosive harness assembly, and associated equipment. The warhead has a dome-shaped configuration, contains 660 pounds of HBX-6, and has a total weight of 1,035 pounds. The rear body section (figure 8-81) consists of the missile motor section, the equipment section, and the actuator section. The missile motor section contains the major portion of the M30 rocket sustainer motor and associated equipment. The M30 series rocket motor (figure 8-83) consists of a welded steel cylinder having a diameter of 28.48 inches and a length of 93.375 inches. The motor chamber contains a case-bonded, single-perforated, solid propellant weighing 2,196 pounds (figure 8-84), a propellant igniter, and two electric squibs. The M30 motor provides the thrust necessary to sustain the missile in flight after the booster has burned out and separated. Attached to the aft end of the sustainer motor M30 is a blast tube and nozzle assembly (figure 8-85) which extends from the forward end of the equipment section to the aft end of the actuator section where it is supported by three adjustable mounts. The weight of the blast tube and nozzle assembly is approximately 180 pounds. The equipment section contains the missile batteries

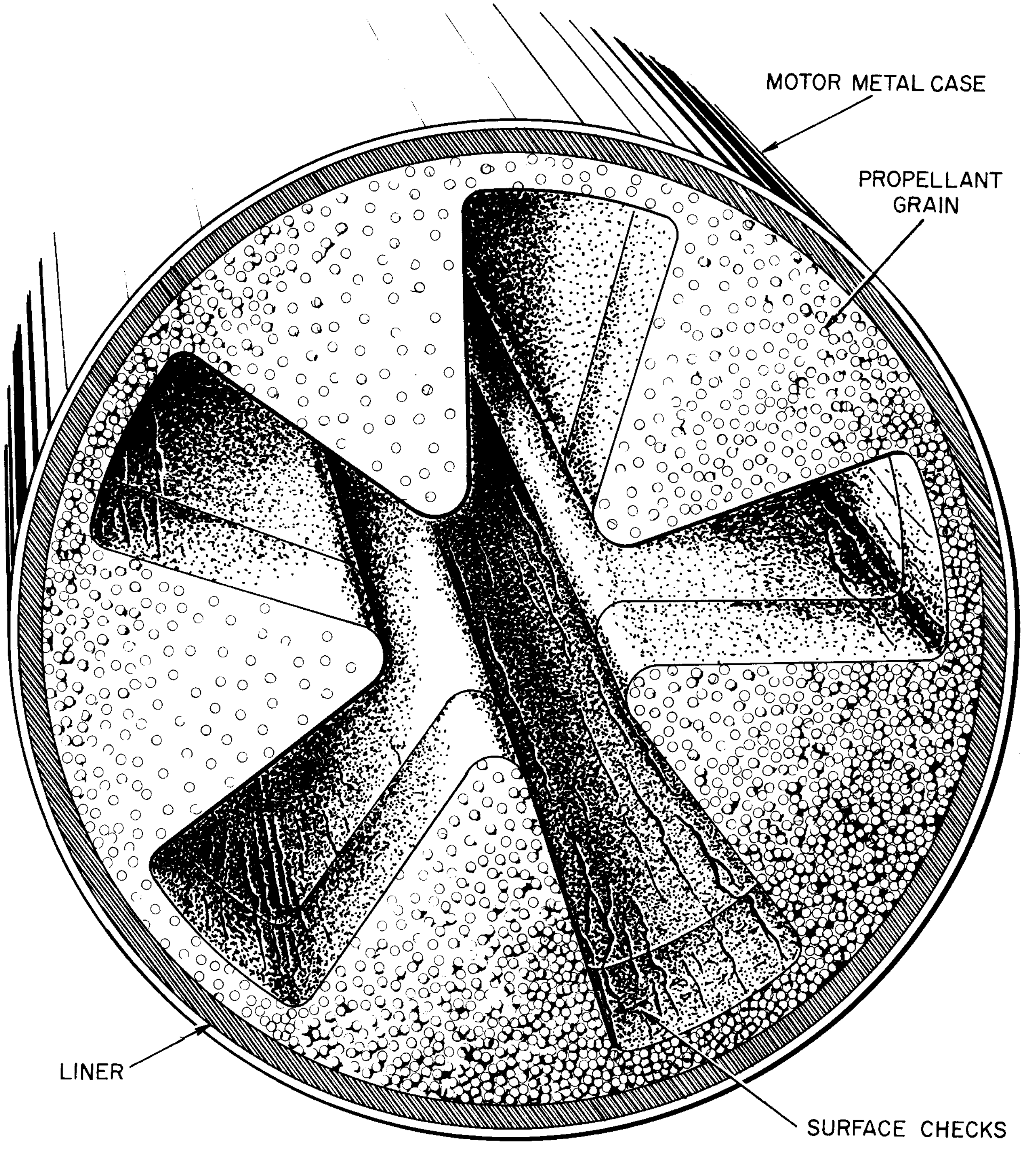
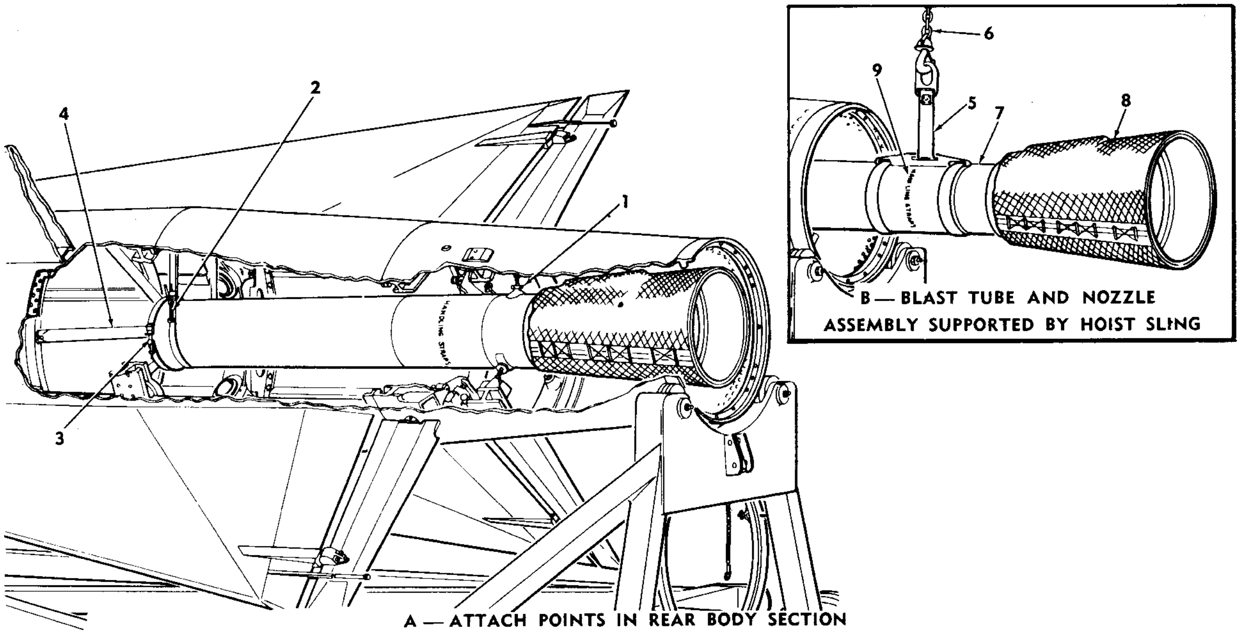


Figure 8-84. Checks on propellant grain surface (alligator-hide appearance).

and either an accessory power unit (APS) or a hydraulic power unit (HPU) in current models. The actuator section contains the actuator assemblies and mechanical linkage that move the elevons. The main fins and elevons (figure 8-81) are positioned at 90 degree intervals around the circumference of the missile body. The main fins extend from the forward end of the warhead body section to the forward end of the actuator section. The four elevons are hinged to the trailing edges of the main fins and are connected to the mechanical linkage in the actuator section. The rocket motor cluster M42 is a solid-propellant booster unit (figure 8-86) which delivers initial acceleration to the NIKE



1	Blast tube adjustable mount (3)	6	Falling hook
2	T-bolt and trunnion bands	7	Blast tube and nozzle assembly
3	Grooved clamp coupling	8	Insulation blanket
4	Shipping support	9	Center of balance area
5	Blast tube hoist sling		

Figure 8-85. Blast tube and nozzle assembly --removal and installation.

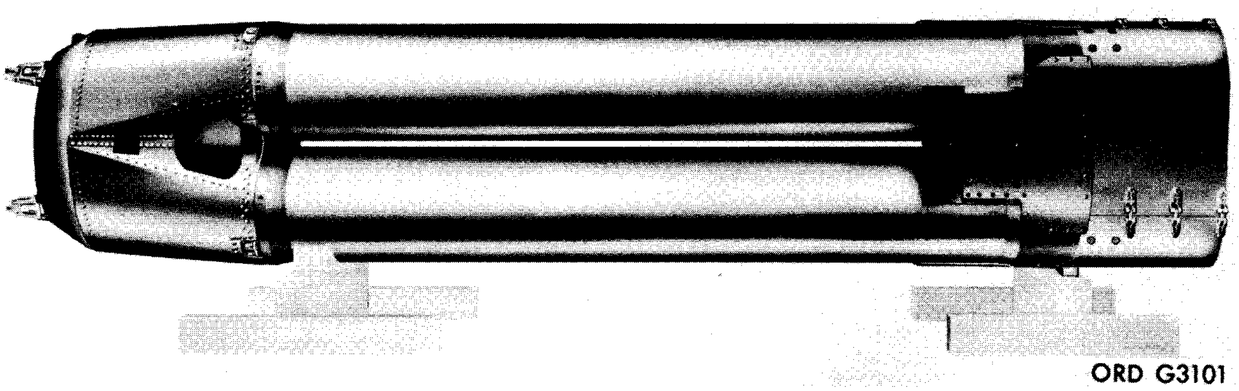


Figure 8-86. Rocket motor M42 series without fins.

HERCULES Missile. The motor cluster consists of four M5El (NIKE AJAX boosters) modified M88 for NIKE HERCULES application (figure 8-87). The four motors are manifolded together with a thrust structure (figure 8-88) four fin fittings, four fins, and hardware necessary for assembly. The thrust structure joins the rocket motor cluster to the missile body. It is a rigid slip joint with an internal, tapered opening in its forward end, designed to mate with the missile boattail. The thrust structure also contains a booster-to-missile lanyard-attach bracket for securing a lanyard assembly which is used to initiate the sustainer motor igniters upon separation of booster unit. Four elevon locks are attached to the forward forming ring of the thrust structure and hold the elevons of the missile immobile during the boost phase of the flight. Each motor of the cluster contains a single,

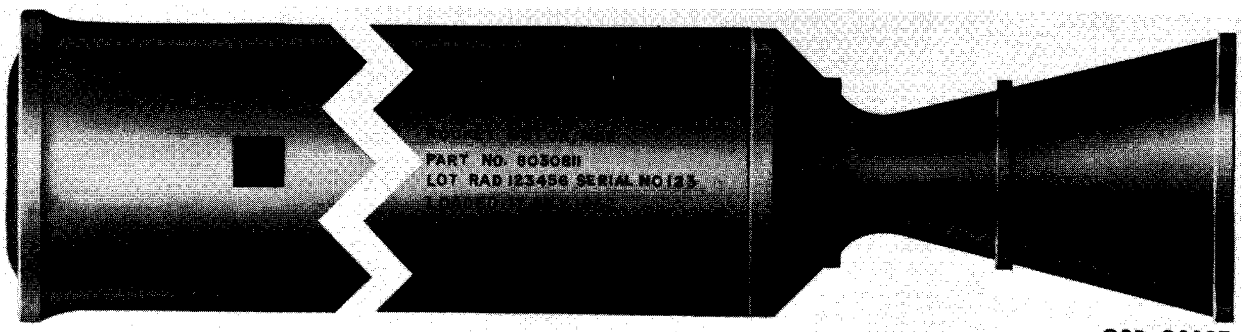


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Figure 8-87. Rocket motor M88.

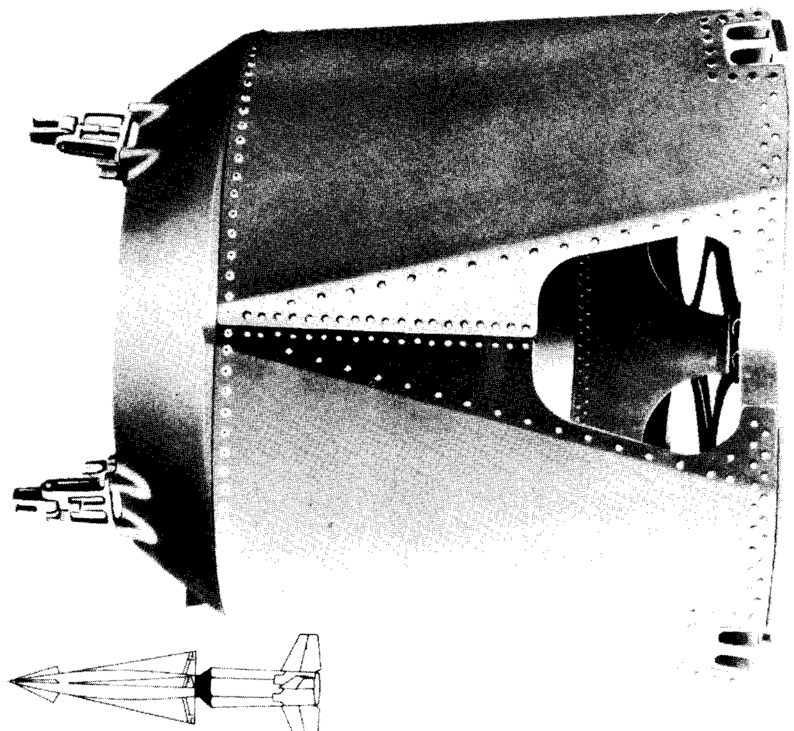

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Figure 8-88. Thrust structure.

doublebase multiperforated, solid grain of propellant cast within an inhibiting cellulose liner. The liner helps to insulate the combustion chamber wall and controls burning of the propellant. The propellant grain is 102 inches long, 16 inches in diameter, and weighs 750 pounds. The weight of the rocket motor cluster is approximately 5300 pounds.

d. Storage containers for the NIKE HERCULES system.

(1) The warhead-body section is stored in a skid-mounted reuseable metal container M409 (figure 8-89) having a removable cover at the forward end and secured to body by 12 quick-opening latches. A receptacle in the end cover houses an air filling valve, a relief valve, and a window through which a humidity-indicator card is visible. A desiccant holder is attached to the inside surface of the end cover. A similar receptacle and desiccant holder are attached to the aft end of the container.

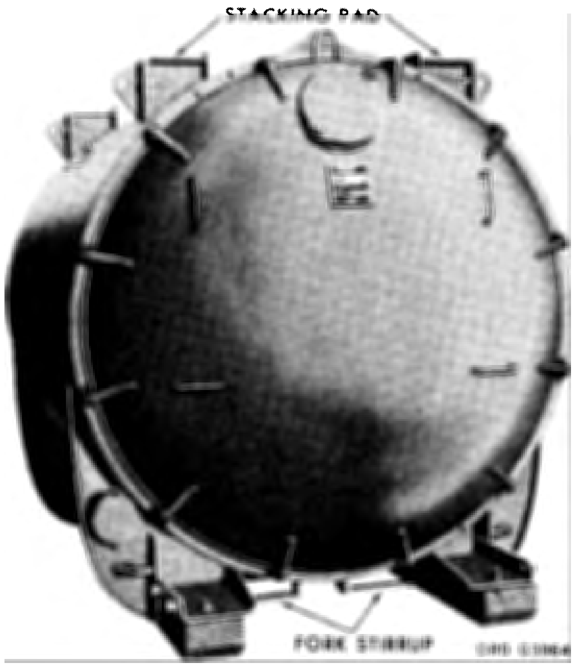


Figure 8-89. Warhead-body-section container M409.

(2) The fore-and-aft-body container M410 (figure 8-90) is a pressurized reuseable container in which the missile components can be stored in a dehumidified condition. The container is similar in construction to container M409. The container has an internal movable rail and is approximately 224 inches long.

(3) The shipping container for the rocket motor cluster M42 (figure 8-91) is a wooden crate with plywood sheathing. The container cover is secured to the base by lag bolts. The rocket motor is secured in cradle assemblies by clamp assembly brackets.

13. SERGEANT ARTILLERY GUIDED MISSILE SYSTEM XMGM29A.

a. General. The Sergeant artillery GM system is a surface-to-surface weapon system that has the capabilities of 100 percent mobility, fast reaction time, high accuracy and reliability, and operation under adverse environmental conditions. This system was designed to minimize the number of major items and personnel to operate the system. The Sergeant missile is one of five major items of the system. The system consists of the Sergeant Missile XM15 (figure 8-92); a four-wheel, semitrailer-mounted, launching station XM504 (figure 8-93); an organizational maintenance test station, AN/MSM-35 (figure 8-94); and a field maintenance test station AN/MSL-36 (figure 8-95).

b. Characteristics. The Sergeant GM is a medium-range missile which follows a modified ballistic trajectory at supersonic speed. It is designed to deliver nuclear, chemical, or biological warheads, and has a maximum range of 85 miles, and a minimum range of 28 miles. The missile is powered by a solid propellant rocket motor providing thrust for approximately 30 seconds during flight. Range control is achieved by aerodynamic dragbrakes. An inertial guidance system requires no control from ground stations after firing and is not vulnerable to any known electronic countermeasures. The missile is approximately 34 feet long, 31 inches in diameter, and weighs 10,000 pounds as fired.

c. Missile Reference System (figure 8-96). The missile reference system enables personnel to

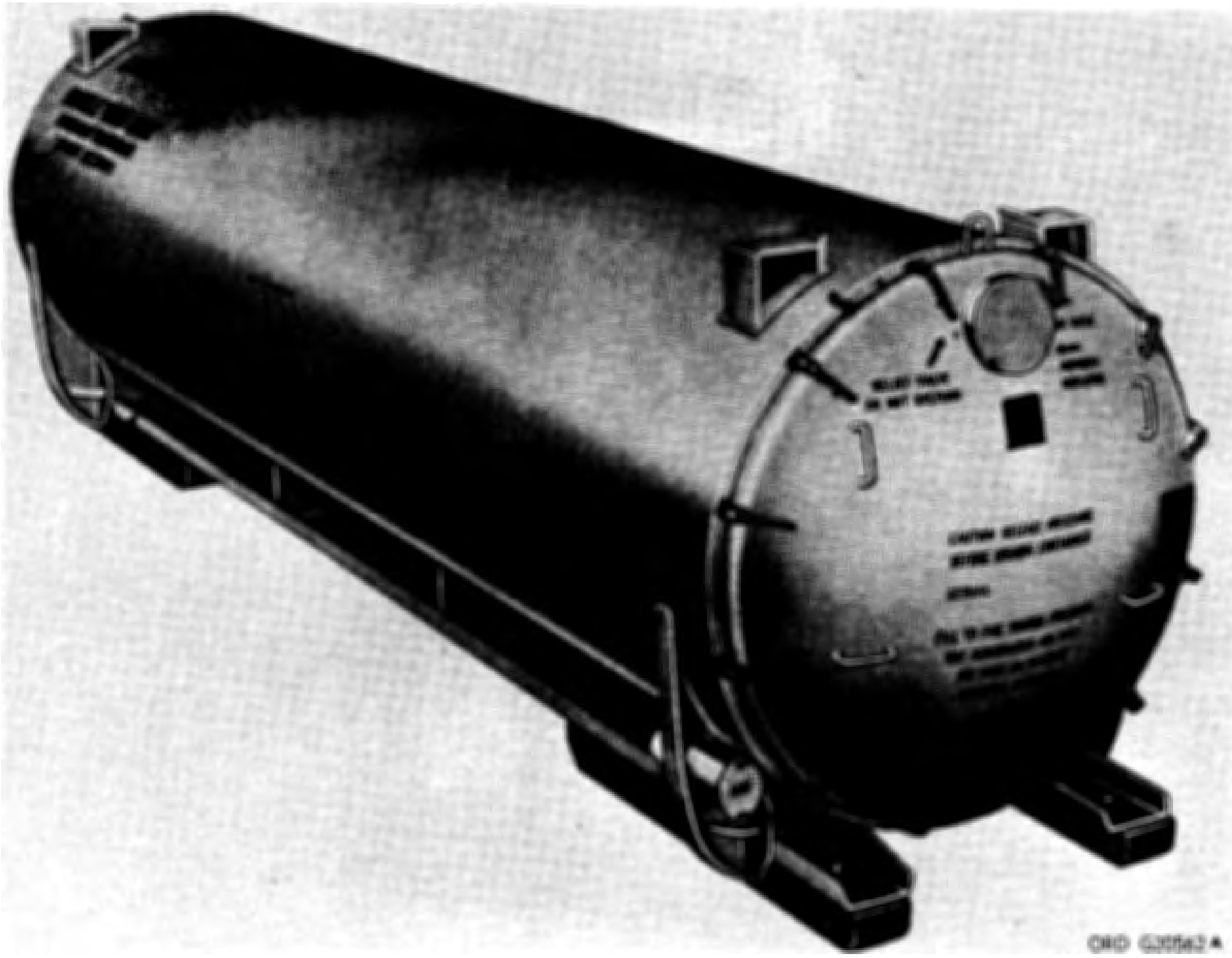


Figure 8-90. Fore-and-aft-body-section container M410.

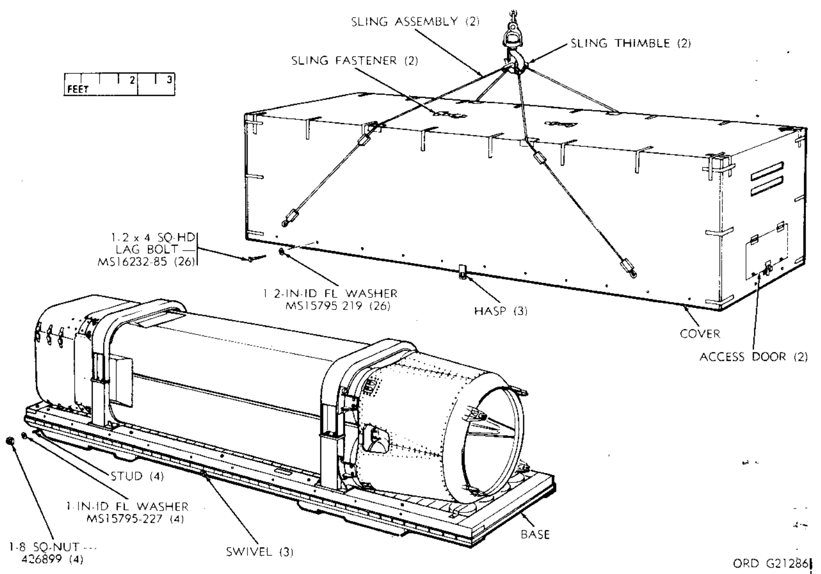


Figure 8-91. Cover of rocket motor M42 container.

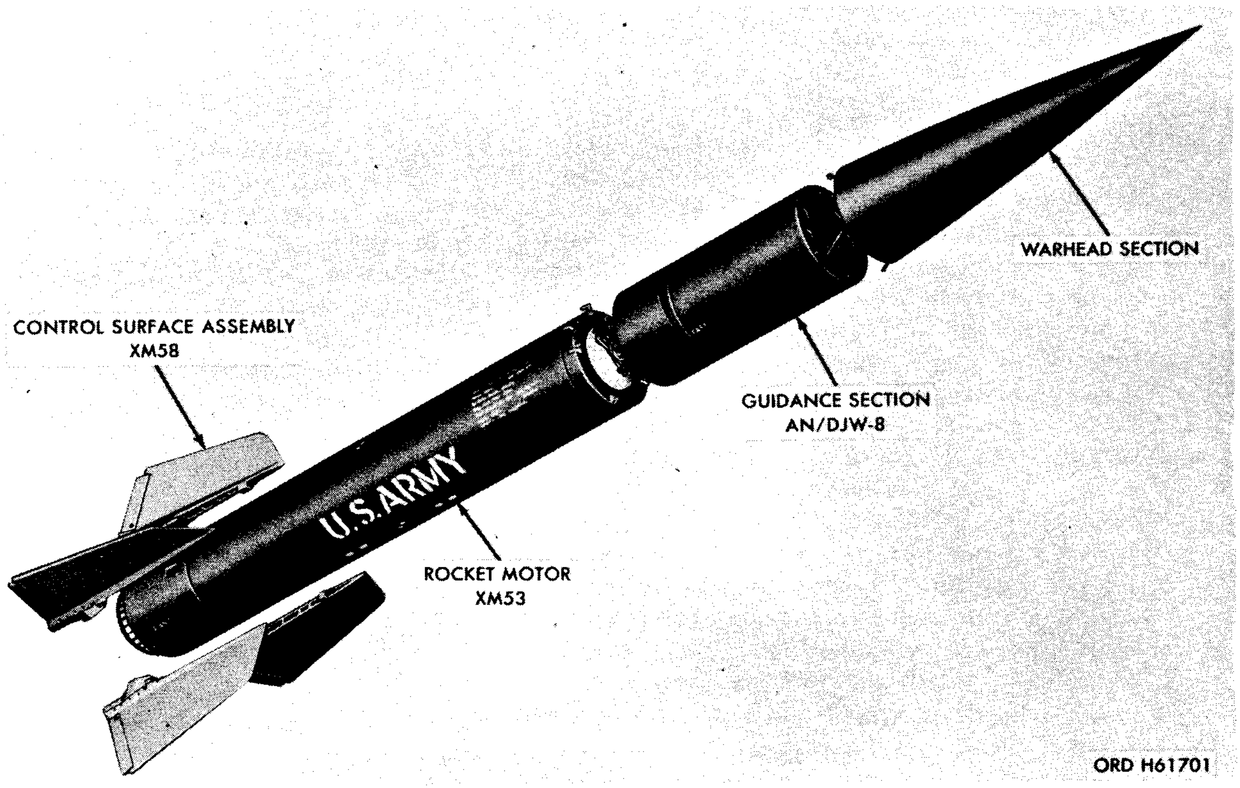


Figure 8-92. SERGEANT Missile Sections.

locate points on the missile by reference to quadrant and station. For orientation of the quadrants, the missile is viewed from the rear with the launching hooks at the top. The missile is divided into four quadrants by two imaginary planes, one vertical and one horizontal, passing through the center of the missile. The vertical plane is the north-south plane, and the horizontal plane is the east-west plane. The rocket motor has SOUTH, EAST, NORTH, and WEST paint markings on its outer perimeter which indicate the boundaries between the quadrants, and the south cover of the guidance section has SOUTH EAST, and WEST paint markings. The quadrants are designated as southeast (SE), northeast (NE), northwest (NW), and southwest (SW). The station number of a point on the missile is the distance, in inches, of that point from the tip of the warhead section, as measured along the central axis of the missile.

d. Description. The Sergeant missile consists of four major assemblies; the warhead section, guidance section, rocket motor, and control surface assembly.

(1) Due to security restrictions, warheads will not be discussed in this lesson. For a description of the warhead section, refer to (S) TM 9-1100-300-12.

(2) Guidance Section AN/DJW-8 (figure 8-97). The guidance section consists of a forward and aft guidance body assembly. The skin of the forward guidance body assembly is divided into two removable covers. The south cover assembly encloses the southwest and southeast quadrants and the north cover encloses the upper portions of the northeast and northwest quadrants. A plastic sheet is secured around the drag-brake blades of the aft guidance body assembly to keep air from being drawn into the guidance section through the drag-brake blade openings and to keep foreign matter from entering the drag-brake mechanism. The plastic sheet is not removed prior to firing.

(a) Forward Guidance Body Assembly. The forward guidance body consists of a

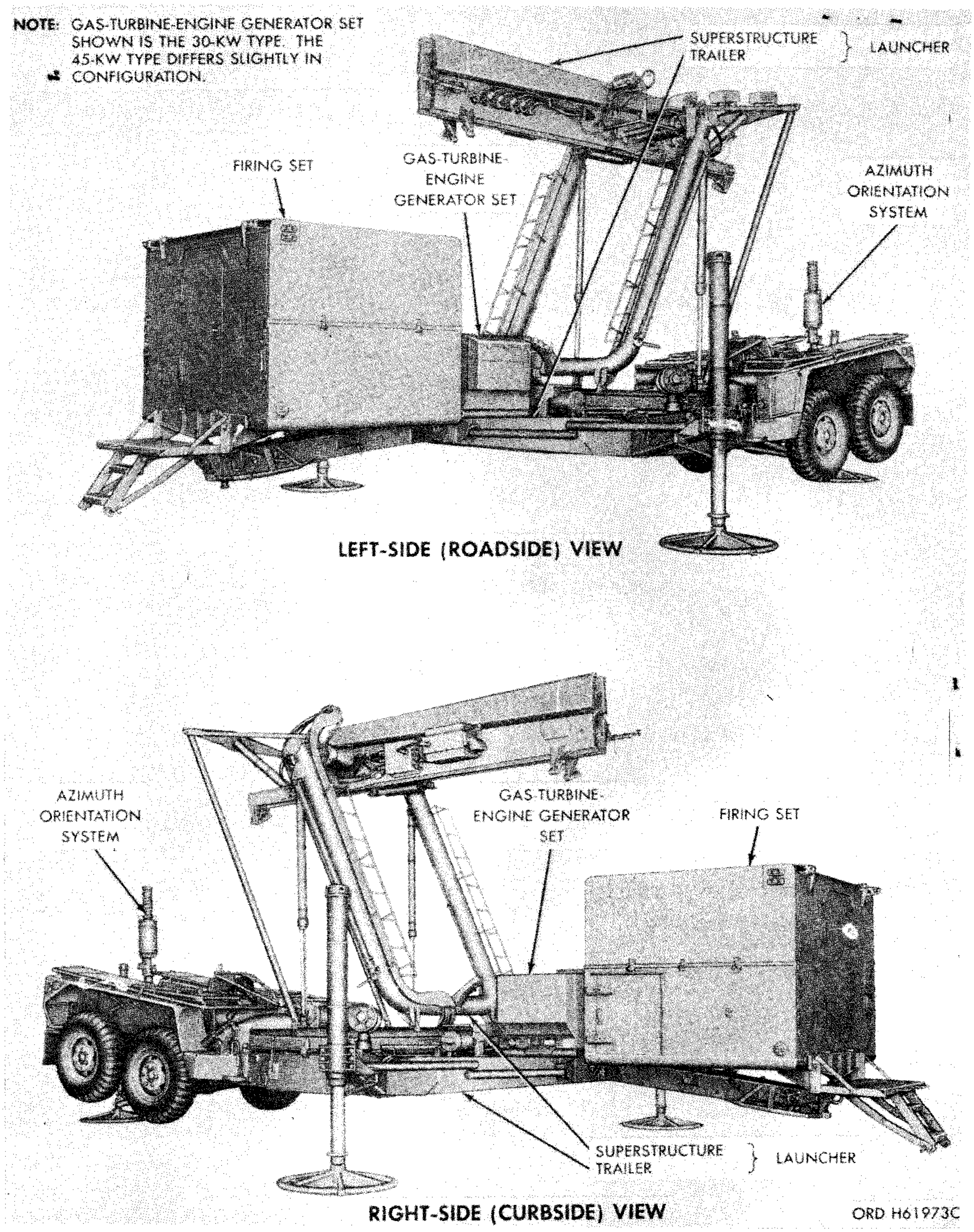


Figure 8-93. Semitrailer-mounted guided-missile launching station: 4-wheel, XM504.

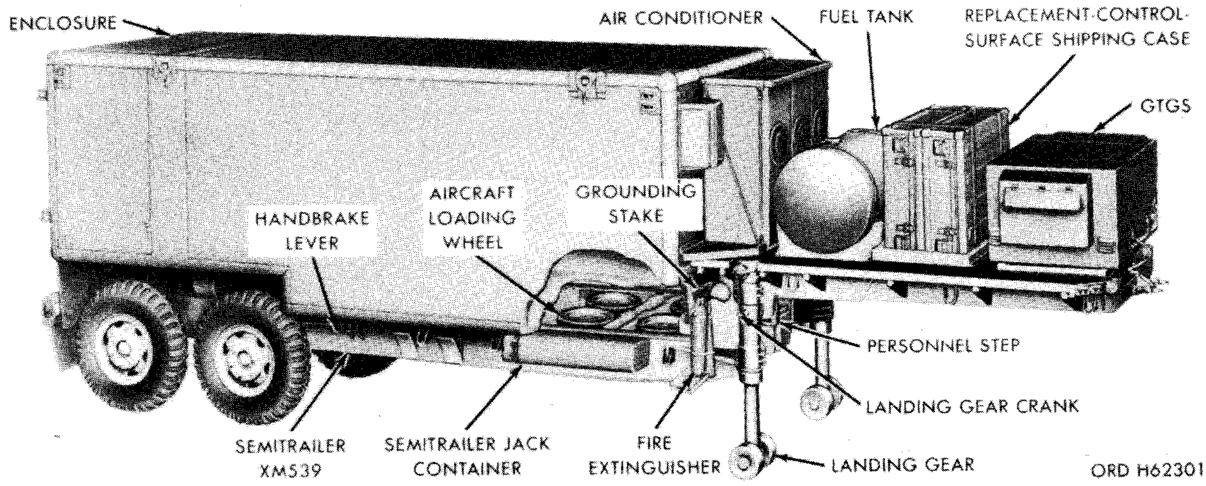


Figure 8-94. Organizational maintenance test station AN/MSM-35.

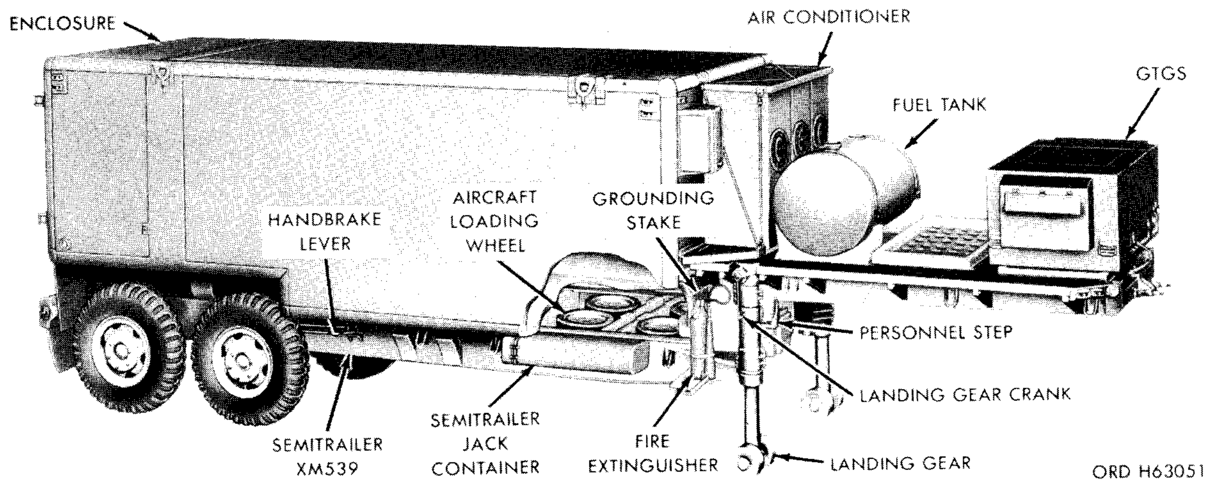


Figure 8-95. Field maintenance test station AN/MSL-36.

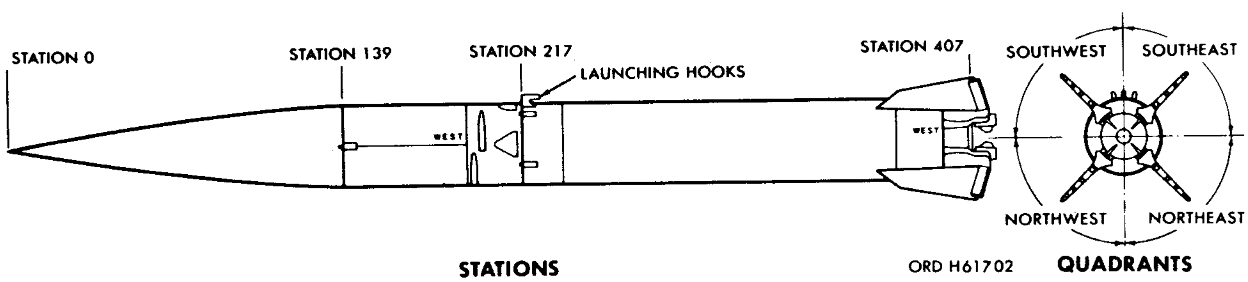


Figure 8-96. Missile reference system.

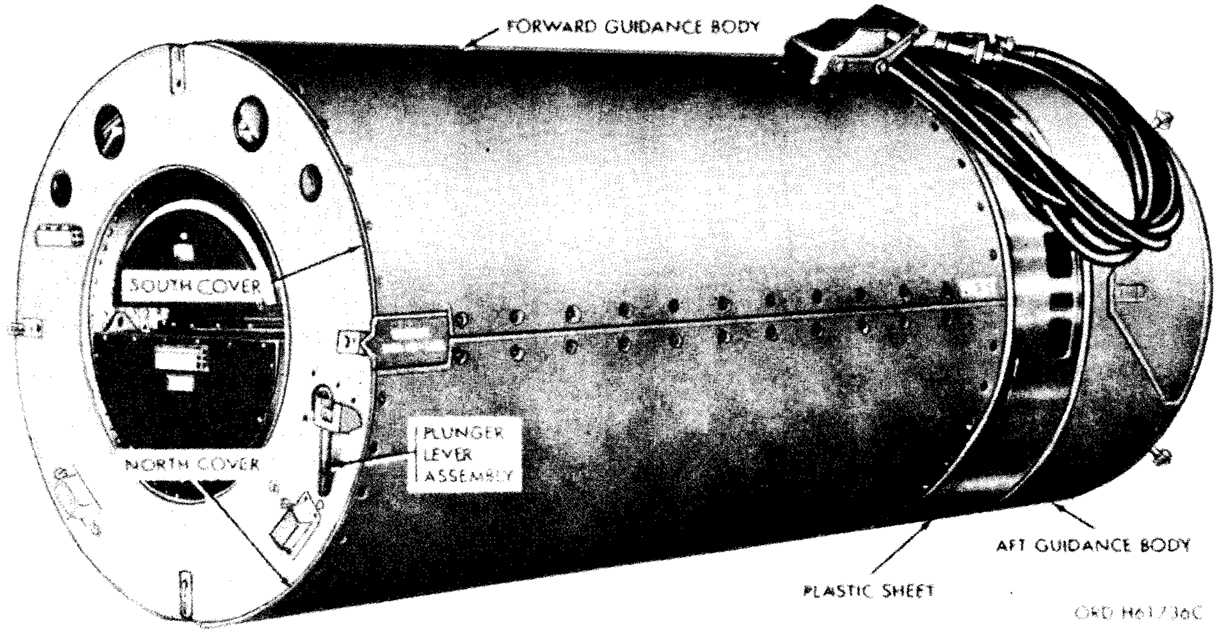


Figure 8-97. Guidance section AN/DJW-8.

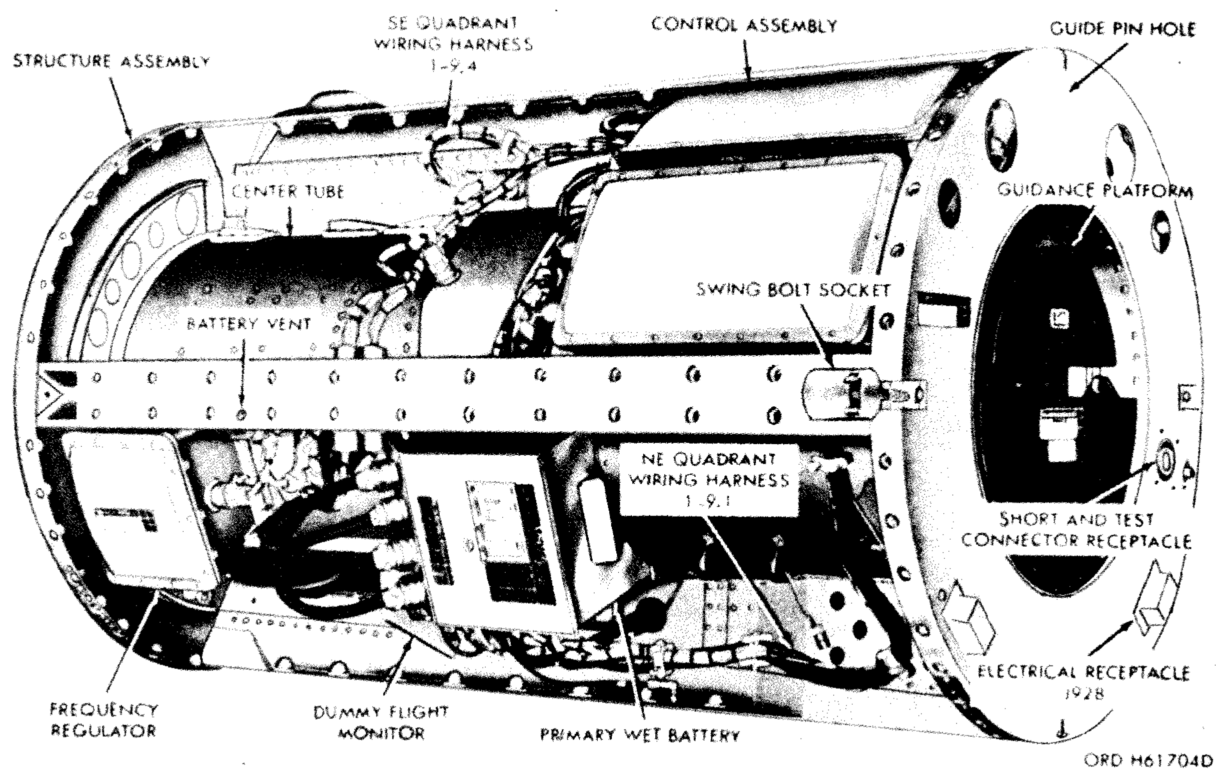


Figure 8-98. Forward guidance body assembly southeast and northeast quadrants with covers removed.

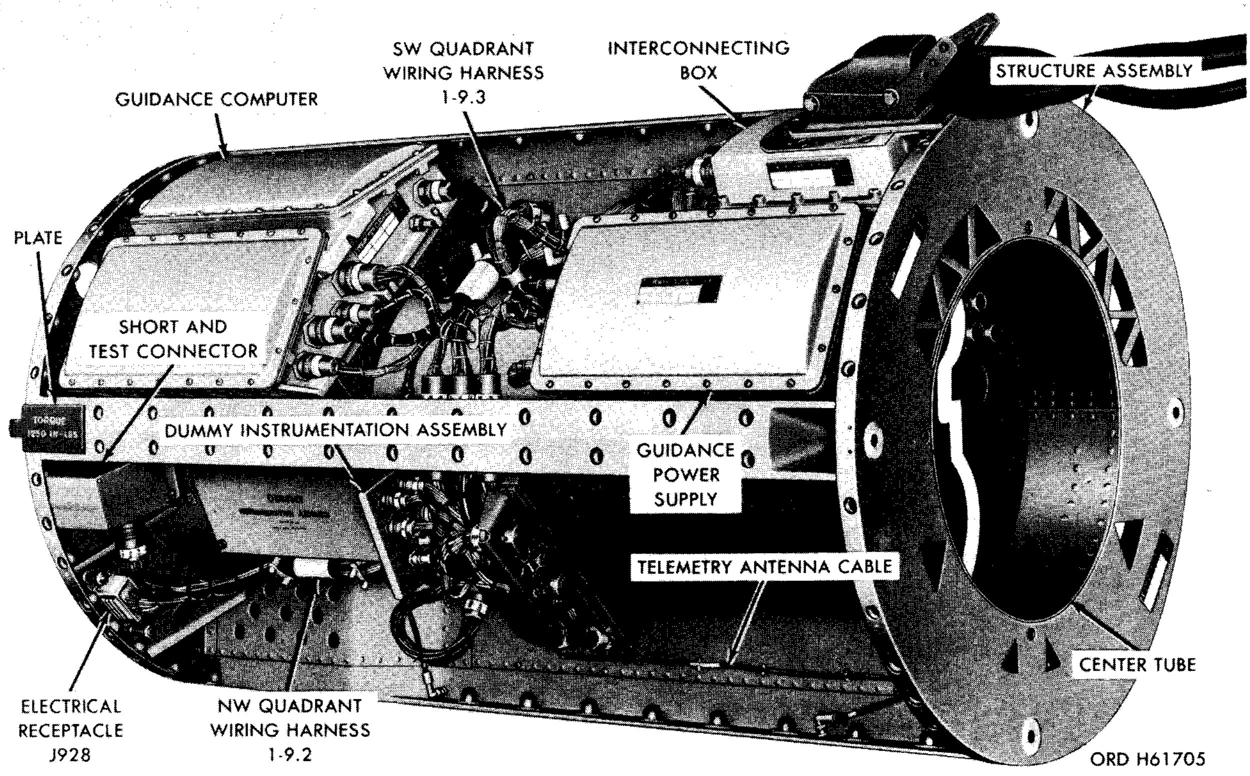
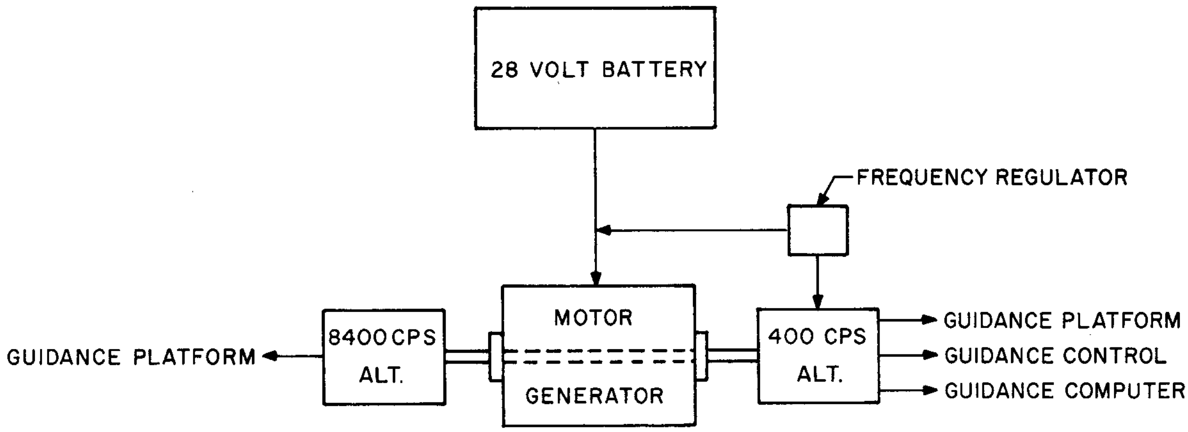


Figure 8-99. Forward guidance body assembly southwest and northwest quadrants with covers removed.

structure assembly and the electrical and electronic assemblies identified and located in figures 8-98 and 8-99, plus a motor-generator assembly, a connector-resistor assembly, a blower junction box assembly, and a vane axial fan assembly. All of these assemblies are described below. Four swing bolt sockets receive the swing bolts of the warhead section when the sections are assembled. Four guide pin holes receive the guide pins of the warhead section to insure proper alinement during assembly. Four plate assemblies cover the swing bolt sockets after the missile sections have been assembled. A dummy instrumentation assembly and a dummy flight monitor assembly are installed to provide ballast and to anchor telemetry cables. The air-charging valves in the control assembly, the guidance computer assembly, the frequency regulator assembly, and the guidance power supply assembly are not used. The motor-generator assembly (figure 8-100) consists of an 8,400-cps alternator and a 400-cps alternator. Both alternators are driven at 12,000 rpm by a 28-volt dc motor. The motor is bolted to a mounting plate, and the alternators are attached to each side of the motor. The motor-generator is mounted in the forward guidance body center tube and is accessible only after the missile battery is removed. An electrical receptacle is mounted in the end of each alternator and on the top of the motor. The motor-generator supplies 8,400-cps and 400-cps power to the guidance platform assembly and 400-cps power to the guidance computer assembly, the control assembly, and the control surface assemblies. The connector-resistor assembly (figure 8-101) consists of a connector and a thermal resistor. It is located in the forward guidance body center tube just inside the battery access hole, near the motor-generator. The thermal resistor senses missile internal temperature and prevents the missile from being tested if the internal temperature is too high or too low. A fan junction box assembly (figure 8-102) is located in the forward guidance body center tube forward of the battery access hole. The junction box contains two thermostats which control the operation of the forward guidance body vane axial fan assembly and the aft guidance body vane axial fan assembly (below). The forward guidance body vane axial fan assembly is located in the outer wall of the forward guidance body center tube, directly under the guidance



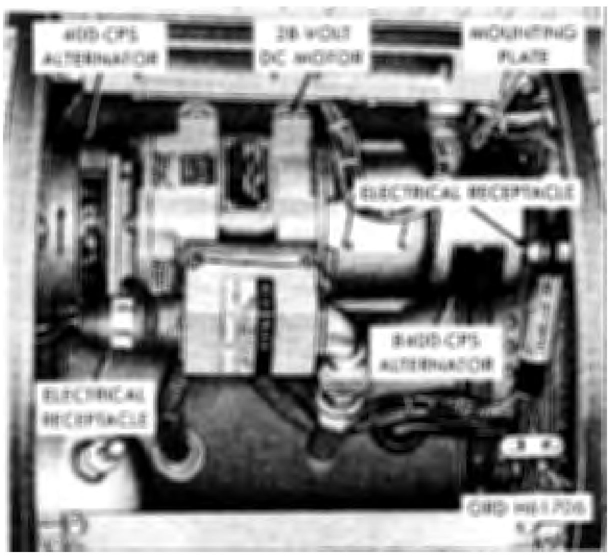


Figure 8-100. Motor-generator assembly--locator view with missile battery removed.

power supply assembly (figure 8-99). The fan draws cooling air from the forward guidance body southwest quadrant and exhausts it into the center tube. The operation of the fan is controlled by thermostats in the fan junction box (above). The control assembly consists of a chassis, two covers, and internal electronic circuitry. Seven electrical receptacles are mounted in one end (figure 8-103) of the chassis. The control assembly (figure 8-103) is mounted in the forward guidance body in the southeast quadrant. The guidance computer assembly (figure 8-104) consists of a chassis, two covers, and internal electronic circuitry. Five electrical receptacles are mounted in one end of the chassis. The guidance computer assembly is mounted in the forward guidance body in the southwest quadrant. The guidance platform assembly (figure 8-105) consists of a chassis, two covers, a cooling unit with two fans, three mutually perpendicular gyroscopes, and internal electronic circuitry. Four electrical receptacles are mounted in the rear cover and one receptacle is mounted in the rear of the cooling unit. The guidance platform assembly is mounted in the forward end of the forward guidance body center tube. The primary wet battery is contained in a sealed metal case (figure 8-106). Four electrical receptacles are mounted in the top of the case. The battery is mounted in

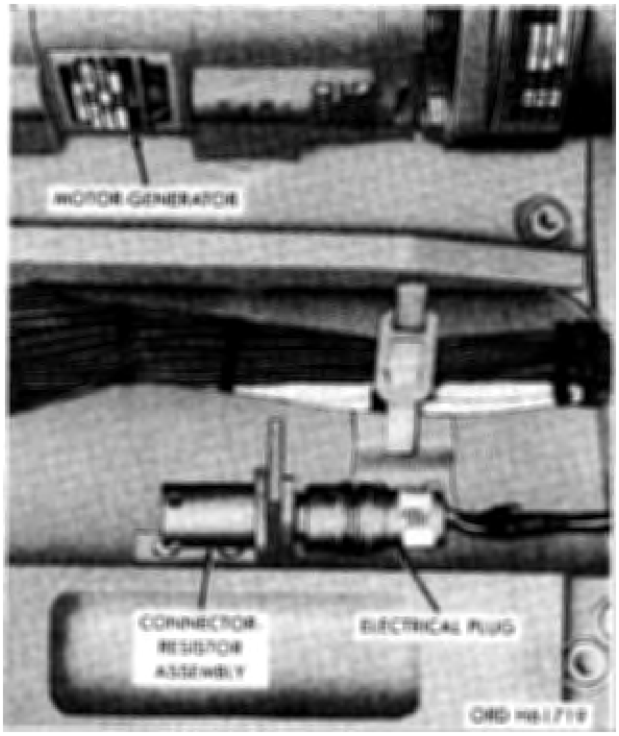


Figure 8-101. Connector-resistor assembly -- locator view with missile battery removed.

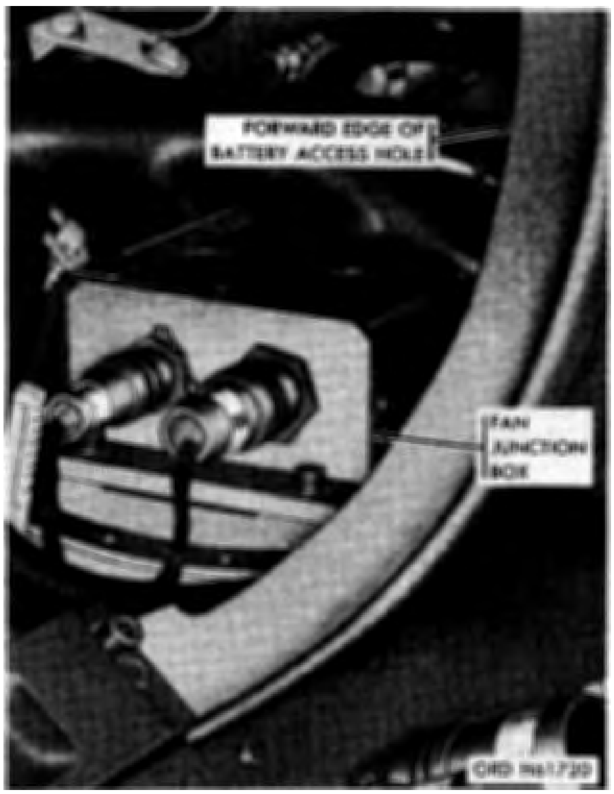


Figure 8-102. Fan junction box assembly -- locator view with missile battery removed.

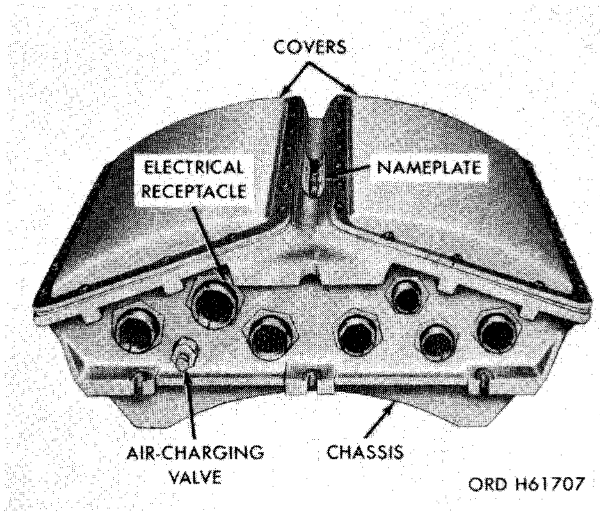


Figure 8-103. Control assembly.

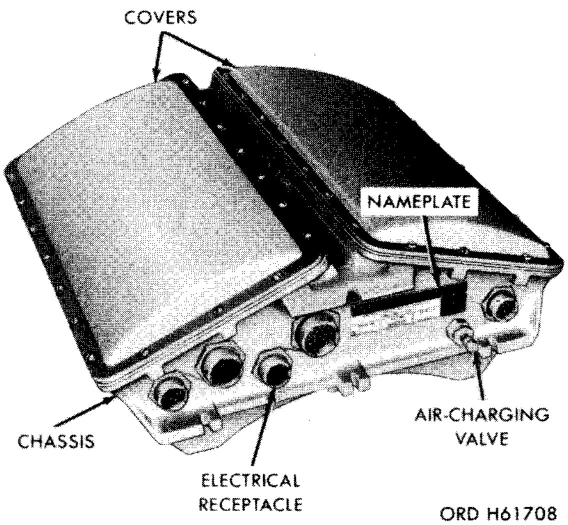


Figure 8-104. Guidance computer assembly.

the forward guidance body in the northeast quadrant. When activated, the battery produces 28-volt dc power to operate the missile electronic and electrical systems. The frequency regulator assembly (figure 8-107) consists of a chassis, a cover, and internal electronic circuitry. An electrical receptacle is mounted in the forward end of the chassis. The frequency regulator is located in the forward guidance body in the northeast quadrant. It controls the frequency of the motor-generator. The guidance power supply assembly (figure 8-108) consists of a chassis, a cover, and internal electronic circuitry. Four electrical receptacles are mounted in the front end of the chassis. The power supply is mounted in the forward guidance body in the southwest quadrant. It supplies dc power, at several different voltages, to other assemblies and subassemblies. The interconnecting box assembly (figure 8-109) consists of an inboard interconnecting box (inboard box) and an outboard electrical box connector (outboard connector). The inboard box and the outboard connector are potted together with potting compound. The outboard connector separates from the inboard box as the missile is fired. The interconnecting box assembly is installed in the rear of the forward guidance body in the

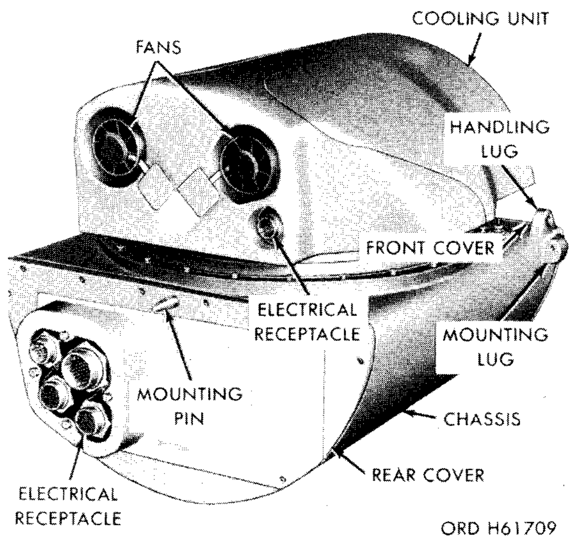


Figure 8-105. Guidance platform assembly--rear view

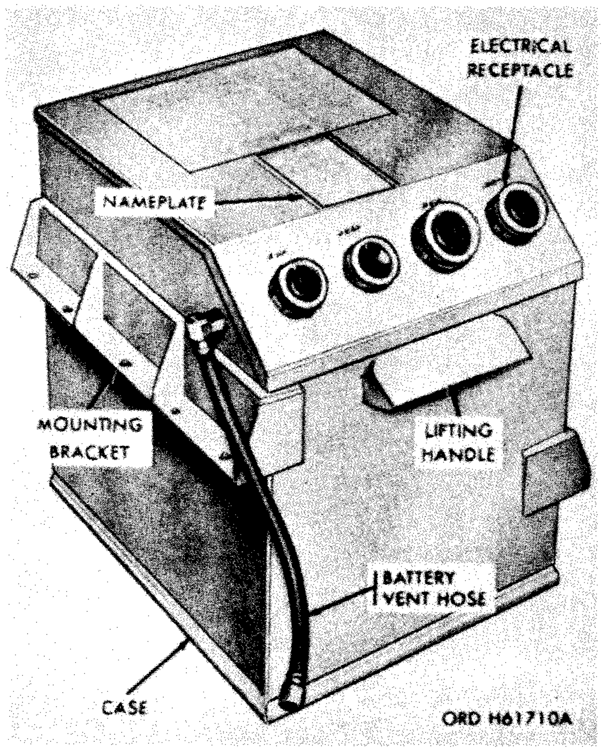


Figure 8-106. Primary wet battery assembly.

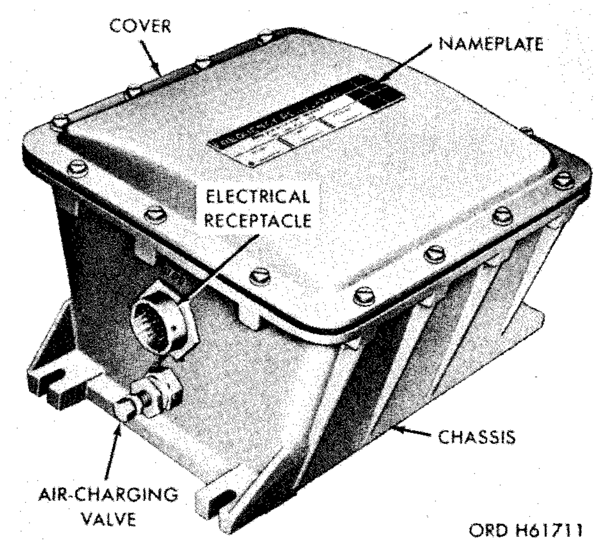


Figure 8-107. Frequency regulator assembly.

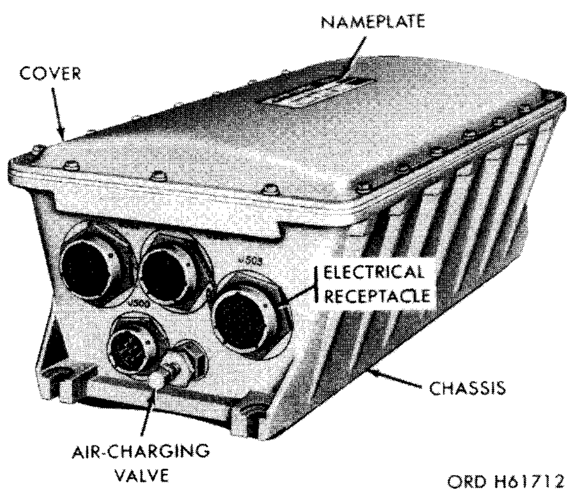


Figure 8-108. Guidance power supply·assembly.

southwest quadrant. It provides connections to the guidance section for checkouts and interconnects the missile and the firing set prior to firing.

(b) Aft Guidance Body Assembly. The aft guidance body assembly consists of the items identified and located in figures 8-110 and 8-111. The power package provides hydraulic power to open and close the two forward and two aft drag brake blades. Brake destroy wiring harness 1-9.5 interconnects the forward guidance body assembly with the rocket motor, three drag brake blade microswitches, the aft guidance body vane axial fan assembly, and the destructor

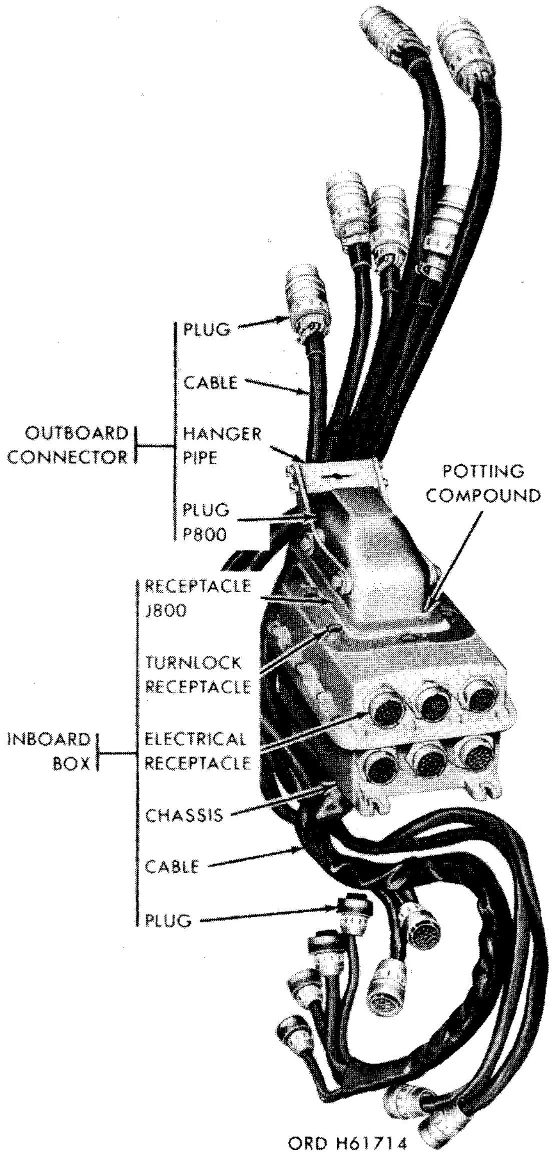


Figure 8-109. Interconnecting box assembly.

assembly. A destructor assembly is installed in place of the dummy door if the missile is to be range fired. The aft guidance body vane axial fan keeps cooling air flowing through the guidance section from front to rear. The north and west access doors, which have pushbutton catches, enable missile assembly personnel to mate the guidance section plugs to the rocket motor receptacles after the guidance section and rocket motor are assembled. The west access door also provides access for installing a destructor assembly and connecting the destructor assembly plug. The access doors also enable ammunition personnel to install the primer into the rocket motor ignition system of an assembled missile. A cover assembly over the strongback slot provides access to the slot for installation of the strongback. The swing bolts attach an assembled guidance section to the rocket motor.

(3) Rocket Motor XM100. Rocket motor XM100 is a solid-propellant type and consists of the items identified and located in figures 8-112 and 8-113. The launching hooks attach the rocket

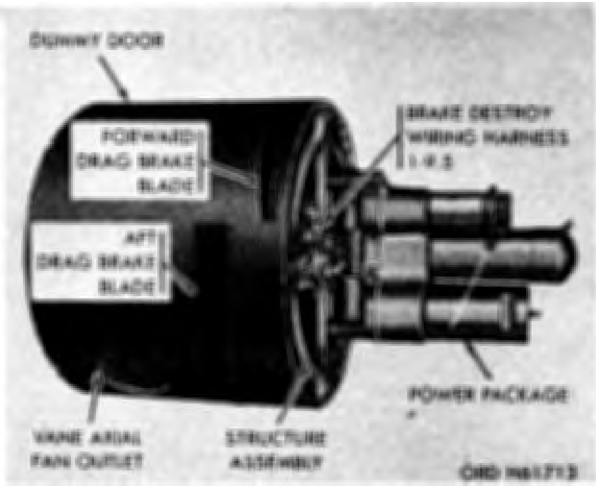


Figure 8-110. Aft guidance body assembly--front view.

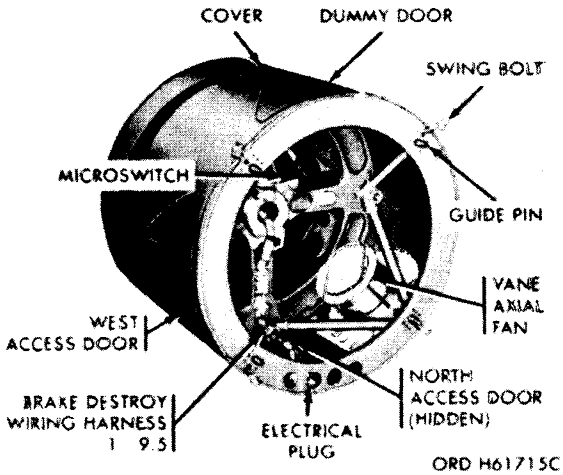


Figure 8-111. Aft guidance body assembly--rear view.

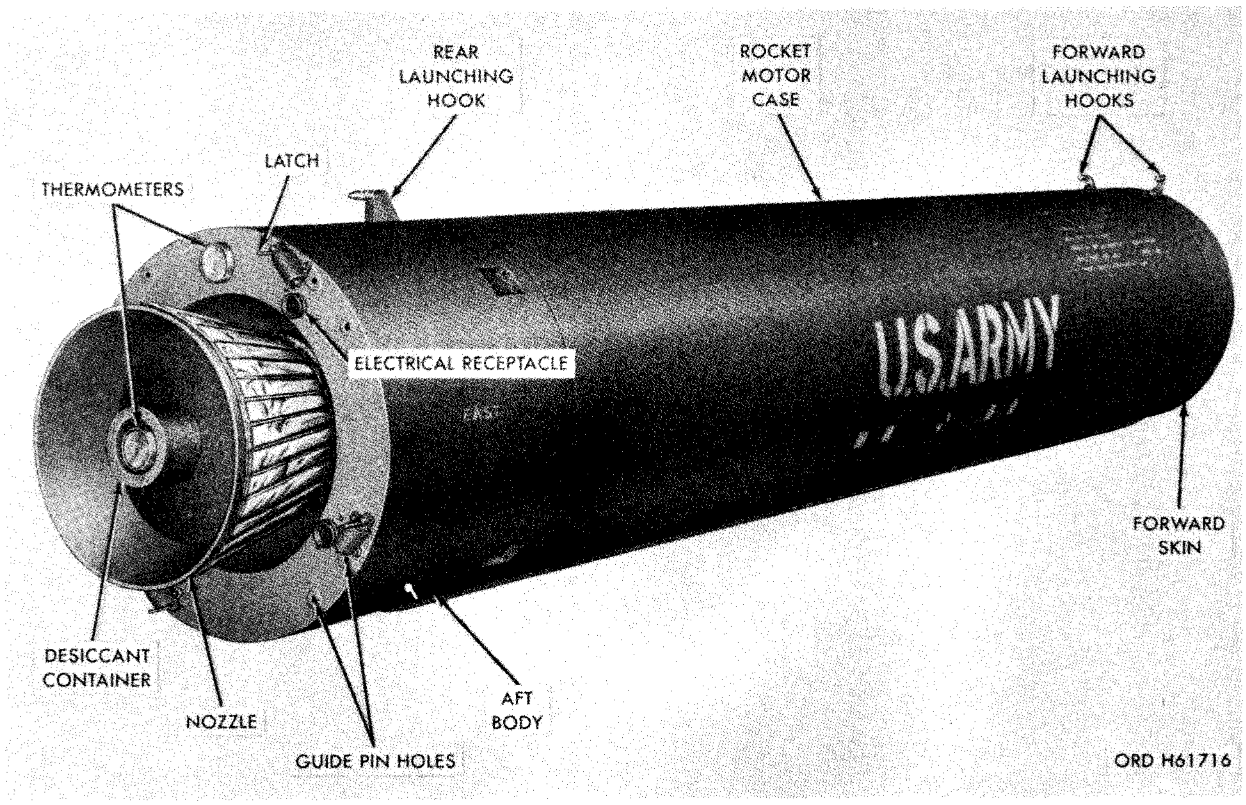


Figure 8-112. ROCKET MOTOR XM100 - REAR VIEW.

motor to the launching station boom. The rocket motor case contains the propellant. The guide pin holes and electrical receptacles (figure 8-112) mate with guide pins and plugs on the control surface assemblies, and the latches hold the control surface assemblies in place. The desiccant container holds the desiccant which keeps the rocket motor interior dry. The thermometers indicate motor skin and interior cavity temperatures. The nozzle provides thrust and direction for the propellant

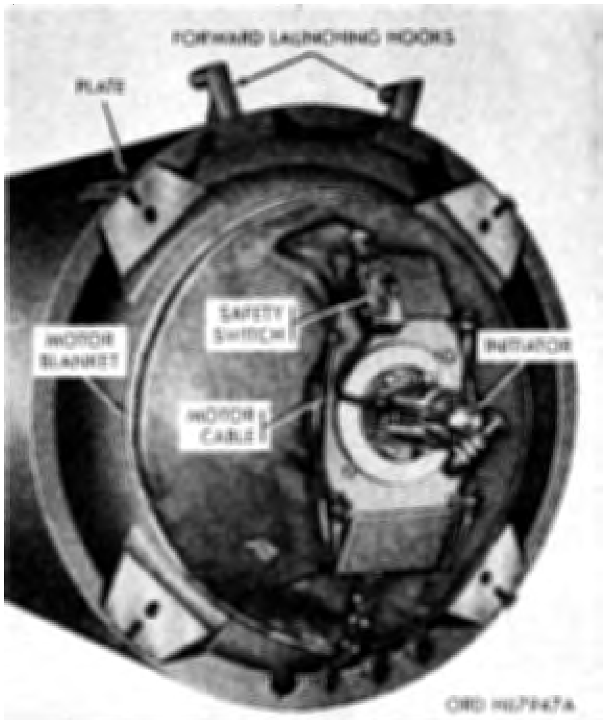


Figure 8-113. ROCKET MOTOR XM100 - FRONT VIEW.

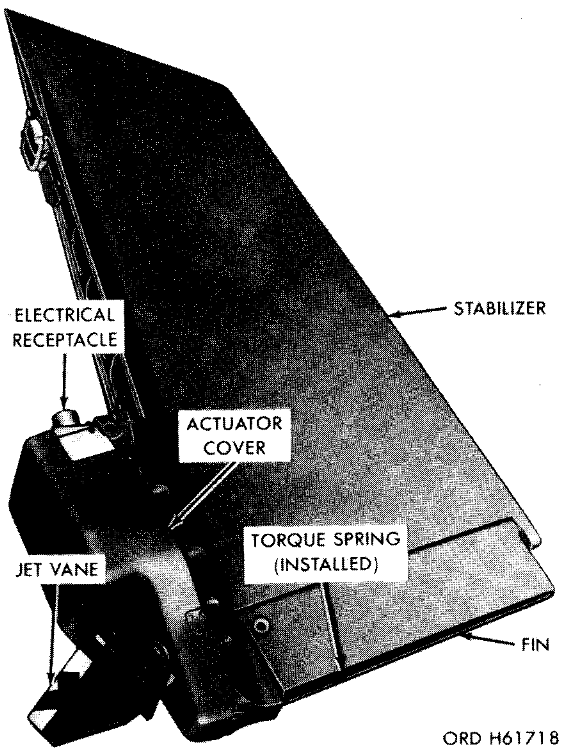


Figure 8-114. CONTROL SURFACE ASSEMBLY XM94.

and protects the control surface actuators. The initiator (figure 8-113) ignites the propellant in the ignition booster assembly, which, in turn, ignites the rocket motor. The motor blanket shields the components of the guidance section from the heat of the rocket motor. Four plate assemblies are installed to cover the swing bolt sockets after the guidance section and rocket motor are mated.

(4) Control Surface Assembly XM94. The control surface assembly (figure 8-114) consists of a stabilizer, a fin, an initial control rudder, an electrical actuator (not shown), an actuator cover, and an electrical receptacle. Each missile has four control surface assemblies, which are mounted on the rear of the motor section. The actuator moves the fin and the initial control rudder in response to electrical signals received from the guidance section. The initial control rudders extend into the opening of the rocket-motor nozzle to control direction during thrust, and the fins provide areodynamic control. For testing, a torque spring is installed through the fin to restrict fin movement. The torque spring is part of the control-surface shipping case.

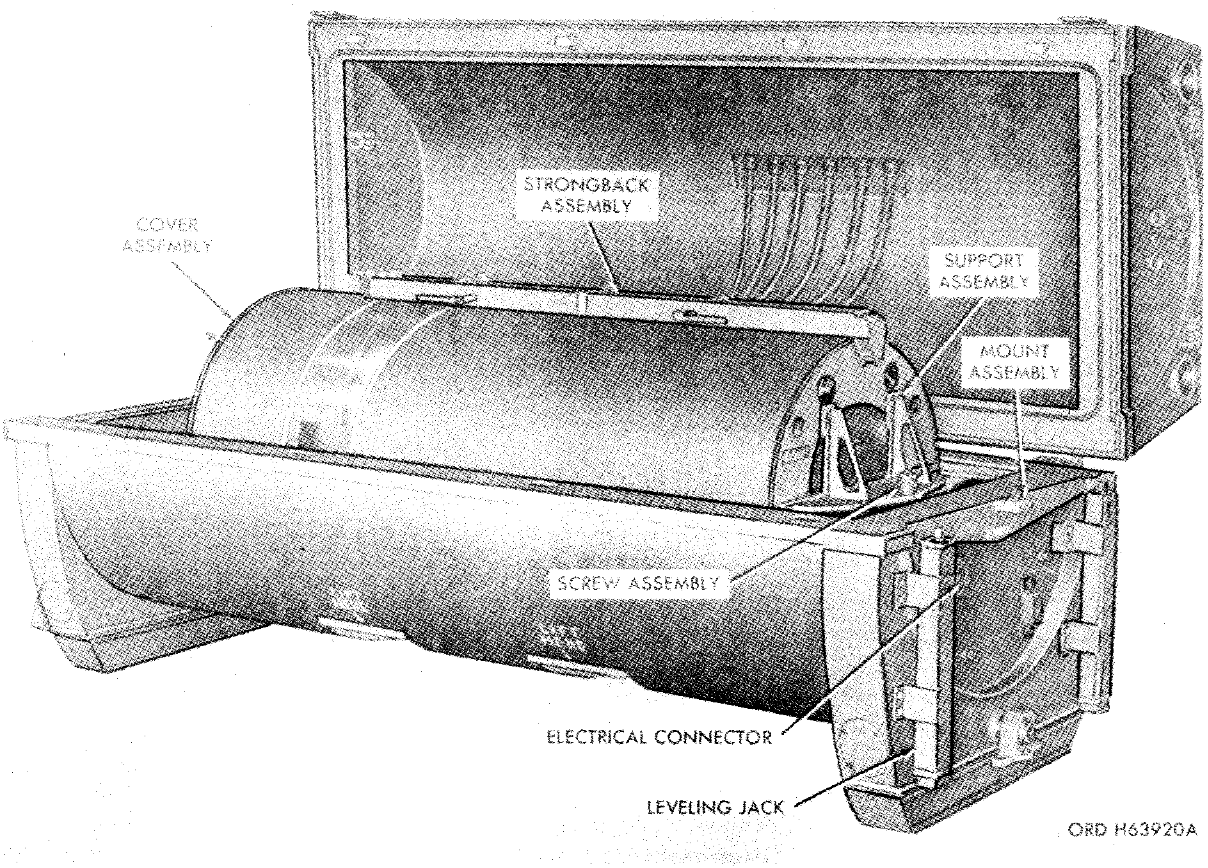


Figure 8-115. GUIDANCE-SECTION CONTAINER XM420 WITH GUIDANCE SECTION.

(5) Sergeant Missile Section Containers.

(a) Guidance-Section Container XM420 (figure 8-115). The guidance-section container is equipped with six electrical connectors for test and checkout of the guidance-section electronic assemblies. The container is equipped with an electrical heater in the forward end. A mount assembly is located on the forward end of the lower container section. Three leveling jacks, two on the forward end of the container and one on the rear end, level the container during electrical checkout of the guidance section on the transport semitrailer. The guidance section is secured in the container by a support assembly and screw assembly at the forward end, and by a cover assembly and screw assembly at the rear end. Pins located on the support assembly mate with the guidance-section guidepin receptacles. Holes in the cover assembly mate with the guidance-section guide pins. A strongback assembly is secured to the guidance section by a pin on the forward end and by a pin and handle lock on the circumference of the guidance section near the rear end. The container has a gross weight of 2,033 pounds.

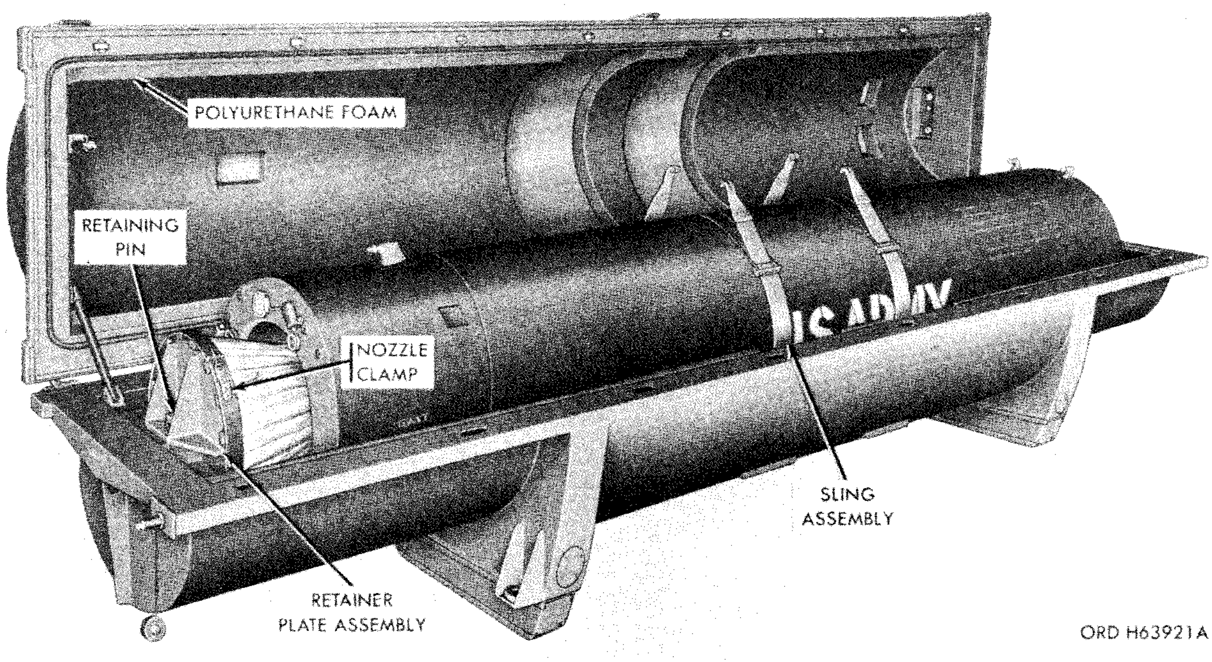


Figure 8-116. ROCKET-MOTOR CONTAINER XM419 WITH ROCKET MOTOR.

(b) Rocket-Motor Container XM419. The container for the rocket motor (figure 8-116) is lined with polyurethane foam and heating blankets, contoured to fit the rocket motor. A retainer plate assembly (nozzle plate) is fastened over the mouth of the nozzle by a nozzle clamp. A hole in the nozzle plate fits over a retaining pin which is part of the container. Two sling assemblies make up a handling fixture for the rocket motor. This reusable aluminum container is approximately 18.3 feet in length and weighs 8,303 pounds loaded.

(c) Control-Surface Shipping Case XM123E1 (figure 8-117). The control-surface shipping case consists of an upper case section, a lower case section, eight latch sets, four latch set assemblies, a cable assembly, a torque spring, a plug cap, a relief valve, a humidity indicator, four handles, a logbook receptacle, and cushioning for the control surface assembly. A preformed packing between the upper case section and lower case section seals the case. The cable assembly permits a control surface assembly to be checked out while packed in its shipping case. The cases are made of aluminum, are reusable, and weigh 172 pounds loaded.

14. Pershing Artillery Guided Missile System XMGM - 31A.

a. General. The missile (figure 8-118) is a two-stage, surface-to-surface missile with an all-inertial guidance system. This type of guidance places the warhead section in a preselected ballistic trajectory by using data inserted into the system before the missile is fired. Thus, once the missile is fired it is completely free of ground control and all known electronic countermeasure methods. The missile is capable of being stored in a combat- ready condition in containers (figure

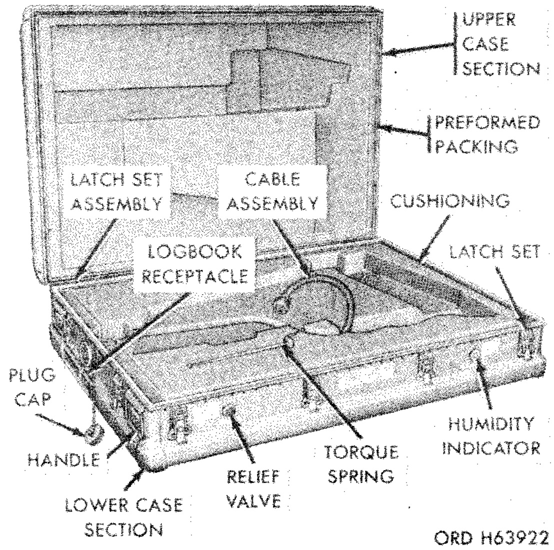


Figure 8-117. CONTROL SURFACE SHIPPING CASE XM123E1.

8-119) and is quickly assembled and fired with a high degree of reliability. The complete weapon system, consisting of the missile and its ground support equipment, is very mobile. It is moved on the ground by full- tracked vehicles or air transported by fixed-wing aircraft or helicopter. The flexibility of this system provides an effective extension of the artillery.

b. Physical description. The missile (figure 8-120) is a four-section, aerodynamic structure that is 34.6 feet in length, 3.3 feet in diameter, and weighs approximately 10,275 pounds. Each section of the missile is handled as an individual item and is interchangeable with the same section from other missiles or from storage. The first stage body section (figure 8-120) provides the initial thrust to boost the missile into a predetermined trajectory. The main structure of this section is formed by the high-strength steel case of the rocket motor. The remainder of the section consists of an aluminum alloy skin supported by circular aluminum frames. The second stage body section (figure 8-120) is similar in structure and appearance to the first stage body section except for minor differences in the size and shape of the air fins and jet vanes, the overall length of the section, and the additions of a thrust termination device and a motor case venting system on the second stage. The guidance and control body section (Figure 8-120) is a pressure- tight, aluminum alloy, tapered structure that contains the guidance and control system. The warhead section (figure 8-120) is a conical reentry structure consisting of an ablative-type plastic-coated body with an aluminum sub-structure. This section is described in detail in TM 9-1100-375-12. The four missile sections are joined by three splice bands (figure 8-121). Each of these splice bands consists of four similar segments which, at the time of assembly, are seated in the grooved ends of the missile sections and bolted together. The first and second stages and the warhead and guidance sections are joined by separation splice bands. Two of the four bolts on these splice bands are the explosive type (figure 8-122), which break apart when detonated and allow the missile sections to separate. Heat shields protect the explosive bolts on the first stage separation splice band from excessive heat caused by friction as the missile passes through the atmosphere. The guidance section and the second stage are joined by a retaining splice band similar to the separation splice bands, but without the explosive bolts. These sections do not separate from each other as do the sections joined by the separation splice bands, but separate as a unit from the warhead section. The electrical cable connections between the sections use breakaway-type connectors that are pulled free by wire lanyards as the sections separate. The lanyards are slightly shorter than the cables; this assures a clean separation without the possibility of the cables breaking. The flame shield junction box door on the second

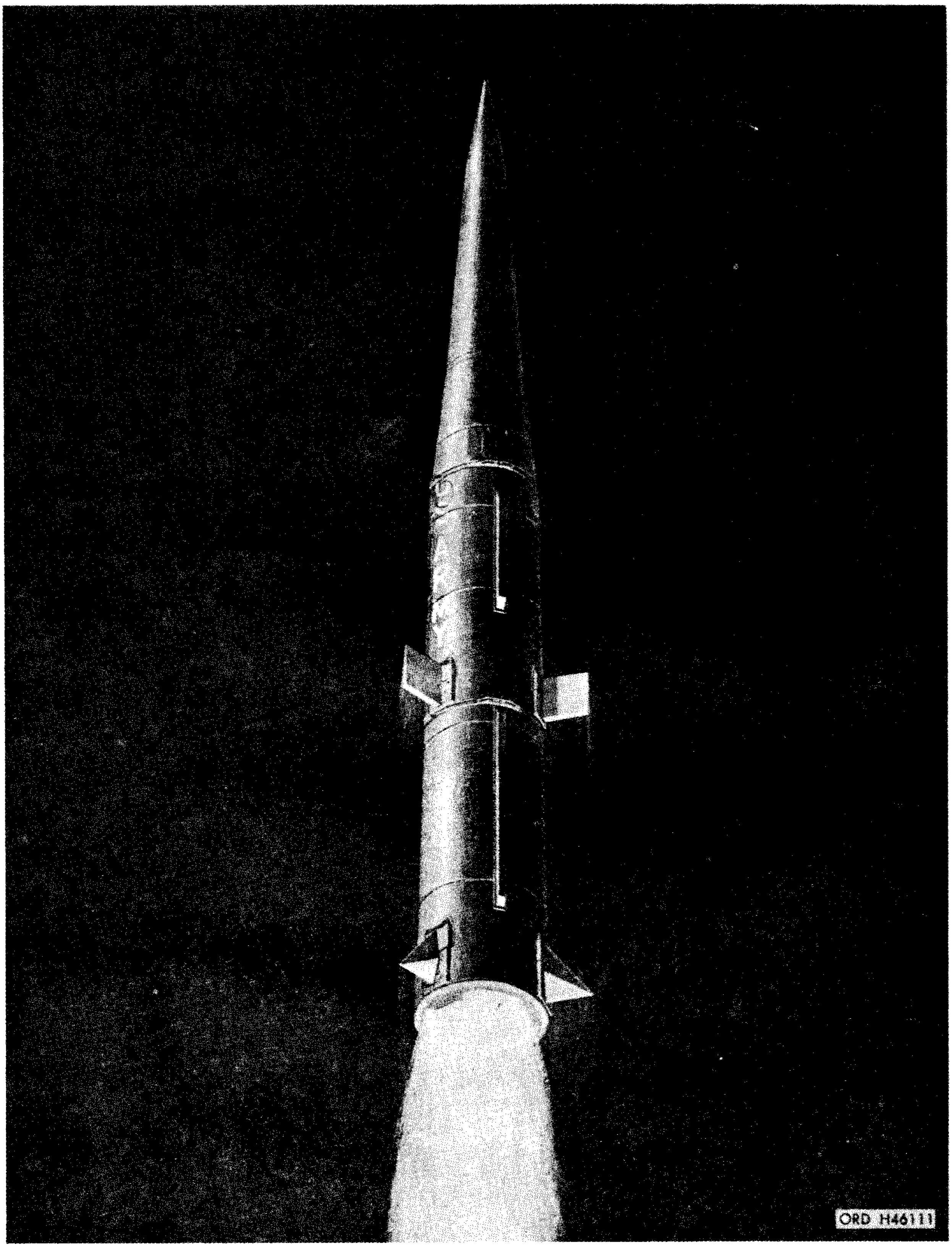
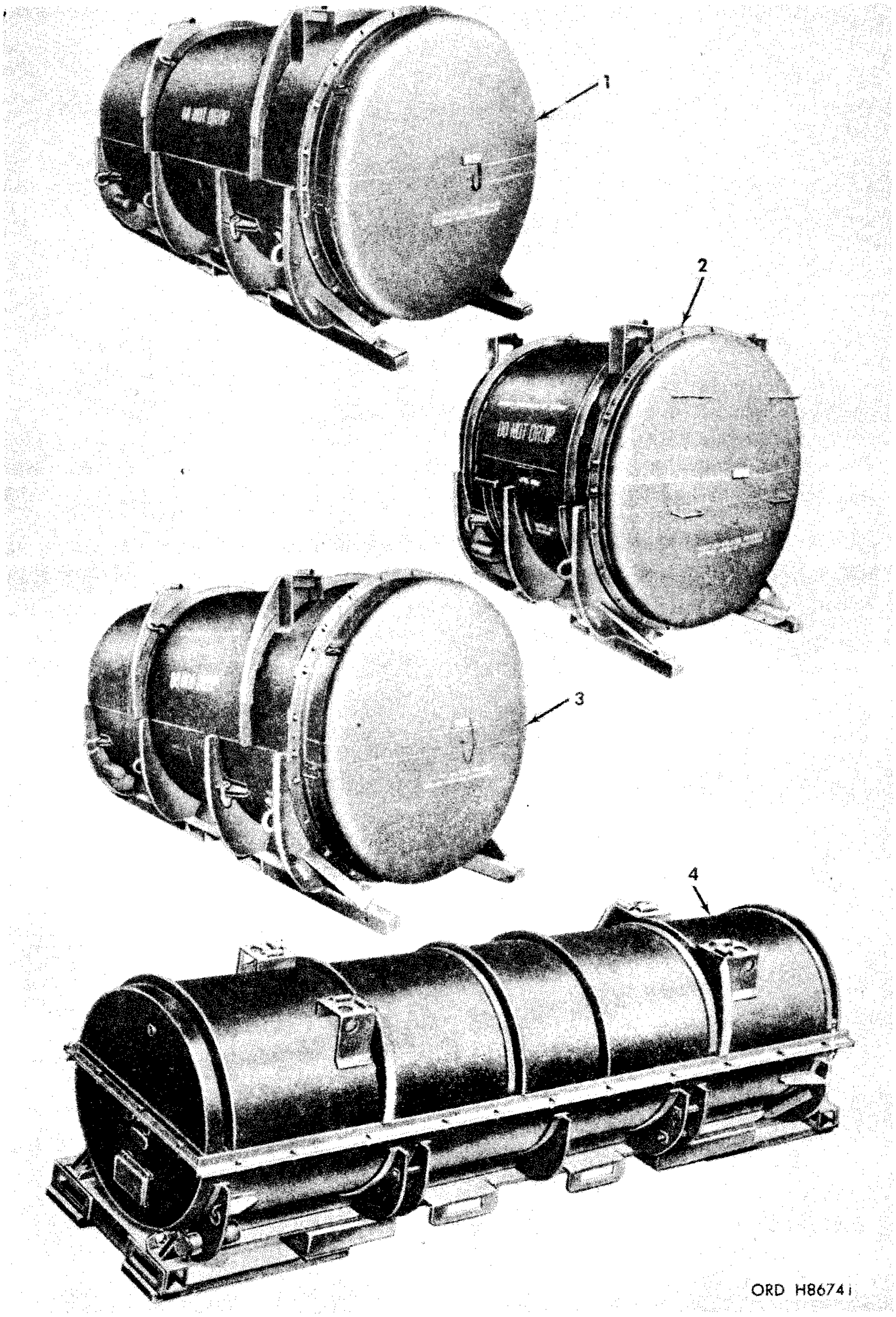
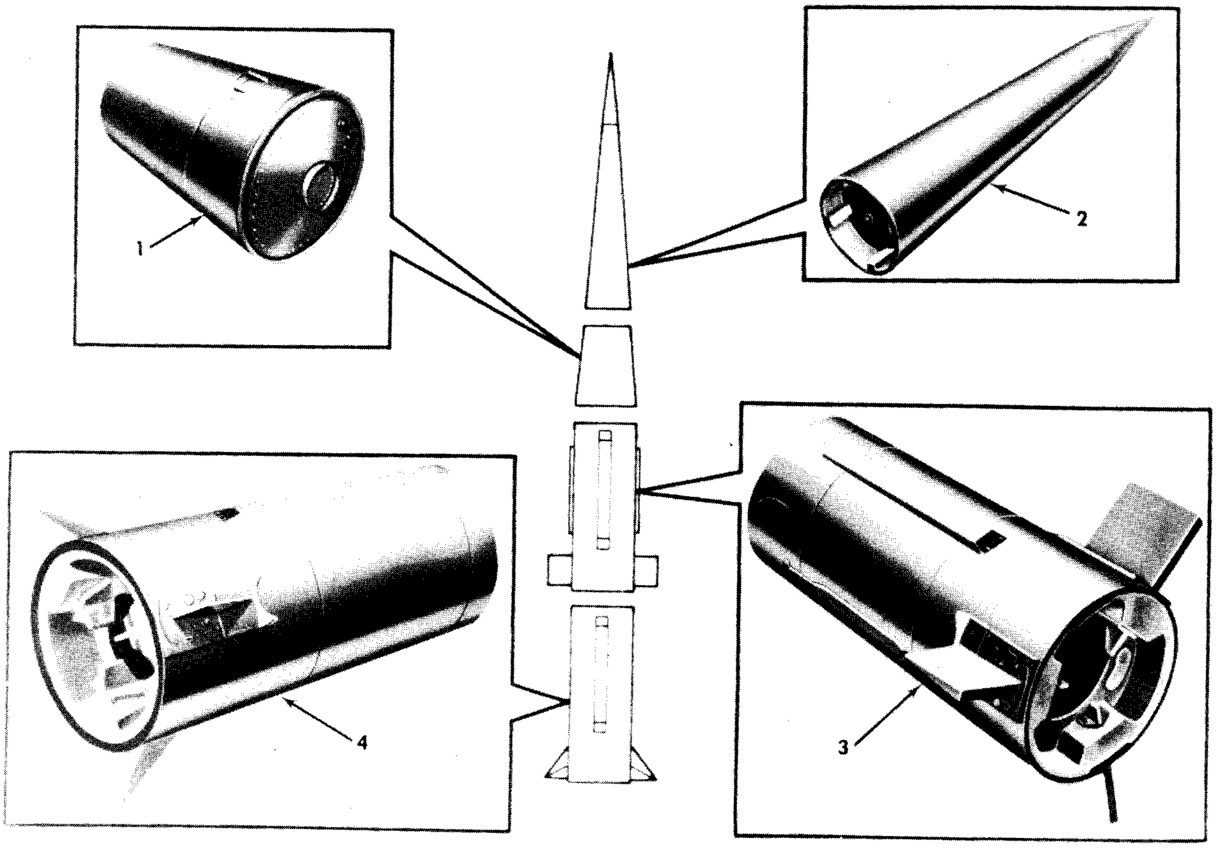


Figure 8-118. Surface Attack Guided Missile XMGM31A.



1 First stage body section container
2 G and C section container
3 Second stage body section container
4 Warhead section container

Figure 8-119. Missile body sections containers.



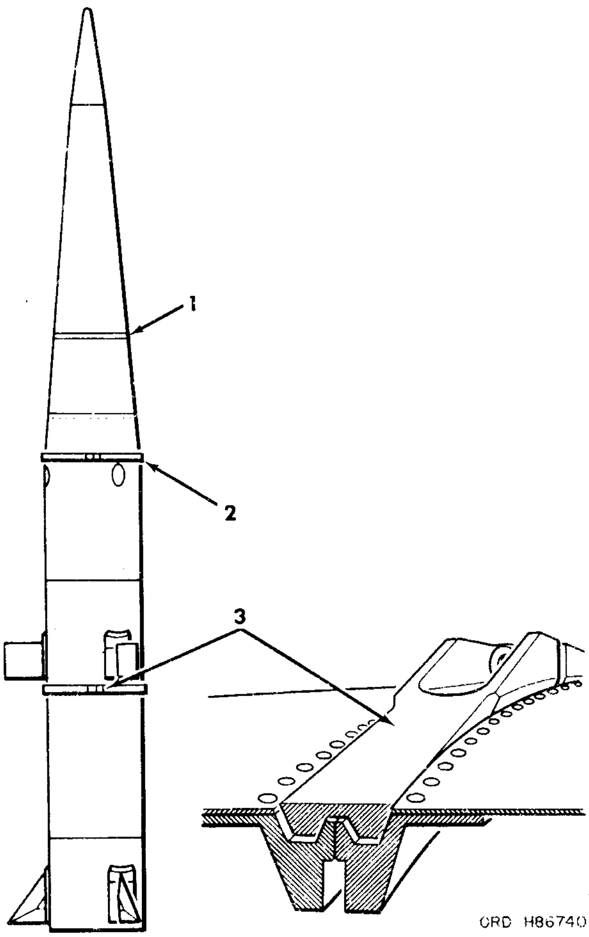
1	Guidance section	3	Second stage
2	Warhead section	4	First stage

Figure 8-120. Missile sections.

stage is held open by a ball lockpin that is withdrawn after the cables are connected, allowing the door to close after the cables are pulled free. Thermostatically controlled, electrically heated, blankets are supplied for use on the first and second stages during cold weather operation. Because of different temperature requirements, the guidance section is equipped with an electrically heated blanket that remains on the section until just before the missile is erected.

c. Theory of Operation.

(1) The missile is powered by two solid-propellant rocket motors located in the first and second stage body sections. The first stage motor provides the initial thrust required to place the missile in a predetermined trajectory. When the first stage motor burns out, the missile coasts without thrust for a period of time depending on the range of the target. Just prior to second stage ignition, the burned-out first stage body section separates from the missile and falls behind. The second stage motor burns until its thrust is terminated at a point determined by the program for the selected trajectory. Simultaneous with the termination of second stage thrust, the second stage and the guidance and control body sections separate as a unit from the warhead section. The warhead section then continues in a ballistic trajectory to the target. The missile is controlled in attitude and guided in its trajectory by an inertial guidance system located in the guidance and control body section. This system establishes and maintains a reference point relative to the firing position and then senses movements of the missile away from this reference. Corrections in attitude and displacement from the planned trajectory are made by control surfaces (air fins and jet vanes) located on the first and second stage body sections. Both air fins and jet vanes are required for

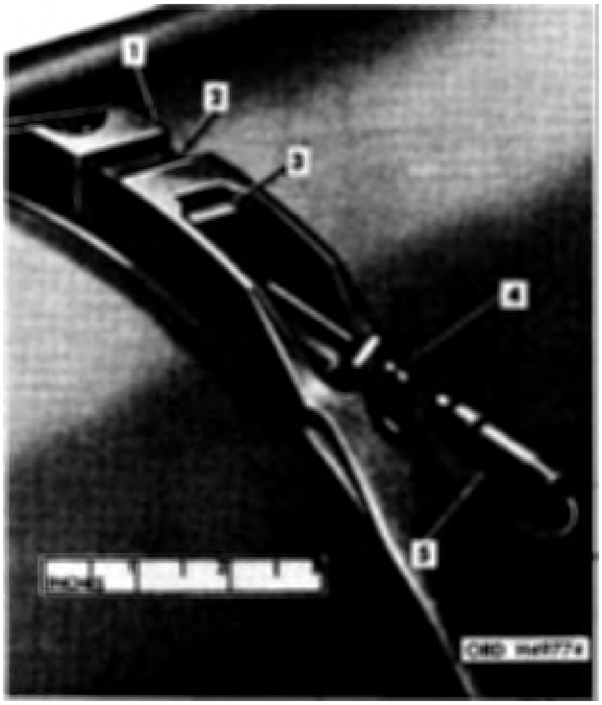


1 Separation splice band
2 Retaining splice band
3 Separation splice band

Figure 8-121. Body sections splice bands.

control because of the changes in air density and missile velocity. The jet vanes are located in the exhaust stream directly behind the motor where they provide effective control by deflecting the exhaust gases during the first few seconds after firing, and in the thin upper atmosphere. The air fins extend outward into the air stream and become effective (in the atmosphere) as the velocity of the missile increases. Until first stage separation occurs, the control surfaces on the second stage body section are locked, and control is maintained by the first stage control surfaces. The warhead section is the only one of the missile sections that travels all the way to the target. Once the missile has attained the required velocity and is following a predetermined trajectory, there is no further need for the first and second stage body sections or the guidance and control body section. By separating these sections, unnecessary drag and possible destruction of the warhead section during reentry are eliminated.

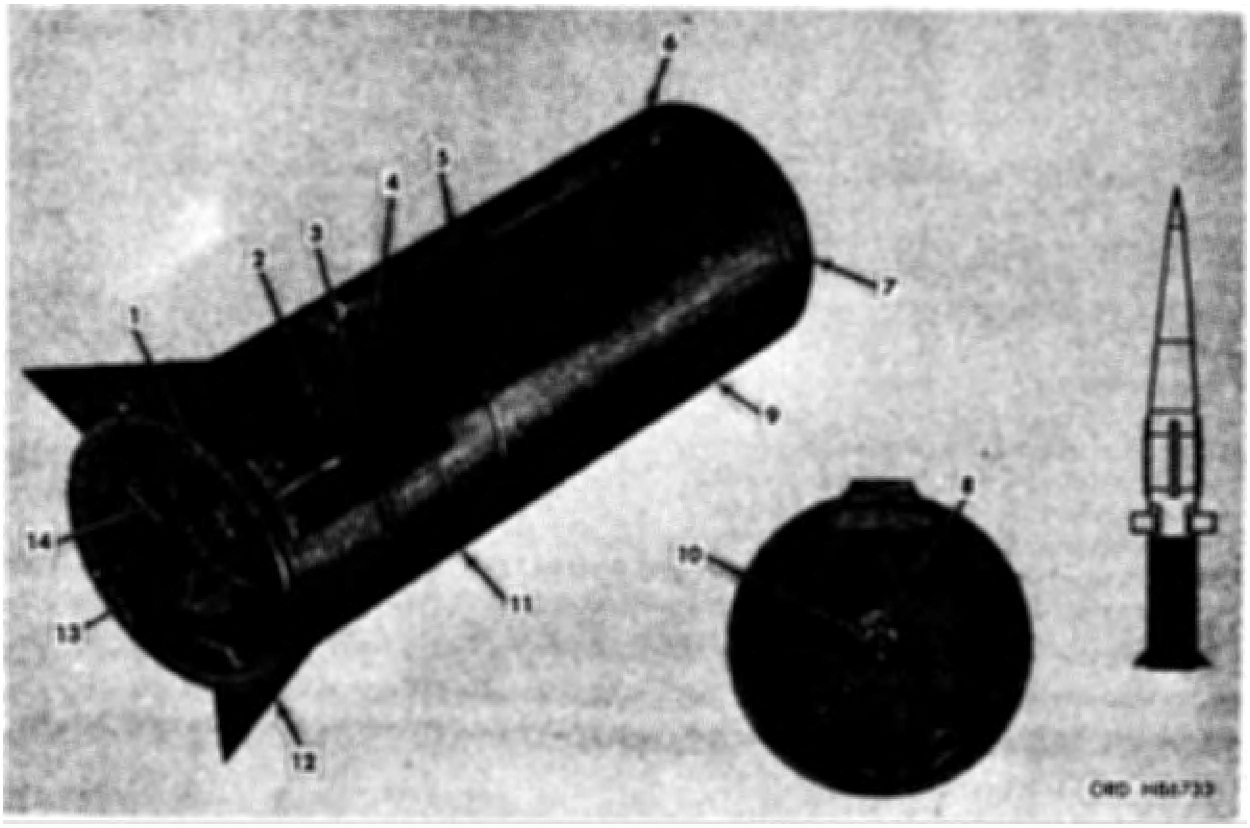
(2) First Stage Body Section (figure 8-123). The main structure of the first stage body section is formed by the solid-propellant rocket motor assembly. The propellant is ignited in a sequence which starts with an electrical impulse applied to two exploding bridgewire (EBW)



1	Splice band	4	Detonator
2	Heat shield	5	Connector
3	Explosive bolt		

Figure 8-122. Explosive separation bolt.

initiators. These initiators discharge into a pyrogen unit which, in effect, is a small solid-propellant rocket inserted into the head end of the motor. Heat and pressure developed by the pyrogen unit ignite the motor propellant along its entire length. The fiberglass nozzle assembly bolted to the rear of the steel motor case increases the efficiency and thrust of the motor by shaping and accelerating the stream of exhaust gases. The throat of the nozzle is fitted with a shaped, compressed graphite insert, to withstand the intense heat of the exhaust in this area. A nozzle closure, fitted with a desiccant container and humidity indicator, protects the motor from the entry of foreign objects and excessive moisture before firing. A breather valve, located on the desiccant container, prevents the buildup of excessive pressure within the motor. The closure is bonded to the nozzle and is not removed until it is blown out by the initial thrust of the motor. Structural protection for the nozzle assembly is provided by the control package. The control package contains three hydraulic actuation assemblies located 120 degrees apart around the outer circumference. The hydraulic actuator assemblies operate the jet vanes and air fins upon command from the guidance and control system. The shaft of each air fin is mounted in its hydraulic actuation assemblies by a self-locking set screw. The shafts of the jet vanes extend through the flame shield and are secured in the hydraulic actuation assemblies by a nut. To withstand the extreme heat of the rocket exhaust, the jet vanes are made of machined molybdenum-tungsten alloy. The air fin and jet vane are coupled within each hydraulic actuation assembly and operate as a single unit. The flame shield, which is fitted inside the control package, provides protection for electrical cables and the hydraulic actuation assemblies. The control package also contains a tailplug receptacle through which certain electrical power and command voltages are supplied. When the tailplug is pulled free, a spring-loaded cover snaps shut over the receptacle for protection of the receptacle. An additional receptacle is provided for the electric heaters of the hydraulic actuation assemblies. The first stage body section is mechanically mated to the second stage body section by the forward adapter. The forward end of this structure forms a mating ring which is grooved to accept the separation splice band. The pyrogen unit, initiators, and electrical cables are located within the forward adapter.

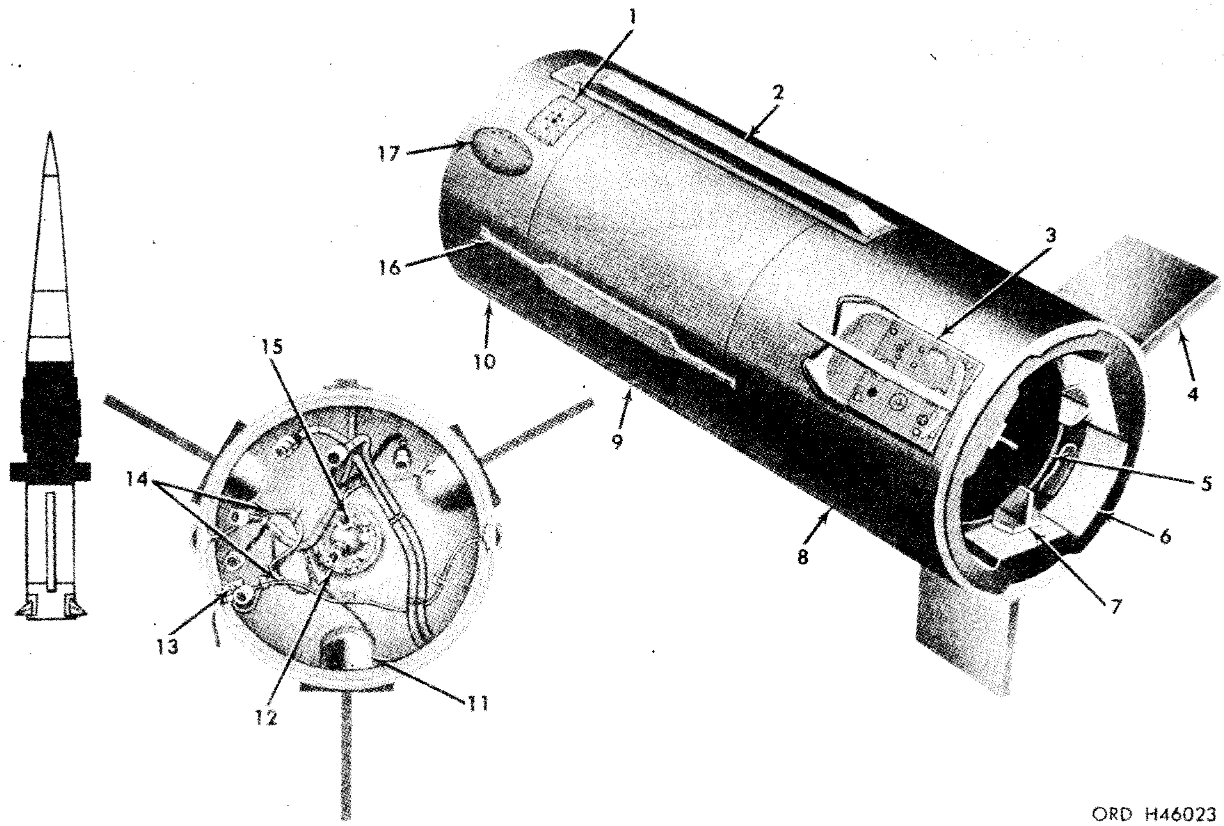


1	Nozzle assembly	8	Initiator (2)
2	Hydraulic actuation assembly (3)	9	Rocket motor case
3	Tailplug receptacle	10	Pyrogen unit
4	Heating receptacle	11	Control package
5	Electrical cable harness cover	12	Air fin (3)
6	Initiator access door	13	Flame shield
7	Forward adapter	14	Jet vane (3)

Figure 8-123. First stage body section.

Breakaway connectors are used on the electrical cables and are fastened to the forward adapter with wire rope lanyards. These lanyards are slightly shorter than the cables, and evenly pull the connectors free when the body sections separate. Because the motor case forms the outer skin of the missile between the forward adapter and the control package, the electrical cables are clamped to the outside of the body section and are protected by the electrical cable harness cover. An initiator access door is located in the forward adapter to provide access to the initiators when the first and second stage body sections are coupled by the splice band.

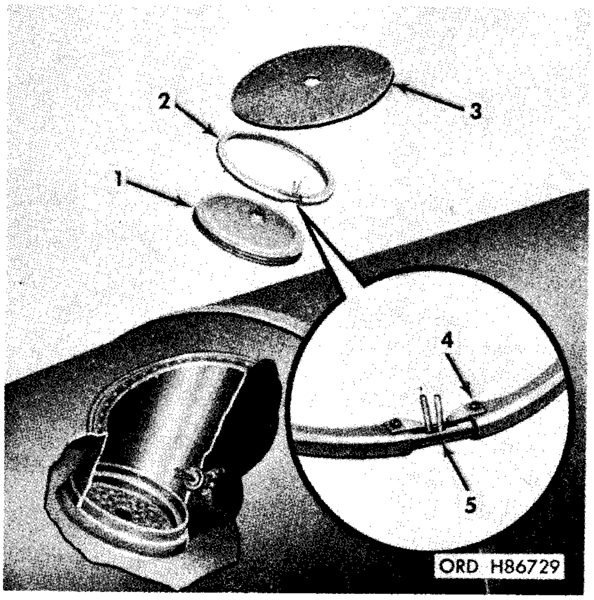
(3) Second Stage Body Section. The second stage body section (figure 8-124) is similar to the first stage body section paragraph c(2) except for the addition of a thrust termination device and a case venting system, and for minor differences in the size and shape of the air fins, jet vanes, and nozzle assembly. These differences are necessary because of the functional requirement of the second stage body section. The thrust termination device has three thrust reverser port covers that are located on the forward adapter. The port covers seal reverser tubes which extend downward to dome assemblies (figure 8-125) in the front end of the motor. The dome assemblies are each secured by a retaining ring which contains an explosive sector. Upon command to terminate thrust, the sectors explode, allowing the retaining rings to collapse. This allows the internal pressure of the motor to blow out the dome assemblies and the port covers, and vent through the reverser tubes.



1	**Initiator access door**	10	**Forward adapter**
2	Electrical cable harness cover	11	Reverser tube (3)
3	Hydraulic actuation assembly (3)	12	Pyrogen unit
4	Air fin (3)	13	Safe and arm mechanism
5	Nozzle assembly	14	Explosive lead assembly
6	Flame shield	15	Initiator (2)
7	Jet vane (3)	16	Retainer assembly (2)
8	Control package	17	Thrust reverser port (3)
9	Rocket motor case		

Figure 8-124. Second stage body section.

This action applies reverse thrust to the second stage. Thrust reversal and termination occur simultaneously with separation so that the warhead may continue on its trajectory without interference from the second stage motor. For the second stage body sections with serial numbers 00030 through 00312, the EBW case venting system consists of a safe and arm mechanism (S and A mechanism), an explosive lead assembly, and two shaped charge retainer assemblies. The S and A mechanism and the explosive lead assembly are mounted inside the forward adapter of the second stage body section, and each retainer assembly is mounted on the outside of the motor case on the missile horizontal centerline. The S and A mechanism is an electromechanical device which initiates the explosive train of the case venting system. The lead assembly continues the explosive train as initiated by the S and A mechanism. The explosive train continues to the two shaped charge retainer assemblies. After separation and thrust termination have begun, the explosive train is detonated, and the additional area opened in the rocket motor case quickly vents the internal pressure within the motor to assure that warhead stability is maintained throughout separation. The shaped charge retainer assemblies are stored in their own containers during ground handling. A

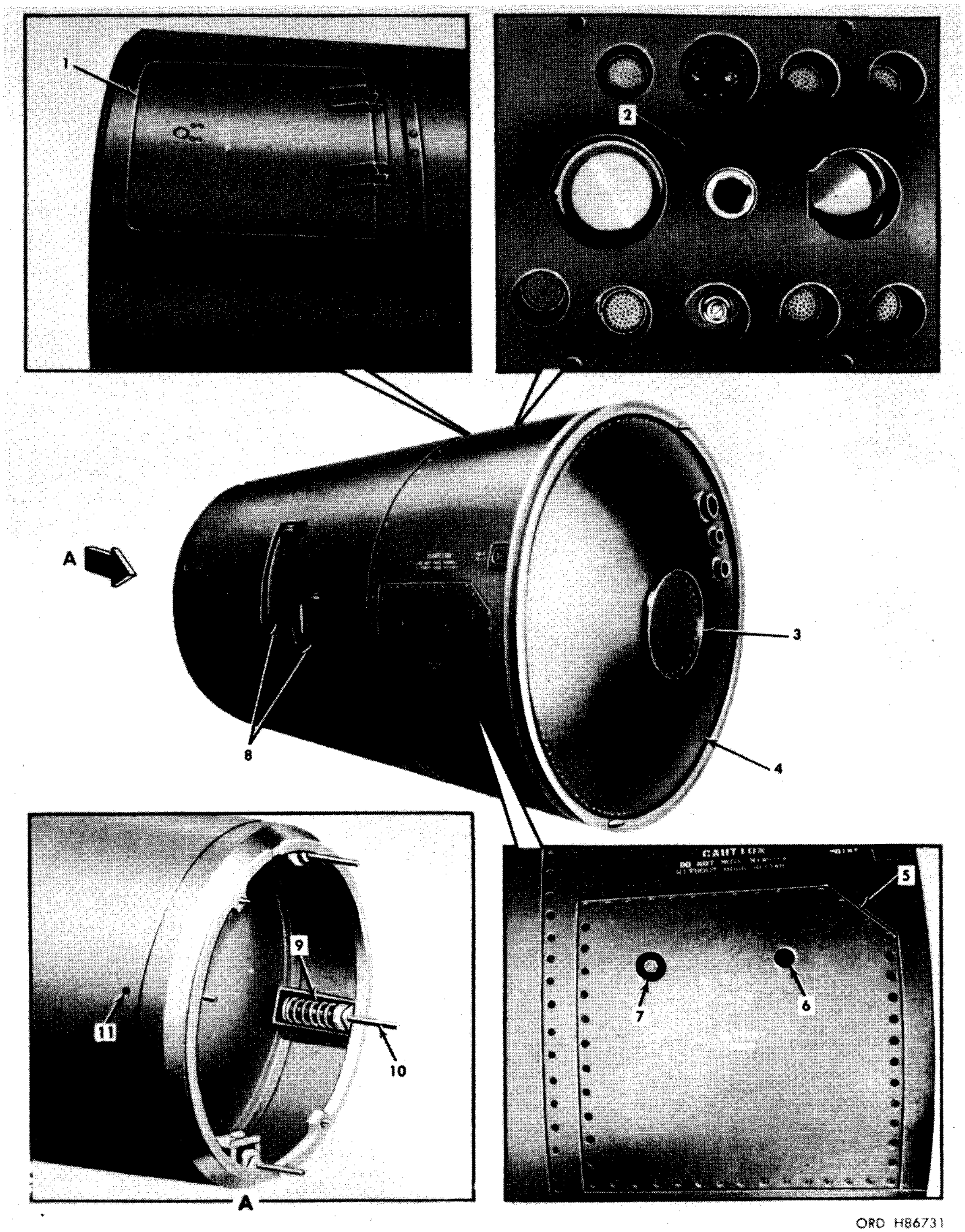


1	Dome assembly
2	Retaining ring
3	Port cover
4	Retaining clip (2)
5	Exploding sector

Figure 8-125. Thrust reverser tube.

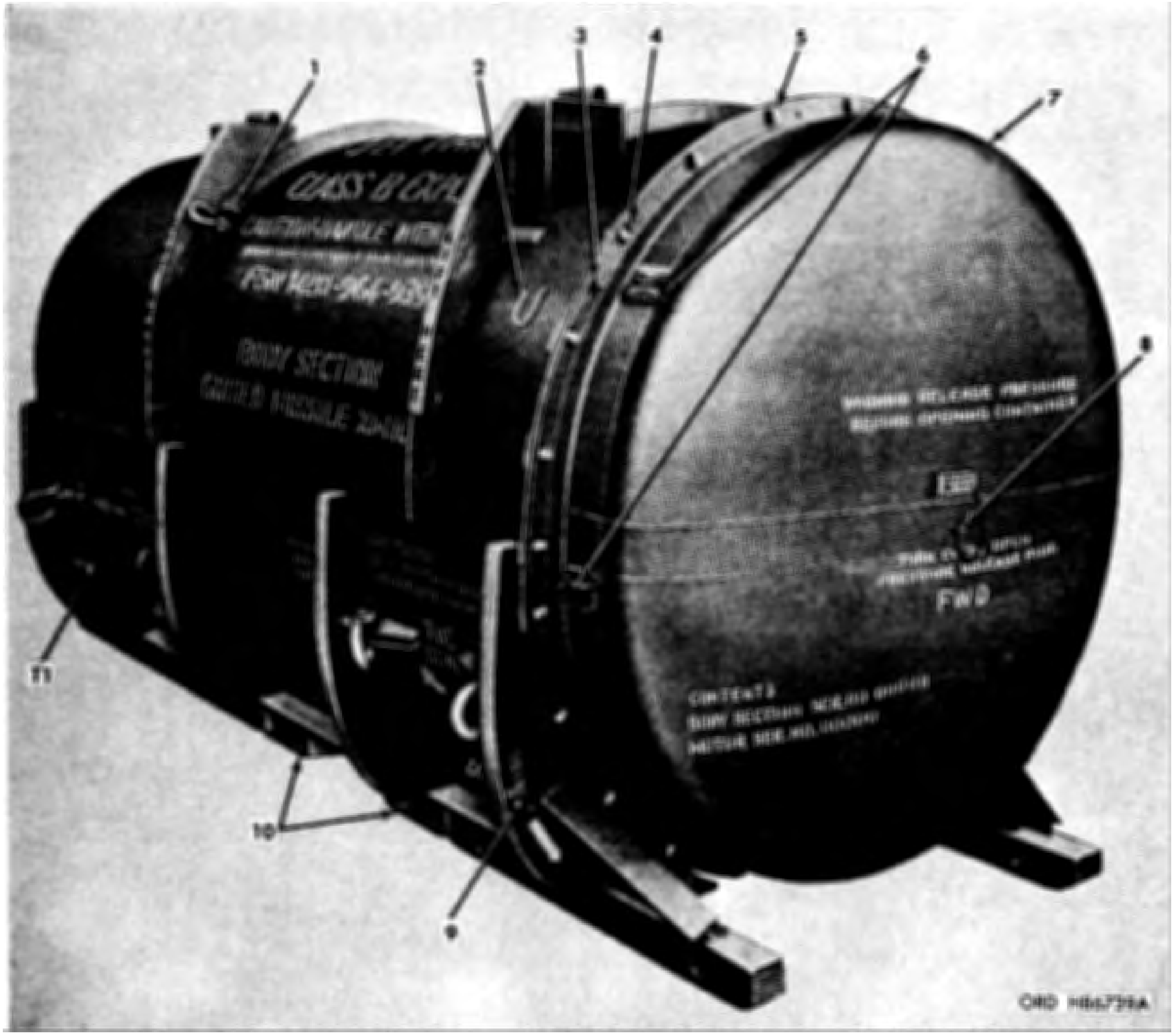
safety pin with a green cloth streamer is provided to mechanically prevent accidental arming of the S and A mechanism. The safety pin is removed from the S and A mechanism only after installation of the shaped charge retainers, immediately prior to missile erection. For the second stage body sections with serial numbers 00313 and higher, the EBW case venting system consists of two firing unit assemblies, two detonator assemblies, associated electrical cabling, and two shaped charge retainer assemblies. The firing unit assemblies, detonator assemblies, and cabling are mounted inside the forward adapter of the second stage body section, and each retainer assembly is mounted on the outside of the motor case on the missile horizontal centerline. After separation and thrust termination are initiated, an electrical signal from the firing unit assemblies ignites detonators in the detonator assemblies. The explosive train continues to the two shaped charge retainer assemblies. The shaped charges detonate and the additional area opened in the rocket motor quickly vents the internal pressure within the motor to assure that warhead stability is maintained throughout separation. The shaped charge retainer assemblies are stored in their own containers during ground handling. The shaped charge retainers are installed immediately prior to missile erection. A difference also exists in the second stage flame shield, which is fitted with spring-loaded covers over the electrical connectors. These covers snap shut after first stage separation to prevent damage to the connectors by the exhaust of the second stage motor.

(4) Guidance and Control Body Section. The guidance and control body section (figure 8-126) contains the electrical power supplies, power distribution system, and the major assemblies of the guidance and control system with the exception of the hydraulic actuation assemblies. The base assembly is the frame of the guidance section, and has mounting brackets for the assemblies located within the section. The rear end of the base assembly is sealed by a pressure dome secured with screws. Access to the missile battery assembly is provided by the battery access door, which is secured to the base assembly. This door is equipped with a pressure relief valve to maintain an internal pressure of 14.7 psi. Electrical and air connections from the ground networks are made through the umbilical connectors in the base assembly. These connectors are protected by the spring-loaded umbilical door, which snaps shut and provides protection for the umbilical connectors when the umbilical mast is ejected. Spring-loaded valves in the two umbilical air connections allow conditioned air to be applied to the section during testing operation, and the valves seal to prevent loss of internal pressure during flight. The cover assembly is sealed at the forward end by a riveted steel dome and is secured to the base assembly by screws. Two sight windows in the cover assembly



1	Umbilical door	7	Pressure test plug
2	Umbilical connectors	8	Sight window (2)
3	Access cover	9	Separation spring (4)
4	Pressure dome	10	Plunger (4)
5	Battery access door	11	Separation spring locking port (4)
6	Pressure relief valve exhaust port		

Figure 8-126. Guidance section.

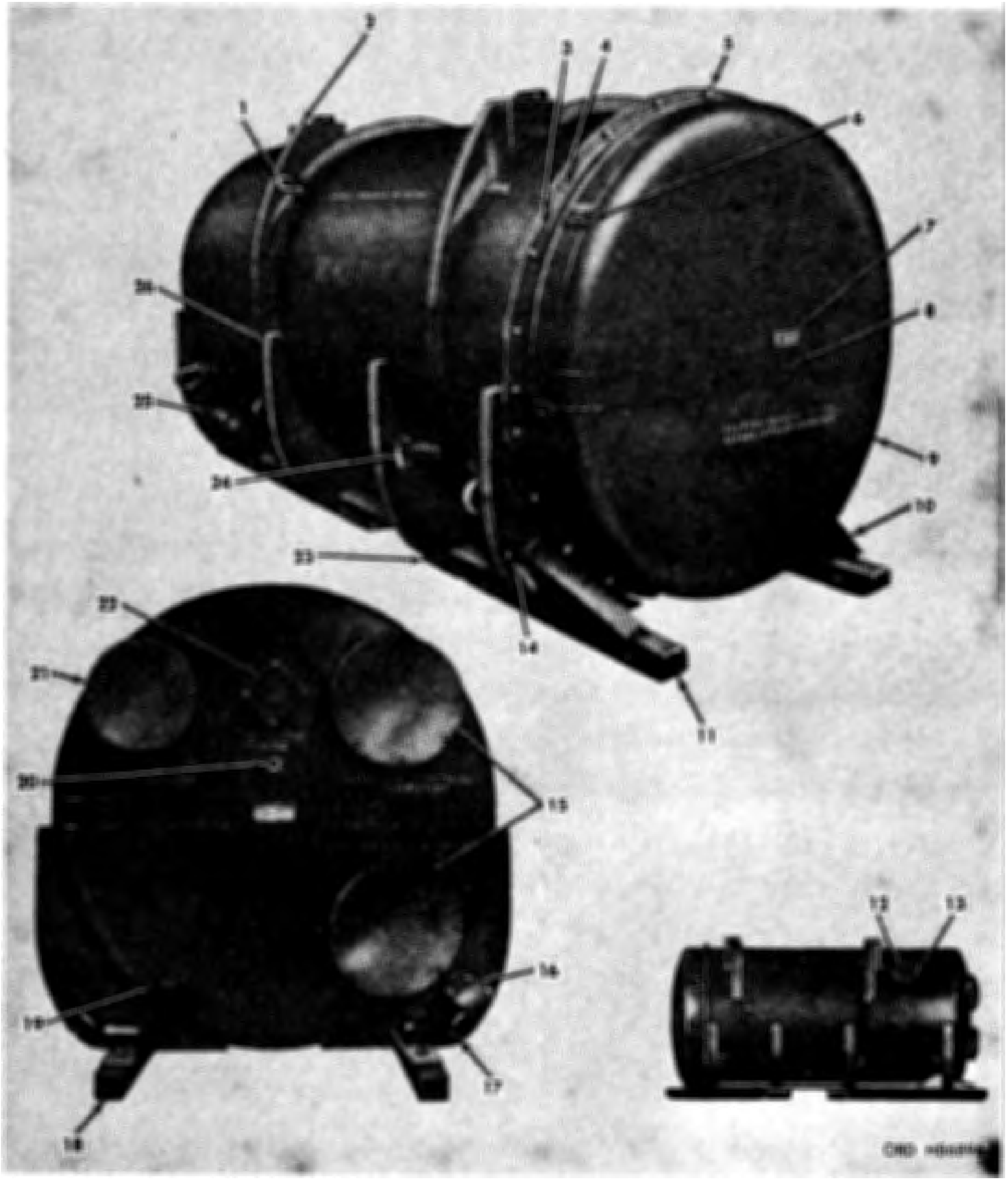


1 Sling shackle (4)
2 Retaining hook
3 Cover guide pin (3)
4 T-bold (4)
5 Cam bolt (20)
6 Cover handle (4)
7 Cover assembly
8 Pressure release plug
9 Grounding lug
10 Forklift channel
11 Record receptacle

Figure 8-127. First stage missile section shipping and storage container.

provide visual access to an internal reference point used for laying the missile on the firing azimuth. The electrical cable connections between the guidance section and the warhead section have breakaway connectors that are pulled free by wire lanyards as the sections separate in flight. The lanyards are slightly shorter than the cables, assuring a clean separation between the two sections.

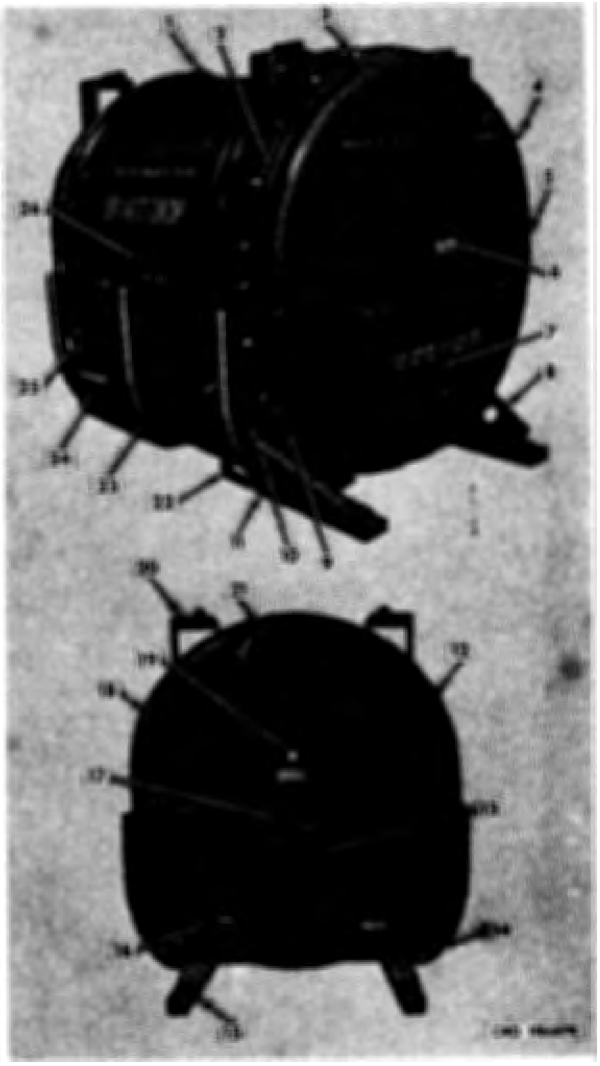
(5) Warhead Section. The warhead section (figure 8-120) is described and illustrated in detail in TM 9-1100-375-12. Only two electrical cables are required between the guidance section and the warhead section. At separation, the breakaway connectors are pulled free by the wire rope lanyards attached to the guidance section, assuring a clean break without strain on the cables. A flanged collar on a connector holds two separation sensor switches, closed until the connector is pulled free. When the switches are released, a signal is developed within the warhead section



1 Sling shackle (4)
2 Stack pad (4)
3 Cover guide pin (2)
4 T-bolt (4)
5 Cam bolt (20)
6 Cover handle (4)
7 Identification plate
8 Pressure release plug
9 Cover assembly
10 Towing bracket (2)
11 Skid (2)
12 Footpad storage bracket
13 Footpad (4)
14 Grounding lug
15 Interstage electrical connector receptacle cover
16 Record receptacle cover
17 Tow ring (2)
18 Skid (2)
19 Shock and temperature monitor indicator
20 Humidity indicator
21 Electrical heater receptacle cover
22 Initiator storage receptacle cover
23 Forklift channel (2)
24 Anchor shackle (8)
25 Record receptacle
26 Rollover ring (8)

Figure 8-128. Second stage body section container, exterior view.

indicating that separation is complete. After separation, the warhead is caused to spin, preventing oscillation or tumbling.



1	Sling shackle (2)
2	Cover guide pin (3)
3	Cam bolt (20)
4	Cover handle (4)
5	Cover assembly
6	Identification plate
7	Pressure release plug
8	Towing bracket (2)
9	T-bolt (4)
10	Grounding lug
11	Skid (2)
12	Umbilical electrical connector receptacle cover
13	Heating blanket connector receptacle cover
14	Two ring (2)
15	Skid (2)
16	Shock monitor assembly
17	Leveling pad
18	Interstage electrical connector receptacle cover
19	Humidity indicator
20	Stack pad (4)
21	Umbilical pneumatic receptacle cover
22	Forklift channel (2)
23	Rollover ring (6)
24	Record receptacle (containers 00347 and below)
25	Anchor shackle (4)
26	Leveling pad

Figure 8-129. G and C section container, exterior view.

d. Missile Containers and Configuration.

(1) Container XM475 (figure 8-127) with the first stage body section weighs approximately 9110 pounds.

(2) Container XM476 (figure 8-128) with the second stage body section weighs approximately 7322 pounds.

(3) Container XM474 (figure 8-129) with the guidance and control section weighs approximately 2511 pounds.

(4) Container XM483 with warhead weighs approximately 2596 pounds.

e. Storage. Guided missile sections and components, since they contain delicate electronic equipment sensitive to both humidity and temperature extremes, should be stored in igloo type magazines or storage equal to warehouse storage in accordance with approved ammunition storage drawings. Minimum storage conditions are above ground, but sheltered. Outdoor storage in oversea theaters is authorized for empty containers being held for repair or rebuild where igloo-type magazines or warehouses are not available. Temperature storage limits, as marked on containers, will be complied with. NOTE: Outdoor storage of missile sections shall be limited to one high unless storage area has a paved surface. The maximum height for outdoor storage is two high.

15. **SUMMARY.** The lesson you have completed provides a comprehensive narrative and illustrative coverage of the types, characteristics, identification, function, and packaging configuration of representative small rockets, and an individual detailed coverage of all the Army guided missile systems. Information concerning the nuclear warheads for the applicable missile system is necessarily limited because of security classification. This lesson should be used as a primary information source or for refresher material that should assist you in performing your duties as an ammunition maintenance or storage supervisor. To further assist you in clarification of details of the missile systems, it is suggested that you refer to DA PAM 310-4 and procure the technical manuals applicable to the various missile systems.

MMS SUBCOURSE NUMBER 621, AMMUNITION MATERIEL

EXERCISES FOR LESSON 8

1. What station numbers identify the pedestal section of the 762mm rocket?

   A. 290 - 327
   B. 147 - 290
   C. 134 - 147
   D. 115 - 134

2. What is the purpose of the shaped charge retainer assemblies in the second stage of the Pershing missile?

   A. Initiate reverse thrust
   B. Vent the motor case
   C. Ignite explosive bolts
   D. Actuate pyrogen unit

3. What is the filler for the Mk 25 Mod 1 HVAR head?

   A. TNT
   B. Composition B
   C. Octol
   D. HBX-6

4. What is a characteristic of the M412 PIBD fuze?

   A. Graze functioning
   B. Variable time
   C. Heat seeker
   D. All ways armed

5. What is the purpose of the lanyard of the M31 series 762mm rocket?

   A. Activate motor igniter
   B. Withdraw pins from percussion primers
   C. Pull safety wire from M12 timer
   D. Remove pins from launcher shoes

6. How is range control achieved by the Sergeant guided missile?

   A. Timing of booster separation
   B. Controlled burning of propellant
   C. Reverse thrust
   D. Aerodynamic dragbrakes

7. How does the gunner know when he has the Redeye missile locked on target?

   A. An audible signal
   B. A luminous indicator
   C. A blip on reticle
   D. When gyro is activated

8. What restricts the burning of a rocket propellant grain?

   A. Configuration
   B. Catalyst
   C. Inhibitor
   D. Trap assembly

9. What is used to assist the gunner in tracking the SS11 missile in flight?

   A. Automatic plotting board
   B. Starlight scope
   C. Radar
   D. Flares

10. What completes the firing circuit to the detonator of the Shillelagh warhead?

   A. Electrical firing probe penetrates detonator
   B. Crush switch is actuated by inertia
   C. Crushing of nose shells
   D. Thrust decay releases firing pin

11. What causes the 4.5 inch rocket to spin in flight?

   A. Angled nozzles
   B. Radial vanes
   C. Canted fins
   D. Rotating disks

12. Where are axial forces in a rocket motor produced?

   A. Aft end of nozzle
   B. Forward end of tube
   C. Center of combustion chamber
   D. Throat of nozzle

13. Which radar of the Hawk missile system detects low altitude targets?

   A. CWAR
   B. PAR
   C. PAL
   D. HPIR

14. How is the explosive loaded into the 66mm AT rocket warhead?

A. Sintered
B. Extruded
C. Pressed
D. Cast

15. How is the azimuth of the predicted intercept point transmitted to the selected missile on a launcher in the Nike - Hercules system?

A. Integrated manually using two plotting boards
B. Preset on magnetic disk
C. Sent as gyro azimuth preset data by computer
'D. By TTR system supplying accurate target position

16. What color bands identify the filler of the M55 115mm rocket?

A. White and blue
B. Green and gray
C. Yellow and green
D. Red and yellow

17. What is the source of energy used to actuate the fins of the 2.75 inch rocket?

A. Spring loaded action
B. Piezoelectric crystal
C. Set back force
D. Pressure from propellant gases

18. When will the HPIR lock on the target in the Hawk missile system?

A. As synchonized rotation of the PAR and CWAR are coordinated
B. If a reflected signal bearing a change of frequency is received
C. If target identification by SIF is accomplished
D. When target is presented on radar display indicator

19. What is Pascal's Law?

A. Jet force is always equal to forward thrust
B. Pressure is equal and opposite in all directions
C. Pressure is inversely proportional to temperature and jet velocity
D. Directional force is in the same proportion inversely as nozzle atmospheric pressure

20. How is the 5-inch rocket head base fuze, armed?

A. Centrifugal force
B. Creep action
C. Gas pressure
D. Jet vanes

LESSON 9. DEMOLITION MATERIALS

MMS Subcourse Number 621 . . . . Ammunition Materiel

Lesson Objective . . . . To give the student a general knowledge of the types, identification, use, characteristics, and filler of demolition materials.

Credit Hours . . . . Three

TEXT

1. **INTRODUCTION.** The contents of this lesson should be of sufficient coverage to give you a general knowledge of demolition material as used in military operations. Military demolition operations are the destruction by fire, water, explosive, and mechanical or other means for the reduction of areas, structures, facilities, hazardous munitions, or materials to accomplish a military objective. Demolition materials have offensive and defensive uses; for example, the removal of enemy barriers to facilitate the advance of friendly troops, or the construction of barriers to delay or restrict enemy movement. Demolition explosives may be used for improvised land mines and boobytraps; and, when necessary, land mines, artillery projectiles, and bombs may be used for demolition operations.

2. **Demolition materials.**

a. Explosive charges

(1) Characteristics - desirable properties

(a) Relative insensitivity to shock or friction including insensitivity to bullet impact.

(b) Sufficient sensitivity to be positively detonated by simple initiators.

(c) Proper detonating velocity for intended purposes.

(d) High power per unit of weight consistent with required insensitivity.

(e) Storage stability at temperatures between minus 80 degrees F and plus 165 degrees F with sufficient stability to retain usefulness for a reasonable time in any climate.

(f) Suitability for underwater use.

(g) Convenient size and shape to facilitate packaging, logistics, and handling by troops.

(h) High density (weight per unit of volume).

Table 9-1. Characteristics of Principal United States Explosives Used for Demolition.

Name	Principal use	Smallest cap* required for detonation	Velocity of detonation (meter/sec) (feet/sec)	Relative effectiveness as external charge (TNT-1.00)	Intensity of poisonous fumes	Water resistance
TNT	Main charge, booster charge, cutting and breaching charge, general and military use in forward areas.	Special blasting cap.	6,900 mps., 23,000 fps.	1.00	Dangerous	Excellent
Tetrytol			7,000 mps., 23,000 fps.	1.20	Dangerous	Excellent
Composition C-3			7,625 mps., 25,035 fps.	1.34	Dangerous	Good
Composition C-4			8,040 mps., 26,481 fps.	1.34	Slight	Excellent
Ammonium Nitrate	Cratering and ditching.		3,400 mps., 11,000 fps.	0.42	Dangerous	Poor
Military Dynamite M1.	Quarry and rock cuts.		6,100 mps., 20,000 fps.	0.92	Dangerous	Good
Straight Dynamite (commercial) 40%	Land clearing, cratering quarrying, and general use in rear areas.	No. 6 commercial cap.	4,600 mps., 15,000 fps.	0.65	Dangerous	Good (if fired within 24 hours).
50%			5,500 mps., 18,000 fps.	0.79		
60%			5,800 mps., 19,000 fps.	0.83		
Ammonia Dynamite (commercial) 40%			2,700 mps., 11,000 fps.	0.41	Dangerous	Poor
50%			3,400 mps., 11,000 fps.	0.46		
60%			3,700 mps., 12,000 fps.	0.53		
Gelatin Dynamite (commercial) (commercial) 40%			2,400 mps., 7,900 fps.	0.42	Slight	Good
50%			2,700 mps., 8,900 fps.	0.47		
60%			4,900 mps., 16,000 fps.	0.76		
Ammonia Gelatin Dynamite (commercial) 40%	Land clearing, cratering, quarrying, and general use in rear areas.	No. 6 commercial cap.	4,900 mps.		Slight	Excellent
60%			5,700 mps.			
PETN	Detonating cord	Special blasting cap	7,300 mps.	1.66	Slight	Good
	Blasting caps.	N/A				
TETRYL	Booster charge.	Special blasting cap, N/A	7,100 mps.	1.25	Dangerous	Excellent
Composition B	Shaped charges.	Special blasting cap.	7,800 mps.	1.35	Dangerous	Excellent
Amatol 80/20	Bangalore torpedo	Special blasting cap.	4,900 mps.	1.17	Dangerous	Poor
Black Powder	Time blasting fuze.	N/A	400 mps.	0.55	Dangerous	Poor

* Electric or nonelectric

(2) Types. The principal types of explosives commonly used for demolition purposes are shown in table 9-1. In using the table to determine the proper type of explosive to be employed for a specific purpose, the velocity of detonation should be considered. Table 9-1 may be used to determine the appropriate explosive for a given operation. Explosives with a high velocity of detonation are best for cutting and breaching operations, while those with a lower velocity of detonation are best for cratering, ditching, and quarrying operations. Block demolition charges are used in general demolition operations. They are composed of the high velocity detonating explosives amatol, composition B, composition C series, tetrytol and TNT, and the low velocity explosive, ammonium nitrate. With the exception of the 40 pound ammonium nitrate cratering charge and the 1/4 pound TNT charge, which are made in cylindrical form, the other charges are made in the form of rectangular blocks.

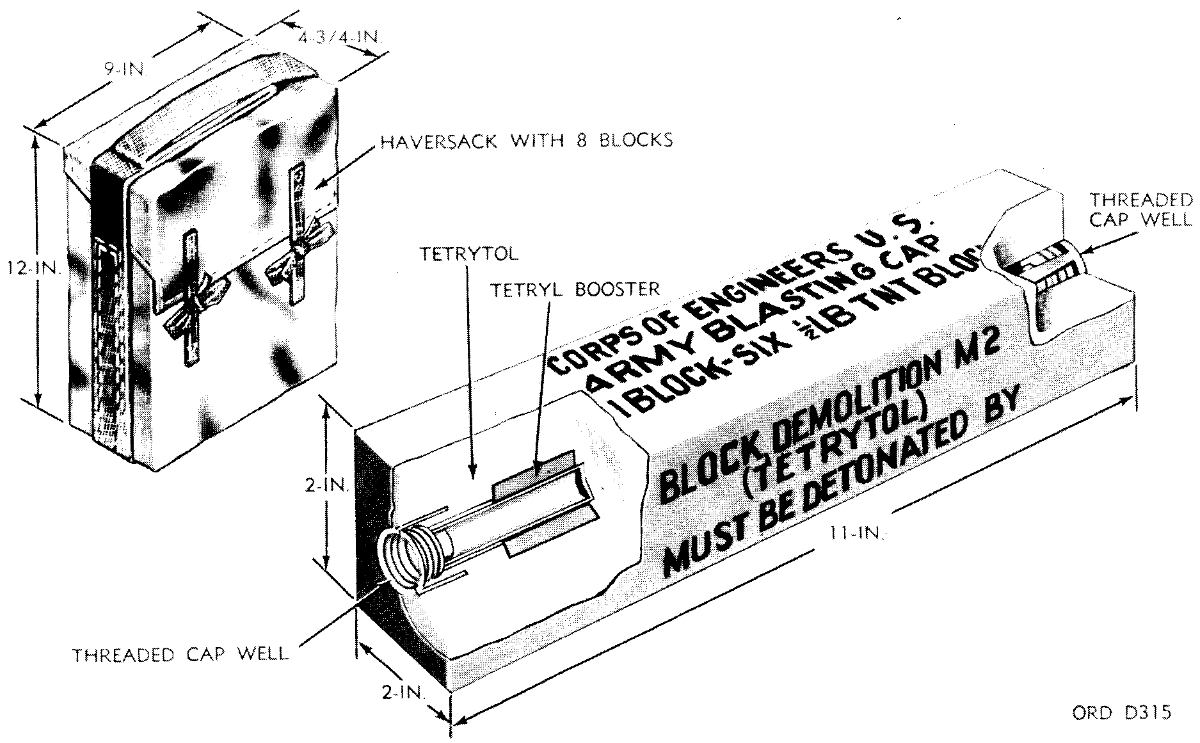


Figure 9-1. Charge, demolition: block, M2 (2½ pounds, 75-25 tetrytol).

(3) Description.

(a) Charge, demolition: block, M2 (2½ lb, 75-25 tetrytol). This charge (figure 9-1) has a tetryl booster pellet and threaded cap well cast in each end. The tetryl pellet is more sensitive than the tetrytol charge and gives the explosive force of the primer a "boost" to assure high order detonation of the tetrytol. The threaded cap well is designed to receive a detonator, a primed firing device, or a priming adapter with an electric or nonelectric blasting cap. Tetrytol is more powerful than TNT and is only slightly soluble in water. It is very brittle and breaks very easily when dropped. This charge is effective for cutting and breaching, but is not desirable as a cratering charge. Tetrytol, however, is now being eliminated. No more will be issued after present stocks are exhausted. Each block is wrapped in olive-drab, asphalt-impregnated paper. They are packed 8 per haversack, 2 haversacks (16 charges) per wooden box.

(b) Charge, demolition: block, M3 (2½ lb, composition C-2 or composition C-3). This

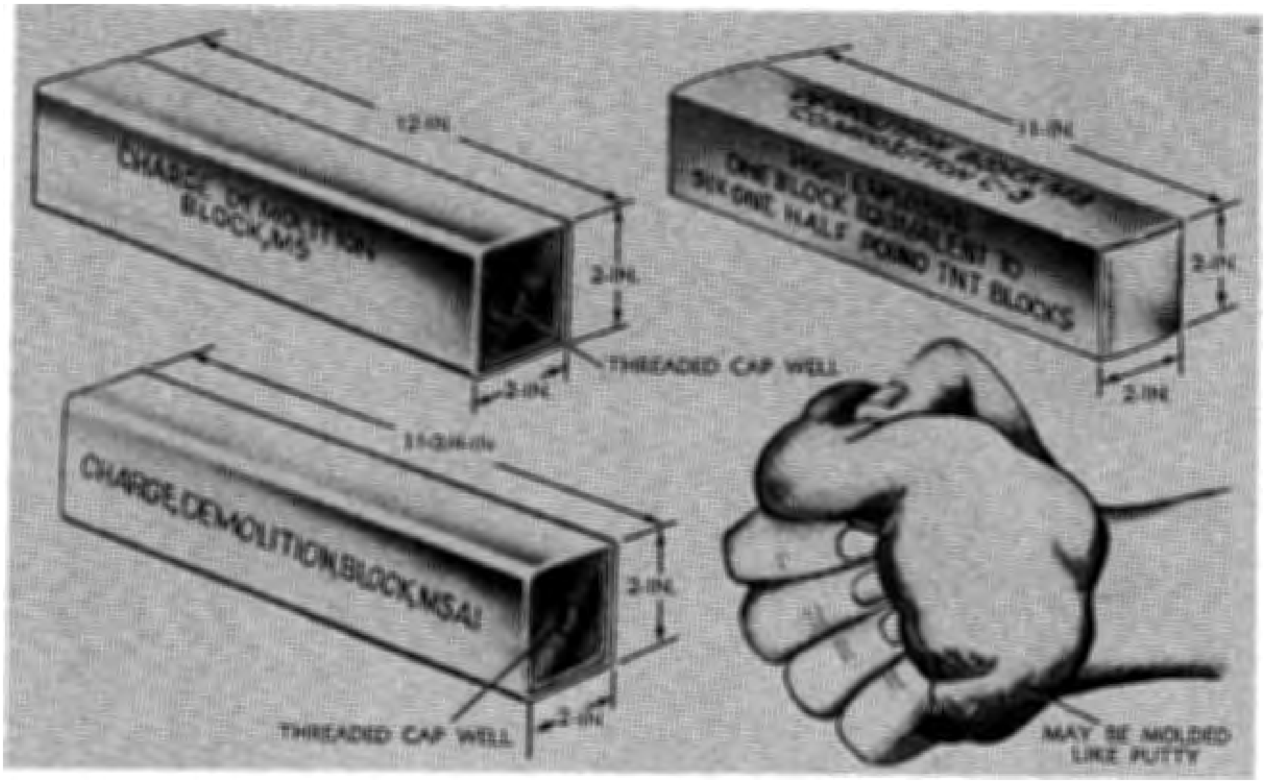


Figure 9-2. Plastic demolition charges.

charge (figure 9-2) is available in either explosive composition C-2 or C-3. The two explosives are similar and are interchangeable. C-2 and C-3 are pliable and may be molded at temperatures between minus 20 degrees F and plus 125 degrees F. The explosives are more pliable at temperatures above freezing, but have a tendency, at higher temperatures, to emit gases which will cause sickening headaches. The plasticity of the composition permits it to be molded by hand like putty and packed into intimate contact with irregular objects with resulting high demolition efficiency. These explosives are suitable for underwater demolition and may be initiated by detonating cord or a special blasting cap. The M3 charge is enclosed in a cardboard wrapper perforated for easy opening, and is packed the same as the M2 charge (see para (3)(a) above).

(c) Charge, demolition: block, M5 (2½ lb, composition C-3) and block, M5A1 (2½ lb, composition C-4). These charges (figure 9-2) are similar in appearance and construction, but differ in length and type of explosive. The M5 charge is 12 inches long and is made of composition C-3, while the M5A1 charge is 11 3/4 inches long and is made of composition C-4. Composition C-4 has many advantages over composition C-3; it is more powerful, and may be molded over a broader range of temperatures (minus 70 degrees F to plus 170 degrees F). The M5A1 charge is more stable, is less sticky, and will not adhere to the hands. It is less subject to water erosion when used for underwater work. The explosive for both charges are encased in white plastic containers with a threaded cap well in each end. The M5 and M5A1 charges are packed 1 per polyethylene bag, 24 bags per wooden box.

(d) Charge, demolition: block, (¼, ½, and 1 lb. TNT). Trinitrotoluene (TNT) is one of the most important military explosives. Its high detonating velocity makes it effective for cutting and breaching. TNT is insoluble in water and therefore, can be used in underwater operations. The ¼ lb TNT block (figure 9-3) is issued in a cylindrical, olive-drab, plastic container, and the ½ and 1 lb blocks are issued in rectangular, olive-drab, plastic containers. All three containers have metal

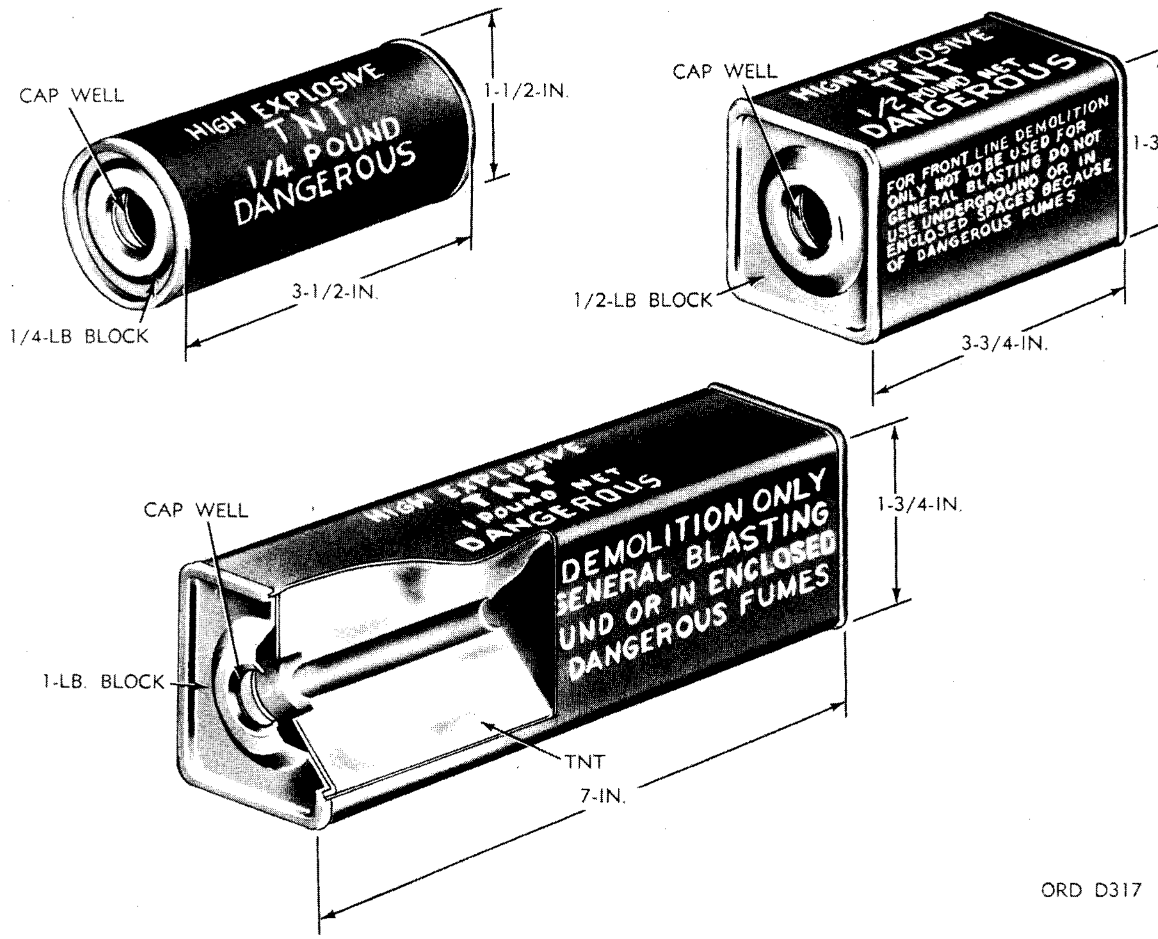


Figure 9-3. TNT demolition charges.

ends and threaded cap wells to receive detonators, primed firing devices, and priming adapters for electric and nonelectric blasting caps.

(e) Charge, demolition: chain, M1 (eight 2½ lb, 75-25 tetrytol charges). The M1 chain demolition block (figure 9-4) may be used as an alternate to TNT. The blocks are cast 8 inches apart on detonating cord, with 24 inches left free at each end of the chain (total 192 inches). 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. The 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. A tetryl pellet booster is cast into the blocks at each end and can be initiated by means of an electric or nonelectric blasting cap. If the detonating cord is cut, the ends should be waterproofed to prevent penetration by moisture. Tetrytol is now being eliminated. When present stocks are exhausted, no more will be procured. The chain (8 blocks) is packed in OD haversack, two haversacks per wooden box.

(f) Charge, demolition: M112 (XM 112). This charge (figure 9-5) is an improved version of the conventional composition C-4, demolition block M5A1. The thickness of the block was reduced by one-half, as it was found that an explosive is more efficient when used in a thin layer over a large area than when the same weight of explosive is used in a thick mass over a small area. The advantages over the standard demolition block M5A1 are self-adherence to any surface, dull gray in color to aid in camouflage, and a handier size (1 inch by 2 inches by 11 inches, 1¼ lbs

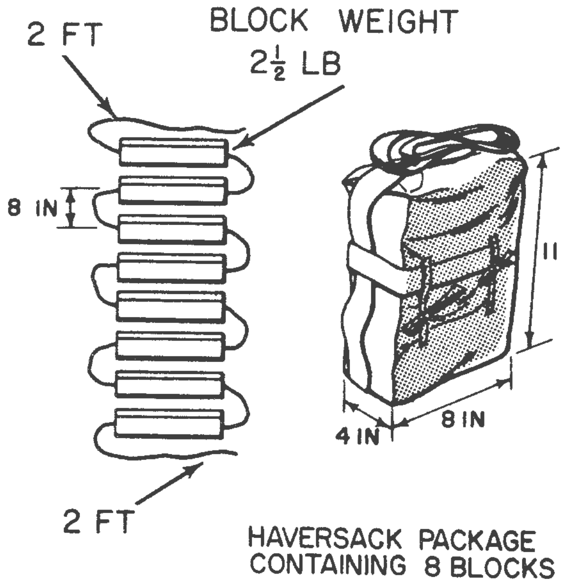


Figure 9-4. M1 chain demolition block.

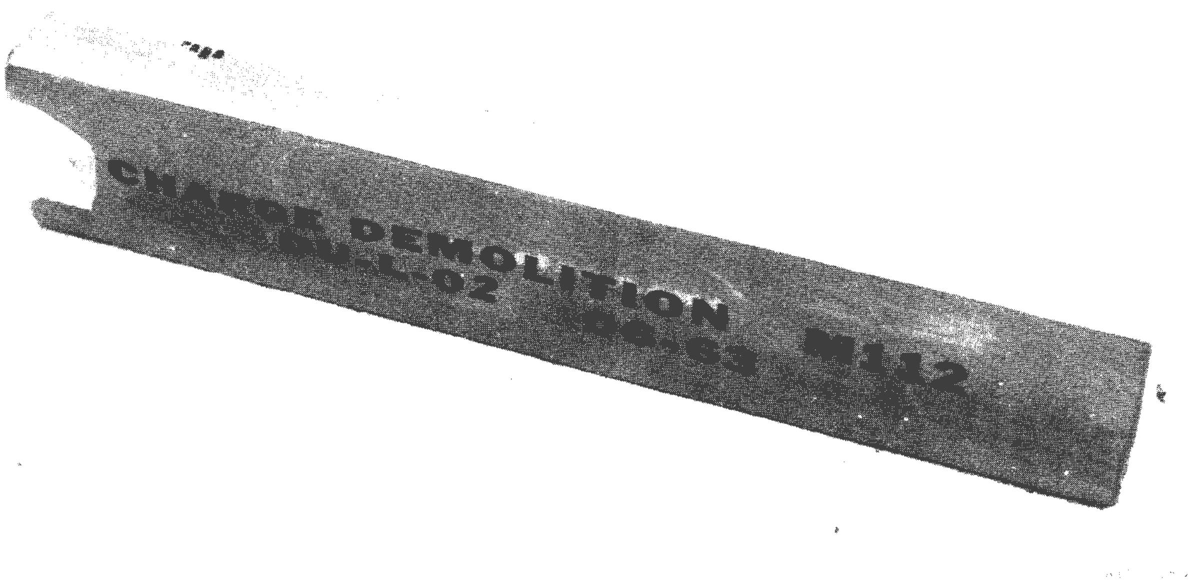


Figure 9-5. Charge, Demolition: M112 (XM112).

as compared with 2 inches by 2 inches by 11 inches, 2½ lbs for the M5A1). The M112 charge is capable of safe, sure, and speedy application to all kinds of targets under such conditions as rain or under water, and in arctic or tropic environments. It meets guerrilla warfare requirements and can be initiated by standard blasting caps in air or under water. The composition C-4 is packaged in a tight, water-resistent, mylar-film container with a pressure-sensitive adhesive tape on one surface. The charge will neither crack nor exude when subjected to prolonged exposure to extreme temperatures. Thirty demolition charges are packed per barrier wrapper in a wirebound wooden box.

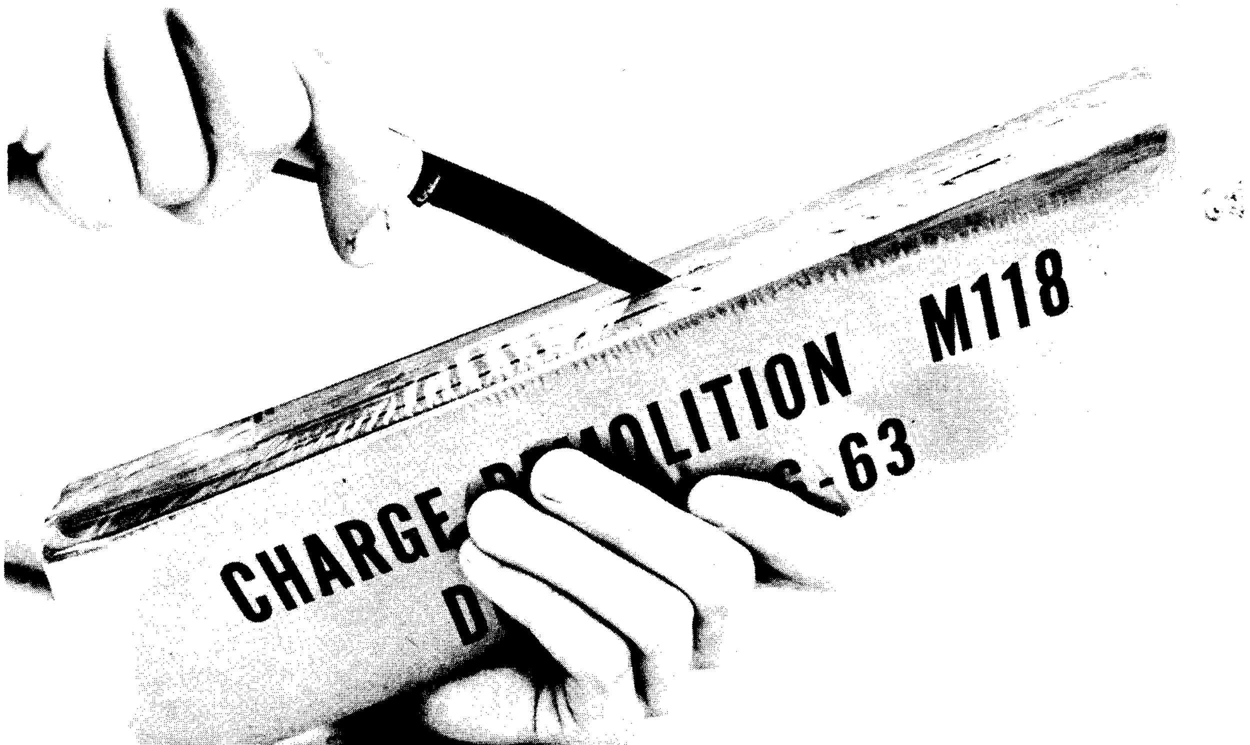


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Figure 9-6. Opening container with knife.

(g) Charge, demolition: M118 (XM 118). This charge (figure 9-6) is commonly called Flex-X. It consists of four sheets of Flexible Explosive ¼ inch by 3 inches by 12 inches with a pressure-sensitive adhesive tape attached to one surface. The exact explosive contained in the M118 charge will vary with the manufacturer. At present, some manufacturers use PETN as a basic explosive, while others use RDX. Charges of future procurement may include still other explosives. Flex-X can be cut and shaped with a steel knife on a nonmetallic surface. It does not crumble as in the case of composition C-4 and retains its flexibility through a wide temperature range (minus 40 to plus 160 degrees F). Flex-X will not detonate if struck by a caliber .30 bullet fired from a distance of 40 feet, can be initiated by standard blasting caps in air and under water, and satisfies guerrilla warfare requirements. Application of Flex-X to a target is illustrated in figure 9-7. A blasting cap holder (figure 9-8) is attached to one end of the Flex-X and a blasting cap is inserted in the holder until end of cap presses against Flex-X. Blasting cap holder M8 is self-securing to Flex-X by means of three slanted, protruding teeth which prevent withdrawal. Two dimpled spring arms hold the blasting cap in the M8 holder. Other methods of priming are illustrated in figure 9-9.

(h) Charge, demolition, roll: M186. The M186 roll demolition charge (figures 9-8 and 9-10) is identical to the M118 charge except that the Flex-X is in the form of a 50-foot roll on a plastic spool, rather than in sheet form. Each foot of the roll provides approximately ½ pound of explosive. The M186 charge is especially adaptable for defeating targets which require using flexible explosive in lengths longer than 12 inches. Included with each roll are 15 M8 blasting cap holders and a canvas bag with a carrying strap (figure 9-8).

(i) Charge, demolition: block, ammonium nitrate and nitramon, 40 pound (cratering). These charges (figure 9-11) are the least sensitive of military explosives. In order to permit priming by ordinary means, the 40 pound charges are provided with TNT boosters in the central portion

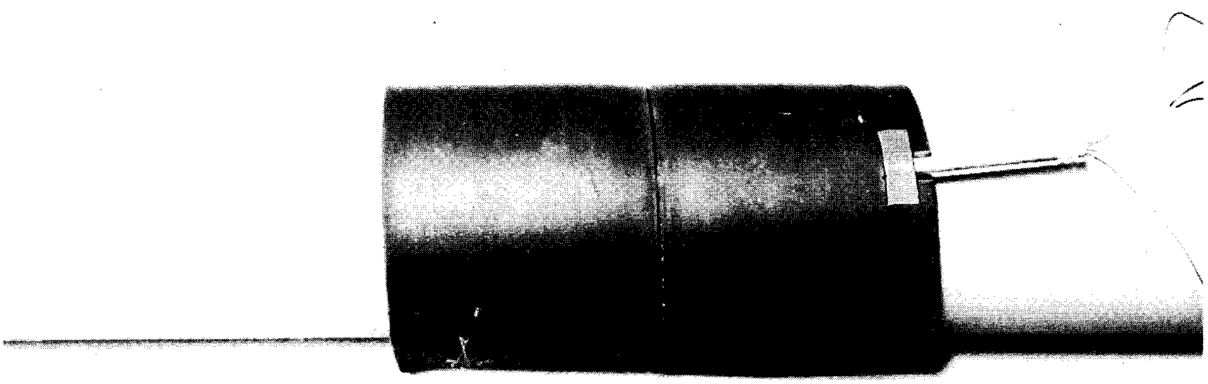


Figure 9-7. Single sheet Flex-X applied to target with blasting cap.

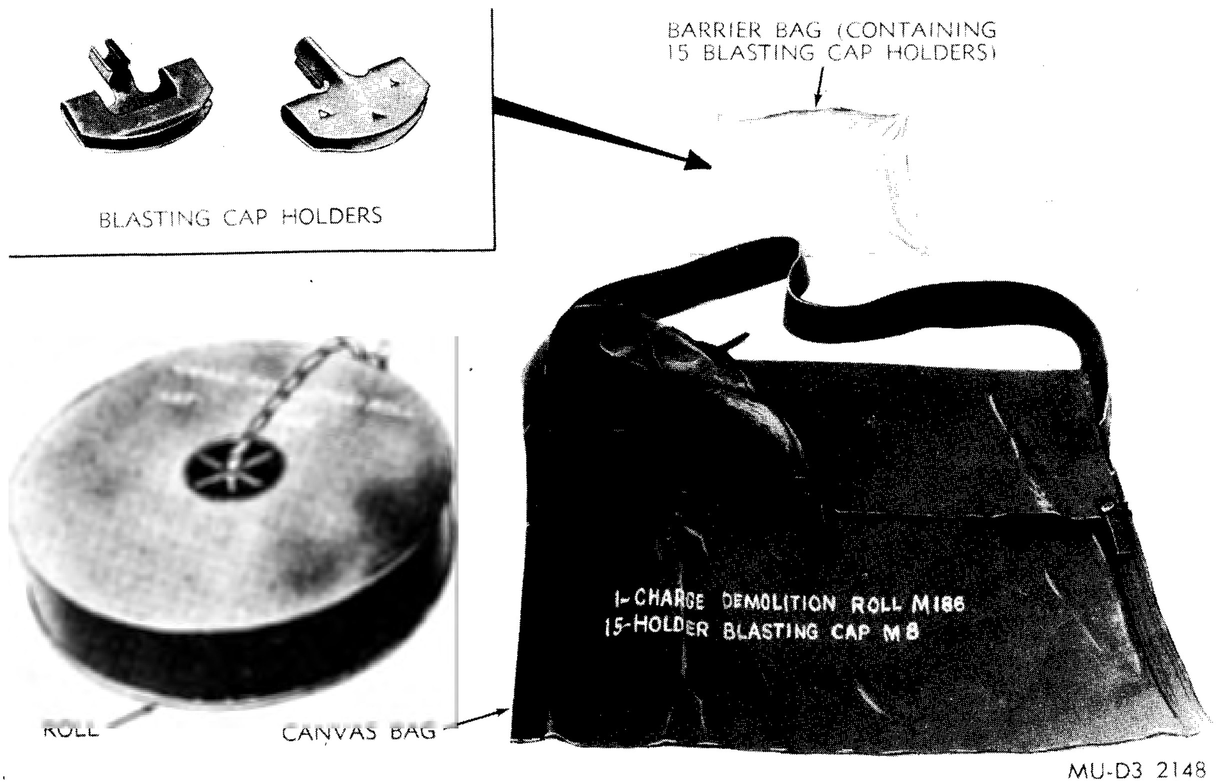


Figure 9-8. Charge, Demolition, Roll: M186.

next to the priming tunnels. The explosives in these charges have a low detonating velocity which produces a pushing or heaving effect which makes them suitable for cratering and ditching operations. These explosives readily absorb moisture making them less sensitive to initiation. It is not possible to initiate these explosives when wet. The charges are packed in a watertight, cylindrical metal container, one container per wooden box (figure 9-12). Priming tunnels are attached to the outside of the container midway between the ends. One tunnel serves as a cap well for priming with an electric or nonelectric blasting cap. The other tunnel is for priming with detonating cord passed through the tunnel and knotted at the end. A cleat between the tunnels is

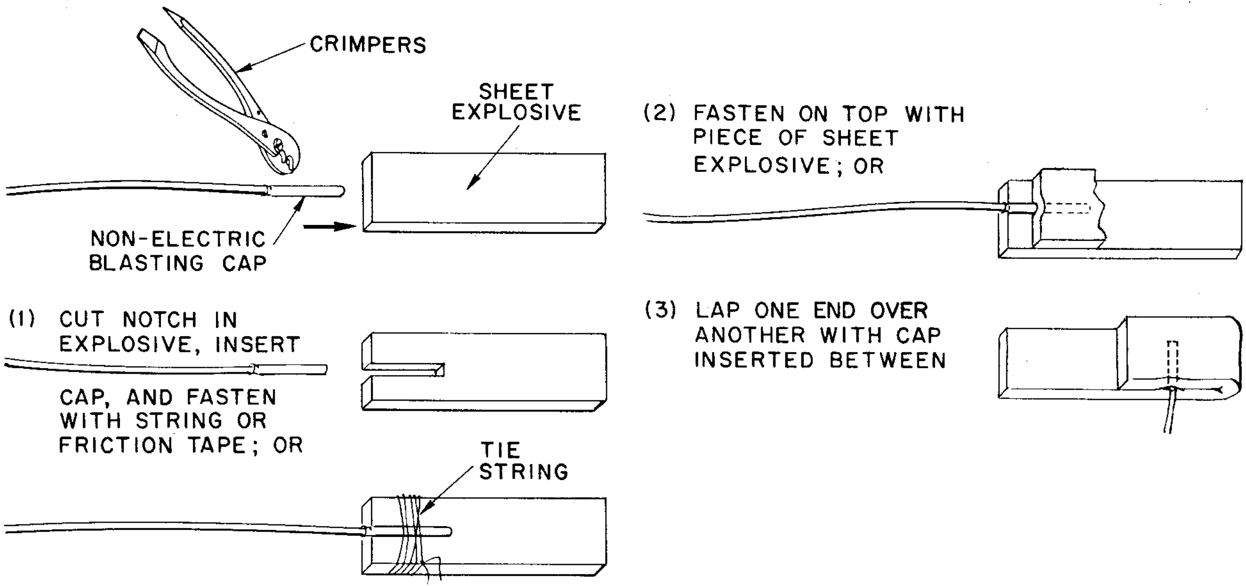


Figure 9-9. Nonelectric priming of sheet explosive.

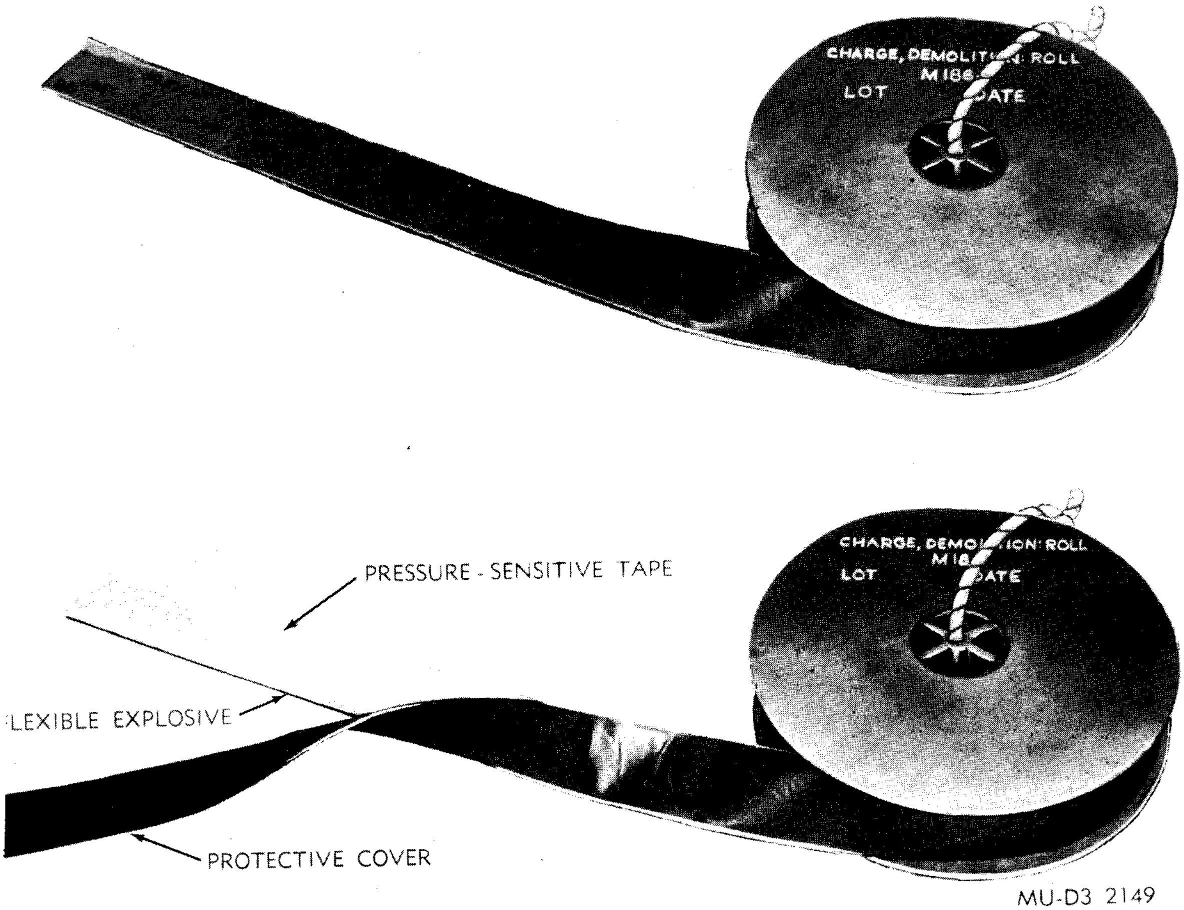


Figure 9-10. M186 Charge partially unrolled.

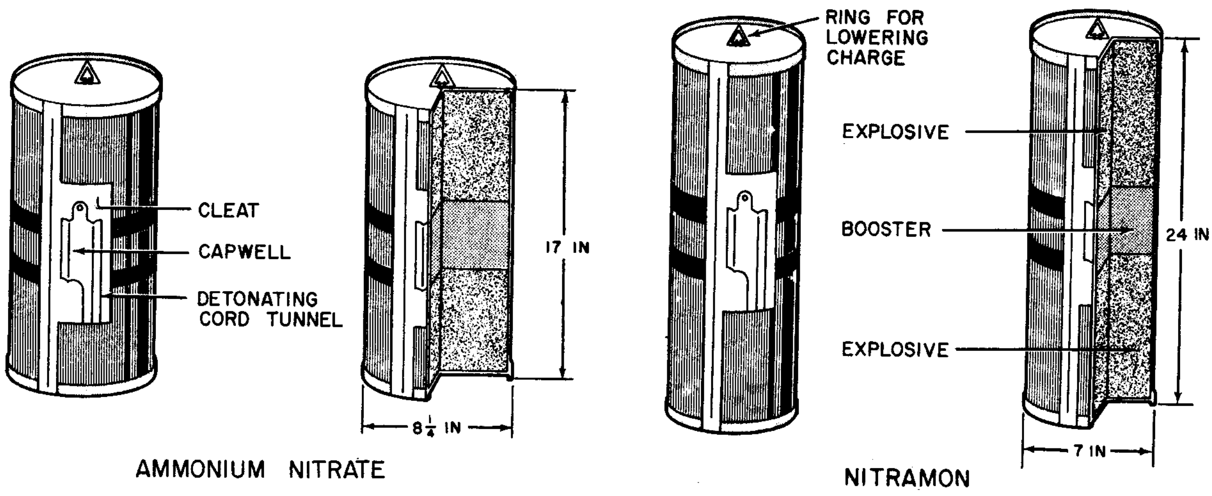


Figure 9-11. Ammonium nitrate and nitramon cratering charge.

provided for securing time blasting fuze, electrical firing wire, or detonating cord in place. A metal ring is provided on the top of the container for lowering the charge into a hole.

(4) Shaped demolition charges. Shaped charges used in military demolition operations consist of cylindrical blocks of high explosive having a conical or hemispherical metal-lined cavity in one end, and a conical shape with blasting cap well at the other end. Detonation of the explosive causes the shape charge to focus a narrow, concentrated jet on the target, blasting boreholes in steel, concrete, and similar material. Maximum penetration is obtained when the charge is detonated at an optimum distance, called "stand-off," from its target. This distance is provided by a fiber sleeve or metal legs supporting the charge at the time of firing.

(a) Charge, demolition shaped 15 pound, M2A3 and A4. This charge (figure 9-13) contains approximately 9½ pounds of composition B with a 50/50 pentolite booster weighing approximately 2 pounds. The charge is encased in a moisture-resisting, molded, fiber container. The top of the charge has a threaded capwell for receiving a blasting cap, an adapter, or any standard firing device. **NOTE: Dual priming, however, is extremely difficult because of the configuration of the case and the need for priming at the exact rear center.** A cylindrical fiber base slips on the end of the charge to hold the charge at the proper stand-off distance. A cone of glass is used as a cavity liner in this charge. This charge will pierce 36 inches of reinforced concrete, and will penetrate 8 inches of armor plate. The M2A4 shaped charge was developed to provide a charge less susceptible to gunfire than charge M2A3. Charge M2A4 is identical to charge M2A3 in performance, but differs in booster size and explosive content. The 50/50 pentolite booster has been replaced by a booster of approximately 50 grams of composition A-3. Also, the main charge of composition B has been increased to maintain the same total weight as charge M2A3. These charges are packed three per carton, one carton per waterproof bag, one waterproof bag (3 charges) per wooden box for a total weight of 65 pounds.

(b) Charge, demolition: shaped, 40 pound, M3 and M3A1. The M3 charge (figure 9-13) contains approximately 27¼ pounds of composition B, with a 50/50 pentolite booster weighing approximately 1¾ pounds. The charge is encased in a metal container. The cavity liner is made of metal. A threaded cap well is provided for receiving a blasting cap and adapter or any standard firing device. A metal tripod providing correct stand-off distance is shipped unassembled, but nested with the charge in the same container. This charge will penetrate 60 inches of reinforced concrete or 16 inches of armor plate. The M3A1 charge is identical to the M3 charge except that the same modifications were made in explosives of the M3A1 charge as were made in the M2A4 charge,

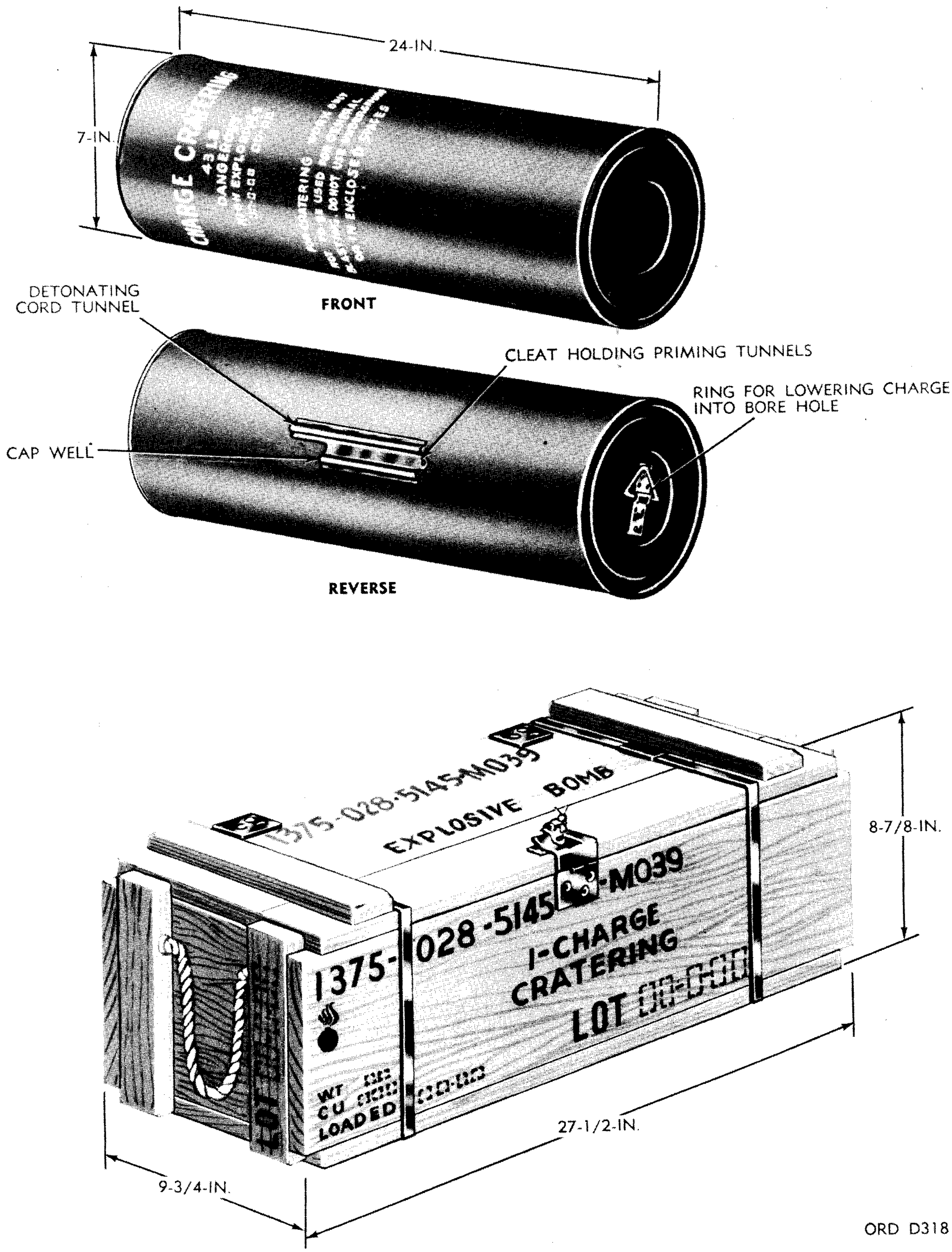
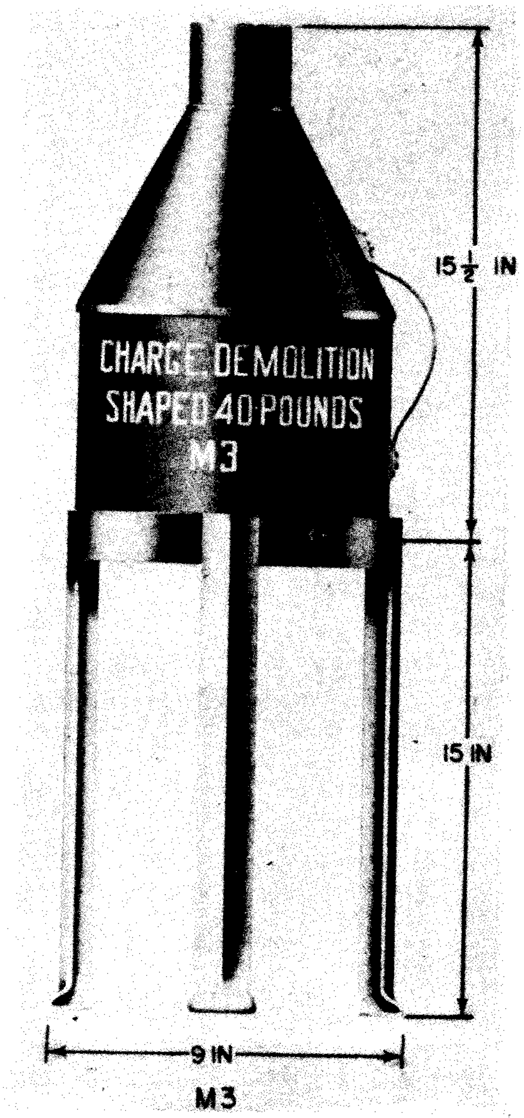


Figure 9-12. Charge, demolition: block, ammonium nitrate, 40-pound (cratering).



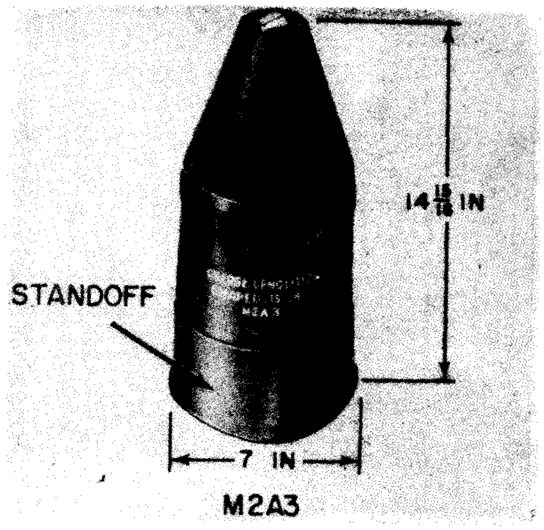


Figure 9-13. Shaped charges.

paragraph (a) above. These charges are packed one per wooden box and weigh 65 pounds.

(5) Containers, shaped demolition charge, Mk 1 Mod O, Mk 2 Mod O, Mk 3 Mod O and Mk 7 series. These containers (figure 9-14) are designed for use in opening explosive-filled ordnance by initiating low-order detonation. When filled with composition C-series plastic explosive, the liners form the explosive into a mold to produce a shaped charge. Shaped charge containers are available in several shapes and sizes. The plastic explosive must be carefully packed and tamped into the container to prevent formation of cavities or voids which would be detrimental to the high-speed jet formed when the charge is detonated. The Mk 7 series consists of eight sizes of linear charge containers designated Mod 1 through Mod 8. Each container is in the shape of a long, narrow, metal rectangle with a wedge-shaped cavity liner, and metal legs. The wedge in the bottom of the rectangle provides the shape of the charge. Legs provide the proper stand-off distance and clips are provided to attach equal-size containers together end to end. When the linear container is loaded and placed longitudinally on a projectile, bomb, or rocket head, the container produces a straight linear cut when fired. The charge is initiated by forming additional plastic explosive around a nonelectric or a

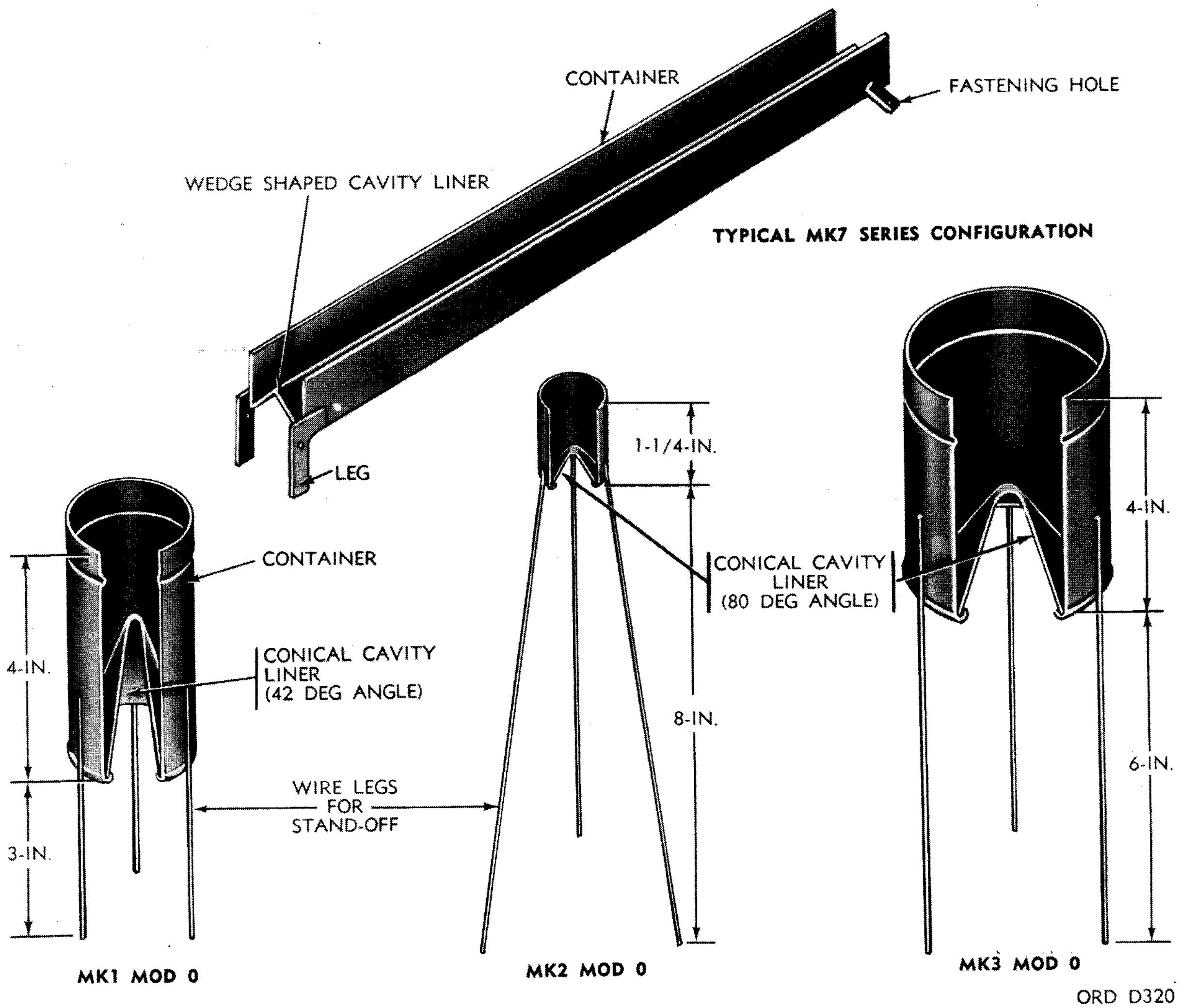


Figure 9-14. Demolition charge container for shaped demolition charges.

special electric blasting cap and placing it in the center of the length of the charge.

(6) Charge, demolition: shaped, Mk 45 Mod O. This small shaped charge (figures 9-15), which is used primarily for explosive ordnance disposal (EOD), is 4½ inches high and 2½ inches in diameter. It contains approximately 33½ grams of RDX in a fully waterproof, bakelite case. The case incorporates a stand off spacer, and is equipped with ¼ inch of pressure sensitive, foam-backed tape, so the charge may be easily attached to practically any surface. A copper cavity liner enables the charge to penetrate up to 4½ inches of steel. Initiation may be accomplished by placing a blasting cap into the cap well at the top of the case, or a length of detonating cord inserted through the hole in the lower part of the cap well. Each charge is packed in a cylindrical plastic case, 12 cases per box.

(7) Dynamites.

(a) General. Dynamites are low to medium velocity explosives used for excavation, cratering and general demolition operations in rear areas. Dynamites of both commercial and military formulations are available and characteristics of each are as shown in table 9-1.

Figure 9-15. Charge, demolition: shaped, Mk45 Mod O.

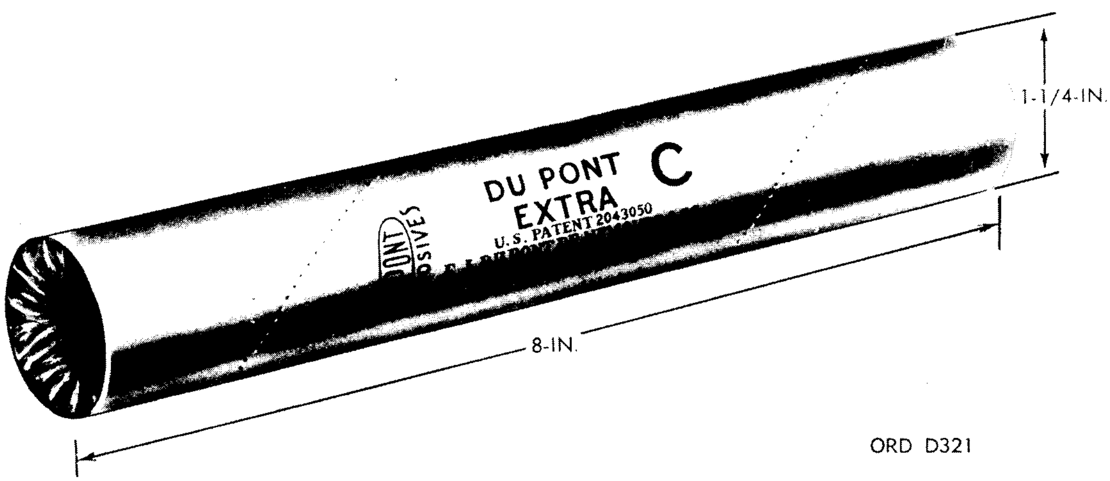


Figure 9-16. Commercial dynamite.

(b) Commercial dynamites. Three types of commercial dynamite (figure 9-16 and 9-17) are available for use in military operations: ammonia dynamite, gelatin dynamite, and ammonia gelatin dynamite. Ammonia dynamite contains ammonium nitrate added to nitroglycerin as the explosive base and is not suitable for underwater use or use in extremely wet areas. Gelatin dynamite is a plastic dynamite that has an explosive base of nitrocotton dissolved in nitroglycerin and is relatively insoluble in water. Ammonia gelatin dynamite is a plastic dynamite that has an

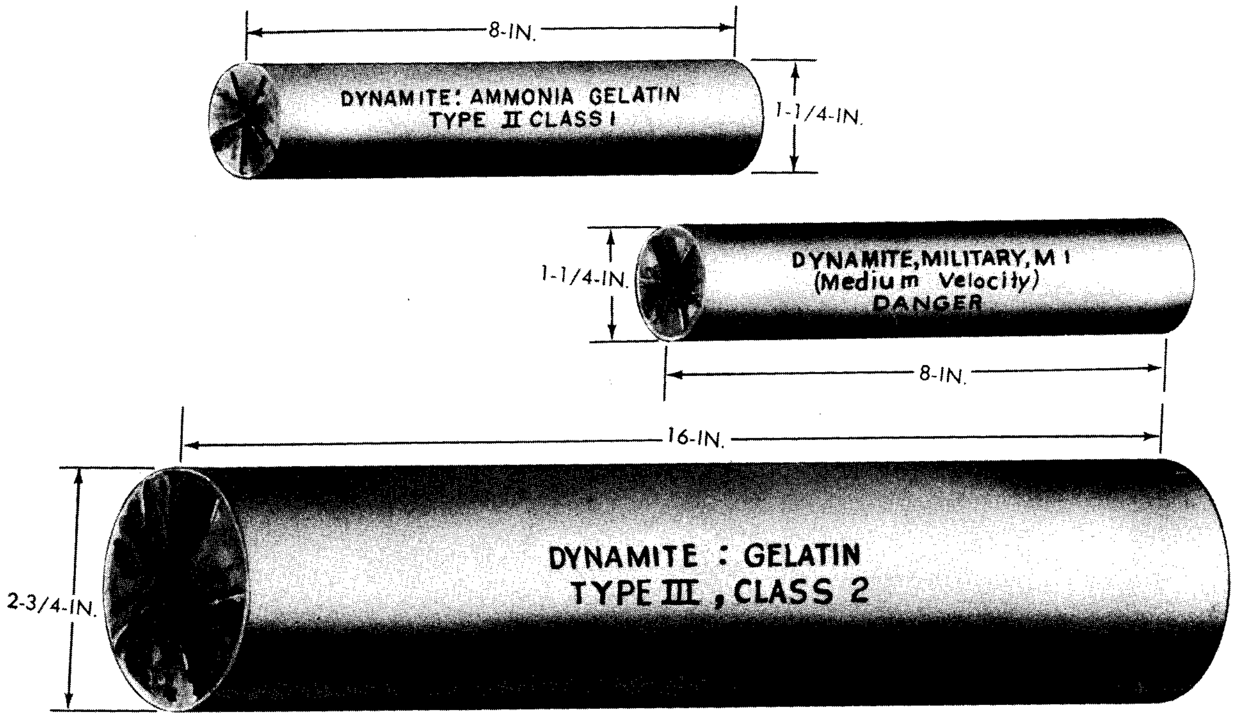


Figure 9-17. Dynamite: military, M1; dynamite, ammonia gelatin, type II, class I; and dynamite: gelatin, type III, class 2.

explosive base of nitrocotton dissolved in nitroglycerin with ammonium nitrate added. It is suitable for underwater use. The percentage designation of commercial dynamites is the percentage by weight of the nitroglycerin content. The use of commercial dynamites is restricted to noncombat areas due to its relatively high sensitivity to shock and friction. Commercial dynamites, because they exude nitroglycerin at temperatures above 30 degrees F and become unduly sensitive, must be turned in storage. Accordingly, it will be necessary to turn the cases, based on average storage temperature, in accordance with the following:

Average storage temperature	*interval between turnings*
Below 30° F.	Do not turn
30° to 60° F.	Every 4 months
60° to 75° F.	Every 3 months
Over 75° F.	Every 6 weeks

(c) Military dynamite, M1. Dynamite M1 (figure 9-17) is for general use as medium velocity blasting explosive to replace 60 percent commercial dynamites in military construction, quarrying, and service demolition work. It is packaged in paraffin-coated, cylindrical, paper cartridges having a nominal diameter of 1¼ inches and a length of 8 inches. Unlike commercial dynamite, it contains no nitroglycerin and will not freeze in cold storage, nor exude in hot storage. Shipping containers do not require turning in storage. Complete information on dynamites, including packaging, is shown in table 9-2.

b. Priming and initiating components.

Table 9-2. Dynamites.

Nomenclature	Uses	Water resistance	Packing: Description	Dimensions (inches): Length	Width	Height	Weight (lbs)
DYNAMITE: military M1.	Quarry and rock cuts.	Good	1. Packed 50 stick/wtrprf bag, 2 bag (100 stick)/ wdn bx. 2. Packed 65 stick/ctn. 2 ctn (130 sticks. 50 lb)/ wdn bx.	19-7/8 19-7/8	11-7/8 11-7/8	11-1/8 11-1/8	62
DYNAMITE: ammonia. 40%.	Land clearing. Quarrying.	Poor	1. Packed 211 stick/wtrprf/ wdn bx.	17-3/4	10	11-1/2	
DYNAMITE: ammonia gelatin, 40%, Type II, Class 1.	Cratering, and general use in rear areas.	Excellent	1. Packed 96 stick (50 lb)/ wdn/bx. 2. Packed 140 stick (50 lb)/ wdn bx.	17-3/4 19-1/4	12 8-1/2	8 13	57 59
DYNAMITE: ammonia gelatin, 60%.	"	Excellent	1. Packed 165 stick (50 lb)/ wdn bx.	19-3/4	13	8-1/2	62
DYNAMITE: gelatin 40% (stick 1-1/8 in. dia, 8 in. long).	"	Good	1. Packed 50 lb/wdn bx.	17-3/4	11-1/2	7-1/2	59
DYNAMITE: gelatin, 40% (stick 2-3/4 in. dia, 8 in. long).	"	Good	1. Packed 10 stick (50 lb)/ crdbd bx.	17-1/4	12	8-3/4	54.2
DYNAMITE: gelatin, 60% Type III, Class 1.	"	Good	1. Packed 103 stick (50 lb)/ wdn bx.	19-5/8	12-3/8	8-1/2	59.1
DYNAMITE: gelatin, 60%.	"	Good	1. Packed 11 stick (50 lb)/ wdn bx.	21	12-1/4	8-3/8	57.4
DYNAMITE: gelatin, 75%.	"	Good	1. Packed 50 lb/wdn bx.	8-1/2	19-1/4	13	59.0

Abbreviations: bx . . . box(es), crdbd . . . cardboard, ctn . . . carton, lb . . . pound(s), wdn . . . wooden, wtrprf . . . waterproof

(1) General. This paragraph describes the initiating and priming components used in conjunction with the explosive charges described in paragraph 2a. The variety of initiating and priming components permits considerable flexibility in the design and placement of a demolition complete round so that specific demolition projects may be accomplished with the maximum efficiency and safety, appropriate to the tactical situation. The priming component of an explosive train is that component which receives the action, such as a flame or an electric impulse, which was initiated by the initiating component. Priming components, properly selected, will produce high-order detonation in an explosive charge. Priming and initiating components include blasting caps, detonating cord, time blasting (safety) fuse, time blasting fuse igniters, detonators, destructors, and firing devices.

(2) Blasting caps.

(a) General. Blasting caps are used for initiating high explosives. The types of caps required for positive detonation of various explosives are shown in tables 9-3 and 9-4. They are also

Table 9-3. Electric Blasting Caps.

Nomenclature	Lead wire characteristics	Packing				
		Description	Dimensions (inches)			Weight (lbs)
			Length	Width	Height	
CAP, BLASTING: commercial, electric, No. 6, instantaneous.	Short lead, 4 ft through 10 ft.	500/wdn bx ---------	18	13-3/8	12	48.6
CAP, BLASTING: commercial, electric, No. 6, instantaneous.	Medium lead, 12 ft through 40 ft.	As required --------	------	------	------	------
CAP, BLASTING: commercial, electric, No. 6, instantaneous.	Long lead, 50 ft through 100 ft.	As required --------	------	------	------	------
CAP, BLASTING: commercial.	Short lead, 4 ft through 10 ft.	1. 70/ctn. 5 ctn (350 cap)/wdn bx.	15	12-1/2	6-1/2	222
CAP, BLASTING: commercial electric, No. 8, instantaneous.	Medium lead, 12 ft through 40 ft.	As required ---------	------	------	------	------
CAP, BLASTING: commercial electric, No. 8, instantaneous.	Long lead, 50 ft through 100 ft.	As required ---------	------	------	------	------
CAP, BLASTING: electric No. 8, strength.	Lead 6 ft long, copper tinned.	50/ctn -------------	------	------	------	------
CAP, BLASTING: electric, No. 8, strength.	Lead 6 ft long -------	70/ctn -------------	13-3/4	7-1/4	4-3/4	8
CAP, BLASTING: electric, No. 8, strength.	Lead 30 ft long., copper tinned.	25/ctn -------------	------	------	------	------
CAP, BLASTING: electric, No. 8, 1st delay (approx. 1.00 sec).	Lead 12 ft long ------	500/wdn bx ---------	19-1/2	13-1/2	9-1/4	30
CAP, BLASTING: electric, No. 8, 2nd delay (approx. 1.18 sec).	Lead 12 ft long ------	500/wdn bx ---------	19-1/2	13-1/2	9-1/4	30
CAP, BLASTING: electric, No. 8, 3rd delay (approx. 1.35 sec).	Lead 12 ft long ------	500/wdn bx ---------	19-1/2	13-1/2	9-1/4	30.5
CAP, BLASTING: electric, No. 8, 4th delay (approx. 1.53 sec).	Lead 12 ft long ------	500/wdn bx --------	19-1/2	13-1/2	9-1/4	30.0
CAP, BLASTING: electric, high strength.	Lead 6 ft long, copper tinned.	1. 50/ctn ---------- 2. 70/ctn ----------	9 14-1/2	4-1/8 7-1/8	3 3-3/4	2.34 8.0
CAP, BLASTING: electric high strength.	Lead 9 ft long, copper tinned.	50/ctn -------------	7-1/4	4-3/8	3-1/4	4.0
CAP, BLASTING: electric, low strength.	Lead 6 ft long, copper tinned.	50/ctn -------------	6-1/2	6	2-7/8	2.0
CAP, BLASTING: electric, inert.	Various long lead wires.	As required ---------	------	------	------	------
CAP, BLASTING: special, electric.	Lead 12 ft long ------	1. 1/chipbd pkg. 50 pkg/fbrbd bx, 10 bx (500 cap)/wdn bx. 2. As required -----	28-1/4 17-1/2 ------	15-1/4 12-1/2 ------	11-3/4 11 ------	76.5 51.0 ------
CAP, BLASTING: special, electric, M6.	Lead 12 ft long, copper tinned.	1/crdbd spool, 6 spool/ctn, 1 ctn/ water-prf bg, 25 bg/fbrbd bx, 6 fbrbd bx (900 cap).	------	------	------	------

Table 9-4. Nonelectric Blasting Caps.

Nomenclature	Packing				
	Description	Dimensions (inches)			Weight (lbs)
		Length	Width	Height	
CAP, BLASTING: nonelectric, No. 6, instantaneous.	1. 5,000/wdn bx ------- 2. 100/ctn, 10 ctn/fbrbd bx, 1 bx/wtrprf bag, 5 bag (5,000 cap)/wdn bx.	20-1/8 ------	9-7/8 ------	8-3/4 ------	29 -----
CAP, BLASTING: nonelectric, No. 8 instantaneous.	1. 100/ctn, 50 ctn (5,000 cap)/wdn bx. 2. As required ---------	18-1/2 ------	13 ------	7-3/4 ------	50 -----
CAP, BLASTING: special, nonelectric (Type I(J-1)) (PETN or RDX).	1. 50/mtl can, 20 can/fbrbd. ctn, 5 ctn (5,000 cap)/wdn bx. 2. 100/ctn, 10 ctn/crdbd bx, 10 bx (10,000 cap)/inner wtrprf pkg. 1 inner pkg in sawdust/outer wtrprf pkg/wdn bx. 3. As required ----------	24-3/4 22-3/4 ------ ------	17-1/4 17-1/8 ------ ------	14-1/4 14 ------ ------	82 66 ----- -----
CAP, BLASTING: special nonelectric, M7.	6/pprbd ctn, 1 ctn/wtrprf bag, 50 bag/fbrbd bx, 12 bx (3,600 cap)/wdn bx.	------	------	------	-----
CAP, BLASTING: tetryl, nonelectric, type A.	100/ctn, 50 ctn (5,000 cap)/wdn bx.	19	16	8	65
CAP, BLASTING: nonelectric, inert.	As required ------------	------	------	------	-----

used to initiate certain land mine fuzes. They are classified according to the means of initiation as electric and nonelectric. Special blasting caps are used to detonate less sensitive explosives such as TNT, military dynamite, or ammonium nitrate. Commercial caps may be used to detonate the more sensitive explosives such as tetryl or commercial dynamite. *Warning: Blasting caps are extremely sensitive and may be initiated unless handled carefully. They must be protected from shock and extreme heat, and must not be tampered with. They are never to be stored with any other explosives. Caps and explosives must not be carried on the same truck except in an emergency.*

(b) Electric blasting caps. Two types are in use, military and commercial (table 9-3). Military caps are instantaneous, and the commercial, instantaneous and delay (figure 9-18). Instantaneous caps include the M6, the special or military, and the commercial No. 6 and No. 8. No. 8 commercial delay caps are issued from the first to the fourth delay ranging from 1.00 to 1.53 seconds. When two or more electric caps (except the cap M6) are connected in the same circuit, they must be the product of the same manufacturer. This is essential to prevent misfires because caps of different make do not have the same electrical characteristics. The characteristics of the cap M6 are so closely controlled that caps of this model from different manufacturers may be mixed in a firing circuit. Electric caps have lead wires of various lengths for connecting them to the circuit. The most commonly used caps have 12-foot lead wires. A short-circuiting tab or shunt fastens the loose ends of the wires together. This shunt prevents accidental firing of the cap and must be removed before the cap is connected in a firing circuit.

(c) Nonelectric blasting caps. These caps (table 9-4) may be initiated by time blasting fuse, firing devices, and detonating cord. Because they are extremely difficult to waterproof, they should not be used with time blasting (safety) fuse to prime charges placed under water or in wet

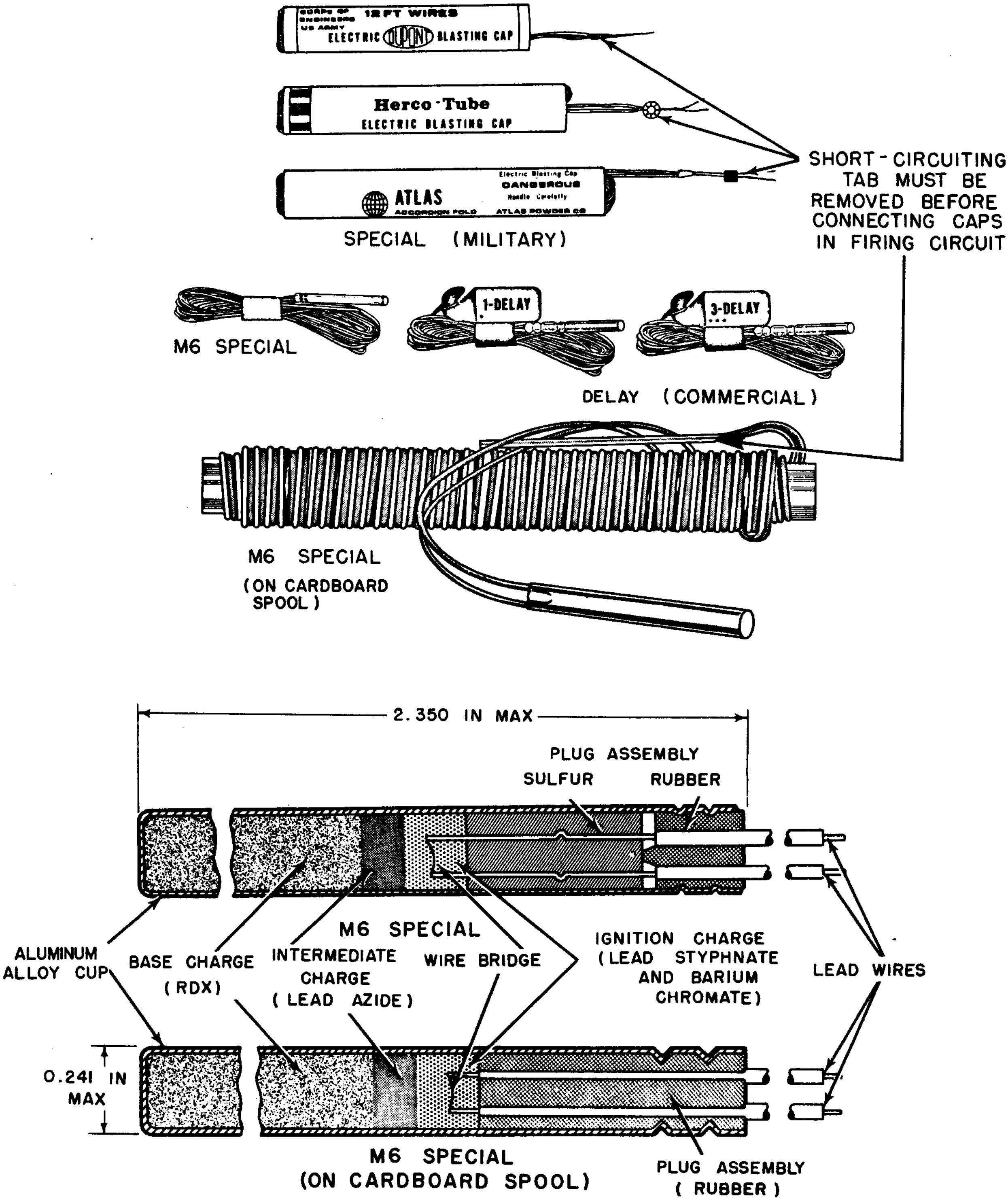


Figure 9-18. Electric blasting caps.

boreholes. Those in use include the commercial No. 6 and No. 8 and the special or military types I (J-1 (PETN or RDX)) and M7 (figure 9-19). The M7 special caps are flared at the open end for easy insertion of the time fuse.

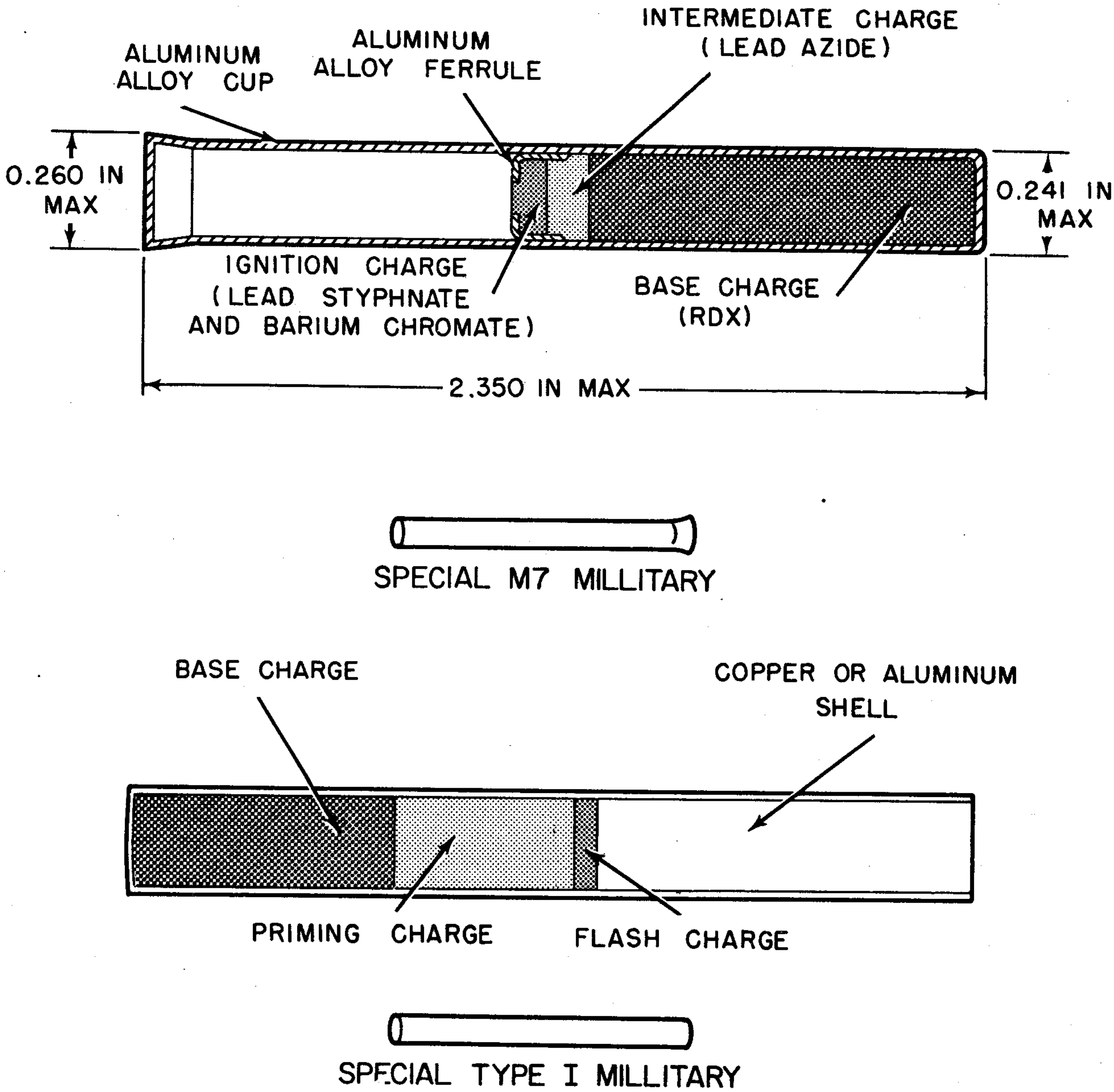


Figure 9-19. Military nonelectric blasting caps.

(3) Detonating cord. Detonating cord (figure 9-20) consists of a core of PETN in a textile tube coated with a layer of asphalt. On top of this is an outer textile cover finished with a wax gum composition. Detonating cord, also known as primacord, may be used as a detonating agent, a priming agent, or alone, as an explosive charge. It may be used for detonating single or multiple charges and will transmit a detonating wave from one point to another at a rate of at least 5900 meters per second. Methods illustrating the use of detonating cord to prime demolition blocks are shown in figure 9-21.

(4) Time blasting fuse.

(a) Fuse, blasting, time: (Safety fuse). Time blasting fuse (figure 9-22) is used to

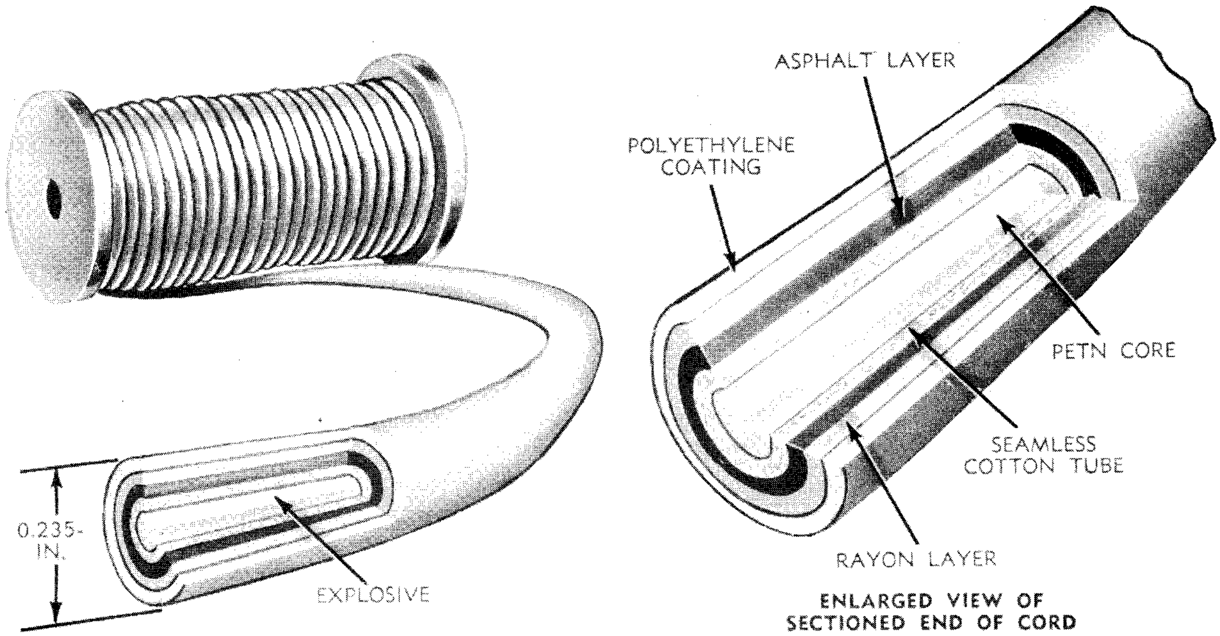


Figure 9-20. Cord, detonating: reinforced, pliofilm wrapped, waterproof.

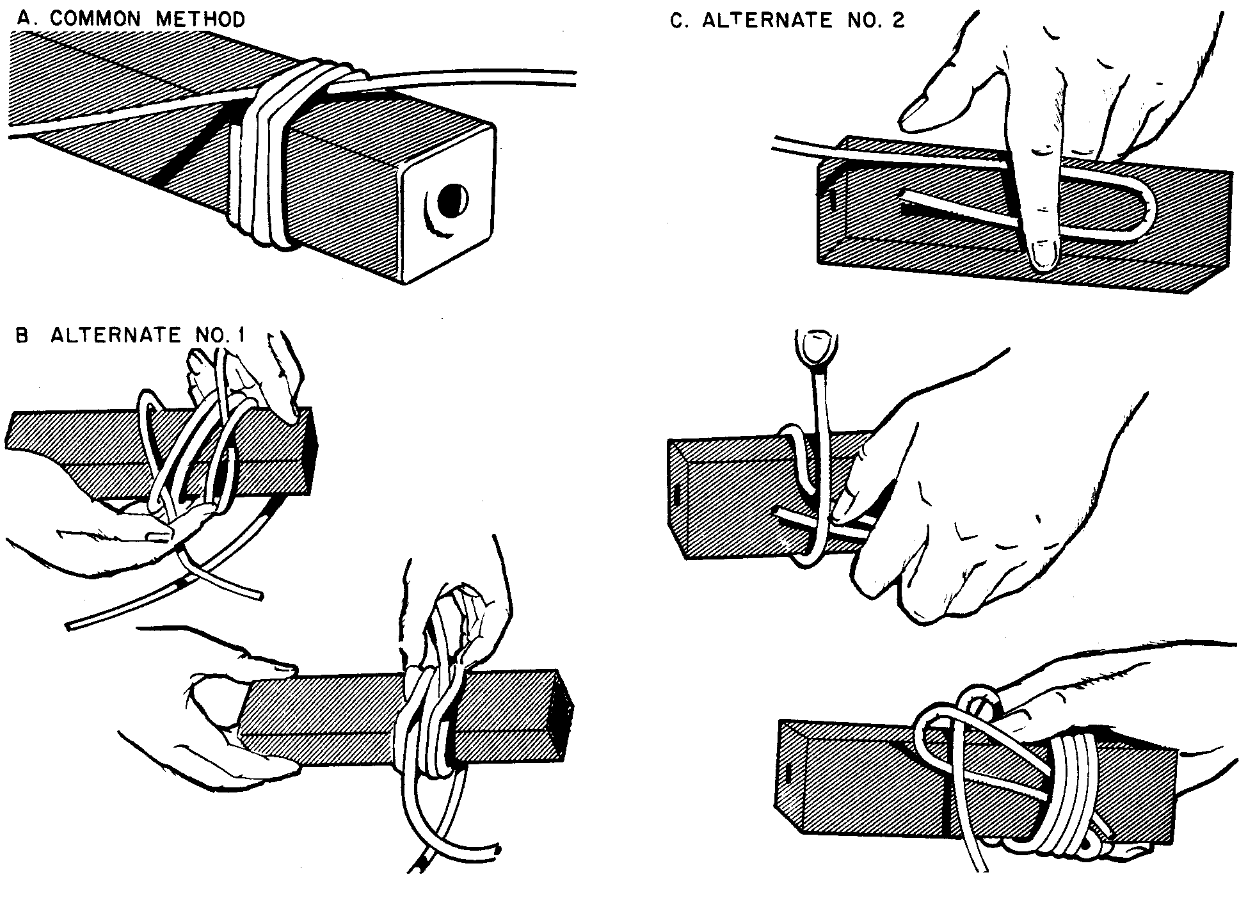


Figure 9-21. Detonating cord priming of demolition blocks.

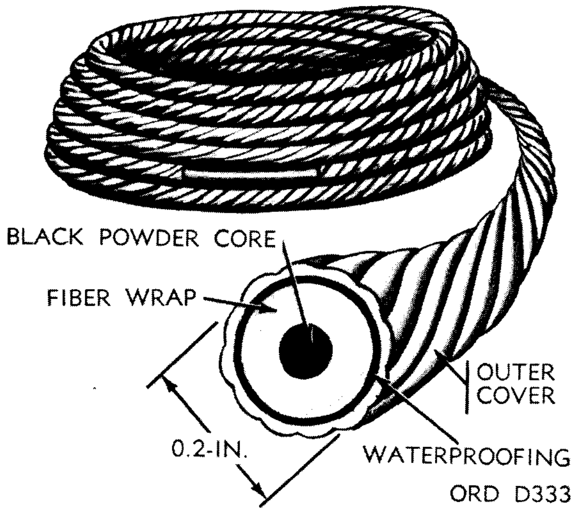


Figure 9-22. Fuse, blasting, time: (safety fuse).

transmit a flame from a match or igniter to a nonelectric blasting cap or other explosive charge, and to provide a time delay during which personnel may retire to a safe distance. Table 9-5 represents data on time blasting fuses. Fuse blasting, time: (Safety fuse) is for general use in military demolitions. It is in the form of a cord approximately 0.20 inch in diameter and has a black powder core covered with several layers of fiber and water-proofing material, and is identified by its color (usually orange), and its corrugated surface. A three-foot length is tested by burning shortly before

Table 9-5. Time Blasting Fuse.

Nomenclature	Means of initiation	Uses	Packing				
			Description	Dimensions (inches)			Weight (lbs)
				Length	Width	Height	
FUSE, BLASTING, TIME: safety fuse.	Match; fuse igniter.	Fire blasting caps, fire black blasting or pellet powder.	1. 50 ft/coil, 2 coil/pkg, 30 pkg (3,000 ft)/ wdn bx.	24-3/4	15-3/4	12-1/2	71.8
			2. 50 ft/coil, 2 coil/pkg., 5 pkg/sealed mtl can, 8 can (4,000 ft)/wdn bx.	30	14-5/8	14-5/8	93.6
			3. 50 ft/coil, 2 coil/pkg. 60 pkg (6,000 ft)/ wdn bx.	29	22	17	162
			4. Packed as required.	------	------	------	----
FUSE, BLASTING, TIME: inert safety fuse.	Non-initiable	Training in use of time blasting fuse.	Packed as required.	------	------	------	----
FUSE, BLASTING, TIME: M700.	Match; fuse igniter.	Fire blasting caps, fire black blasting or pellet powder.	50 ft/coil, 2 coil/ pkg, 5 pkg/ sealed container, 8 container (4,000)ft/wdn bx.	30-1/8	15-1/8	14-7/8	94

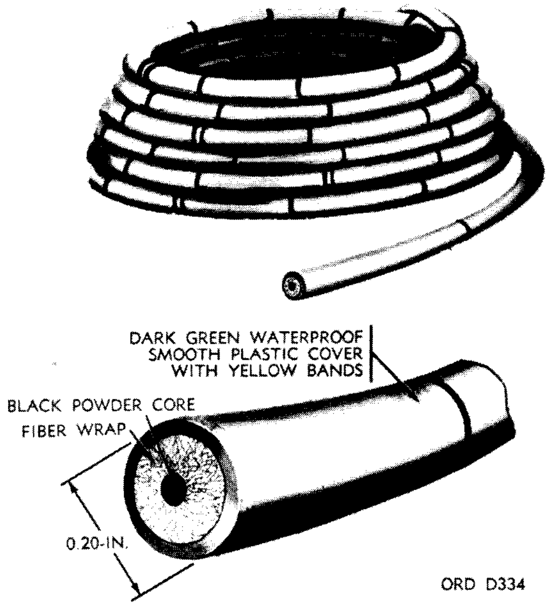


Figure 9-23. Fuse, blasting, time: M700.

Table 9-6. Time Blasting Fuse Igniters.

Nomenclature	Initiating action	Packing				
		Description	Dimensions (inches)			Weight (lbs)
			Length	Width	Height	
IGNITER, TIME BLASTING FUSE: M1, friction.	Pulling handle to draw coated wire through friction powder.	10/wxd crdbrd cntr., 250 cntr. (2,500 igniter)/wdn bx.	31-1/2	18-1/2	10	62.5
IGNITER, TIME BLASTING FUSE: M2, weatherproof.	Pulling release pin ring releases firing pin which strikes percussion primer.	1. 5/wtrprf ctn. 30 ctn (150 igniter)/ wdn bx.	17-1/2	9-1/8	7-1/4	28.6
		2. 5/set up bx, 5 bx/ wtrprf flrbd ctn. 10 ctn(250 igniter)/ wdn bx.	22-1/2	12-1/2	8	46.9
IGNITER, TIME BLASTING FUSE: M60 (T2), weatherproof.	Pulling pull ring releases firing pin which strikes percussion primer.	5/wtrprf wrppd ctn. 60 ctn (300 igniter)/ wdn bx.	21-5/8	11-7/8	13-1/8	56.3
IGNITER, TIME BLASTING FUSE: M2, weatherproof, inert.	Pulling release pin ring releases firing pin which strikes dummy primer.	Packed as required ---	------	------	------	----

use. The rate of burning may vary from a burning time of 30 seconds or less to 45 seconds or more per foot.

(b) Fuse, blasting, time: M700. This fuse (figure 9-23) is similar to fuse described in paragraph (4)(a) above; however, the fuse is a dark green cord with a plastic cover, marked with single painted bands at 1-foot or 18-inch intervals, and double painted bands at 5-foot or 90-inch

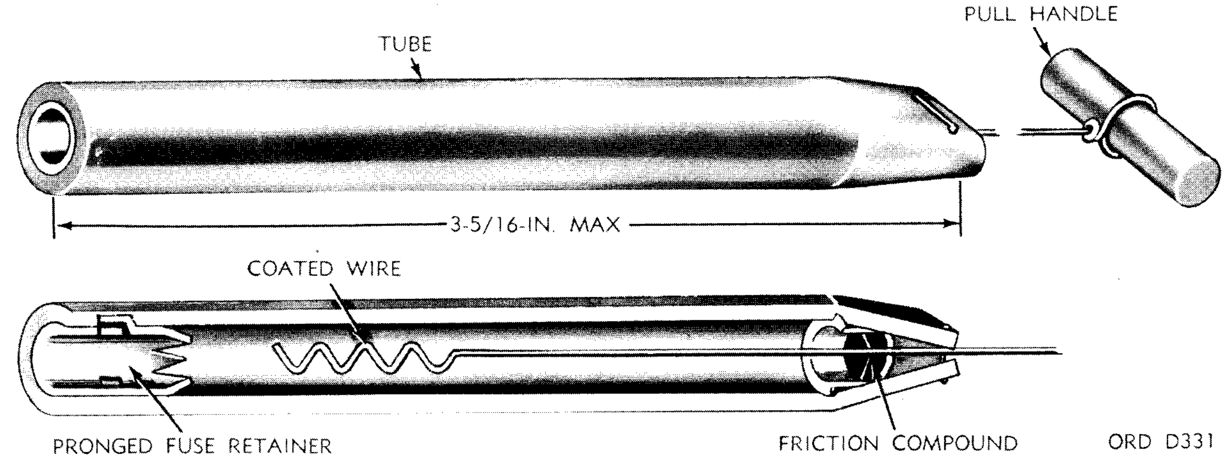


Figure 9-24. Igniter, time blasting fuse: M1, friction.

intervals, depending on date of manufacture. These markings are used to estimate the approximate length of fuse required for tactical situations.

(5) Time blasting fuse igniters.

(a) General. Time blasting fuse igniters are initiating components which are used instead of matches to light time blasting fuse. Fuse igniters are usually more reliable than matches and then use is almost mandatory in rainy and windy weather. Inert components are used for training purposes. Table 9-6 presents data on fuse igniters.

(b) Igniter, time blasting fuse: M1, friction. This igniter (figure 9-24) consists of a paper tube containing friction powder, which is mechanically ignited. The open end, when placed over the end of a length of time blasting fuse, is held in place by a pronged insert inside the fuse igniter. The prongs are inclined so they permit the fuse to enter, but prevent its removal except by force. A pull on the loop, or handle at the closed end, ignites the friction powder which, in turn, fires the powder train in the fuse. To prevent pulling the fuze igniter from the fuse, which will cause an air gap between the fuse end and the igniter, hold the body of the igniter in one hand and pull the igniter wire with the other. If any doubt exists as to whether the fuse is burning and the length of fuse will permit time, pull the fuse igniter off the fuse by force immediately after pulling the igniter wire.

(c) Igniter, time blasting fuze: M2, weatherproof. This igniter (figure 9-25) consists of a barrel that holds the firing mechanism and a base that contains a percussion cap and a pronged fuse retainer. The barrel contains the striker spring and striker, held locked in one end by a release pin. The other end is threaded to fit over the base. Plastic sealing material (included with the igniter) is used to waterproof the joint of time blasting fuse and fuse igniter. When the release pin is pulled, the striker strikes the percussion cap which, in turn, ignites the fuse. The igniter will ignite the fuse under all weather conditions, even under water. *Caution: To prevent breakage of the pull-ring, press the spread ends of the release pin together prior to use, then pull with a twisting motion on the pull-ring. If the igniter is not used, spread the ends of the release pin to their original position.*

(d) Igniter, time blasting fuse: M60 (T2), weatherproof. The weatherproof time blasting fuse igniter M60 (T2) (figure 9-26) is a pull-type assembly and is used to initiate time blasting fuse M700. A cross-sectional view of the complete igniter is shown in figure 9-27. The

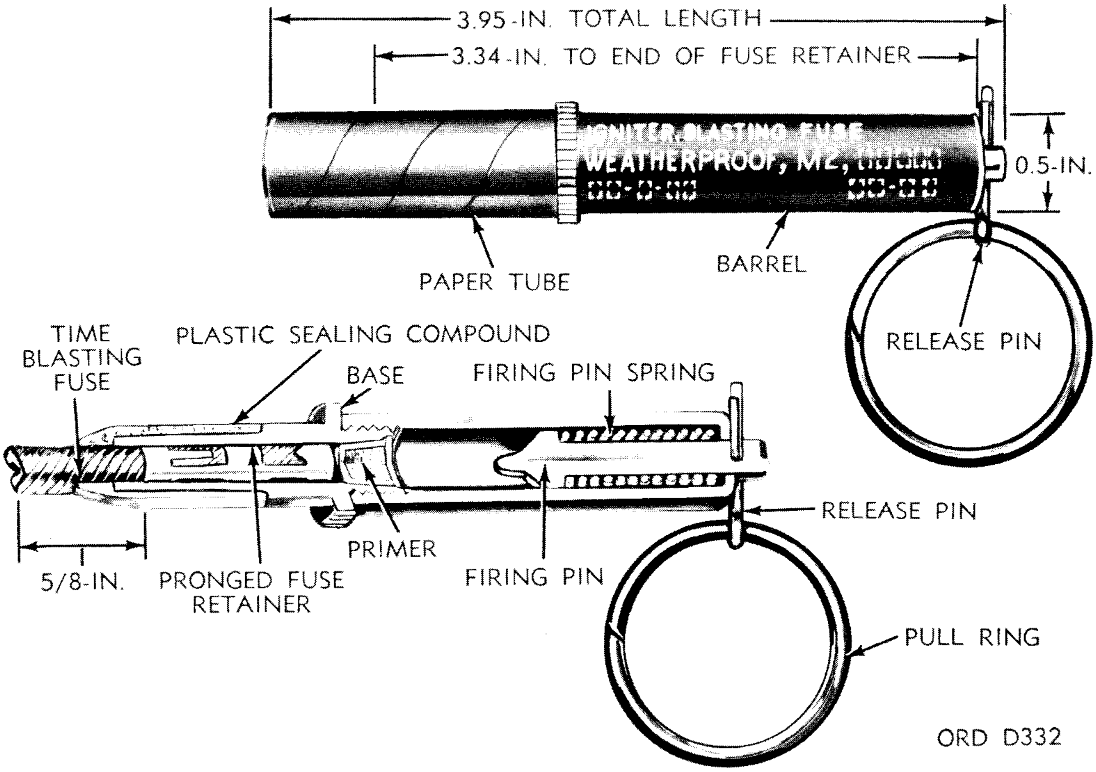


Figure 9-25. Igniter, time blasting fuse: M2, weatherproof.

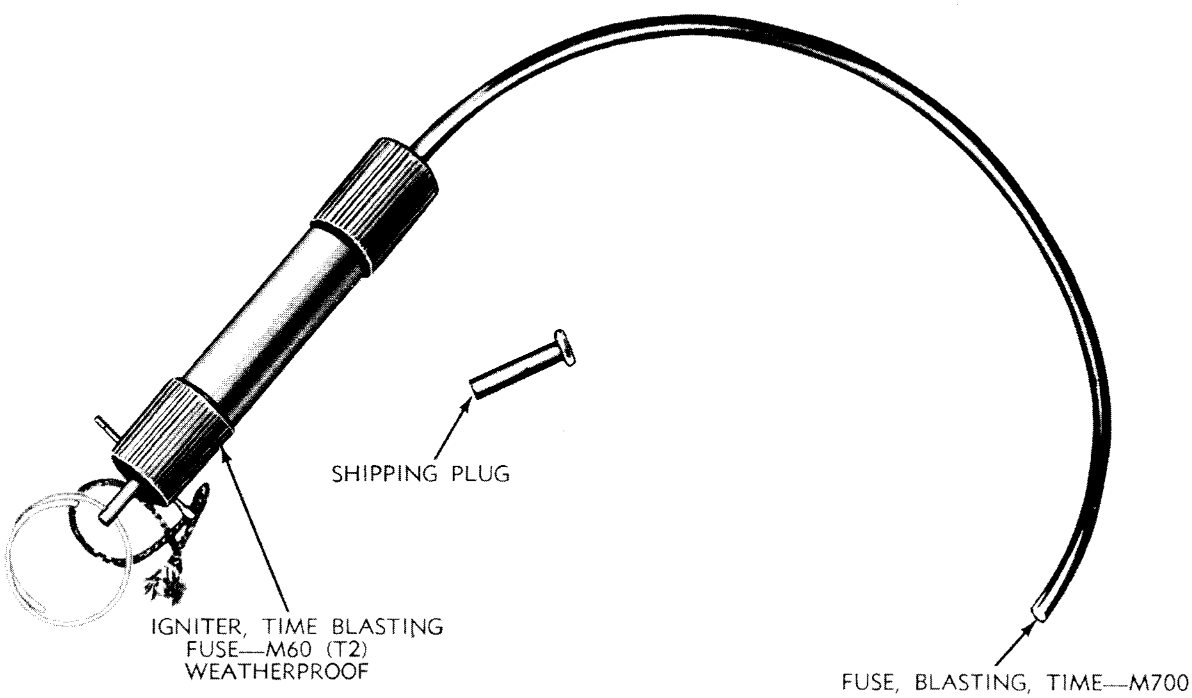


Figure 9-26. Igniter, time blasting fuse: M60(T2), weatherproof, shown assembled to fuse, blasting, time: M700.

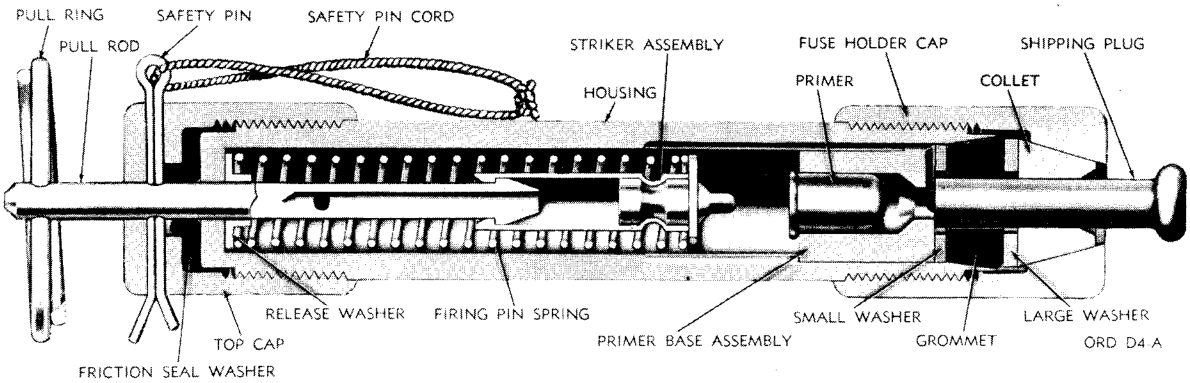


Figure 9-27. Igniter, time blasting fuse: M60(T2) weatherproof.

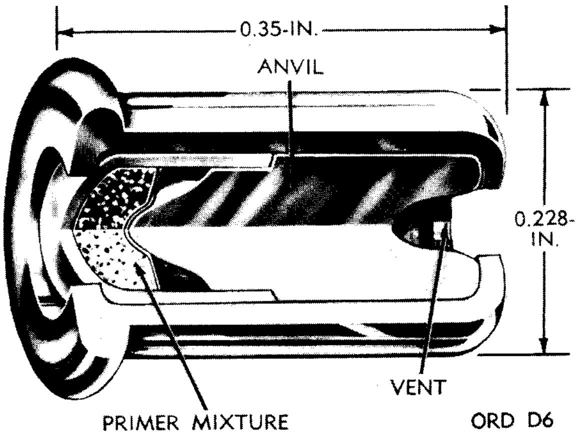


Figure 9-28. Primer, percussion, M39A1.

major parts are the firing assembly, fuse holder assembly, and primer base assembly. The firing assembly consists of a housing with a threaded top cap on one end. A striker assembly (firing pin), pull rod, release washer, and firing pin spring are situated inside the housing. One end of the pull rod protrudes through the top cap and accepts the pull-ring and safety pin. The pull rod has a venting passage which allows the blasting fuse gases to be released to the atmosphere after functioning. The venting passage is open to the atmosphere only when the rod is in the "fired" position and therefore does not affect the weatherproof feature of the igniter. A rubber friction seal washer, located between the top cap and the housing, provides sealing at the pull end of the unit. The fuse holder assembly is located at the end of the housing opposite the pull ring. This assembly consists of a threaded fuse holder cap with a split tapered collet located inside of it. A tapered grommet, assembled between the small washer and the large washer, is located just inside the housing. The shipping plug goes through the fuse holder cap and is held in place by the grommet and the collet. The rubber grommet provides a seal for the fuse end of the igniter. The primer base assembly is located inside the housing, next to the small washer, and consists of the primer base with a percussion primer M39A1 (figure 9-28).

(e) Functioning. In use, the shipping plug is removed from the igniter and is replaced with time blasting fuse. The safety pin is then removed by a pull of approximately 10 to 30 pounds on the safety pin cord. The pull-ring is then pulled outward with a force of approximately 5 to 15 pounds. This carries the pull rod and firing pin back against increasing spring compression until the

Table 9-7. Detonators

Nomenclature	Initiating action	Operation	Delay data	Packing Description	Dimensions (inches) Length	Width	Height	Weight (lbs)
DETONATOR, FRICTION: M1 or M1A1*, 15-sec delay. DETONATOR, FRICTION: M2, 8-sec delay.	Pulling friction material coated wire through flash compound.	1. Flash compound ignites delay fuse. 2. Delay fuse fires blasting cap.	1. Temperature/Time delay 8-sec. delay det. *Degrees F* 140---7.8 to 9.1 sec--- 100---8.6 to 9.6 sec--- 60---9.5 to 10.2 sec--- 20---10.4 to 11.2 sec--- -40---9.6 to 11.0 sec--- 2. Temperature/time delay 15-sec delay det. *Degrees F* 140---13.1 to 14.0 sec--- 100---14.2 to 15.0 sec--- 60---15.3 to 17.1 sec--- 20---16.0 to 18.0 sec--- -40---17.5 to 19.5 sec---	10 pkg, 5 pkg/inner pkg, 4 pkg (200 detonator)/ wdn bx.	26-1/8	11-3/8	12	M1=56.0 M2=53.9
DETONATOR, FRICTION: M1A1, 15-sec delay, inert. DETONATOR, FRICTION: M2 8-sec delay, inert.	See service counterpart above.	See service counterpart above.	Inert -------	1/mtl cntr.	------	------	----	-------
DETONATOR, PERCUSSION: M1A2 (M1E1), 15-sec delay.	Removal of safeties releases firing pin.	1. Firing pin fires percussion primer.	1. 8-sec and 15-sec nominal delay.	25/ctn, 8 ctn (200 detonator)/wdn bx.	24-1/2	13	11	75.0
DETONATOR, PERCUSSION: M2A1 (M2E1), 8-sec delay.		2. Percussion primer fires delay fuse. 3. Delay fuse fires blasting cap.	2. Above 60°F actual delay will be less than nominal. 3. Below 60°F actual delay will be greater than nominal.					

Nomenclature	Initiating action	Operation	Delay data	Packing				
				Description	Dimensions (inches)			Weight (lbs)
					Length	Width	Height	
DETONATOR KIT, CONCUSSION: M1.	Concussion wave from nearby blast causes release of firing pin. (In water firing pin is retained until delay tablet dissolves).	1. Firing pin fires percussion primer. 2. Percussion primer fires blasting cap.	1. In air: no delay. 2. In water: blue tablet, approx 3-1/2 min; yellow tablet, approx 7 min.	1/mtl cntr 5 cntr (50 detonator)/ wdn bx.	21-1/4	19-1/2	13	71.0
DETONATOR KIT, CONCUSSION: M1 inert.	See service counterpart above.	See service counterpart above.	See service counterpart above.	As required.	------	------	----	-------

*Models M1 and M1A1 are identical in construction and use.

split cylinder of the striker assembly slips over the release washer. The release washer forces open the split cylinder and disengages the striker assembly from the pull rod. This permits the compressed spring to drive the striker assembly against the primer. This action initiates the primer and the resultant spit of flame ignites the time blasting fuse. The gases resulting from the burning fuse are emitted through the venting passage in the pull rod to the atmosphere. To prepare for use, unscrew the fuse holder cap two or three turns. (Care must be taken not to unscrew the cap completely since this may cause the split collet to become disarranged.) Push the shipping plug in and then work the plug from side to side while withdrawing it from the igniter. Retain the shipping plug and all moving parts in case the igniter is not used. Insert a freshly square-cut end of time blasting fuse into the igniter as far as possible. In so doing, a fair amount of resistance is offered when the fuse passes through the rubber grommet. Hand tighten the fuse holder cap sufficiently to insure proper holding and sealing. Hold the igniter firmly with one hand. With the other hand, remove the safety pin by pulling the safety pin cord. The igniter is now fully armed. To fire, pull outward on the pull-ring.

Note. Some gas will escape through the venting passage of the pull rod but this gas is cool and will not affect the user. *Warning: The igniter should never be lifted or handled by the pull-ring or safety pin cord. The safety pin should not be removed until after the time blasting fuse has been inserted and just prior to use. Defective igniters are never repaired.*

(6) Detonators.

(a) General. Detonators are explosive devices, sensitive to mechanical initiation, and are used to detonate explosive charges. Detonators combine the functions of firing devices and blasting caps in a single unit. They may or may not incorporate a time-delay mechanism. Detonators used in demolition work are classified according to the initiating action as friction, percussion, and concussion. Delay percussion detonators were developed as improved replacements for the delay friction detonators. They may be used wherever the friction detonators are used, and are suitable for underwater use. Table 9-7 presents a summary of data on detonators.

(b) Detonator, friction: M1 or M1A1, 15-second delay. The 15-second delay friction detonator M1 or M1A1 (figure 9-29) consists of a cylindrical-shaped, olive-drab plastic housing containing a pull wire coated with friction material. The pull wire is set in a flash compound. A tube

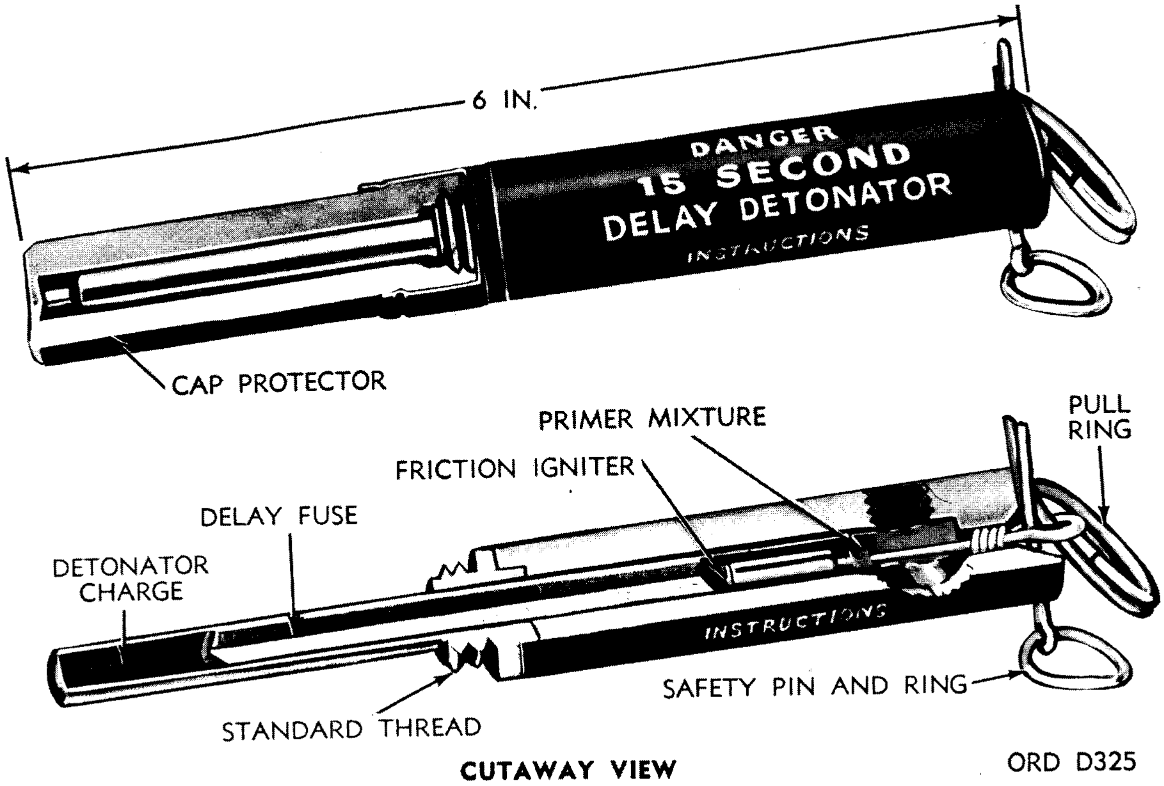


Figure 9-29. Detonator, friction: M1 or M1A1, 15-second delay.

set in the lower end of the housing contains a 15-second time fuse and a blasting cap. The 15-second delay friction detonator may be distinguished by the marking on the surface of the delay housing and the shape of the pull ring. The 15-second delay friction detonator has a circular pull-ring.

(c) Detonator, friction, M2, 8-second delay. Except for the delay period, the marking and the shape of the pull-ring, the 8-second delay friction detonator (figure 9-30) is identical in construction, functioning, and use to the 15-second delay friction detonator described in (b) above. The 8-second delay friction detonator may be distinguished from the 15-second delay friction detonator by the marking on the surface of the delay housing and by the shape of the pull-ring. The 8-second delay friction detonator has a T-shaped pull-ring.

(d) Detonator, percussion: M1A2 (M1E1), 15-second delay. This delay percussion detonator (figure 9-31) consists of firing pin assembly joined to a delay housing and primer holder assembly, with a special blasting cap crimped to an integral coupling base on one end of the delay housing and primer holder assembly. The 15-second delay percussion detonator may be distinguished by the marking on the surface of the delay housing and by the shape of the pull-ring. The 15-second delay percussion detonator has a circular pull-ring.

(e) Detonator, percussion: M2A1 (M2E1), 8-second delay. Except for the delay period, marking, and the shape of the pull-ring, the 8-second delay percussion detonator (figure 9-32) is identical in construction, functioning, and use to the 15-second delay percussion detonator described in (d) above.

(7) Detonator kit, concussion: M1.

(a) General. The concussion detonator kit M1 is essentially a mechanical firing device

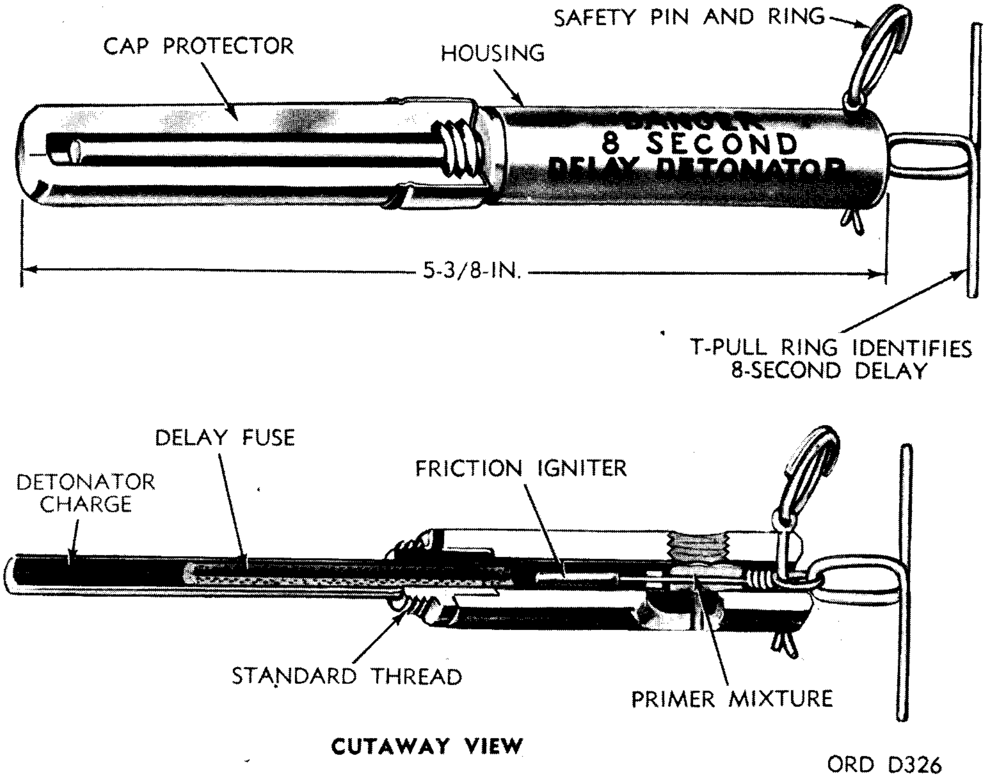


Figure 9-30. Detonator, friction: M2, 8-second delay.

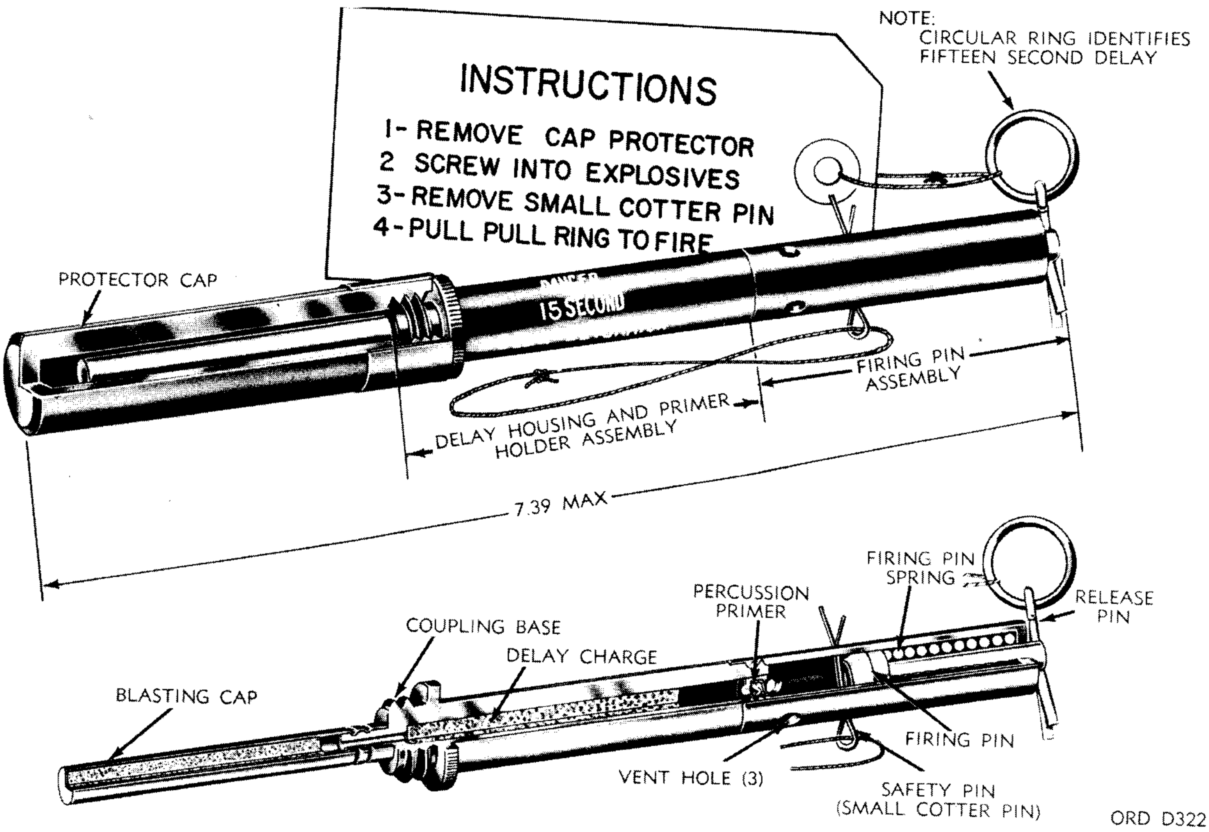


Figure 9-31. Detonator, percussion: M1A2 (M1E1), 15-second delay.

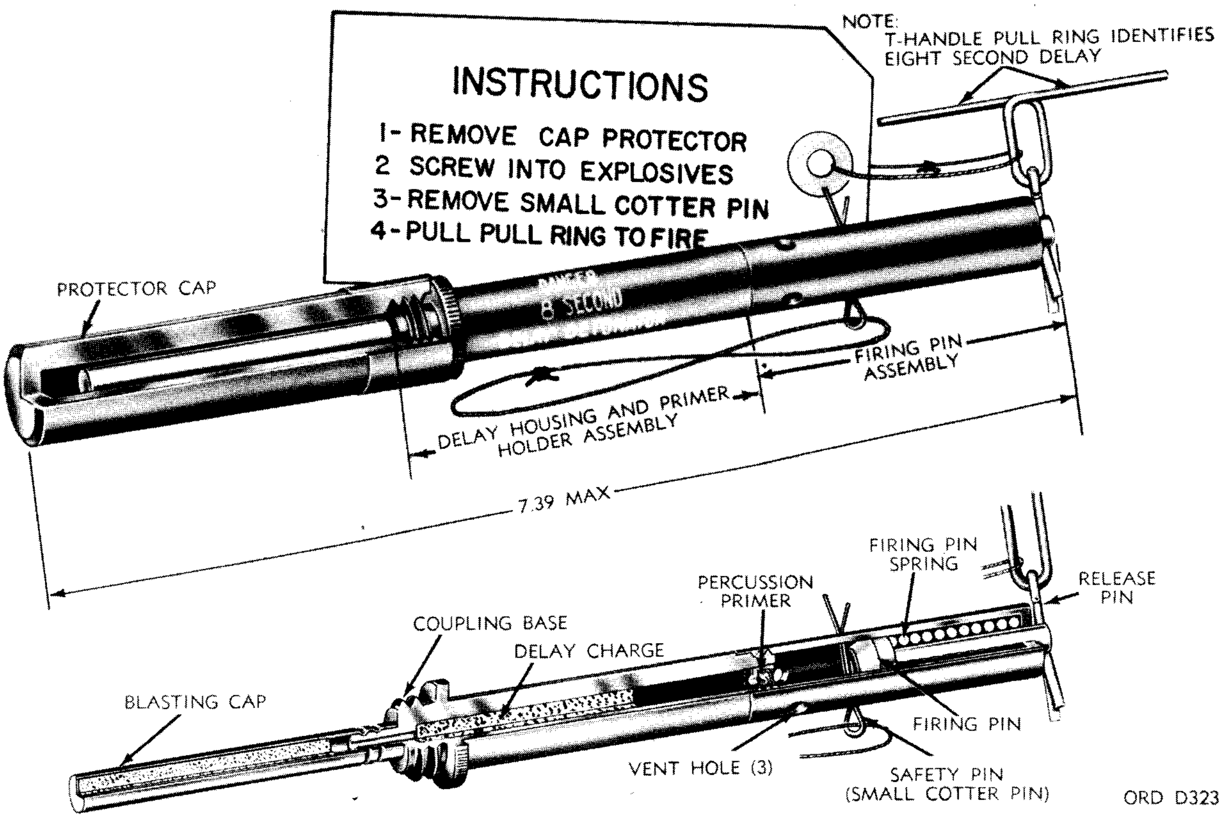


Figure 9-32. Detonator, percussion: M2A1 (M2E1), 8-second delay.

with a blasting cap attached. It is actuated by a detonation wave from a high-explosive blast. A number of demolition charges fitted with this type of firing device, in water or air, can be fired simultaneously when within range of the blast from an initiating charge or within range of each other, without connecting the demolition charges by detonating cord or other firing arrangements. The kit (figure 9-33) consists of a firing mechanism, base plug (shipping plug), primed coupling base and blasting cap assembly, blue and yellow salt delay pellets, and pellet sleeve cover assembly.

(b) Firing mechanism. This mechanism consists of a circular body containing a bronze grill-protected, snap-type diaphragm which is in contact at its center with a spring-loaded firing pin which is housed in a cylindrical projection integral with the body. The bronze diaphragm is protected by a sheet rubber disphragm. A pellet sleeve, which projects from one side of the device, contains a metal spacer, a space for a salt delay tablet, and a sleeve plug. Before installation, the firing pin is restrained in its unfired position by a steel safety ball which is held in place against the beveled shoulder of the firing pin by the metal spacer in the pellet sleeve; the spacer is in turn held in place by a safety cotter pin. After removal of the safety cotter pin (air installation), or after the removal of the safety cotter pin and partial dissolution of the installed salt delay pellet (water installation), the firing pin is restrained in its unfired position only by a split firing pin release spring which engages a groove in the diaphragm end of the firing pin.

(c) Base plug (shipping plug). The base plug is a metallic plug which is assembled to the firing mechanism during storage and shipment.

(d) Primed coupling base and blasting cap assembly. This assembly consists of the same type metal coupling base with assembled primer and nonelectric blasting cap as used with firing devices.

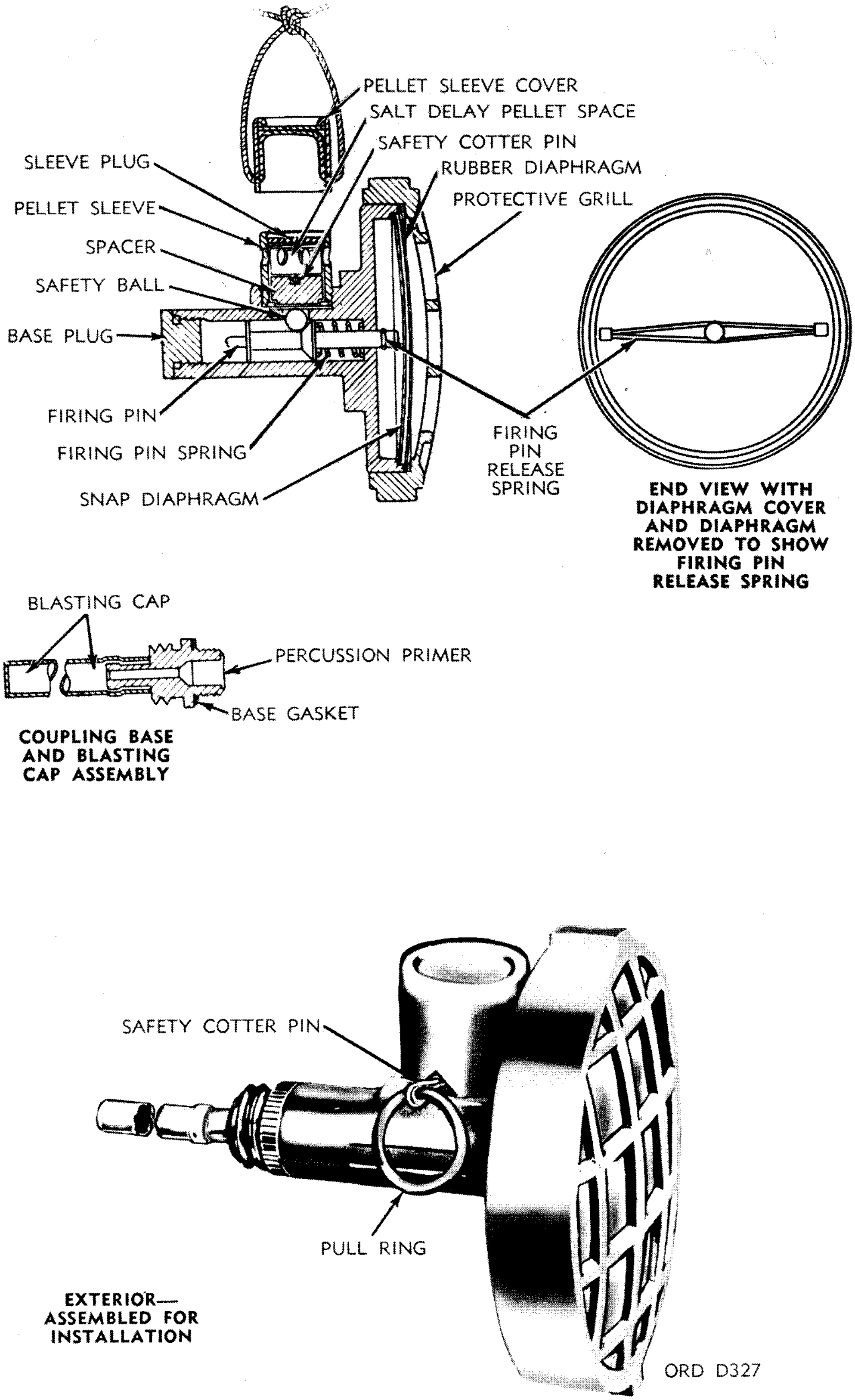


Figure 9-33. Detonator Kit, concussion: M1.

Table 9-8. Operating Range of Concussion Detonator Kits.

Weight of initiating charge (lbs)	In water: Depth of water (ft)	In water: Recommended range (ft)	In air: Recommended range (ft) *p = 99%	In air: Recommended range (ft) *p = 99.9%
0.5	2	10	------	------
0.5	4	50	------	------
0.5	6	80	------	------
0.5	8	80	------	------
2.5	-----	-----	12.5	10.8
2.5	2	20	------	------
2.5	4	80	------	------
2.5	6	90	------	------
2.5	8	150	------	------
5	-----	-----	14.1	11.5
10	-----	-----	18.8	15.7
15	-----	-----	21.5	18.0
20	-----	-----	25.2	21.2
20	2	20	------	------
20	4	80	------	------
20	6	180	------	------
20	8	260	------	------

*p = Probability that detonator at indicated distance will be caused to function by initiating charge.

(e) Salt delay pellets. Two cylindrical compressed salt delay pellets, one blue for 3½ ± ½-minute delay and one yellow for 7 ± 1-minute delay, are packed with the kit.

(f) Pellet sleeve cover assembly. This assembly consists of a paper tube crimped to a chipboard sleeve cover with pull cord. It is assembled over the pellet sleeve in order to prevent the salt delay pellet from dissolving while the device is being installed under water. The cover should not be removed until the last possible moment before removing the safety cotter pin.

(g) Painting and marking. Firing mechanisms for use with the primed coupling base and blasting cap assembly are painted olive-drab with marking in yellow. Those for use with the inert coupling base and inert blasting cap for training are painted black with marking in white.

(h) Functioning in water. After the device with the salt delay pellet of the desired delay has been installed in a demolition charge, and the pellet sleeve cover and safety pin removed, water flows through the holes in the pellet sleeve and starts to dissolve the salt delay pellet. As the pellet is dissolved, the steel safety ball is forced from its position by the beveled shoulder of the firing pin under the force of the firing pin spring. This allows the firing pin to move toward the coupling base about one-sixteenth of an inch and leaves the firing pin release spring as the only restraint to the firing pin, thus arming the device. A detonation wave from an underwater explosion of sufficient strength will snap the disphragm against the top of the firing pin overcoming the restraint of the firing pin release spring and driving the firing pin into the primer. The flame from the primer explodes the blasting cap which in turn explodes the demolition charge.

(i) Functioning in air. After the device has been installed (without salt delay pellet) in a demolition charge, and the pellet sleeve cover and safety cotter pin removed, the steel safety ball if forced against the pellet sleeve spacer, allowing the firing pin to move toward the coupling base about one-sixteenth of an inch, and leaving the firing pin release spring as the only restraint to the firing pin. In this armed condition, a detonation wave from an air explosion of sufficient strength will snap the disphragm against the top of the firing pin and cause the explosion of the demolition charge. Operating range of concussion detonator kits, M1 are presented in table 9-8.

(j) Precautions in use. Since the salt delay pellets become soft before they are

Table 9-9. Explosive Destructors.

Nomenclature	Packing				
	Description	Dimensions (inches)			Weight (lbs)
		Length	Width	Height	
DESTRUCTOR, EXPLOSIVE, Universal, M10.	1. fbr cntr. 50 cntr (50 destructor)/wdn bx.	16-3/4	15-1/8	16-5/8	77.9
DESTRUCTOR, EXPLOSIVE, M19 (T15).	1. fbr cntr, 6 cntr (6 destructor)/wdn bx.	20-3/4	8-3/4	7	26.5

completely dissolved in water, the device is dangerous after half the arming time elapses. Therefore, personnel should be clear of the danger area within half the arming time so determined. This is because a nearby concussion from enemy bombs, projectiles, or other causes could fire the device after the salt delay pellet has softened. The initiating charge should not be fired until the full dissolving time of the salt delay pellet has elapsed. The pellet sleeve cover fits over the pellet sleeve and completely protects a salt delay pellet from dissolving during the placing of an underwater installation. The cover should not be removed until the last possible moment before pulling the safety cotter pin.

(8) Explosive destructors.

(a) General. Explosive destructors are used to adapt ammunition and other explosive matêrial, for use in demolition work, booby traps, and improvised mines. Usually this type of material cannot be reliably detonated by special blasting caps. Explosive destructors are also used to destroy deteriorated or abandoned ammunition. Tabulated data for destructors is presented in table 9-9.

(b) Destructor, explosive, universal, M10. This destructor (figure 9-34) is a sheet-steel tube consisting of various size threaded assemblies. A plastic closing plug and cork gasket is used to keep the destructor sealed during shipment, storage, and handling. A blasting cap bushing is threaded to receive any issue firing device. An activator bushing with a felt washer is threaded to receive activator M1 (see lesson 5, figure 5-23). A booster assembly consists of two identical externally and internally threaded booster cups screwed together. The cup to which the activator bushing is attached contains cylindrical tetryl pellets with central holes which allow for the insertion, without interference, of either a blasting cap or an activator. The other cup contains cylindrical tetryl pellets (without central holes) and a felt pad. An ammunition bushing adapts the destructor for use with other types of ammunition, i.e., loaded projectiles and bombs. This bushing is a hexagonal-headed steel collar with two different size external threads and an internal thread. The internal thread of 1.5 inch diameter fits the external threads of the booster cups and adapts the destructor for use with any ammunition having 1.7 inch or 2.0 inch diameter right-hand-threaded fuze cavities. Thus, there is a proper size external thread available for attachment of the destructor to artillery projectiles, bombs, and rockets having corresponding size fuze wells.

(c) Destructor, explosive: M19 (T15). This destructor (figure 9-35) consists of an explosive- filled, cylindrical body with a removable ogive. The ogive may be removed and discarded if not needed for a particular operation. This destructor is primed with a delay detonator, a delay firing device with a special blasting cap, a nonelectric special blasting cap initiated with time blasting fuse or detonating cord, or an electric special blasting cap. The cap well, on each end of the body is threaded to accept firing device coupling bases or priming adopters. If the ogive is not needed in placing the primed destructor, a dual firing system may be desirable by removing the ogive, the shipping plug, and priming as described for aft cap well (see above).

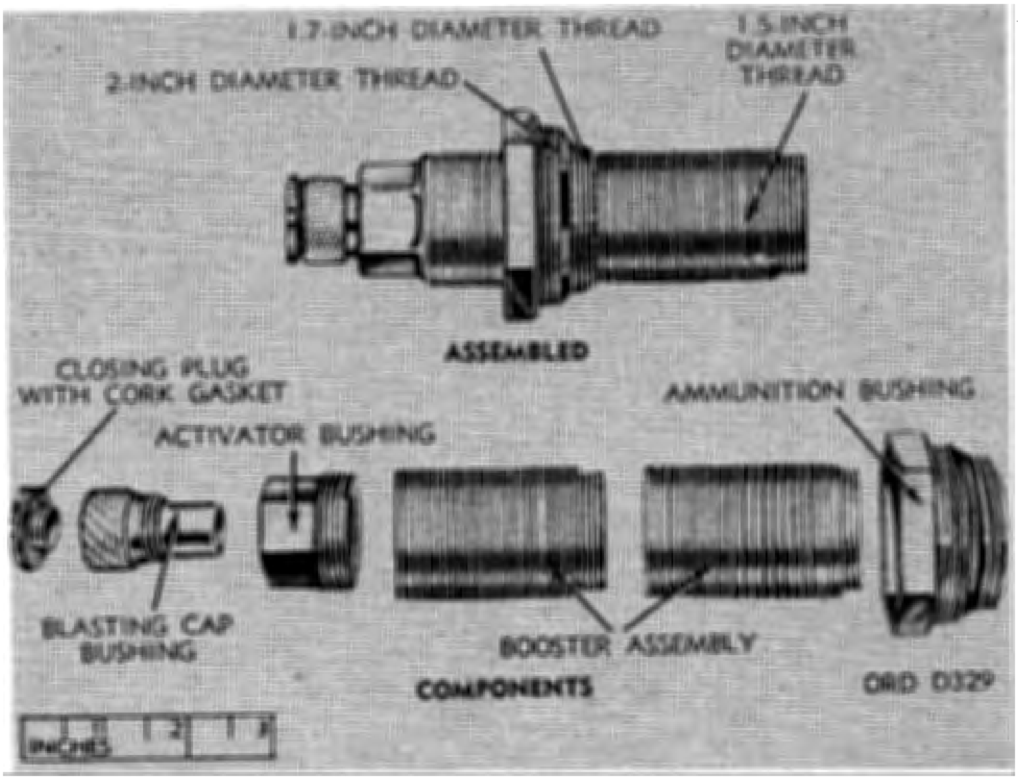


Figure 9-34. Destructor, explosive: universal, M10.

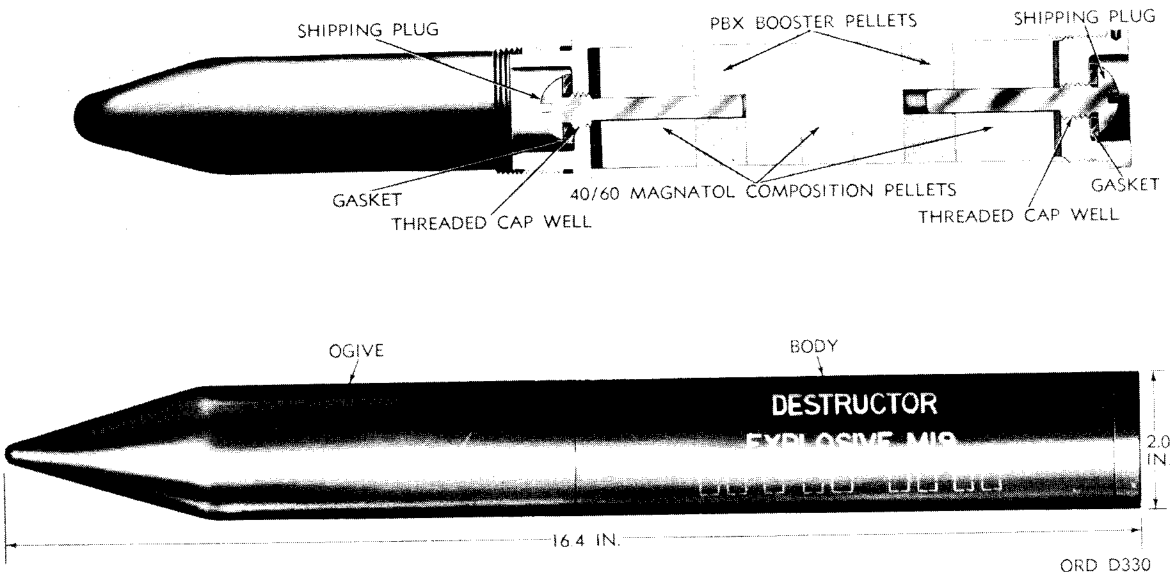


Figure 9-35. Destructor, explosive: M19 (15).

c. Firing devices and components.

(1) General. A firing device is a device designed to initiate a train of fire or detonation of demolition charges, boobytraps, or mines, principally by action on a nonelectric blasting cap or

Table 9-10. Firing Devices and Components.

Nomenclature	Initiating action	Uses	Packing				
			Description	Dimensions (inches)			Weight (lbs)
				Length	Width	Height	
FIRING DEVICE, DEMOLITION: M1, 10-min. delay, black.	Finger pinch	To provide delay action firing of mines, demolition blocks and other explosive charges.	1. 10/paprbd bx, 10 bx (100 device) wdn bx.	17-3/8	6-3/8	4-1/2	10.7
			2. 10/paprbd bx, 32 bx (320 device)/wdn bx.	------	------	------	----
			3. 10/paprbd bx, 10 bx/fbrbd, 5 bx (500 device) wdn bx.	21-3/4	12-7/8	11	55
FIRING DEVICE, DEMOLITION: M1, 15-min delay, red. FIRING DEVICE, DEMOLITION: M1, 1 hour delay, white. FIRING DEVICE, DEMOLITION: M1, 2-1/2 hour delay, green. FIRING DEVICE, DEMOLITION: M1, 5-1/2 hour delay, yellow. FIRING DEVICE, DEMOLITION: M1, 11-1/2 hour delay, blue.	Finger pinch	To provide delay action firing of mines, demolition blocks and other explosive charges.	10/ctn, 12 ctn (120 device) wtrprf wdn bx, M12.	14-1/4	10-1/8	7-7/8	19.7
FIRING DEVICE SET, DEMOLITION: M1 delay type.	-----------	-------------	1 set/paprbd bx, 10 bx/fbrbd bx, 5 lbs (50 set)/ wdn bx.	21-3/4	12-7/8	11	55
FIRING DEVICE, DEMOLITION: M1, pressure type.	20-lb press	Mines and boobytraps.	5/crdbd bx, 30 bx/ wtprf-wxd cloth-paper (150 device)/wdn bx.	40-3/4	10-1/2	7-3/4	78
FIRING DEVICE, DEMOLITION: M1A1, pressure type.	20-lb press	Mines and boobytraps.	1. 5/bx, 50 bx (250 device) wdn bx.	27-1/4	12-3/4	10-1/4	80.0
			2. Packed as req'd.	------	------	------	----
FIRING DEVICE, DEMOLITION: M1A1, pressure type, inert.	Inert, non-initiable.	Training ------	Packed as req'd --	------	------	------	----
FIRING DEVICE, DEMOLITION: M5, pressure release type.	Removal of restraining load.	Antitank mines and booby-traps.	1. 4/paprbd bx, 5 bx/fbrbd bx, 10 bx (200 device)/ wdn bx.	19-7/8	11-7/8	9-1/2	51.9

activator. It is a separate item of issue and is packed in its own packing box. Firing devices (table 9-10) are of two general types, the tubular type and the box type. The tubular-type firing devices, consisting of head, case, and coupling base, are arranged for actuation by pressure, pull, or release of pull according to the design of the particular model. The box-type firing devices, consisting of a rectangular steel body and coupling base, are arranged for release of pressure. The coupling base,

Table 9-10. Firing Devices and Components—Continued

Nomenclature	Initiating action	Uses	Packing				
			Description	Dimensions (inches)			Weight (lbs)
				Length	Width	Height	
			2. Packed as req'd.				
FIRING DEVICE, DEMOLITION: M5, pressure release type, inert.	Inert, non-initiable.	Training ------	As required ------	------	------	------	----
FIRING DEVICE, DEMOLITION: M1, pull type.	3-pound pull	Anti-personnel mine M3 anti-tank mines, as improvised mines, and boobytraps.	1. 5, (w/2 spool of trip wire)/ chipbd bx, 30 bx (150 device and 60 spool wire)/ wdn bx. 2. 5, 2/w spool of trip wire/chipbd bx, 1 chipbd bx/ leadfoil env. 40 env (200 device w/80 spool wire)/wdn bx. 3. Packed 250/wdn bx. 4. Packed as req'd.	13-1/2 21	10 13	8-1/2 11-1/2	35.0 65.0
FIRING DEVICE, DEMOLITION: M2, pull friction type, inert (w/trip wire).	Inert, non-initiable.	Training ------	As required ------	------	------	------	----
FIRING DEVICE, DEMOLITION: M3, pull-release type.	Release or 6-lb pull.	Antipersonnel mine M3 improvised mines and boobytraps.	1. 5 (w/two 80-ft spool of trip wire)/pkg, 5 pkg/inner pkg, 6 inner pkg (150 device and 60 spool wire)/ wdn bx. 2. Packed as required.	15-3/8 ------	11-3/8 ------	10-3/4 ------	49.9 ----
FIRING DEVICE, DEMOLITION: M3, pull-release type, inert.	Inert, non-initiable.	Training ------	Packed as required	------	------	------	----
FIRING DEVICE, DEMOLITION: M1, release type.	Removal of restraining load.	Boobytraps----	4/chipbd bx, 20 bx (80 device)/wdn bx.	26-1/4	10-1/2	8-1/2	44.1
BASE, COUPLING, FIRING DEVICE: (w/primer percussion, M27).	-----------	Component for demolition firing devices.	50/wtrprf ctn, 10 ctn (500 base)/ wdn bx.	15-1/2	13-3/4	10	34.4
PRIMER, PERCUSSION: CAP, M2.	Release of firing pin.	For coupling of demolition firing device.	1. 2,500/wdn bx. 2. 100/crdbd bx, 50 bx (5,000 primers)/crdbd bx (w/excelsior inside)/wdn bx.	15-1/8 18-5/8	13-1/4 9-3/4	11-1/8 7-1/2	18.5 24.0
PRIMER, PERCUS-	Release fir-	For coupling	1. 100/ctn, 50 ctn	19	10	8	24.0

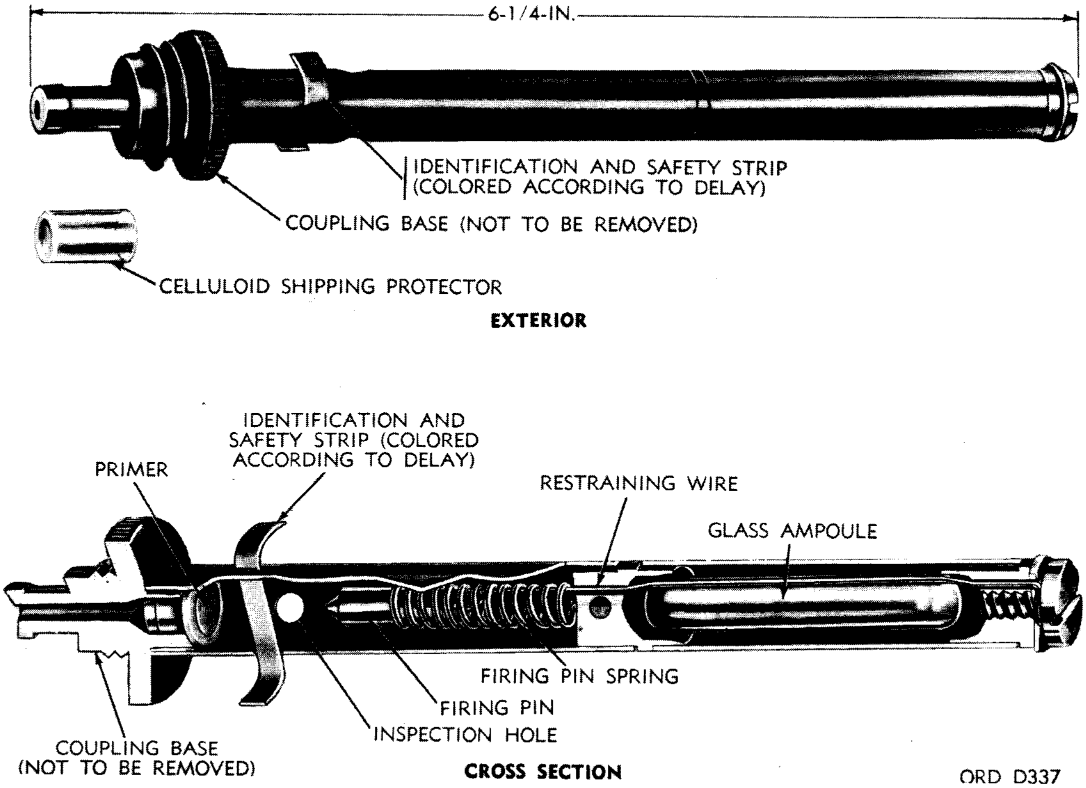


Figure 9-36. Firing device, demolition: delay type, M1.

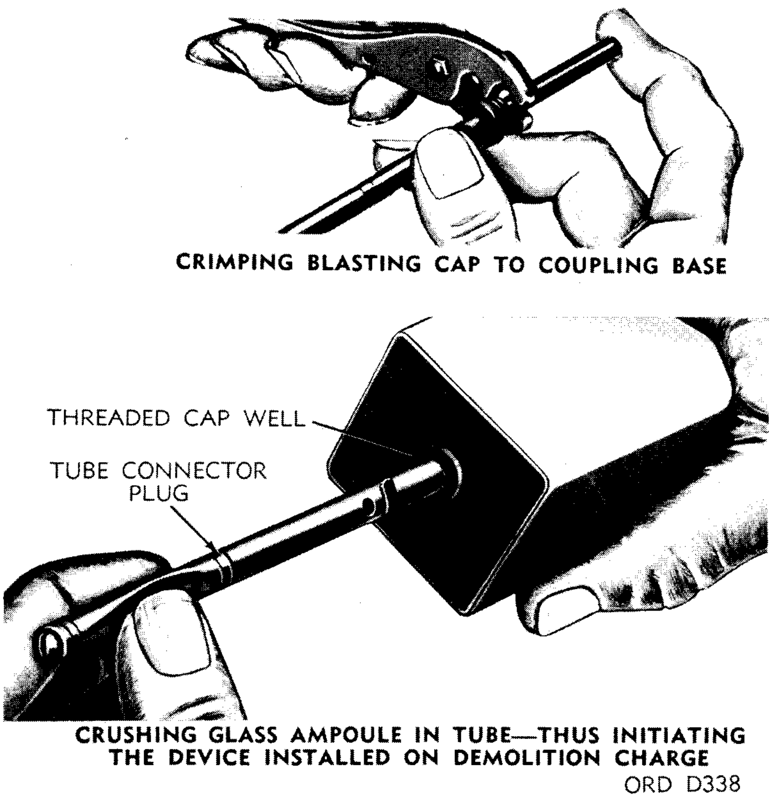


Figure 9-37. Firing device, demolition: delay type, M1-method of installation.

Table 9-11. Effect of Temperature on Delays of Firing Device, Delay Type, M1.

Temp. (deg. F)	Black		Red		White		Green		Yellow		Blue		t° C.
	OM	ST	OM	ST	OM	ST	OM	ST	OM	ST	OM	ST	
-25	-----	-----	8.5 hr	3.3 hr	3 day	1.3 day	------	------	------	------	------	------	-32
0	8 hr	2.5 hr	45 min	20 min	17.5 hr	8 hr	2.6 day	1.2 day	8.5 day	3.8 day	23 day	10 day	-18
+25	36 min	16 min	25 min	11 min	5.5 hr	2.5 hr	17 hr	8 hr	2.0 day	20 hr	5.0 day	2.2 day	-4
50	15 min	7 min	17 min	8 min	2 hr	55 min	6 hr	2.7 hr	14 hr	6.0 hr	1.3 day	14 hr	+10
75	9 min	4 min	15 min	7 min	1 hr	27 min	2.5 hr	70 min	5.5 hr	2.5 hr	11.5 hr	5 hr	24
100	5 min	2.0 min	8 min	3.5 min	32 min	14 min	70 min	30 min	2.5 hr	65 min	5.2 hr	2.3 hr	38
125	4 min	1.5 min	5 min	2 min	20 min	9 min	35 min	15 min	80 min	36 min	2.5 hr	1.1 hr	52
150	3 min	1 min	4 min	1.5 min	15 min	6 min	20 min	9 min	46 min	21 min	80 min	36 min	66

OM–Most likely delay if two devices are used in the same charge. If only a single device is used, this value should be increased approximately 15 percent.

ST–Reasonable safe time. Delays of less than this value should not occur more than one in a thousand.

fitted to all types, contains a percussion primer. All firing devices are physically interchangeable, as coupling bases have the same thread (9/16 inch) for attachment to mines or explosive charges. The coupling base of the delay- type firing device is not removable. The coupling bases of all other type firing devices are removable. Inert firing devices, which contain an inert percussion primer, are provided for training. Inert firing devices used for training purposes are to be imployed in exactly the same manner and with the care and precautions as are the explosive loaded items which they simulate. Thus, it is essential that personnel in training be thoroughly familiar with all procedures and instructions pertaining to the explosive firing devices.

(2) Firing device, demolition: delay type, M1.

(a) Description. This is a chemical device (figure 9-36) used for delay action firing of mines or demolition charges. The device consists of a two-part case or tube, the parts being joined near the center by a coupling. The tube is about 3/8 inch in diameter and the device is 6-¼ inches long including a primed coupling base, which is not removable, but has the same size thread and nipple as on all firing devices. The half of the case attached to the coupling base is brass and the other half is thin copper, capable of being crushed between thumb and finger. The copper half contains a sealed glass ampoule of corrosive chemical and the brass half houses a firing pin and spring. An identification and safety strip, colored according to the length of delay (table 9-11) in which the device functions, extends through slots opposite an inspection hole near the primer of the coupling base. Devices with black, red, white, green, yellow, and blue strips are packed separately, according to color. A restraining wire, extends from the end of the device where it is held by a screw, along the ampoule, through a firing pin spring, and to the firing pin to which it is attached.

(b) Functioning. When the glass ampoule is crushed (figure 9-37) the corrosive liquid is released. The liquid then eats through the restraining wire releasing the firing pin. The firing pin, driven by a spring, fires the primer in the coupling base. A temperature correction table (one in each box) shows the delay of a device having a strip of particular color at various temperatures as shown in table 9-11.

(c) Preparation for use, The card found in each box of devices indicates the color for the required delay at the prevailing temperature (table 9-11). Select a device with identification strip of this color. Look in or insert a nail or wire into the inspection hole to make sure that the firing pin has not been released. Examine the copper half of the tube of the device (this half contains the glass ampoule of corrosive chemical), to see that it is not dented and that there is no evidence that the ampoule has been crushed. Remove the celluloid protective shipping cap from the coupling base and crimp on a nonelectric blasting cap. Insert the blasting cap into the cap well of

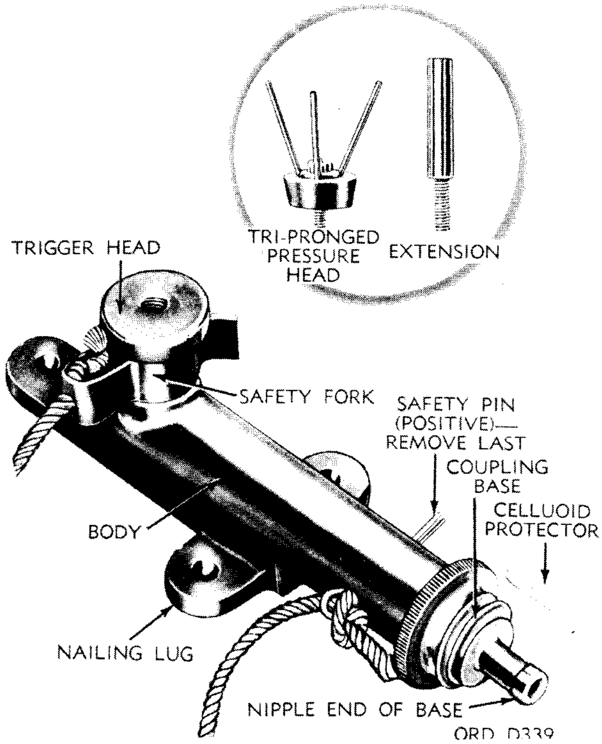


Figure 9-38. Firing device, demolition: M1A1, pressure type.

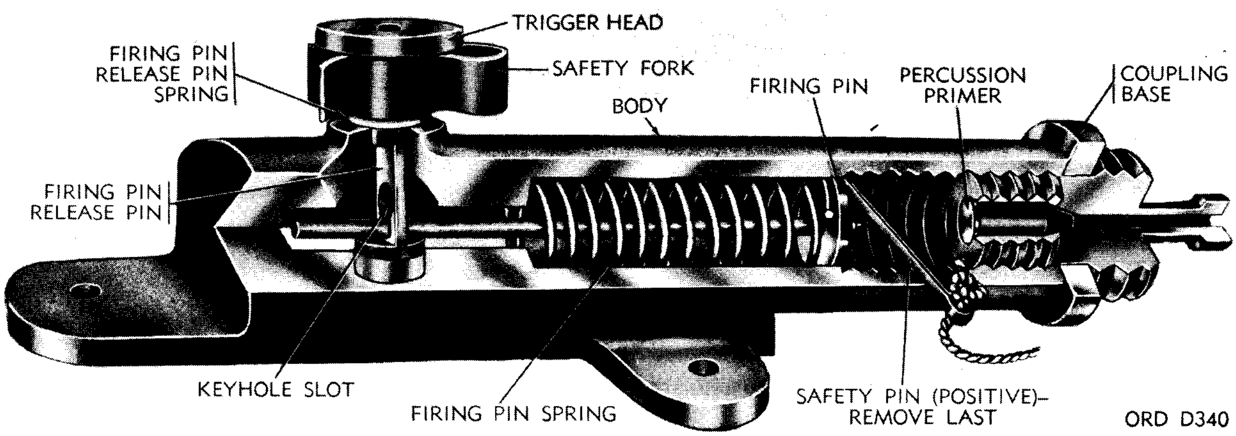


Figure 9-39. Firing device, demolition: M1A1, pressure type-sectioned.

the demolition charge or mine, as the case may be, and screw the device into the threads of the well. If detonating cord is used, tape one end of the cord to the blasting cap on the delay firing device, then extend the other end of the cord to the charge, or mine, where it must be fitted with another blasting cap for insertion or taping. Crush ampoule between thumb and fingers. Look through inspection hole to see whether the firing pin has been released. If the firing pin rests on the identification and safety strip, remove the device and discard. If the firing pin has not been released, withdraw the strip.

(d) Neutralizing. There is no safe way to neutralize this firing device. If an extreme necessity arises to neutralize the device before the period of delay expires, a cotter pin or wire should be inserted very gently through the inspection holes. The device should then be removed from the charge and discarded, because, once actuated, no attempt must be made to reuse it.

(3) Firing device, demolition: M1, pressure type, and M1A1, pressure type.

(a) Description. These firing devices (figures 9-38 and 9-39) are similar in functioning and appearance. They are designed for actuation by pressure and intended for use in mines and boobytraps. The firing device consists of a head, case, and coupling base. The case that contains the firing mechanism has three lugs, each with a hole for use in anchoring the device. The firing mechanism consists of a spring-loaded firing pin held in the "cocked" position by a firing pin release pin, which is attached to the pressure cap. This is accomplished by a keyhole-shaped opening in the trigger pin. The smaller part of this opening fits into a groove in the firing pin (cocked position); the larger part of the opening permits the free movement of the firing pin upon release. The head, an integral part of the case, contains the firing pin release pin mechanism, which terminates in a pressure cap. A tapped hole in the center of the pressure cap is provided for use of an extension. The coupling base, which screws into the case, contains the primer. A removable fork, located under the pressure cap, prevents movement of the firing pin release pin. The safety pin, which passes through a hole in the case between the firing pin and the primer of the coupling base, prevents the firing pin from striking the primer should the firing pin be accidentally released.

(b) Functioning. A pressure of 20 pounds on the pressure cap compresses the firing pin release pin spring and pushes the release pin inward. When the enlarged portion of the keyhole-shaped opening in the release pin is in line with the spindle, the firing pin is released. The spring-loaded firing pin then fires the primer.

(c) Preparation for use. Check the firing mechanism as directed below: Unscrew the coupling base from the firing mechanism and inspect the primer. Invert the coupling base and hold it against the firing mechanism, with the nipple extending into the threaded end of the firing mechanism. Holding the coupling base firmly against the case, remove safety fork and safety pin. Depress the pressure cap. The firing pin should strike the nipple end of the coupling base sharply, indicating proper functioning of the firing mechanism. Recock the firing mechanism by pushing firing pin inward with unsharpened end of a pencil or a small blunt rod and, at the same time, pressing downward on the pressure cap, so that the end of firing pin can pass through the enlarged portion of the keyhole in the firing pin release pin. Release pressure on pressure cap to allow the narrow part of the keyhole to engage the groove on the spindle. Replace safety pin and safety fork. The safety pin and the safety fork should be free enough for easy removal after the firing device has been installed. Screw the coupling base into the firing mechanism handtight. This restores firing device to original condition.

(d) Installing and arming. Remove protector tube from nipple, crimp a nonelectric blasting cap on the nipple, and then screw firing device, with safety fork and safety pin in place, into a mine or other explosive charge. Bury and anchor the assembled mine and firing device on a firm flat foundation. Place or arrange some suitable object such as a pressure board in contact with, but not bearing on, the pressure cap. If the particular object does not touch the pressure cap, screw extension rod into pressure cap and adjust by unscrewing the rod up snugly against object, then backing the rod away one quarter turn to relieve any pressure on pressure cap. If the tri-pronged pressure head is to be used, screw it into the pressure cap and adjust in the same manner. The extension rod and the tri-pronged pressure head are illustrated in the insert in figure 9-38. Remove the safety fork. It should pull off easily. A sudden jerk may cause firing device to function. If the safety fork does not pull off easily, check the installation to make sure there is no pressure on pressure cap. Using the attached cord, pull out safety pin slowly and carefully. If the safety pin resists a gentle pull, the firing pin may have been released and is pressing against it. In such a case, replace the safety fork, remove the installation, and remove firing device from mine. Unscrew

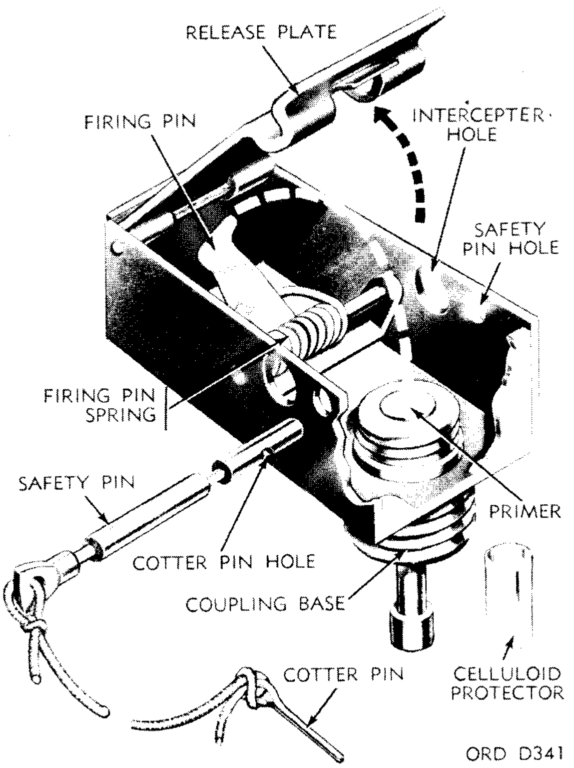


Figure 9-40. Firing device, demolition: M5, pressure release type.

coupling base and check firing mechanism. If the firing mechanism is defective, replace it. Retain safety fork and safety pin for subsequent use in disarming.

(e) Neutralizing. Carefully insert the safety pin into the case of the firing device, then install safety fork. Take up assembled firing device and mine or demolition charge. Remove firing device from mine or demolition. Restore firing mechanism and coupling base to original condition and packing.

(4) Firing device, demolition: M5, pressure release type.

(a) Description. This device (figure 9-40) consists of a rectangular pressed-steel case containing a spring-loaded striker. The striker is restrained by a release plate, which is held in place by a safety pin. A coupling base fits into the threaded hole in the bottom of the case. This device is used to activate antitank mines equipped with supplementary fuze wells (cap wells) and for general boobytrap installations with charges having a threaded well.

(b) Functioning. When the restraining load of at least 5 pounds is removed and the release plate moves more than 5/8 inch, the firing pin is released. The firing pin, impelled by the spring, fires the percussion cap.

(c) Installing and arming. Inspect the device to make sure that there are no obvious defects, that firing pin is cocked, and that the safety pin is in proper position. Remove small cotter pin. Slip a nail (common - 6, 8, or 10 penny) or a length of 10 gauge wire through interceptor holes. Remove the coupling base. Remove the celluloid shipping cap from the coupling base and crimp on a nonelectric cap. Screw the coupling base into the firing mechanism. Screw the device into the threaded fuze well (cap well) of charge or mine. Install so that the release plate is held closed by weight of a mine, a charge, or a boobytrap bait, or by wedging against some stable object. If the device is in the ground, use the small board issued with the device to provide solid foundation. See that the safety pin is in proper position and adjust the installation so that the safety pin will slip out easily. Remove the safety pin gently by pulling attached cord. If striker falls, it can be felt striking the interceptor hole nail or wire. (If this happens, remove the restraining load and check device. If device is defective, discard it.) Recock device and repeat process. If no clicking sound is heard, pull out wire or nail from interceptor hole. It should come out easily.

(d) Neutralizing. Insert wire or nail through interceptor holes. Insert safety pin. Remove restraining load. Insert cotter pin. Remove the device from mine or charge. Unscrew coupling base and destroy or store in a safe place. Protector cap from used 15-second delay detonator may be used. *Warning: Do not attempt to remove blasting cap from the coupling base.*

(e) Reuse. If the primer (percussion cap) in the standard coupling base has been fired in training or if there is no blasting cap attached to the base, the base may be reused by removing the fired primer and pressing a primer M2 (or M3) firmly into place. To recock, proceed as directed below. Remove the coupling base. Hold the firing mechanism with release plate up, hinge of release plate toward you. With nail held in right hand perpendicular to long axis of firing mechanism, force the firing pin back to cocked position. Hold down release plate and withdraw nail. Insert safety pin. With release plate held down firmly, withdraw safety pin to see that it slides out easily; replace safety pin.

NOTE. Other methods of recocking may be used if found satisfactory.

(5) Firing device, demolition: M1, pull type.

(a) Description. This firing device (figure 9-41) is designed for actuation only by a pull on a trip wire and is intended for use with improvised antipersonnel mines, for boobytrapping antitank mines, and for setting up boobytraps. The firing device consists of a cylindrical case (body), head, and coupling base. The head, which is permanently joined to the case, contains a release pin, release pin ring, a loading spring, and a safety pin. The case, which contains the firing mechanism consisting of the firing pin and compression spring, also contains a positive safety pin. The coupling base, which screws into the case, contains the primer. The outer end of the coupling base is threaded to fit activators and firing device wells (cap wells). It has a nipple to which a blasting cap may be assembled. The pull-ring end of the firing pin, which is slotted axially to form four jaws, passes through a cylindrical opening in the case. The end of the release pin, fitting into an axial hole in the slotted end of the firing pin, causes it to engage on the upper surface of the opening, thereby restraining downward movement of the firing pin. The safety pin, which passes through a hole in the head and a hole in the release pin, prevents accidental movement of the release pin during shipment and handling. The positive safety pin, which passes through a hole in the case between firing pin and primer, prevents the firing pin from striking the primer should the firing pin be accidentally released. An anchor cord, on the case, is used to anchor the firing device firmly during installation.

(b) Functioning. A direct pull of 3 to 5 pounds on the trip wire causes the release pin to be pulled outward, overcoming the resistance of the loaded release pin spring. The slotted end of the firing pin, being no longer restrained by the cylindrical opening, passes through the opening. The released firing pin, driven by the compression spring then fires the percussion cap.

(c) Preparation for use. Check firing device as follows: Unscrew the primed coupling base and inspect primer. Invert coupling base and hold it so that the nipple end is inside the case. Holding coupling base firmly against the case, remove the positive safety pin and head safety pin. Pull outward on the pull-ring. Firing pin should strike the end of the nipple sharply, indicating

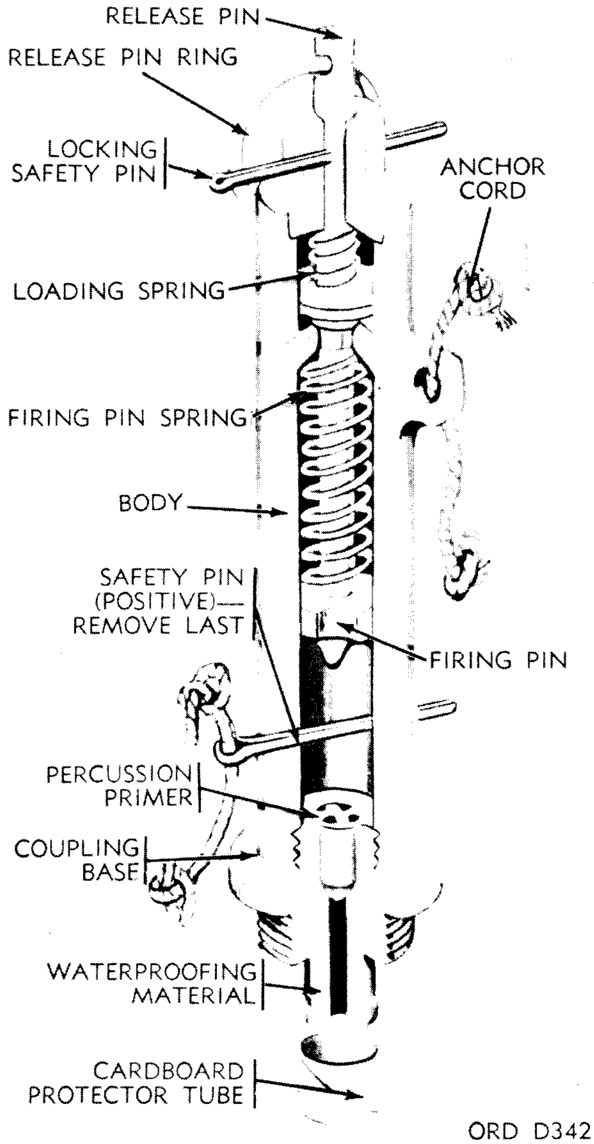


Figure 9-41. Firing device, demolition: M1, pull type.

proper functioning of assembly. Recock firing device by pushing firing pin inward with unsharpened pencil or blunt rod until release pin slips into place, thus expanding slotted head of firing pin. Insert positive safety pin and head safety pin, then screw the primed coupling base into the case, primer end inward. Safety pins should be free enough for easy removal after the firing device has been installed.

(d) Installation and arming. Remove the primed coupling base. remove the protector cap from the nipple and crimp on a nonelectric blasting cap. Screw primed coupling base into the case (body). Screw the firing device, with safety pins in place, into a mine or demolition charge. Install loose trip wire, attaching anchor end first. Unspool the trip wire to the mine. Before connecting trip wire to the firing device, step off to the side and inspect for detectability of trip wire and mine. If necessary, rearrange the installation to obtain adequate concealment. Attach free end of wire to pull-ring, drawing up excess wire through pull-ring just taut but without strain. Remove the head safety pin. If it does not pull out easily, trip wire may be too tight. Adjust trip

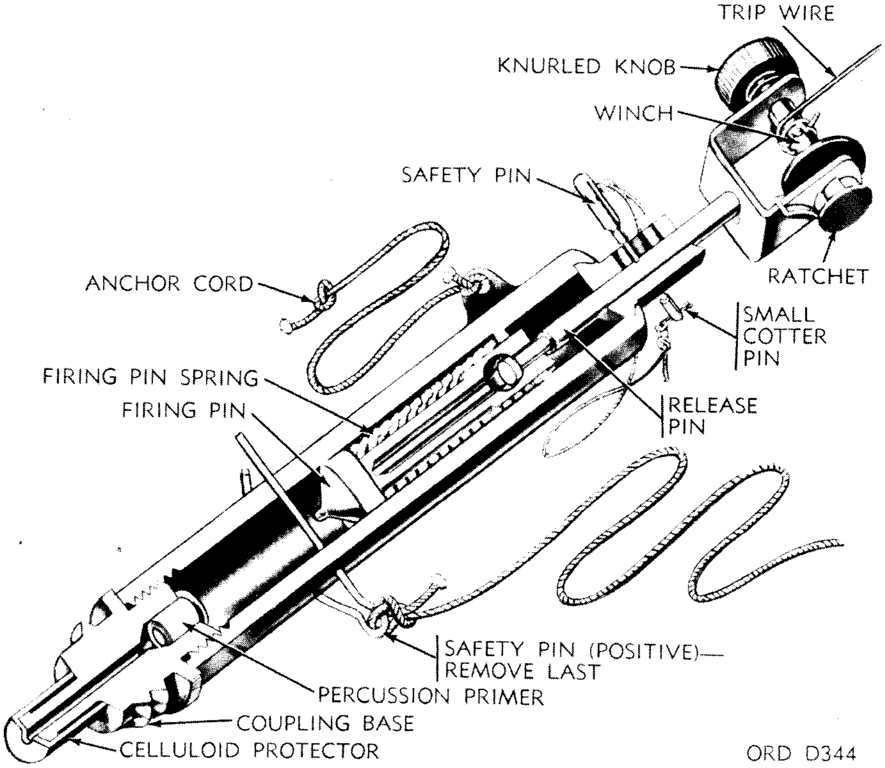


Figure 9-42. Firing device, demolition: M3, pull-release type.

wire if necessary. If head safety pin still binds, remove the coupling base and check mechanism. If defective, replace faulty firing device with a serviceable one. Using the attached cord, pull out the positive safety pin slowly and carefully. If it resists a gentle pull, the firing pin may have been released and is pressing against it or spread of legs of the positive safety pin is excessive. If spread of legs is not excessive but the pin still resists gentle pull, install head safety pin, unscrew coupling base, and check mechanism. If defective, replace faulty firing device with a serviceable one. Retain safety pins for future use in disarming the firing device.

(e) Disarming and removal. Carefully insert the positive safety pin first, then the head safety pin into the firing device. After insertion, spread legs of safety pins just enough to prevent accidental loss of pins during handling and shipment. Disconnect trip wire from the pull-ring. Unscrew firing device from mine or charge. Restore firing device to original condition and packing.

(6) Firing device, demolition: M3, pull release type.

(a) General. This firing device (figures 9-42 and 9-43) is a mechanical device containing a percussion cap. It is designed for actuation by either an increase (pull) or decrease (release) of the tension in a taut trip wire and is intended for use with antipersonnel mine M3, improvised antipersonnel mines, or in setting up boobytraps.

(b) Description. The firing device consists of a head, body, coupling base, firing pin, release pin, safety pin, and winch assembly. The head, which is crimped to the body, acts as a guide for the release pin. The body contains a spring- loaded firing pin, in which the knob end of the release pin is installed. The coupling base, which screws into the body, contains the primer. The outer end of the coupling base is threaded to fit activators and firing device wells (cap wells) and has

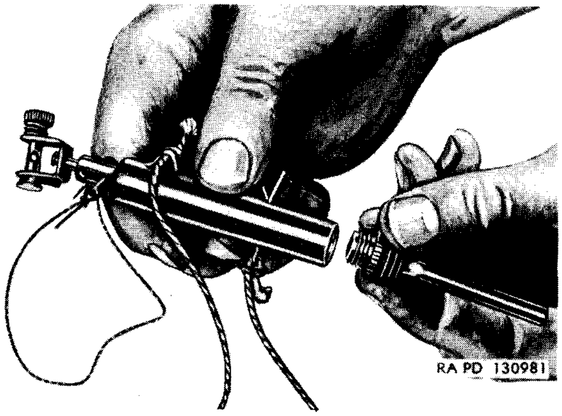


Figure 9-43. Assembling pull-release type firing mechanism to primed coupling base with crimped-on blasting cap.

a nipple, to which a blasting cap may be assembled. The outer end of the firing pin is slotted longitudinally to form four jaws, and grooved internally to receive a knob on the inner end of the release pin. The slotted end of the firing pin passes through a cylindrical opening in the body, in which position it is held by the knob of the release pin when the release pin is in its normal axial position and the safety pin in place. The safety pin passes through an elongated opening in the head and a hole in the release pin. A small cotter pin, which passes through a hole in the end of the safety pin, prevents accidental movement of the safety pin during shipment. The safety pin, when in position, prevents forward or rearward movement of the release pin (beyond the slight movement permitted by the elongated slot in the head), thus preventing release of the firing pin. The winch, consisting essentially of a bracket, spool with a knurled knob, and a pawl, is attached to the outer end of the release pin. A positive safety pin, one leg of which passes through a hole in the body between the firing pin and the primer, prevents the firing pin from striking the primer should the firing pin be accidentally released. The other leg of the safety pin is bent around the body, to keep it in place during shipment and handling. An anchor cord (12 inches long), attached to the eyelet on the body, is used to anchor the firing device firmly during installation.

(c) Functioning. Pull operation. A direct pull of 6 to 10 pounds on the trip wire causes the release pin and firing pin to be pulled outward until the jaw end of the firing pin passes beyond the constricted opening in the body. In this position, the jaws spread, thereby releasing the firing pin from the knob of the release pin. The jaws then close, releasing the firing pin which, driven by its spring, fires the primer. Tension-release operation. Release of tension, such as cutting or detaching trip wire, permits the release pin and spring-loaded firing pin to move inward. When the end of the firing pin clears the constricted opening in the body, the jaws spread, thereby freeing the firing pin from the release pin. The released firing pin, driven by its spring, fires the primer.

(d) Preparation for use. Inspection before use. Check firing device as follows: unscrew the primed coupling base from the firing mechanism and inspect the primer. Inspect the positive safety pin and the safety pin, to see that they are in place, yet free enough for easy removal after the firing device has been installed. Leaving the positive safety pin and safety pin in position, pull the winch assembly out with the finger until it is stopped by the safety pin, then release; repeat two or three times. The winch assembly should move smoothly approximately ¼ inch and should require a force of 6 to 10 pounds. If the assembly hangs or moves jerkily or too easily, examine the firing device. If fault cannot be corrected, use another firing device.

(7) Firing device, demolition: M1, release type.

(a) General. This firing device (figure 9-44) is designed to be actuated when a

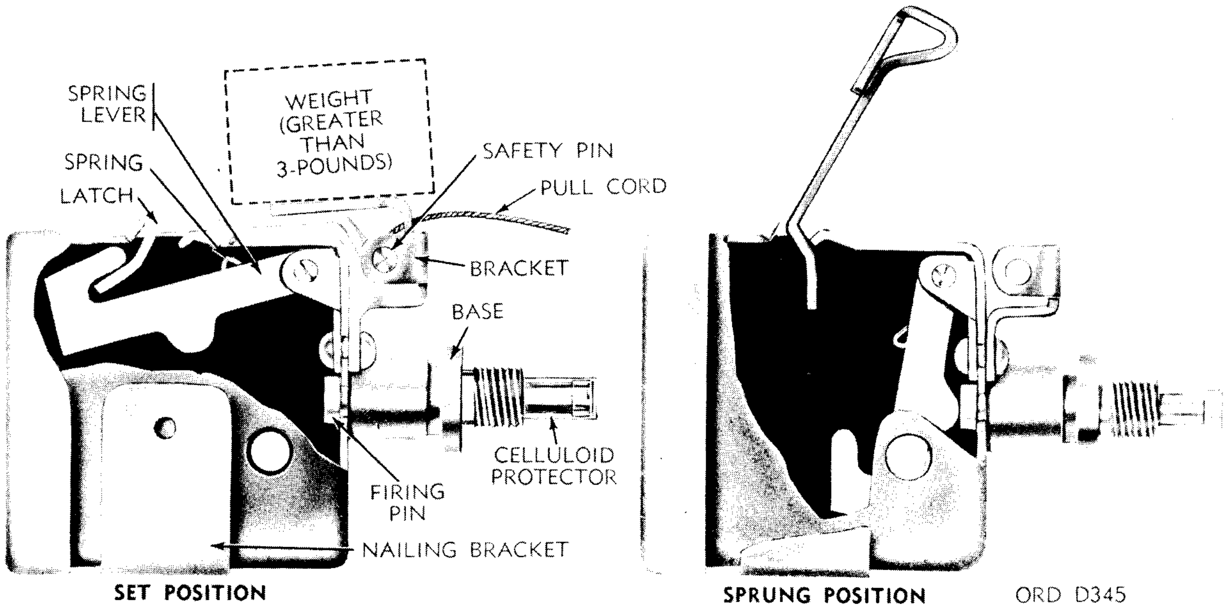


Figure 9-44. Firing device, demolition: M1, release type.

restraining weight is removed from it and is intended for use in setting up booby-traps. The restraining weight is applied at the time of installation. The firing device is restrained from firing as long as there is a load greater than 3 pounds on the top face of latch. .

(b) Description. The firing mechanism of this device is cube-shaped, approximately 2 inches square by 3 inches long. It is fitted with a cover at one end and a threaded hole to receive a primed coupling base at the opposite end. The body houses a spring lever, a spring, and a firing pin. One end of a steel latch engages a lip on the lever, the remaining portion of the latch rests on top of the device and, as issued, is held in place by a safety pin. This arrangement holds the lever in the set position. Two 3/16-inch holes are provided in the sides of the body, to permit the insertion of a nail or heavy gage wire to act as an additional safety device by intercepting the lever and preventing it from striking the firing pin should premature functioning occur during installation. A strip of metal 3/4-inch wide and 4 inches long spotwelded to the base of the body serves as a nailing bracket.

(c) Functioning. Upon removal of restraining weight from the firing device, the lever is unlatched and is driven through an arc of approximately 75 degrees to strike the firing pin, which explodes the primer contained in the coupling base.

(d) Preparation for use. Check firing device for any obvious defects and to make sure that the safety pin is properly installed and that the lever is latched in the set position.

(e) Installation and arming. Remove the cotter pin in the end of the safety pin. Slip a nail or stout wire through the interceptor holes. Remove coupling base, Remove its protector cap and crimp on a nonelectric blasting cap. Screw the coupling base into the firing mechanism. Screw the firing device thus assembled into fuze well (cap well) of the mine or charge. Provide a level surface at the base of the hole in which the mine or charge with firing device assembled is to be planted. A board may be used for this purpose. Place the assembled mine (or charge) and firing device in the hole, with the latch on the firing device uppermost. Place the restraining weight on the exposed surface of the latch.

Warning: The weight placed on the latch must be greater than 3 pounds to prevent firing device from functioning when safety devices are withdrawn.

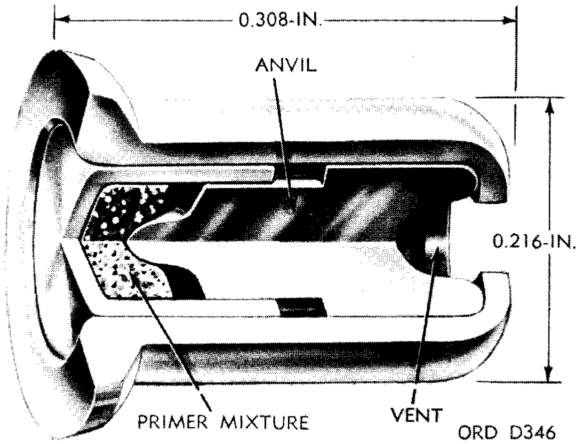


Figure 9-45. Primer, percussion: M27.

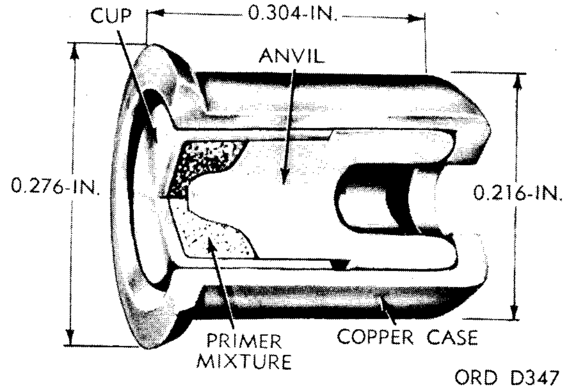


Figure 9-46. Primer, percussion: M2.

Make sure that the safety pin cord and interceptor wire are at ground level in position convenient for removal. Conceal the installation. Gently withdraw the safety pin by pulling on its cord. If it does not come out easily, the load on the mine is too light or improperly placed on the latch. If resistance is met, uncover and check the installation. Withdraw the interceptor wire; it also should come out easily.

(8) Base, coupling, firing device. This is a metal coupling (see firing device illustrations, figures 9-36 thru 9-44) containing a percussion primer and having a nipple to which a blasting cap may be attached. The coupling base is threaded at one end to screw into a standard firing mechanism and at the other end to screw into a cap well of a block demolition charge or certain types of mines. Coupling bases are also issued individually with percussion primer M27 (figure 9-45) for use as replacements in firing devices fired for training and test purposes. A coupling base may be used for several firings before replacement is necessary. The originally installed percussion primer M27 is replaced by a percussion primer M2 (figure 9-46). *Warning: Do not attempt to remove an unfired primer from a coupling base.*

(9) Primer percussion: cap, M2. Percussion primer M2 (figure 9-46). When struck by a firing pin, a percussion primer emits a small but intense flame through its open end which will initiate a blasting cap. Demolition firing devices and firing device coupling bases are issued with percussion primers already installed. Percussion primer M2 is issued separately for repriming firing devices used with regular practice mines or with improvised practice mines or boobytraps. A fired primer may be punched out of a coupling base from the nipple end by a suitable rod. Separately issued primers are used for repriming fired firing devices used in training activities. A new primer may be inserted in place of the fired primer provided it fits snugly enough to be held tightly in place. *Warning: Do not attempt to remove an unfired primer from a coupling base.*

(10)Firing devices may be used with demolition charges (figure 9-47) with heavy antitank mines, if fitted to activators, with light antitank mines, or destructors. When a firing device is used with a service activator or a practice activator (Lesson No. 5) a blasting cap cannot be used. When used with light antitank service mines, with demolition charges, or with universal destructor M10 (Page 9-P34) the firing device requires a crimped-on blasting cap.

d. Miscellaneous accessories and tools.

(1) Adapter, priming: explosive, M1A4. The priming adapter (figure 9-48) is a plastic hexagonal-shaped device, approximately 1.1 inches long, 0.63 inch across the flat portion, and

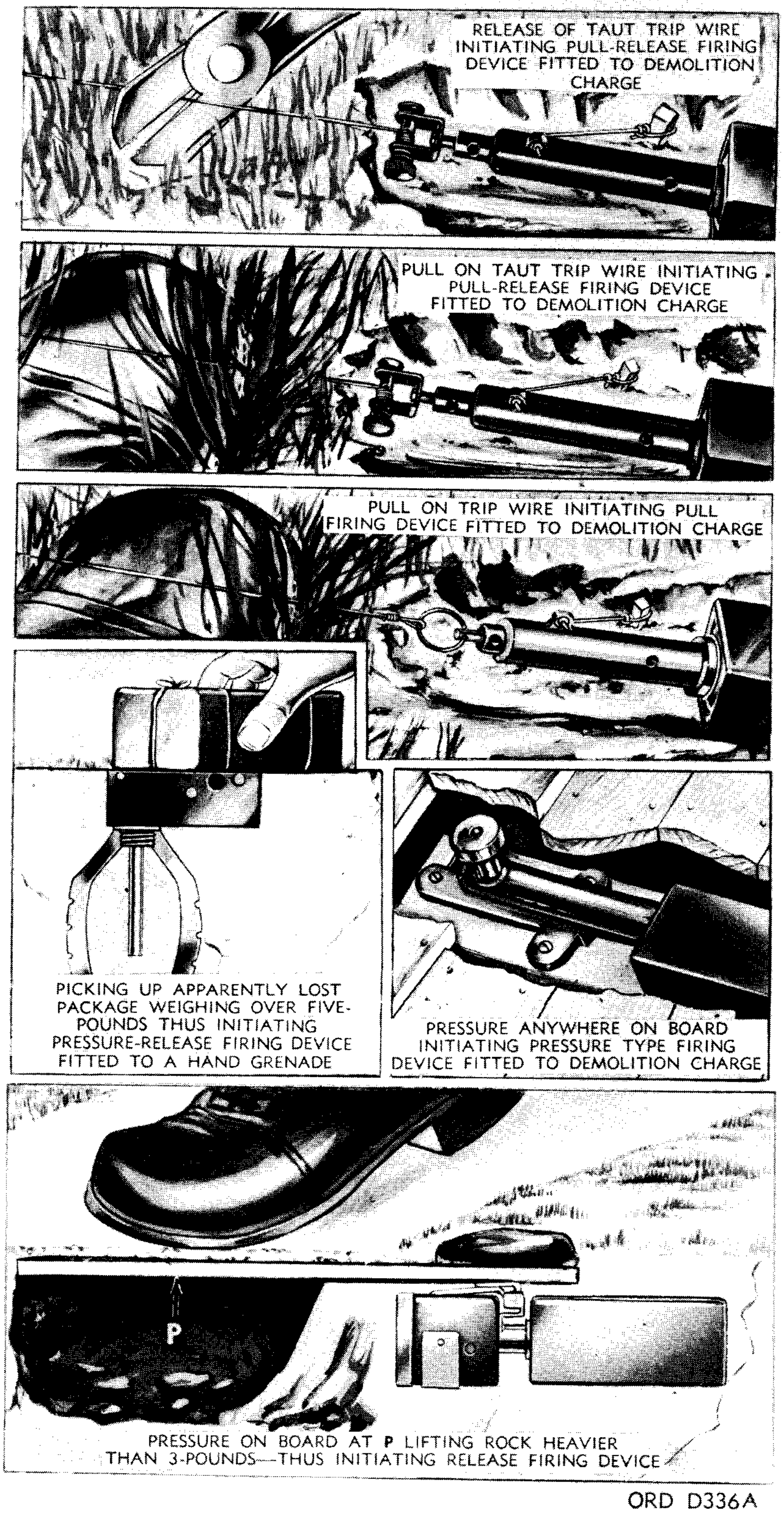


Figure 9-47. Representative methods for using firing devices in boobytrap installations.

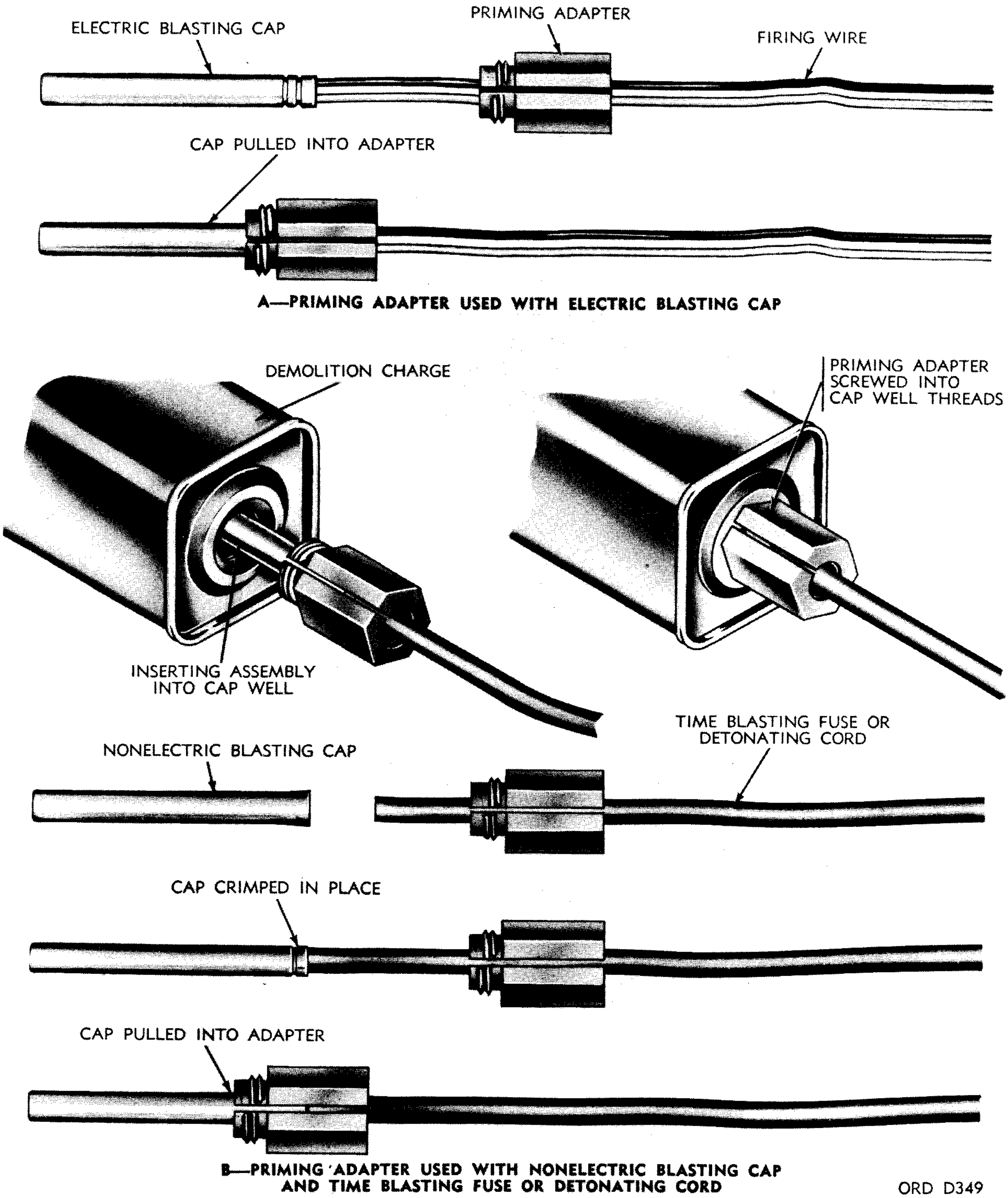


Figure 9-48. Use of explosive priming adapter M1A4 with electric and nonelectric blasting caps.

hexagonal-shaped for 0.85 inch of its total length, the balance of its length being threaded to fit female threads of threaded cap wells and the destructor M10 (page 9-P34). A shoulder inside one end is large enough to permit time fuse or detonating cord to pass through but too small for an Army special blasting cap. The adapter is slotted longitudinally, so the wires of an electric blasting cap can be inserted easily and quickly. The priming adapter M1A4 replaces the M1A2 and M1A3 models which are similar to the M1A4 but have cylindrical bodies. The hexagon-shaped M1A4 model can be more readily handled, using arctic mittens. This item simplifies the priming of military demolition explosives having threaded cap wells and utilizing Army special blasting caps, both electric and nonelectric. The priming adapter is used as indicated below.

(a) When used with electric blasting cap (A, figure 9-48), pass cap wires of the electric cap through slot of priming adapter. Pull cap into adapter. Insert cap into fuze well (cap well) of explosive. Screw the adapter into the well.

(b) When used with nonelectric blasting cap and time blasting fuse M700 (B, figure 9-48), pass the end of the fuse through the adapter. Crimp the nonelectric blasting cap to the fuse. Pull the cap into the adapter. Insert cap into cap well of explosive and screw adapter into place.

(c) When used with detonating cord, cut off and discard 6 inches from the end of the detonating cord. Use same method as for nonelectric cap and time blasting fuse. **Note. Detonating cord alone in the cap well of a TNT block is not sufficiently powerful to detonate it.**

(2) Blasting machines.

(a) General. Blasting machines are small electric generators that produce current for firing electric blasting caps. There are two types in Army use, the 10-cap twisting type and the 50- and 100-cap push-down-handle (rack bar) type. **Note. Blasting machines are not suitable for firing parallel-connected firing circuits.**

(b) Blasting machine: 10-cap. The 10-cap blasting machine (A, figure 9-49) is a component of blasting demolition kit electric and nonelectric, but may be requisitioned separately for replacement purposes. If operated correctly, it will fire 10 electric blasting caps properly connected in series. It weighs 5 pounds. When using this machine, proceed as indicated below. To be sure the machine is working properly and to loosen it up, operate it several times before attaching the firing wires. Insert the T-shaped handle. Insert the left hand through the strap and grasp the bottom of the machine very firmly as shown in C, figure 9-49. With the back of the right hand toward you, grasp the handle and give it a very vigorous clockwise turn as far as it will go.

(c) Blasting machine: 50-cap capacity. The 50-cap blasting machine fires 50 electric caps properly connected in series if operated correctly. It is operated by raising the handle to the top of its stroke, then pushing it rapidly and very forcefully downward as far as it will go.

(d) Blasting machine: 100-cap capacity. The 100-cap blasting machine is similar to the 50-cap machine, except for size and weight, and is operated in a similar manner. It weighs 40½ pounds and will fire 100 caps properly connected in series.

(e) Testing. 10-cap, 50-cap, and 100-cap blasting machines should be function-tested for adequacy and reliability.

(f) Care and preservation. **Note. A handbook of instructions is issued with each 50-cap blasting machine.** Blasting machines are of rugged construction but they house a delicate, electrical mechanism, hence the machine should be treated with care. No attempt will be made to disassemble or repair a blasting machine. Cleaning and oiling will be done only by authorized personnel. When not in use, machines will be stored in a clean, dry, and relatively cool place. Directions for care and

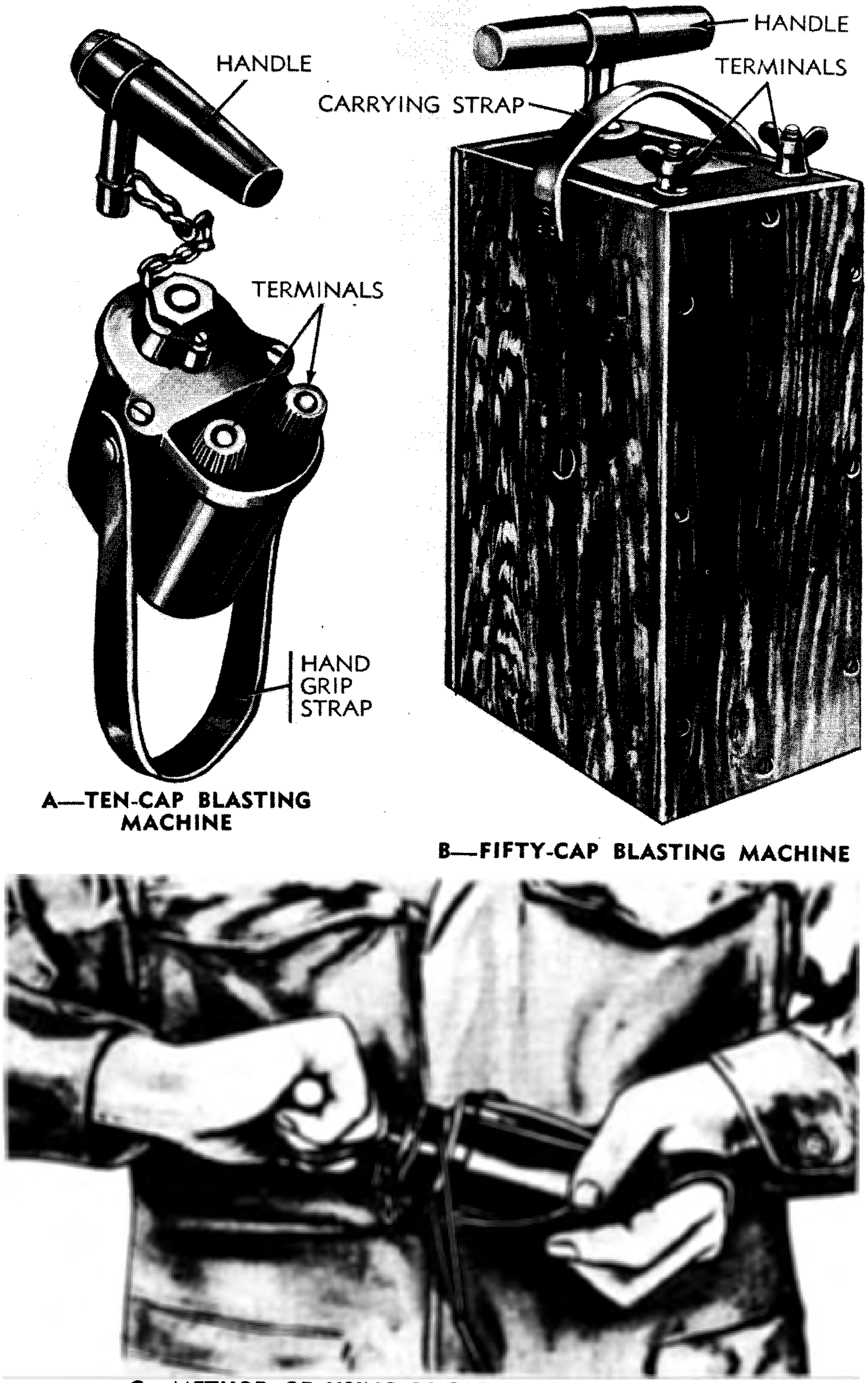


Figure 9-49. Blasting machines: 10-cap and 50-cap capacities.

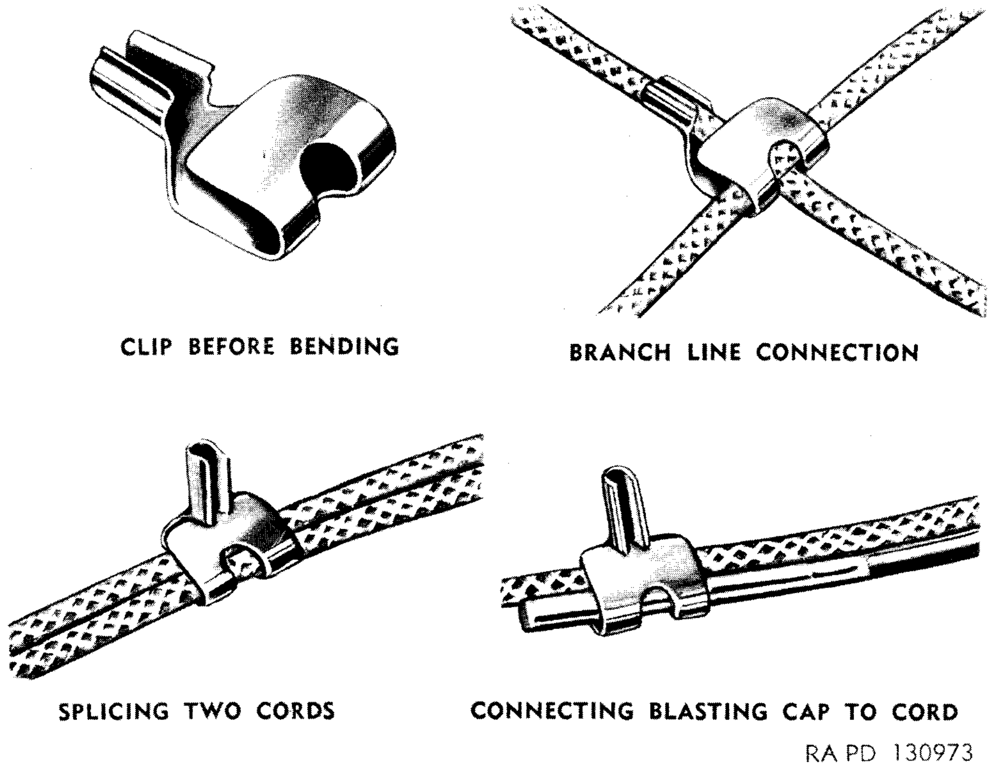


Figure 9-50. Clip, cord: M1, detonating-methods of use.

use on metal plates attached to each machine should be followed carefully.

(3) Clip, cord: M1 (figure 9-50) is a steel device used in making parallel and 90-degree detonating cord connections and also in priming detonating cord with blasting caps.

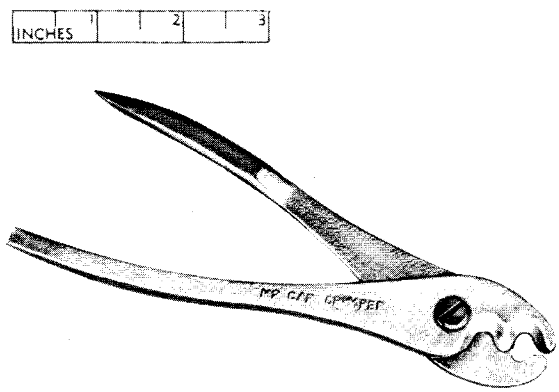


Figure 9-51. Crimper, cap: M2, w/fuse cutter.

(4) Crimper, cap: M2, with fuse cutter.

(a) This crimper (figure 9-51) is designed to squeeze the shell of the nonelectric cap tightly enough around safety fuse or time blasting fuse or detonating cord to prevent it from being

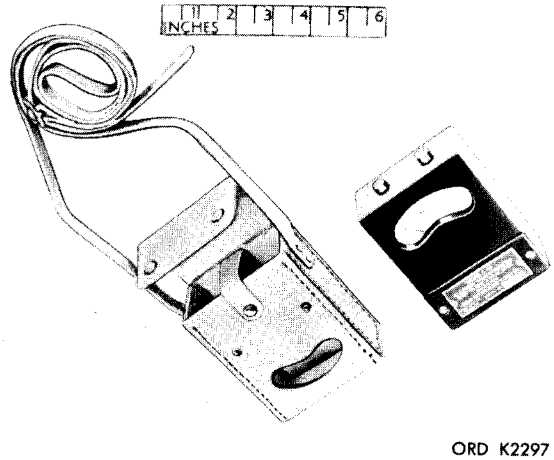


Figure 9-52. Galvanometer, blasting: with leather case and carrying strap.

pulled off easily and still not interfere with the burning of the powder train in the fuse. The lower portion of the jaws of the crimper are shaped and sharpened for cutting fuse or detonating cord. One leg of the handle is pointed for punching holes for caps of dynamite sticks. The other leg has a screwdriver end.

(b) The cutting jaws must be kept clean and must be used only for cutting fuse or detonating cord. The cap crimper must not be used as pliers.

(c) The crimper M2 has a narrow jaw that crimps a water-resistant groove completely around the cap. Earlier model cap crimpers have wider crimping jaws, which form a sleeve at the open end of the cap. Both crimpers are constructed so the jaws cannot be closed tightly enough to injure the cap or fuse.

(5) Galvanometer, blasting: with leather case and carrying strap.

(a) This galvanometer (figure 9-52) is used to test electrical firing circuits. It contains an electromagnet, a small special silver chloride dry-cell battery, and a division scale with indicator needle. The two types of batteries authorized for use in the galvanometer are indicated in (d) below. Some galvanometers also contain an ohms scale. When the two external terminals are joined by a closed circuit, the flow of current from the special silver chloride dry-cell battery causes the needle to move across the scale. The amount of deflection depends upon the amount of resistance in the closed circuit and on the strength of the dry-cell battery.

(b) The galvanometer is issued with a leather case and carrying strap. Lifting the top of the case exposes the terminals and scale which permits use of the galvanometer without removing it from the case. The case and carrying strap may be requisitioned separately for replacement purposes.

(c) The galvanometer must be handled with care and kept dry. Before using, it is tested by holding a piece of metal across its two terminals. If this does not cause a deflection of 23 to 25 units (25 units is full scale) of the needle, the special silver chloride dry-cell battery is weak and must be replaced.

(d) Two types of dry cell batteries authorized for use with this galvanometer are –

BA-245/u Special Silver Chloride Dry-Cell: 0.9 v total voltage; cylindrical shape; 2-terminal, stud and nut type: 3/4-inch diameter, 2 3/8 inch length.	Federal stock No 6135-128-1632	Authorized for use at temperatures ABOVE 0° F.
BA-2245/u Special Silver Chloride Dry-Cell: 0.9 v total voltage; cylindrical shape; 2-terminal, stud and nut type; corrosion-resistant; 3/4 inch diameter, 2 3/8 inch length.	Federal stock No. 6135-833-9909	Authorized for use at temperatures BELOW 0 ° F.

Warning: Only the special silver chloride dry-cell batteries specified above are safe for service in this galvanometer. Dry-cell batteries of the conventional type (flashlight or other) create an extreme hazard when substituted for the special silver chloride dry-cell batteries since the ordinary dry-cell battery furnishes sufficient current to detonate an electric blasting cap.

When using galvanometer at extremely cold temperatures, low temperature battery BA-2245/u is recommended. Battery BA-245/u will freeze and cease to function at temperatures below 0° F. Therefore, if battery BA-245/u is used at extremely cold temperatures, protect it from freezing by placing galvanometer under the clothing near the body. When using galvanometer at temperatures above 32° F., battery BA 245/u is recommended since low temperature battery BA-2245/u deteriorates rapidly at higher temperatures, even when not in use.

Note. All batteries last longer if stored at low temperatures. However, battery BA-2245/u MUST be stored under refrigeration to prevent deterioration.

(e) The special silver chloride dry-cell battery must be connected with proper polarity (red to +; black to –) to obtain correct operation of the galvanometer. Connect galvanometer leads to battery terminals and assure that meter shows a deflection of 23 to 25 units of the scale when a conductor is placed across the terminals of the galvanometer. If the meter shows reversed deflection of the needle, the battery connections must be reversed.

Caution: The special silver chloride dry-cell batteries are subject to corrosion within the galvanometer and should be removed when galvanometer is not to be used for extended periods.

(6) Test set, blasting cap: M51.

(a) This test set (figure 9-53) was developed to replace the blasting galvanometer for continuity testing of electrical firing circuits. The test set is a self-contained unit with a magneto-type generator, an indicator lamp, a handle to activate the generator, and two binding posts for attachment of firing leads. The test set is waterproof and may be used at temperatures as low as –40° F.

(b) To assure optimum useful life, keep test set dry and handle with care. Before using, assure that set is in operating condition as follows: Connect a piece of bare wire between the binding posts. Sharply depress handle while observing indicator lamp. If set is operative, lamp will flash. Remove wire and proceed to test firing circuit.

(c) Continuity testing is accomplished by connecting firing circuit to test set binding posts and then depressing handle sharply. If there is a continuous (intact) circuit (even one created by a short), indicator lamp will flash.

Note. Since test set M51 cannot discriminate between a firing circuit that is properly set up versus one with a short in it, special care must be taken in wiring the circuit to avoid shorting.

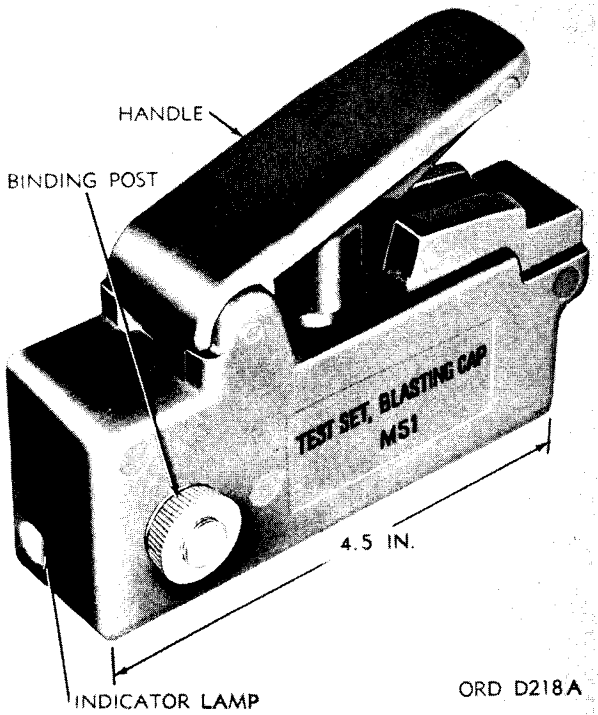


Figure 9-53. Blasting cap test set M51.

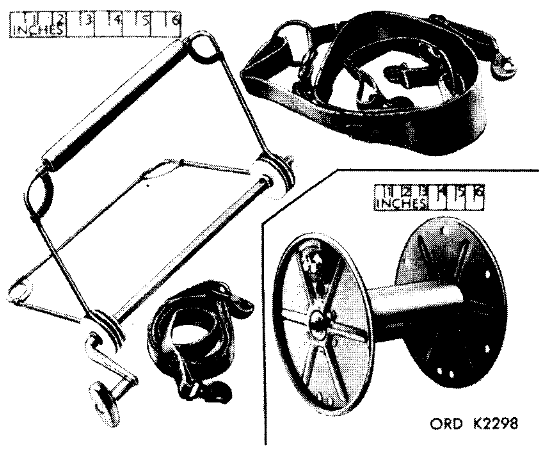


Figure 9-54. Reel, wire: firing, 500-feet, RL-39A, with two carrying straps, with winding device, without wire-components.

(7) Reels.

(a) Reel, wire: firing, 500-foot, RL-39A, with two carrying straps, with winding device, without wire. This firing wire reel (figure 9-54) consists of a spool, a handle assembly, and a crank axle. Two carrying straps are used to carry the reel (figure 9-55). The spool is 9 inches in diameter and about 8 inches wide. It has a capacity of 500 feet of 18-gage firing wire. The fixed end of the wire is brought from the spool through a hole in the side of the drum and fastened to brass thumb nut terminals. Two U-shaped steel rods form the handles. A loop at each end encircles a

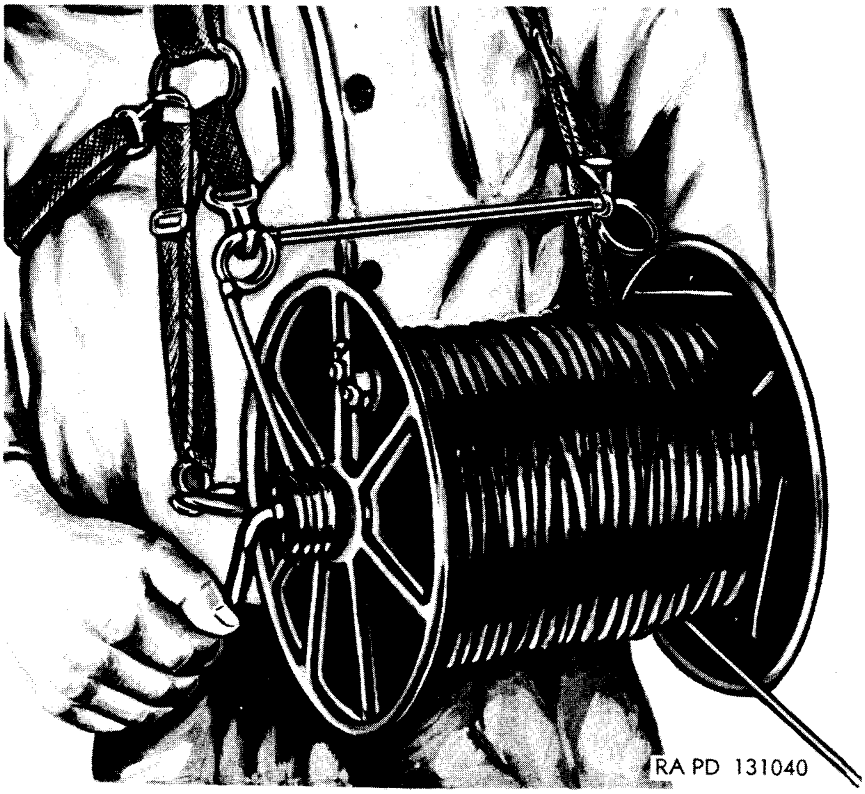


Figure 9-55. Reel, wire: firing, 500-feet, RL-39A, with two carrying straps, with winding device-assembled with wire.

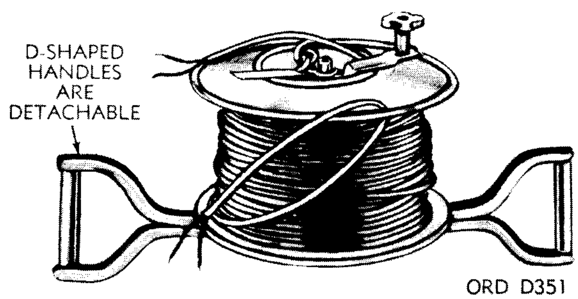


Figure 9-56. Reel, wire: firing, 500-feet, with two detachable D-shaped handles.

bearing assembly, consisting of a brass housing that contains a steel center to receive the axle. The axle is a square 5/16-inch shaft. A crank is riveted to one end and a hole near the other end receives a cotter pin, which holds the axle in place.

(b) Reel, wire: firing, 500-foot, with two detachable D-shaped handles. This firing wire reel (figure 9-56) is a metal drum mounted on an axle, to which two detachable D-shaped handles are fastened. The arm with knob on the side of the drum is used to crank it.

(c) Reel, wire: firing, 1,000-foot, empty. This item is similar to the item described in (b) above, except that it is empty and has a capacity of 1,000 feet of firing wire.

(8) Demolition kit, blasting: explosive initiating, electric and nonelectric.

(a) Components issued as basic kit. The basic kit consists of the items listed below. These items may also be requisitioned separately for replacement purposes.

Quantity	*Item*
2	BAG, CANVAS, CARRYING: demolition kit
1	BLASTING MACHINE: ten-cap capacity
5	BOX, CAP: ten-cap capacity, infantry
1	CHEST, DEMOLITION: engineer platoon, M1931.
2	CRIMPER, CAP: M2 (w/fuse cutter)
1	GALVANOMETER, BLASTING: (w/leather case and carrying strap)
2	KNIFE, POCKET
2	PLIERS: lineman's (w/side cutter), length 8 inches
1	REEL, WIRE: firing, 500 ft, RL-39A, (w/carrying straps, w/winding device, w/spool, w/o wire).
2	TAPE, COMPUTING: demolition charge

Note. In newer demolition kits the blasting galvanometer is replaced by blasting cap test set M51 (figure 9-53).

(b) Components issued separately. The following items are required to complete the kit and should be on hand at all times. These items are not supplied with the kit, and must be requisitioned separately.

Nonexplosive components

Quantity	*Item*
60	ADAPTER, PRIMING, M1A4
2	ADHESIVE: paste, for demolition charges ½ lb. can, M1.
1	CABLE, POWER, ELECTRICAL: firing, vinyl polymer insulation, two conductor, No. 18 AWG stranded, 500-ft coil.
50	CLIP, CORD: M1, detonating.
6	INSULATION TAPE, ELECTRICAL: black adhesive 3/4-inch wide.
1	SEALING COMPOUND: blasting cap, waterproof, ½-pt can.
2	TWINE: hemp, No. 18, 8-oz. ball
2	WIRE, ELECTRICAL: annunciator, waxed double cotton wrapped insulation, solid single conductor, No. 20 AWG, 200-ft coil.

Note. Newer demolition kits will contain one roll of TAPE, PRESSURE-SENSITIVE ADHESIVE FILM, 2 inches wide, 72 yards long, instead of 2 cans of adhesive M1.

Explosive components

Quantity	*Item*
50	CAP, BLASTING: special, electric (type II(J-2 PETN)).
50	CAP, BLASTING: special, nonelectric (type I (J-1 PETN)).
40	CHARGE, DEMOLITION: block, M5A1, 2½ lb. Comp. C-4.
50	CHARGE, DEMOLITION: block, 1 lb. (TNT).
5	CORD, DETONATING: fuse, primacord 100-ft. spool.
5	DESTRUCTOR, EXPLOSIVE: universal, M10.
2	FUSE, BLASTING, TIME: 50-ft. coils.
50	IGNITER, BLASTING FUSE: M2, weatherproof.

(9) Demolition kit, blasting: explosive initiating, nonelectric.

(a) Components issued as a basic kit. The basic kit consists of the items listed below. These items may also be requisitioned separately for replacement purposes.

Quantity	*Item*
2	BAG, CANVAS, CARRYING: demolition kit.
2	BOX, CAP: 10-cap capacity, infantry.
2	CRIMPER, CAP: M2 (w/fuse cutter).
2	KNIFE, POCKET.
2	TAPE, COMPUTING: demolition charge.

(b) Components issued separately. The following items are required to complete the kit and should be on hand at all times. These items are not supplied with the kit, and are to be requisitioned separately.

Nonexplosive components

Quantity	
20	*ADAPTER, PRIMING: M1A4*
2	*ADHESIVE: paste, for demolition charges, ½ lb can, M1.*
50	*CLIP, CORD: M1, detonating.*
2	*INSULATION TAPE, ELECTRICAL: black adhesive, 3/4 inch wide.*
1	*SEALING COMPOUND: blasting cap, waterproof, ½ pt can.*

Note. Newer demolition kits will contain one roll of TAPE, PRESSURE-SENSITIVE ADHESIVE FILM, 2 inches wide, 72 yards long, instead of 2 cans of adhesive M1.

Explosive components	
Quantity	
50	CAP, BLASTING: special, nonelectric (Type I (J-1 PETN)).
40	CHARGE. DEMOLITION: block, M5A1, 2½ lb Comp C-4.
200	CORD, DETONATING: fuse, primacord, 100 ft spool.
2	DESTRUCTOR, EXPLOSIVE: universal, M10.
100	FUSE, BLASTING, TIME: 50-ft coils.
50	IGNITER, BLASTING FUSE: M2, weatherproof.

(10)Explosive kit, earth rod: set No. 1.

(a) General. This kit (figure 9-57), is used for making holes for demolition or constructional purposes as deep as 6 feet and as large in diameter as several inches in earth and soft shale. It is not usable in rock or other hard material.

(b) Description. The kit consists of the nonexplosive and explosive items as listed in (c) below. The main rod is of steel, 6 feet in length and 1¼ inches in diameter. The point, which is 1½ inches in diameter, fits the lower end of the rod and a cylindrical firing chamber, 15 inches long and 4 9/16 inches od, screws on the upper end of the rod. The rod is driven into the earth by the propelling charge M12 exploded in the firing chamber. The propelling charge is exploded by primer M44 which is initiated by time blasting fuse igniter. A removable handle (extractor rod), which fits through holes in the walls of the firing chamber, and is used for gripping and lifting the rod, and an extension which is for lengthening the rod, are used to pull the rod from the earth. The tripod furnished with the kit consists of a 4 3/4 inch ring supported on three adjustable legs. In order to

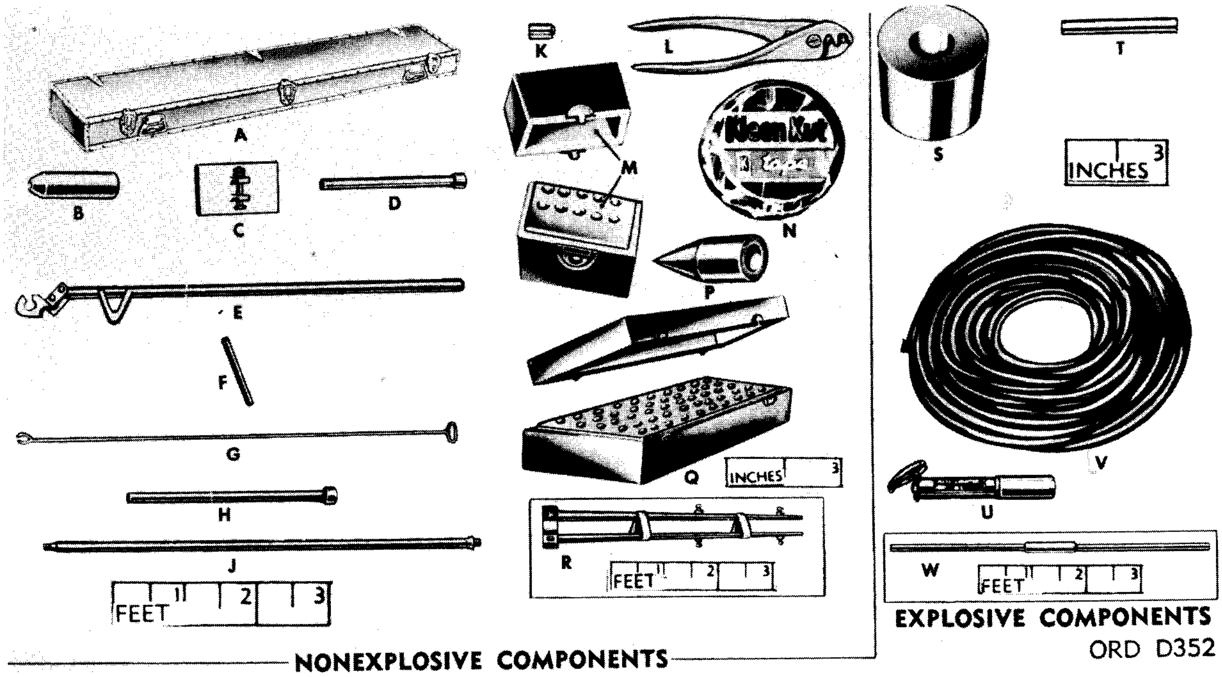


Figure 9-57. Explosive Kit, earth rod: set No. 1.

hold the assembled rod steady for firing, the firing chamber is held within the ring of the tripod, which is centered over the point where the hole is to be made. A linear charge is furnished with the kit for enlarging the diameter of the hole made by the main rod and point. A forked inserting rod is furnished for inserting an improvised linear charge (made up of a bundle of detonating cords) into the hole made by the main rod and point. Such improvised charges may be used as an expedient for enlarging holes to various diameters (depending on the number of detonating cords used in the bundle) when a standard linear charge is not available. The blasting caps and time blasting fuse furnished with the kit are used for detonating either the standard linear charge, or an improvised linear charge.

(c) Components. **Note. The item letters below are keyed to figure 9-57.**

Nonexplosive items

Item letter	*Quantity*	*Item*
A	*1*	*CHEST*
B	*1*	*CHAMBER: firing*
C	*1*	*PLATE: base, extractor, assy.*
D	*1*	*ROD: extension*
E	*1*	*EXTRACTOR: rod*
F	*1*	*ROD: handles and starting*
G	*1*	*ROD: inserting*
H	*2*	*ROD: intermediate*
J	*2*	*ROD: main, long*
K	*100*	*ADAPTER, PRIMING: explosive, M1A3 or M1A4.*
L	*1*	*CRIMPER, CAP: M2 (w/fuse cutter)*
M	*1*	*BOX, CAP: 10-cap capacity, infantry.*
N	*2*	*INSULATION TAPE, ELECTRICAL: black adhesive cotton, 3/4-inch wide.*
P	*100*	*POINT.*
Q	*2*	*BOX, CAP: 50-cap capacity, engineer.*
R	*1*	*TRIPOD*

Explosive items

Item letter	*Quantity*	*Item*
S	*100*	*CHARGE, PROPELLING, EARTH ROD: M12 (w/primer, M44).*
T	*100*	*CAP, BLASTING: special nonelectric (type I (J-1 PETN)).*
V	*2*	*FUSE, BLASTING, TIME: 50-ft. coils.*
U	*200*	*IGNITER, TIME BLASTING FUSE: M2, weatherproof.*
W	*100*	*CHARGE, DEMOLITION: linear (two 3-ft. sections and one connecting sleeve).*

(11)Demolition kit, bangalore torpedo: M1A1.

(a) General. This kit (figure 9-58) consists of a group of 10 loading assemblies (steel tubes filled with high explosive), which are used singly or in series with nose sleeve and connecting sleeves, for blasting a path through barbed-wire entanglements or other obstructions, or used in bundles as substitute explosive charges in the antitank mine-clearing projected charge demolition kits.

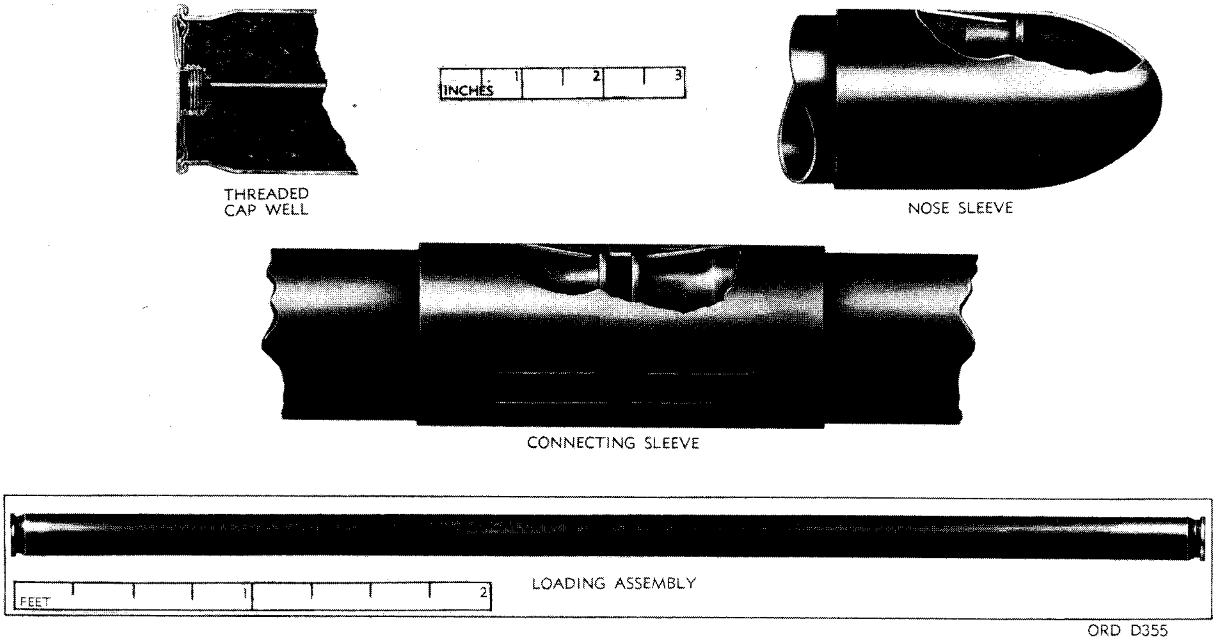


Figure 9-58. Demolition kit, bangalore torpedo: M1A1.

(b) Description and functioning. The loading assemblies (tubes) are 5 feet in length and 2 1/8 inches in diameter, grooved, and capped at each end. The explosive in the tubes is amatol, with a 4-inch booster of TNT at each end. The total weight of explosive in each tube is about 9 pounds. Each end of the loading assembly (tube) contains a threaded cap well, to accommodate any issue firing device with a blasting cap crimped thereto. The nose sleeve has a rounded point at each end, for ease in pushing the tube or tubes through obstacles, and a single clip, which holds the nose sleeve in place at the end of a tube. The connecting sleeve is a short cylindrical coupling, into which the ends of two tubes can fit and be used, or any number of loading assemblies may be used as required. In assembling two or more tubes, a nose sleeve is pressed onto one end of one tube, then the other end of this tube is connected to a second tube by a connecting sleeve, and so on until the desired number of tubes are connected. Detonation of a charge in a tube or all charges in a series of tubes may be accomplished by a firing device with blasting cap screwed into the cap well of the tail end of a tube or the tail end of the last tube in a series. Detonation may also be accomplished by an electric blasting cap with the leads connected to a source of electric current, or by a nonelectric blasting cap attached to time blasting fuse and fuse igniter. An alternate method of detonation may be by wrapping a minimum of four turns of detonating cord around the tube in a one-tube assembly, or around any tube in a multiple-tube assembly, and detonating the detonating cord with a delay detonator or with an appropriately arranged blasting cap primed by a time blasting fuse and fuse igniter.

(c) Packing. Demolition kit, bangalore torpedo: M1A1, is packed in a wooden box, which contains ten 5-foot assemblies (tubes), 10 connecting sleeves, and 1 nose sleeve. The dimensions of the box are 64 1/8 inches long, 13 3/8 inches wide, and 7 1/8 inches high. The gross weight of the kit as packed is 176 pounds.

e. Mine clearing devices.

(1) Demolition kit, projected charge: M1E1.

(a) General. This kit (figure 9-59) consists of a flexible linear charge together with other components required to carry and lay the charge in position. It is used to clear narrow lanes through antipersonnel mine fields (figure 9-60).

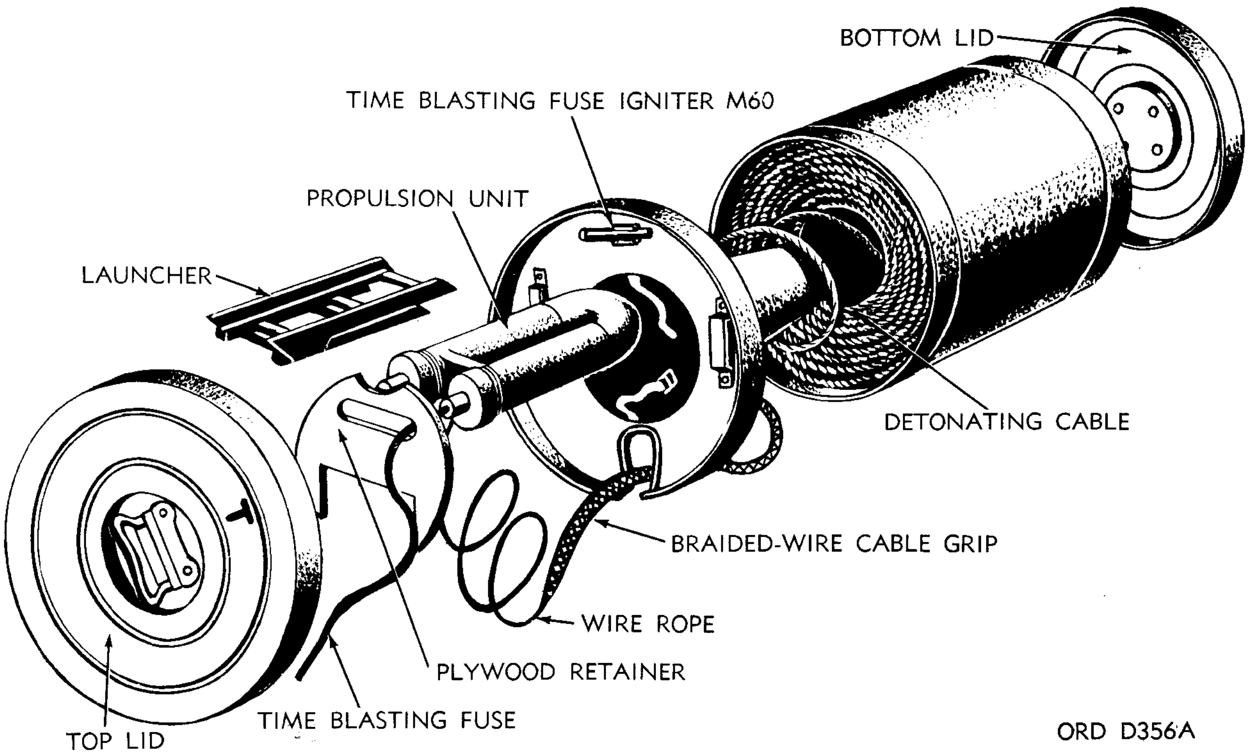


Figure 9-59. Demolition kit, projected charge: M1E1, arrangement of components in case.

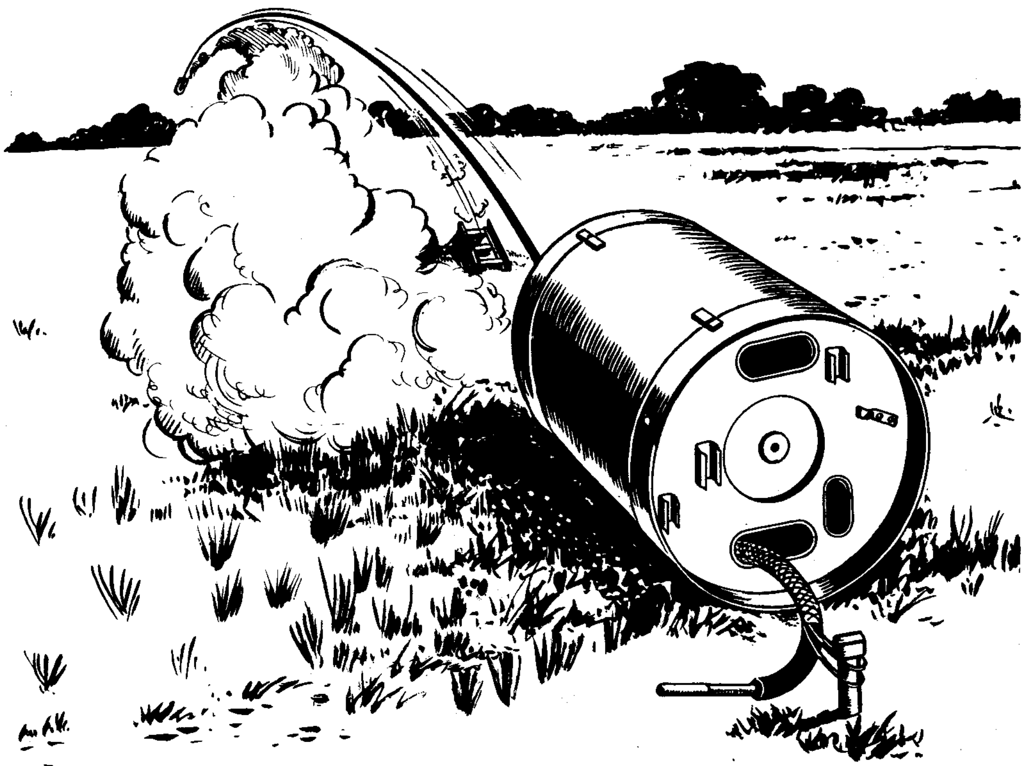


Figure 9-60. Demolition kit, projected charge: M1E1, laying cable over antipersonnel mine fields.

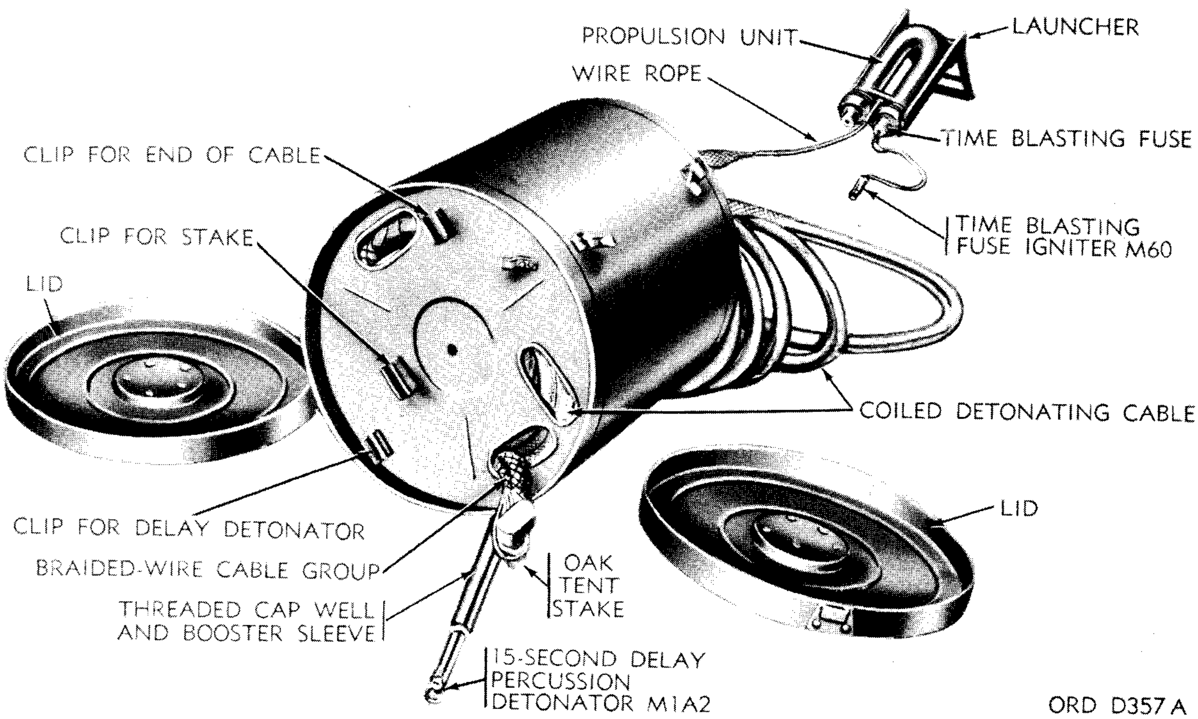


Figure 9-61. Demolition kit, projected charge: M1E1, ready for firing.

(b) Description. The nylon-covered detonating cable is 170 feet long and about 1 inch in diameter, weighs 63 pounds, and contains 46 pounds of oil-soaked PETN. This charge consists of 19 strands of special detonating cord, each strand containing approximately 100 grains of PETN per foot. This contrasts with the 50-60 grains per foot contained in regular detonating cord, which should not be used as a substitute. The cable is coiled around a cone in a carrying case. The cone is removed from the case before the unit is fired. One end of the cable is anchored to the ground and has a sleeve containing a booster charge and a threaded cap well for inserting a 15-second delay detonator. This end also has a braided wire cable grip with two 8-inch wire loops for anchoring the cable to a 13-inch oak tent stake driven into the ground (figure 9-60). The launcher is a folding stand made of small aluminum angles. When set up on level ground with the propulsion unit (rocket motor) on the launcher, the angle of elevation is 38 degrees (figure 9-61). A weatherproof time blasting fuse igniter M60 (figure 9-26) is provided for igniting the propulsion unit, a 15-second delay percussion detonator M1A2 (figure 9-31) for exploding the cable, and a 13-inch oak tent stake for anchoring one end of the cable. The entire assembly is contained in a cylindrical aluminum can (figures 9-62, 63 and 64) 16½ inches in diameter, 20 inches long, and weighing 92 pounds. Both ends of the can have removable lids with carrying handles. The joints between the lids and the case are waterproofed. The loaded case is designed for transportation to the firing point by two men.

(c) Functioning. The cable is projected across the mine field by the propulsion unit (rocket motor) from a launcher, where it is exploded by a 15-second delay detonator. Grass, leaves, other light vegetation, and some soil are blown aside in a lane about 8 feet wide. More soil is blasted aside when the ground is moist and soft than when dry and hard. Camouflaged antipersonnel mines and those near the surface in the 8-foot lane normally are exposed.

1. Mines. If the cable is less than 6 inches off the ground, pressure-type anti-personnel mines with the pressure surface directly under the cable are detonated or destroyed. Pressure-type mines within 5 feet of the cable may or may not be fired, depending on the particular mine installation. *Caution: Mines not exploded by the cable may become extremely sensitive.*

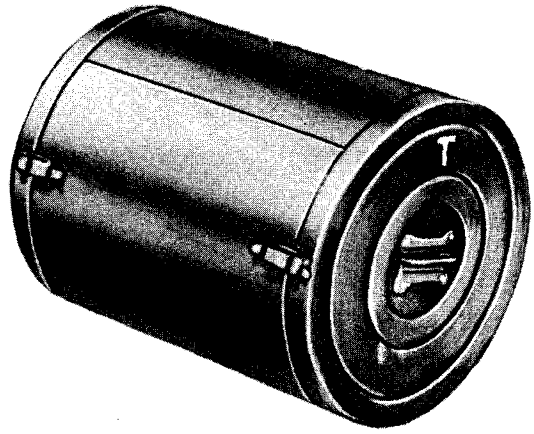


Figure 9-62. Demolition kit, projected charge: M1E1, carrying case.

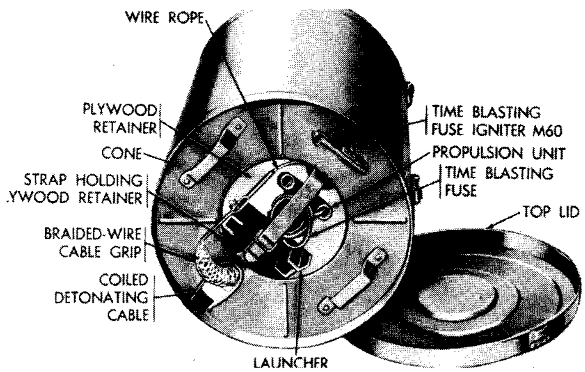


Figure 9-63. Demolition kit, projected charge: M1E1, top lid of case removed.

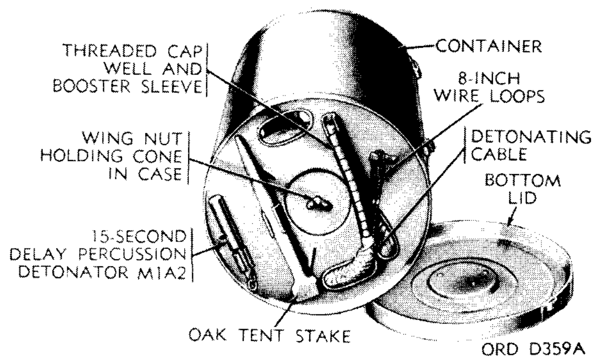


Figure 9-64. Demolition kit, projected charge: M1E1, bottom lid of case removed.

2. Trip wires. The detonation of the cable across trip wires either cuts the wires or detonates the mines to which they are connected.

(2) Demolition kit, projected charge: M3A1.

(a) General. This kit consists of semirigid projected charges approximately 400 feet long, together with the accessories and tools required to assemble the charges and attach them to a light or medium tank. An assembled projected charge must be pulled or pushed into place by a tank or other suitable vehicle (figure 9-65). These projected charges are used to clear wide paths through antitank mine fields.

(b) Description. This projected charge consists of two parallel linear explosive charges encased between corrugated aluminum plates bolted together to form a rigid assembly, which can be towed or pushed by a light or medium tank. It is flexible in vertical plane to permit it to pass over rough ground and rigid enough in horizontal plane so it will maintain a relatively true course when being pushed. The assembled projected charge, shown in cross-section in figure 9-66, is 14 inches wide, 5 inches high, and 400 feet long. It weighs approximately 9,000 pounds, including 4,500 pounds of explosives. A list of parts which comprise the projected M3A1 charge is given in

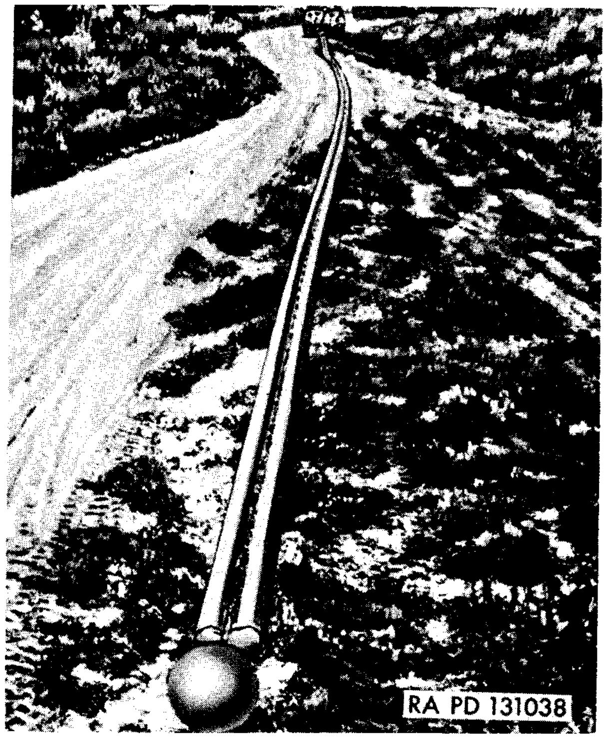


Figure 9-65. Medium tank pushing projected charge M3A1.

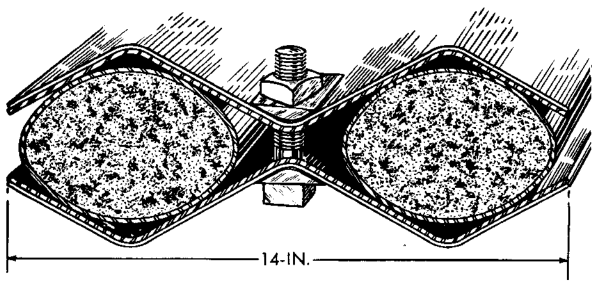


Figure 9-66. Cross section of projected charge M3A1 loaded with linear demolition charges.

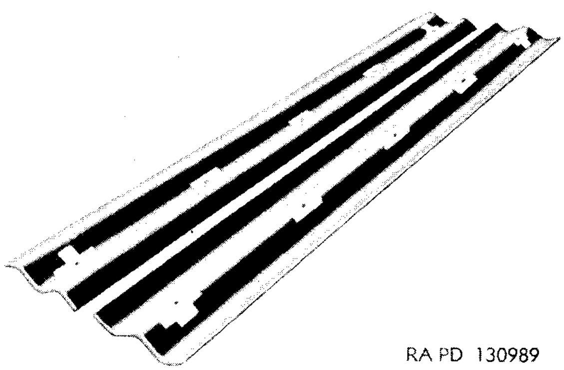


Figure 9-67. Corrugated aluminum plates for projected charge M3A1.

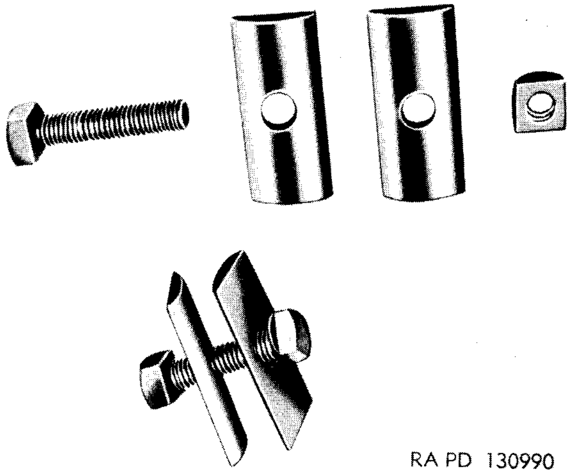


Figure 9-68. Bolts, washers, and nuts for projected charge M3A1.

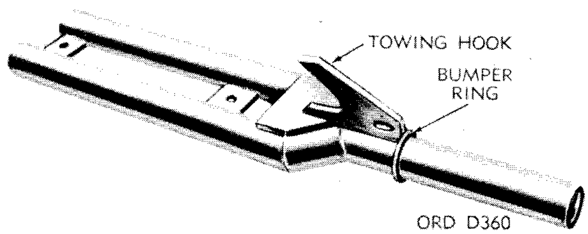


Figure 9-69. Nose adapter and towing hook for projected charge M3A1.

Table 9-12. Components of 400-Foot Projected Charge M3A1.

Item	Quantity
Nonexplosive components:	
Corrugated aluminum body plate	200
11/16-in. bolt, 3 in. long	210
Special washer	420
11/16-in. square nut	210
Nose	1
Nose adapter and towing hook	1
Nose retainer	1
Tamping bag	40
Pushing hook	1
Fuze shield	2
Tail ramp	1
Explosive components:	
Linear demolition charge for projected charge M3A1.	128
Bullet impact fuze M1A1	2

table 9-12. The corrugated aluminum plates (figure 9-67) form the body of the projected charge. Top and bottom plates are identical. Each plate is 9 feet long and 14 inches wide, about 1/8 inch thick, and weighs 16 pounds. Five holes are spaced 2 feet apart along the center of the plate, starting 6 inches from either end. The plates are painted olive drab, with a patch of white paint

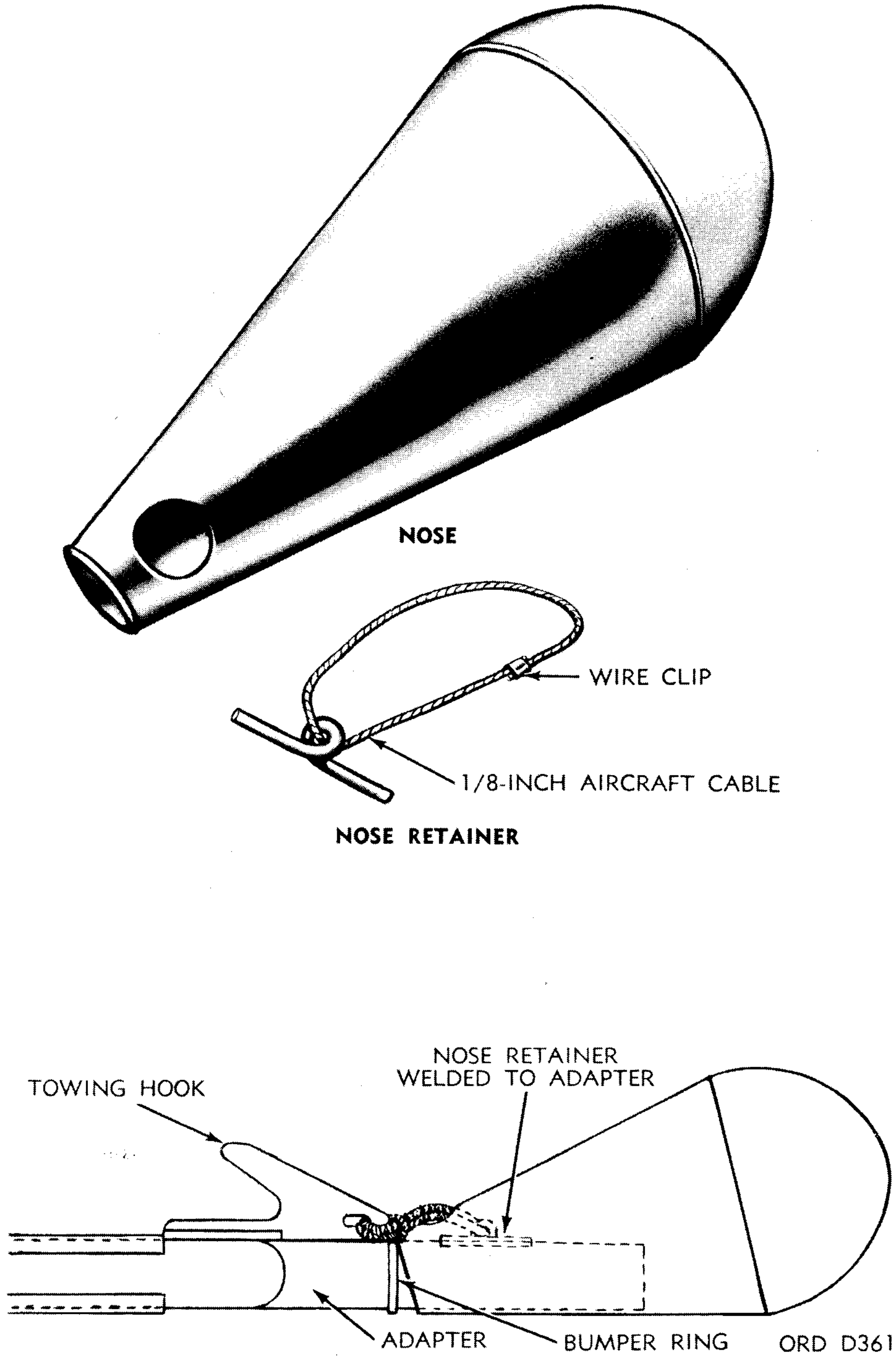


Figure 9-70. Nose and nose retainer for projected charge M3A1.

around each bolt hole for ease in locating holes in night assembly. Eleven-sixteenths diameter by three inches long steel bolts, washers, and nuts (figure 9-68) are used to fasten the corrugated plates together. The washers are specially shaped to assure a uniform bearing surface. Nut and bolt heads are 1 inch square. The nose adapter (figure 9-69) connects the projected charge to the nose. It is fitted between the body plates at the forward end of the projected charge and is secured by two bolts, which fasten the plates together. The towing hook (figure 9-69) is an integral part of the adapter, being welded to its upper side as shown. A bumper ring around the adapter just forward of the towing hook prevents the nose from sliding too far back over the adapter. The hollow pear-shaped aluminum nose (figure 9-70) fits over the nose adapter. It is lashed to the adapter with

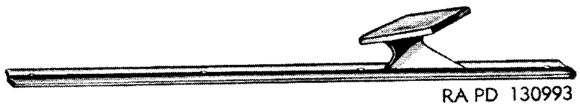


Figure 9-71. Pushing hook for projected charge M3A1.

the 1/8-inch aircraft cable. This cable, which is looped through the slot in the towing hook, is passed through the 3-inch hole in the tapered part of the nose, then through the loop in the nose retainer, and the ends of the cable joined with a wire clip. The nose is free to swivel slightly in any direction and aids in guiding the forward end of the projected charge over or around obstructions, such as trees or boulders. The pushing hook assembly (figure 9-71) consists of a hook welded to a steel bar, which has four bolt holes for attachment to the projected charge. A flat steel plate welded on the top of the hook bears against the belly of the tank during pushing operations. The assembly is bolted to the projected charge's rearmost plate, starting with the second bolt hole from the rear end. Two bullet impact fuzes M1A1 (figure 9-72) are issued with each projected charge demolition kit M3A1. The fuze consists of a target plate of 3/8-inch steel, spring mounted on three studs, and a body, which contains a detonator and two shaped-charge boosters. The target plate bears on a firing pin, which is restrained by a shear pin and safety fork. The safety fork must be removed before the fuze can be operated. In placing the fuze, care must be exercised to have the semicircular end up, since the effect of the two shaped boosters is directly downward, perpendicular to the two flat edges. The fuze M1 (figure 9-73), which may also be used, is similar to the M1A1, except for minor constructional differences. The fuze shield (figures 9-74 and 9-75) serves as a bracket for mounting the fuze and protects it from view and from premature detonation or damage by frontal small-arms fire. A cotter pin chained to the shield is inserted in a hole in the shield to hold the fuze in position.

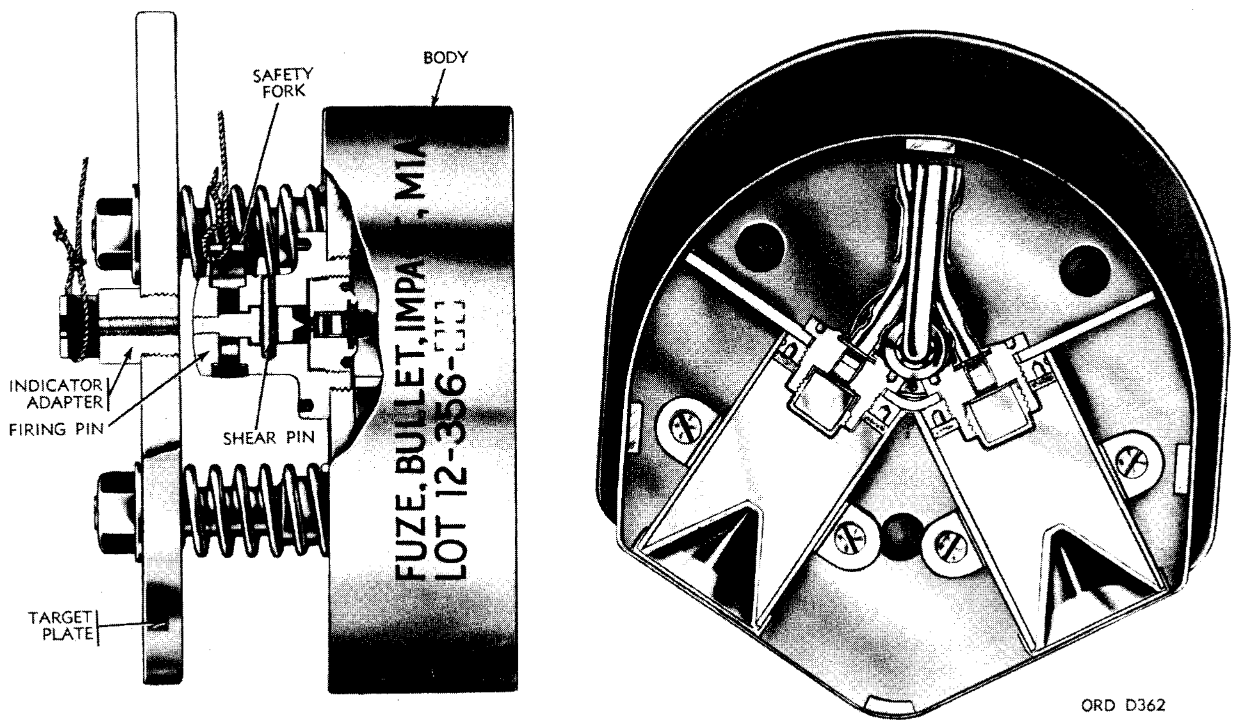


Figure 9-72. Fuze, bullet impact: M1A1-cutaway and rear view.

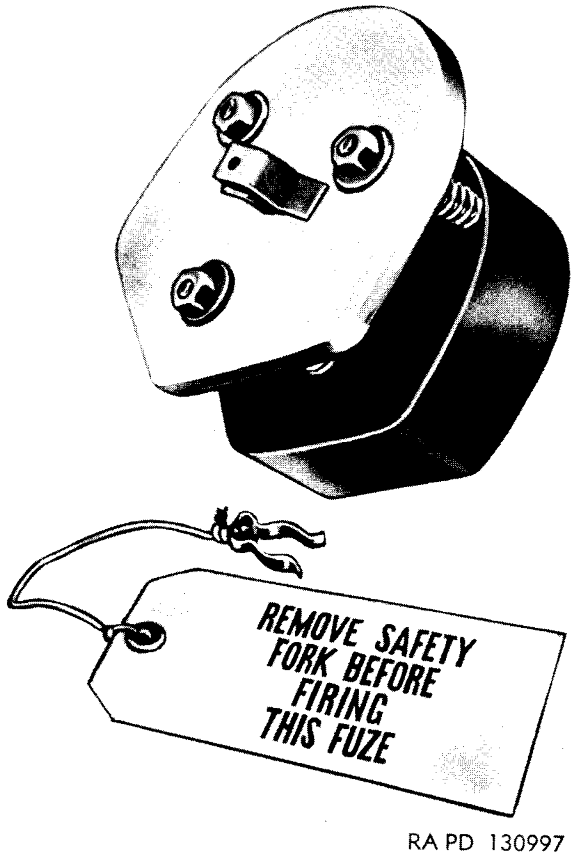


Figure 9-73. Fuze, bullet impact: M1.

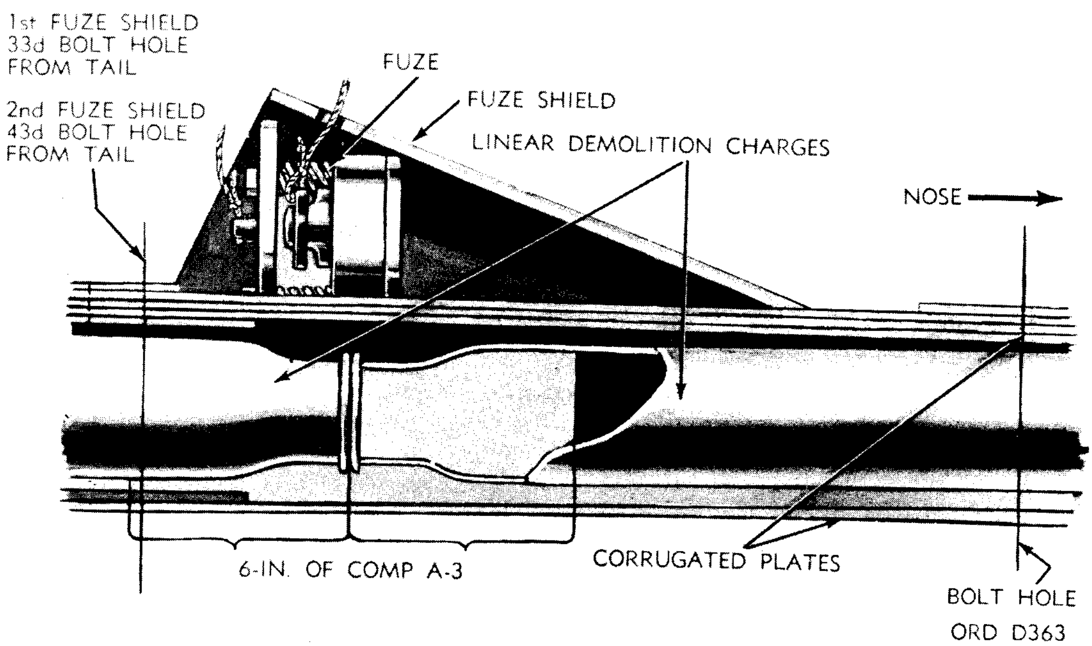


Figure 9-74. Longitudinal section of projected charge M3A1 at fuze.

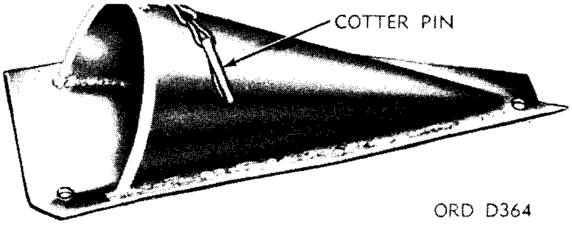


Figure 9-75. Fuze shield for projected charge M3A1.

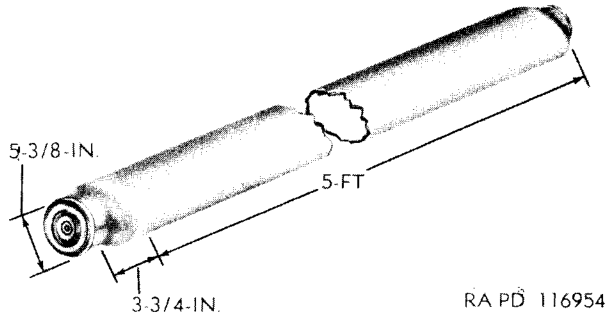


Figure 9-76. Linear demolition charge for projected charge M3A1.

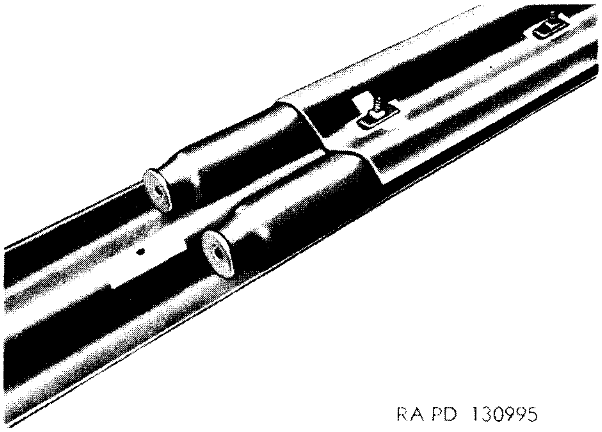


Figure 9-77. Projected charge M3A1 loaded with linear charges.

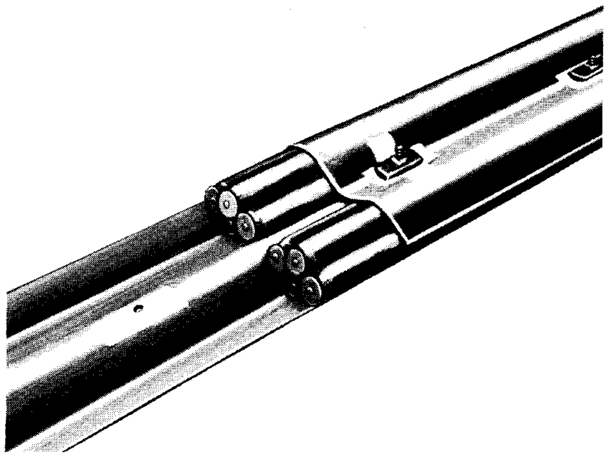


Figure 9-78. Projected charge M3A1 loaded with bangalore torpedoes.

In bolting the shield to the projected charge, it is necessary that the ends of the linear charges be centered directly below the body of the fuze; otherwise, the composition of the charge may not detonate. Explosive elliptical linear charges (figures 9-76 and 9-77) are issued with the projected charge demolition kit M3A1. They are 5 3/8 inches wide, 3 3/4 inches high, and 5 feet long, and weigh 40 pounds, each including approximately 35 pounds of explosive. The bulk of the explosive is composition B, with a 6-inch booster charge of Composition A-3 in each end. One end contains a cap well to receive a blasting cap for use when the charges are used individually for general demolition work. One hundred and twenty-eight charges are loaded in 320 feet of the 400-foot projected charge giving an explosive weight of 14 pounds per foot. Bangalore torpedos may be used as alternate explosive charges when projected charge explosive charges are not available or when stubs of exploded projected charges are salvaged to build new projected charges. A bundle of four bangalore torpedos (figure 9-78) is loaded in each corrugation of the projected charge. The eight bangalore charges (torpedos) give an explosive weight of 14.4 pounds per foot. The tail ramp (figure 9-79) is a small, hinged, steel skid, which fastens to the rearmost bolt of the projected charge. The hinged bar extends beyond the last corrugated plate and drags on the ground to prevent the pushing chain from fouling on the end of the projected charge when engaging the pushing hook. Forty-eight cloth or paper bags, 4 inches in diameter and 24 inches long, are furnished with each projected charge for use as tamping bags (figure 9-80) to prevent the charges from shifting. They are filled with dirt to within 3 inches of the top, the end is folded over, and the bags are placed in both ends of the projected charge. The projected charge is normally detonated by firing at one of the fuzes mounted on the projected charge with either machinegun mounted on the tank. Two fuzes are

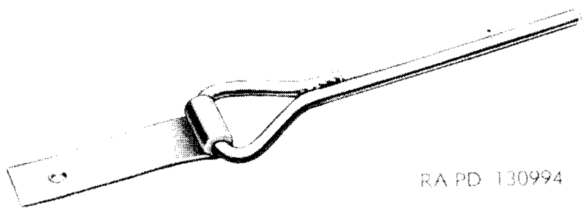


Figure 9-79. Tail ramp for projected charge M3A1.

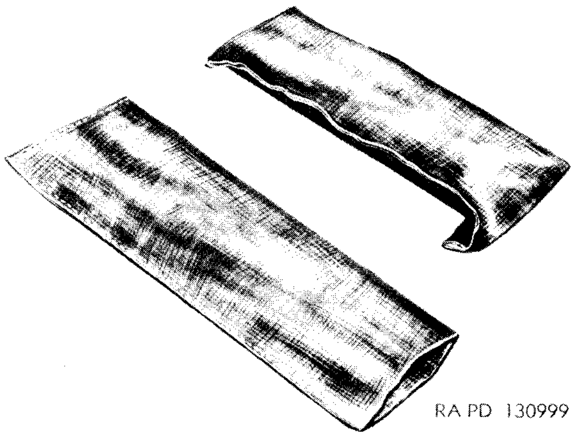


Figure 9-80. Tamping bags for projected charge M3A1.

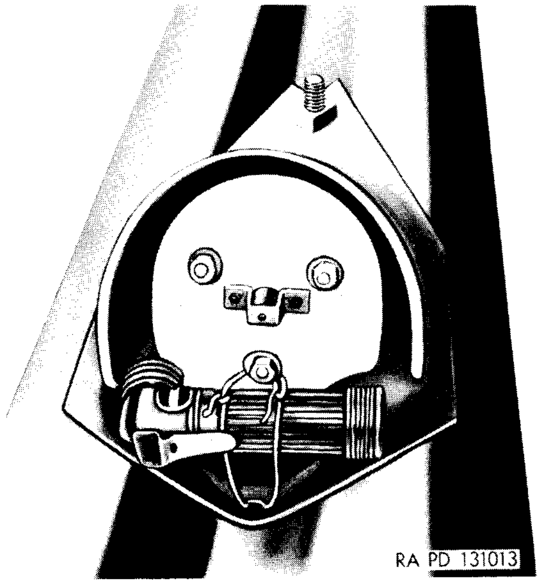


Figure 9-81. Bullet impact fuze illuminated by flashlight.

provided, because the position of the projected charge may place one of the fuzes where it is difficult to see or hit. The coaxially mounted machinegun is generally the better gun to use because it is mounted higher in the tank. In medium tanks where the periscope fitting is inserted in the hatch cover, the bow gunner's view is obstructed; hence, the coaxial gun must be used when firing at night with the fuzes illuminated (figure 9-81). If neither fuze can be hit by machinegun fire, the projected charge is detonated by a direct hit from the tank gun (37mm and over), using a high-explosive projectile with superquick fuze. The projected charge will detonate when any loaded section is hit. Fire should not be directed at the rear 60 feet of the projected charge which contains no explosive.

(3) Demolition kit, projected charge: M157.

(a) General. This kit (figure 9-82) is an antitank, minefield-clearing device which is designed to be towed (dragged) or pushed for emplacement by a medium tank (M48 or M60 series) with accessories. This demolition kit is utilized to clear a path large enough for tanks, vehicles, and personnel to travel through minefields planted with single-pulse, pressure-type mines. This demolition kit is flexible enough in the vertical plane to permit it to pass over rough terrain and rigid enough in the horizontal plane so that it will maintain a relatively true course when being pushed. The flexibility and rigidity is accomplished by use of a joint system and a series of pushing bars running through rectangular enclosures or tunnels in section assembly.

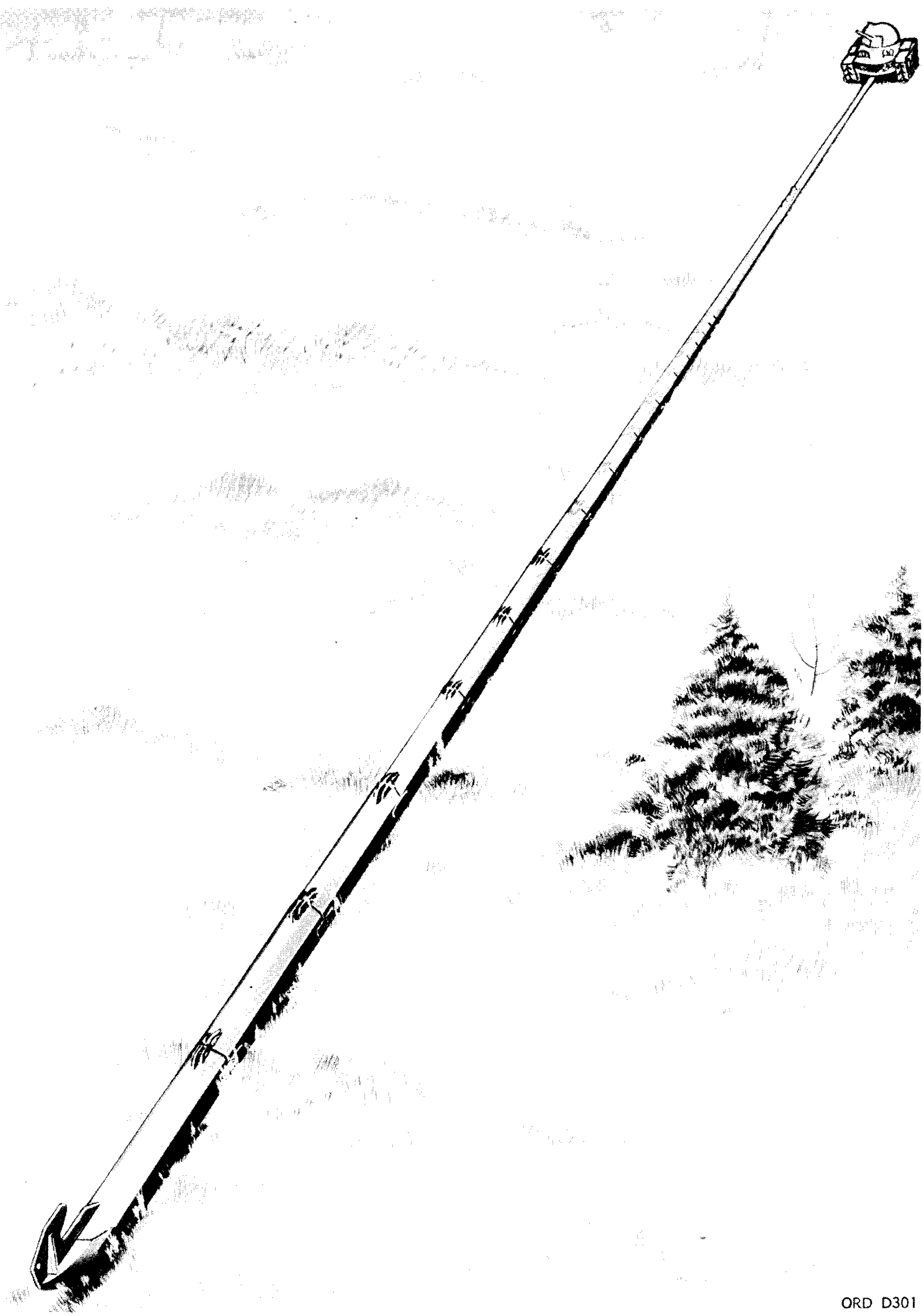


Figure 9-82. Medium tank pushing the Demolition Kit M157.

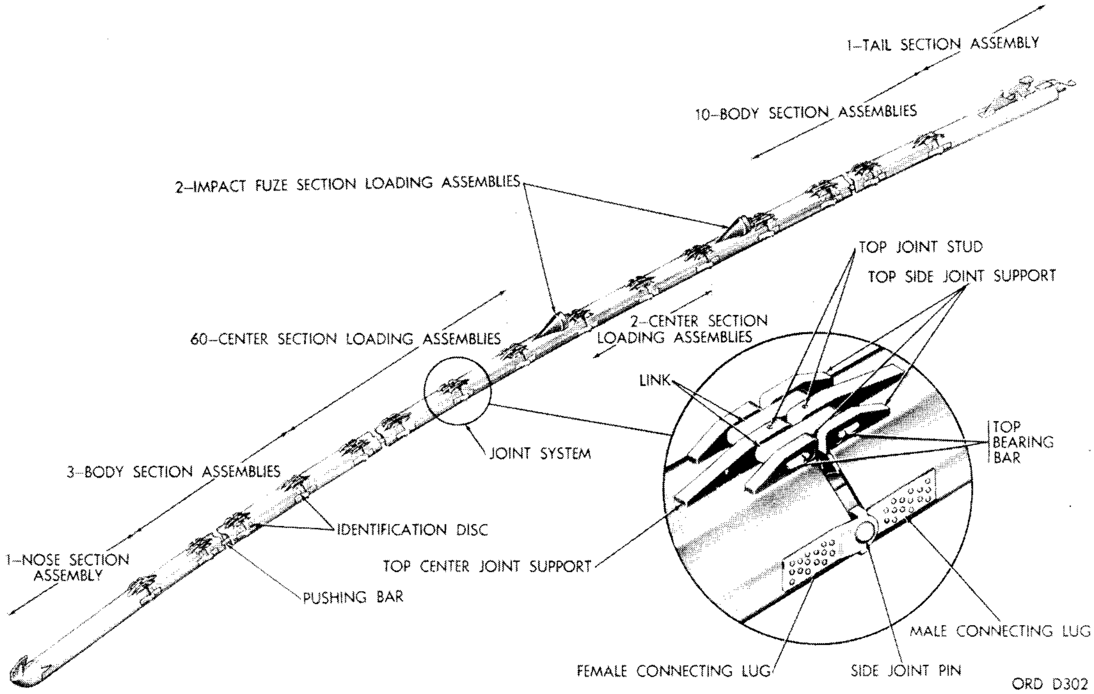


Figure 9-83. Assembly of sections of demolition kit M157.

(b) Description. This projected charge demolition kit consists of 79 irregular hexagonal tubes (section assemblies) which, when assembled (figure 9-83), are approximately 12 inches wide, 7 inches high, 400 feet long, and weigh approximately 11,000 pounds, including approximately 2,880 pounds of Composition B and approximately 320 pounds of Composition C-4. The section assemblies are as follows: nose section, 13 body sections, 62 center-loading sections, 2 impact-fuze sections, and tail section. Each of the 62 center-loading section assemblies and the two fuze section assemblies are loaded with 50 pounds of explosive material. A list of parts which comprise the projected charge demolition kit M157 is given in table 9-13.

(c) Functioning. The force of the bullet (cal. .30 or .50, ball) striking the impact plate of the bullet impact fuze assembly drives the impact plate forward, which in turn, strikes and detonates the impact fuze M603 and booster M120. The detonation of the booster, in turn, detonates the composition B of the fuze explosive container loading assembly. The container shatters downward in a manner which produces a narrow, concentrated detonating jet. This jet stream has the force necessary to penetrate the insert tube walls of the impact fuze section assembly, thereby assuring detonation of the composition B and composition C-4 contained within. Detonation of either of the explosive fuze container loading assemblies will initiate detonation of the other loaded sections (center loading and impact fuze) of the demolition kit. **Note: The bullets fired must strike one of the impact plates in order for the demolition kit to be detonated.**

(4) Demolition kit, projected charge: M173.

(a) General. This kit (figure 9-84) is an antitank minefield clearing device designed to be towed (dragged) by a vehicle to the edge of a minefield. The kit, an expendable item, is used to clear antitank minefields planted with single-impulse, pressure-type mines. It may be towed over land or water by any adequately-sized land or amphibious vehicle containing a suitable 24-volt

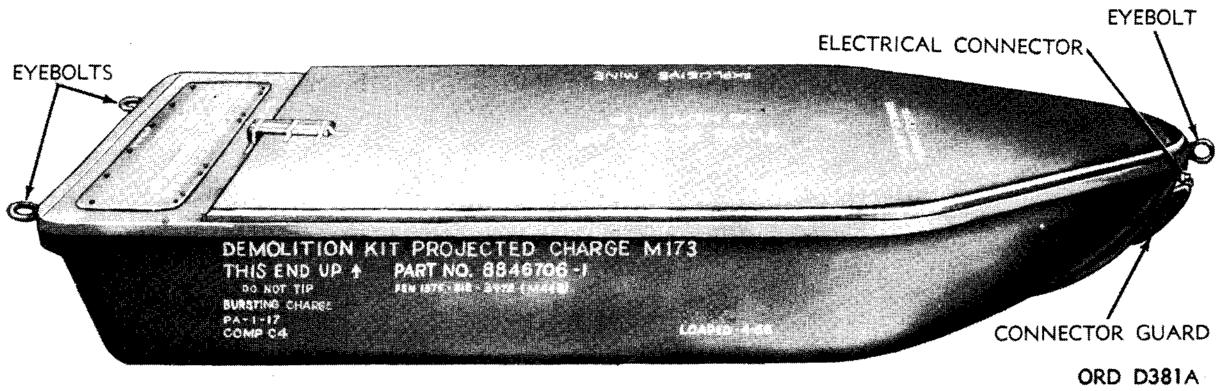


Figure 9-84. Projected charge demolition kit M173.

direct current bayonet-type receptacle. Firing of the kit is accomplished by means of a firing control switch included with the kit.

(b) Description. Each demolition kit (figure 9-85) is fundamentally composed of a waterproof skid M3, a linear charge propulsion system, a linear demolition charge, and necessary accessories to tow and fire the kit.

(c) Functioning. The demolition kit is initially coupled to the tow vehicle by means of a tow cable. Electrical connection of kit to tow vehicle is by a 250-foot coiled electrical cable for initiation of explosive items within the kit. An offshoot of the firing cable is provided for supplying power to electro-explosive devices within tow cable release. After kit has been towed to the desired area, it is electro-explosively released from its coupling by means of the firing control switch operated from within the vehicle. After movement of vehicle a safe distance from the kit, removal of the main cover is accomplished by means of propellant actuated thruster M24, which is electrically initiated from within the vehicle by means of the same switch. Automatic elevation of the launcher tube occurs as the cover slides from the kit. Rotation of the firing control switch

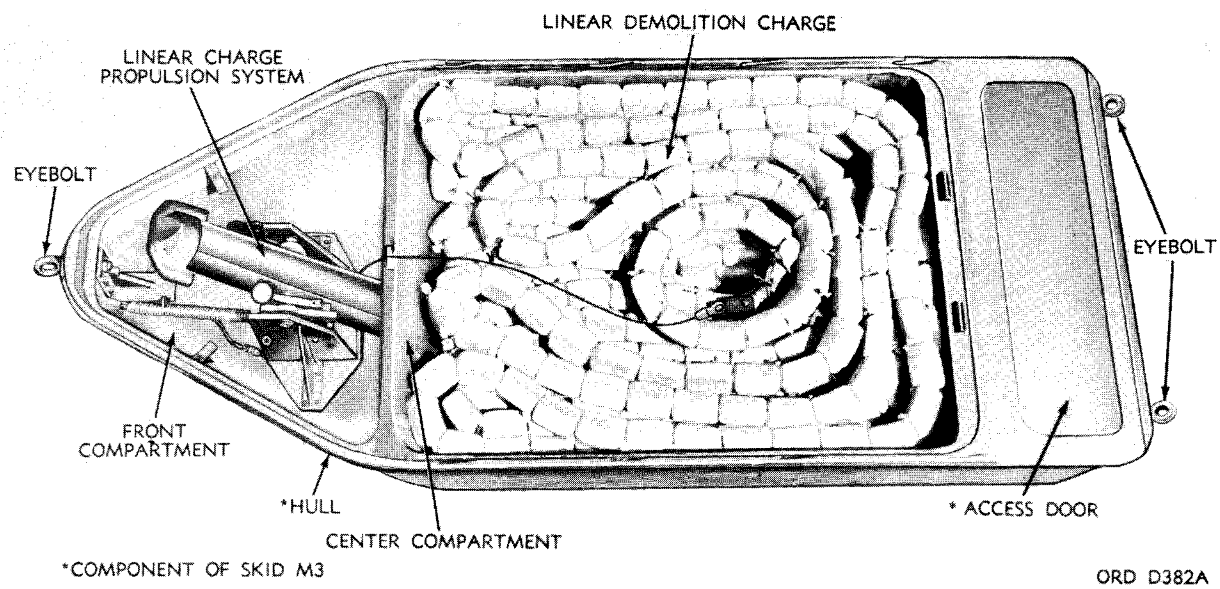


Figure 9-85. Projected charge demolition kit M173—main cover removed.

handle to its ROCKET position then causes ignition of rocket motor M95. When sufficient thrust is built up by rocket motor, it breaks its restraining screw and carries the connected linear demolition charge M96 across the minefield. After linear demolition charge is in place, firing control switch handle is rotated to its CHARGE position. This action initiates fuze M1134.

Table 9-13. Components of 400-Foot Projected Charge Demolition Kit M157.

Item	Quantity
Kit parts:	
Nose section assembly------------------	1
Body section assembly------------------	13
Center loading section assembly---------	62
Impact fuze section assembly------------	2
Tail section assembly ------------------	1
Fuzing:	
Fuze, mine, M603 ---------------------	2
Fuze explosive container loading assembly	2

3. **SUMMARY.** This lesson has provided a comprehensive coverage of demolition materials and associated tools and equipment which should enhance appreciably your knowledge of this type of material. The intention of this lesson is to broaden your overall knowledge of demolition materials and to give you an appreciation of the varied types and complexity of the materials involved. With this knowledge you will be in an advantageous position to perform your duties and assume responsibility in ammunition assignments with assurance and confidence regardless of whether your assignment involves ammunition storage, maintenance, destruction, records, or any combination of these activities.

MMS SUBCOURSE NUMBER 621, AMMUNITION MATERIEL

EXERCISES FOR LESSON 9

1. How frequently is it necessary to turn commercial dynamite in storage when the average temperature is 60° to 75° F?

   A. Every 6 weeks
   B. Every 3 months
   C. Every 6 months
   D. Do not turn

2. What explosive is used in the core of detonating cord?

   A. RDX
   B. PETN
   C. COMP B
   D. Tetryl

3. What combines the functions of firing devices and blasting caps in a single unit?

A. Igniters
B. Primers
C. Actuators
D. Detonators

4. If the identification and safety strip is green, what is the ST of function of the M1 delay-type firing device if actuated when the temperature is 75 degrees F?

A. 50 minutes
B. 70 minutes
C. 2.5 hours
D. 3 days

5. What is indicated when the winch assembly of the M3 pull release type firing device moves approximately ¼ inch?

A. Firing device is functioning normally
B. Release pin may clear jaws of firing pin
C. Anchor cord not holding device in place
D. Firing device is faulty

6. How is the M173 demolition kit projected charge released from the towing vehicle?

A. Pintle removed automatically
B. Propellant thruster
C. Electro-explosively
D. Explosive bolt

7. What silver chloride dry cell battery used in a galvanometer must be stored under refrigeration to prevent deterioration?

A. BA-245/u
B. BA-275-245
C. BA-2245/u
D. BA-3375/u

8. What color most usually identifies safety fuse?

A. Black
B. Orange
C. Green
D. Brown

9. Which demolition explosive has a detonating velocity of 8,040 meters per second?

A. Composition C-3
B. Tetrytol
C. Composition C-4
D. TNT

10. Why is it essential that two or more electric blasting caps connected in the same circuit be the product of the same manufacturer?

A. Easier to connect
B. Insures greater brisance
C. Eliminates use of adapters
D. To prevent misfires

11. What is the minimum pull on the safety pin cord (in pounds) required to remove the safety pin from the M60 (T2) igniter?

A. 30
B. 15
C. 10
D. 5

12. At what angle of elevation (degrees) is the launcher of the M1E1 demolition kit inclined when set up on level ground?

A. 17
B. 38
C. 45
D. 62

13. What is the shape of the opening in the trigger pin of the M1A1 pressure-type firing device?

A. Hexagonal
B. Notched
C. Grooved
D. Keyhole

14. How much delay time (in minutes) is provided in the blue salt delay pellets which are packed with the concussion detonator kit M1?

A. 3½ plus or minus ½ minute
B. 4 plus or minus 30 seconds
C. 6 plus or minus 15 seconds
D. 7 plus or minus 1 minute

15. Which application of the same weight of demolition explosive is most efficient?

A. Thin layer over a large area
B. Thick layer over a small area
C. No relationship between application and efficiency
D. Efficiency is proportional to atmospheric pressure

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