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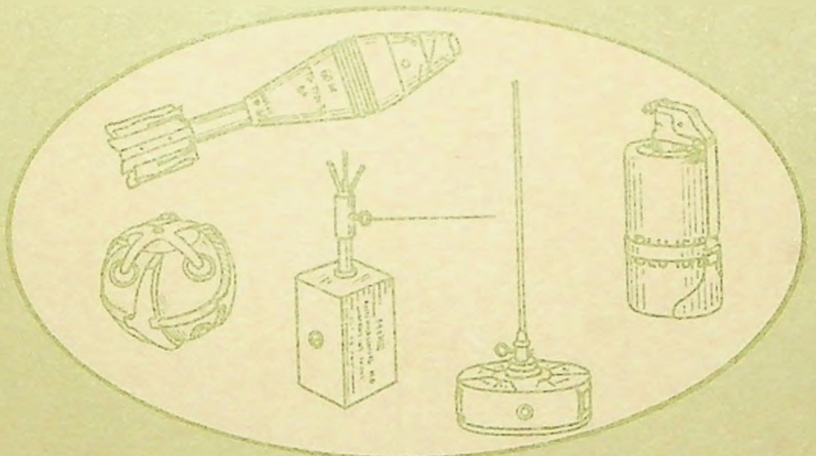
POLICE TECHNICAL SERIES 03-II

RECOGNITION OF EXPLOSIVE AND INCENDIARY DEVICES

PART II
LAND MINES; ARTILLERY, MORTARS,
AND ROCKET PROJECTILES



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U.S. MILITARY ORDNANCE COLOR CODES

BODY COLOR	EARLY COLOR CODE	RECENT COLOR CODE
Yellow White	High Explosive (HE) High Explosive Anti-Tank (HEAT) High Explosive Plastic (HEP)	High Explosive (HE) High Explosive Plastic (HEP) Illuminating APERS Canister
Markings in Yellow, White, Red, Green or Black	Chemical (War Gas) Smoke Illuminating	Chemical (War Gas)
Markings in Yellow or White	Practice Drill Armor Piercing APERS	All Armor Defeating
Markings in Black	High Explosive	High Explosive
Markings in Black or White	Practice	Practice Chaff
Markings in Black	Not Used	Incendiary
Markings in Black Except for WP and PWP Which Are Light Red	Not Used	Smokes
Markings in Black	Illuminating	Illuminating

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This document was produced as part of the information dissemination service of the National Bomb Data Center conducted by the International Association of Chiefs of Police, Inc. for the U.S. Department of Justice under contract J-LEAA-018-70.

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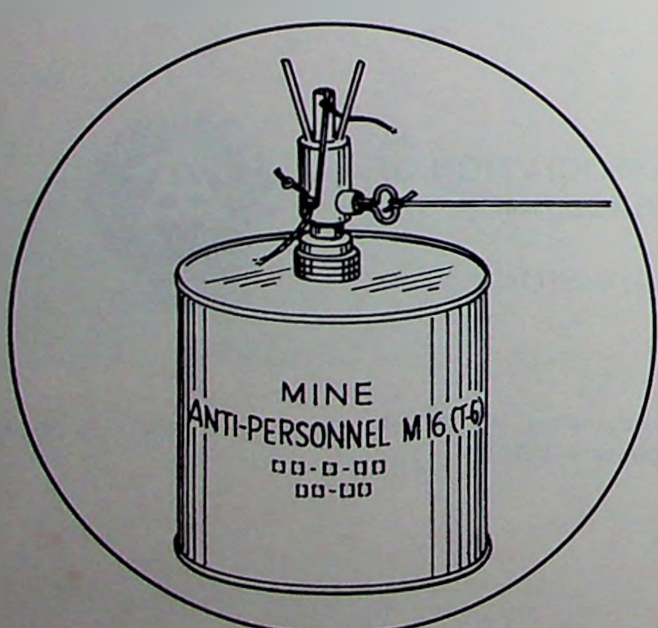

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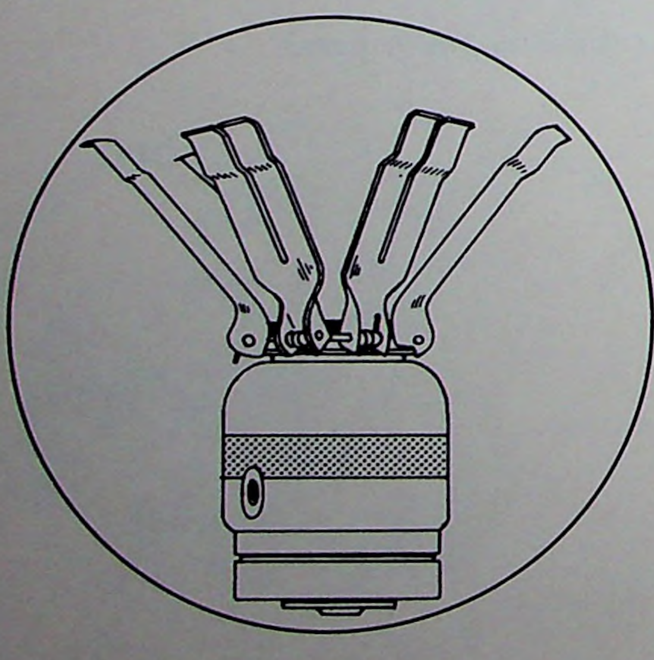


RECOGNITION OF EXPLOSIVE AND INCENDIARY DEVICES

Part II

Land Mines; Artillery, Mortar, and Rocket Projectiles

The purpose of this publication is to provide public safety personnel with a guide to the key identification features of commonly encountered *types* of explosive and incendiary devices. While construction and functioning details are frequently provided, these data are included only to facilitate recognition. Attempts to dismantle or render safe these devices should be made only by fully qualified bomb technicians.

This publication is the second of a two-part series. The first publication in the series, *Hand and Rifle Grenades*, covers those explosive and incendiary devices normally thrown into the target area by hand or projected for short distances by standard and improvised small arms. This document will cover those devices that are emplaced by hand (land mines), projected from crew-served weapons (artillery and mortar rounds), self-propelled (rockets), or that are disseminated from larger containers (bomblets and sub-projectiles).

Within each part are sections which cover those classes of *military* and *improvised* ordnance items that are most likely to be encountered by public safety personnel. The approach throughout has been to provide recognition data. However, it should be noted that some ordnance items will not possess the common or general identification features normally associated with their particular classification. Although there will always be these exceptions to general identification rules, such cases are rare and any unidentified device can and should be treated as explosive and dangerous.

While this series of publications should assist in the recognition of most ordnance items, no individual is likely to be able to correctly identify or recognize all ordnance items. Since recognition ability is an acquired skill, it must be constantly exercised or the skill deteriorates. When unidentifiable ordnance items are encountered and as time permits, the Research Division of the International Association of Chiefs of Police. Eleven Firstfield Road, Gaithersburg, Maryland 20760, will provide technical assistance in identification of these items to the law enforcement community. Should such technical assistance be desired, it is recommended that initial contact be established via telephone in order to insure that photographic and measurement criteria are mutually understood.

SECTION ONE
LAND MINES

Land mines are ground-concealed explosive devices. They are considered by the military of all nations as defensive weapons and are commonly employed to deny rapid access to battlefield areas and to impede the forward progress of enemy forces. Both military and improvised land mines are also employed by terrorists and revolutionaries to kill, injure, and demoralize security forces and, in many cases, the general population of target nations. Because they detonate without warning, kill and maim indiscriminately, and function from concealment, land mines produce a psychological effect that is entirely disproportionate to that produced by a similar amount of explosive delivered on target by other means.

Recognition of land mines is important to public safety personnel in the United States for two reasons. First, military land mines frequently turn up in the hands of civilians as souvenirs or found property. Secondly, both military and improvised land mines have been used with lethal effectiveness in attacks against law enforcement officers. While familiarity with the recognition characteristics of land mines will not guarantee the safety of the officer, such knowledge may well contribute to his own safety and that of the public he serves.

Military Use of Land Mines

Military land mines employed throughout the world fall into three broad categories:

- Anti-tank or anti-vehicular mines
- Anti-personnel mines
- Chemical mines

Anti-tank or anti-vehicular mines usually employ high explosive charges ranging from 3 to 30 pounds and generally destroy or disable the vehicular target by blast pressure. An anti-vehicular mine containing three pounds of high explosive will have sufficient force to destroy a military jeep and will severely damage or destroy even a large military truck. On the other hand, an armored tank might detonate the same mine with little or no damage to its heavily armored exterior.

Because blast pressure, even from relatively large explosive charges, may not be consistently effective against heavily armored tanks, some anti-tank mines incorporate special design features other than simple blast to achieve their purpose. Certain mines, for example, are constructed so that a steel plate is literally fired point-blank at the tank body or tread by the detonation of the main explosive charge. The steel plate is capable of penetrating any known tank armor, totally destroying the vehicle. Other anti-tank land mines use shaped explosive charges to ram or punch holes in tank armor, killing the crew or setting fire to the vehicle.

Land mines in the anti-personnel category (blast pressure, fragmentation, or a combination of both) are employed to delay the movement of personnel on foot. While casualties generally result from the detonation of anti-personnel mines, their main purpose is to delay and demoralize dismounted troops.

Chemical mines, treated as a separate category, are used to disseminate a variety of chemical agents, usually toxic in nature. Chemical mines are employed against both foot personnel and vehicles. For use against armored vehicles, they are combined with anti-tank explosive devices.

Military Land Mine Doctrine. All military powers have developed elaborate and detailed doctrine for the employment of various types or categories of land mines. Most of this detailed information is of little value to the public safety officer and can be easily obtained from the appropriate military manuals. Common points for the placement of land mines are at road intersections, approaches to bridges, inside or along the approaches to tunnels, and at any point where a detour route is not readily available or where it is desirable to deny enemy access through open fields, valleys, stream beds, or other routes of advance. Anti-personnel mines are also placed around defense perimeters and are employed singly and in groups to harass and delay enemy troops at points where they are likely to congregate or pass.

Placing land mines in a dirt road or open field poses no real problem if time and equipment are available. A hole is dug in the surface of the ground and the mine is planted beneath the surface. The dirt removed in digging the hole is then used to emplace and conceal the mine. Where a concrete or asphalt road is to be mined, the surface of the road may be broken open and the mine emplanted in the same manner as with a dirt road. However, because of the time-consuming aspect of such an operation, this procedure is not generally followed. Instead, the mines are often placed along the shoulder of the road and a barrier of some sort, such as a fallen tree or dummy land mine, is used to cause advancing vehicles and troops to pull onto the shoulder where the mines have been emplaced. This placement is also common in terrorist or revolutionary mine attacks, as is the practice of placing the mine on the road surface and covering it with dirt or mud to create the appearance of an earth slide or spill.

Terrorist Use of Land Mines

While land mines are employed primarily as defensive weapons by the military forces of the world, they become essentially offensive weapons when utilized by terrorist groups or revolutionary movements. The mine, or as it is more commonly known, the "bomb," is used as one of the basic weapons in attacks on existing political establishments.

By employing the mine or bomb, the terrorist group attempts to demonstrate that the established order is vulnerable, may be attacked at will, is powerless to stop the terrorists, and unable either to protect its own institutions or the general public. While the validity of this tactic has been questioned in terms of the extent to which it does or does not produce the desired effect, the use of bombing has been common among revolutionary movements throughout the world.

A series of randomly placed large bombs exploding in a city serves not only to instill terror, but, from a propaganda point of view, inflates the power of a revolutionary group beyond all fact. At the same time, the established government, through its law enforcement or military apparatus, appears helpless or at least ineffectual.

Indiscriminate and discriminate terrorist bombing tactics of this type are currently being carried out by the Front de Liberation de Quebec (FLQ) in Canada, the Irish Republican Army (IRA) in Northern Ireland, and the various guerrilla forces operating in Southeast Asia. Bombs or mines are placed in roads, police stations, restaurants, business and commercial establishments, or any other location selected by the terrorists. These bombs cover the entire spectrum of construction ranging from several hundred pounds of gelignite (dynamite) packed into an automobile abandoned at an intersection in Belfast or 150 pounds of dynamite in a Volkswagen automobile parked in a building tunnel in Montreal to 5 pounds of explosive in a lunch box left on a city bus or a stick of dynamite dropped into a corner mailbox.

It is impractical, if not impossible, to attempt to describe the variety of bombs which could be constructed through improvisation because such construction is limited only by the ingenuity of the builder. It suffices to say that *anything* from a loaf of bread (Canada) or melon (Vietnam) to a bucket of human waste (Korea) or a coffin (Ireland) can and has been converted into a bomb or mine. It is even difficult to identify the size of the bomb or mine that may be employed, except in very general terms. Figure 197 illustrates an attempt to identify and estimate the size and type of "average" improvised bombs or mines which have been employed throughout the world in the last 25 years by terrorists.

At best, the weights indicated in Figure 197 are a rough estimation. Unless the bomb or mine is neutralized and recovered or unless the terrorist is captured and confesses, it is difficult to accurately determine the size or construction of an improvised explosive device after it has detonated. Additionally, unless the terrorist group is very well organized and supplied, it does not

TYPE OF IMPROVISED MINE	AVERAGE WEIGHT OF EXPLOSIVE PER MINE
Small blast anti-personnel mines	1/2 to 5 pounds
Small fragmentation anti-personnel mines	ounces to 10 pounds
Large blast/fragmentation anti-personnel mines	15 to 30 pounds
"Average" blast anti-vehicle mines (buried in road)	20 to 60 pounds
Mines placed inside cars and trucks	50 to over 1,500 pounds
Bombs employed against aircraft (hijacking)	ounces to 10 pounds
Anti-ship mines	5 to 50 pounds
Anti-railroad mines	10 to several hundred pounds

Figure 197
AVERAGE SIZE OF IMPROVISED MINES AND BOMBS

normally employ standard or uniform bombs. For example, the devices used in bombing actions attributed to the Weatherman faction of the SDS in this country have ranged in size from less than a pound used against a selective service office to approximately 1,600 pounds, placed in a van and employed against a university research laboratory.

As a practical matter, it is generally agreed that the largest bomb that could be concealed and delivered by hand would contain approximately 50 pounds of explosive. This estimate is based upon the total weight that could be hand carried by a well-conditioned man of average stature. While larger packages could be carried by larger men, it is assumed that in most instances the individual selected to deliver the bomb to the target would be of average appearance so as to avoid attracting undue attention.

On the other hand, the maximum practical size for a bomb delivered by vehicle is limited only by the amount of space available in the vehicle. Bicycles carrying 10 to 80 pounds of explosives have been used as delivery vehicles in Saigon, while in other parts of the world bombs of equal or larger size have been delivered by ice cream pushcarts, camels, jeeps, donkeys, passenger cars, baby buggies, motorcycles, and trucks.

LAND MINE FUZES

Whatever their size or construction design, land mines must include a fuze system. In some cases a secondary firing device, often referred to as a *booby trap firing device or fuze*, is included to make neutralization of the mine more difficult. Both military and improvised primary and secondary fuzes can be grouped roughly into three categories:

- Action Fuzes. Action fuzes require some "action" on the part of the target to achieve detonation. The action required may be anything from simple pressure to a complex series of actions that culminate in detonation.

- Delay Fuzes. Delay fuzes are firing devices that are preset to detonate after some fixed period of time. The delay period may be *activated* either by the person setting the device or by some action of the target.

- Controlled Firing Fuzes. In this mode the mine or bomb is detonated by a person who functions the fuze at a moment when he believes the target is correctly positioned in relation to the explosive device.

Military land mines are generally provided with action fuzes. Terrorist mines may employ either action or delay fuzes and both military and terrorist applications may utilize controlled firing techniques.

Pressure-Functioned Fuzes

The fuzes employed in military anti-tank and anti-vehicular mines are generally of the pressure-functioned action type. In most cases, the target vehicle must be in contact with, or in proximity to, the buried land mine in order to be destroyed. The simplest method of insuring that the mine and target are in the correct position is to have the weight of the target itself trigger the mine.

Shear Wire Action. A simple pressure-functioned anti-tank or anti-vehicle mine fuze employing a shear wire is illustrated in Figure 198.

The illustrated pressure-functioned fuze consists of a striker with a small, exposed body surface (striker head) which protrudes slightly above the ground. The weight of the target forcing down on the striker head causes the heavy copper shear wire, which passes through the striker and holds it away from the detonator, to break. This allows the target weight to drive the striker into the detonator and explode the mine. Shear wire action, pressure-functioned, land mine fuzes are probably the simplest and most common type of land mine fuze in use today.

Belleville Spring Action. Some pressure-functioned land mine fuzes employ a Belleville spring to cause detonation of the mine. The Belleville spring works the same way in the land mine fuze as the "cricket" spring does in a child's toy. The spring is normally bowed in an upward position and when sufficient pressure is applied, the spring suddenly pops into a downward position. In a child's toy, this action provides a loud snapping sound; in a land mine fuze, it causes the striker to drive into the

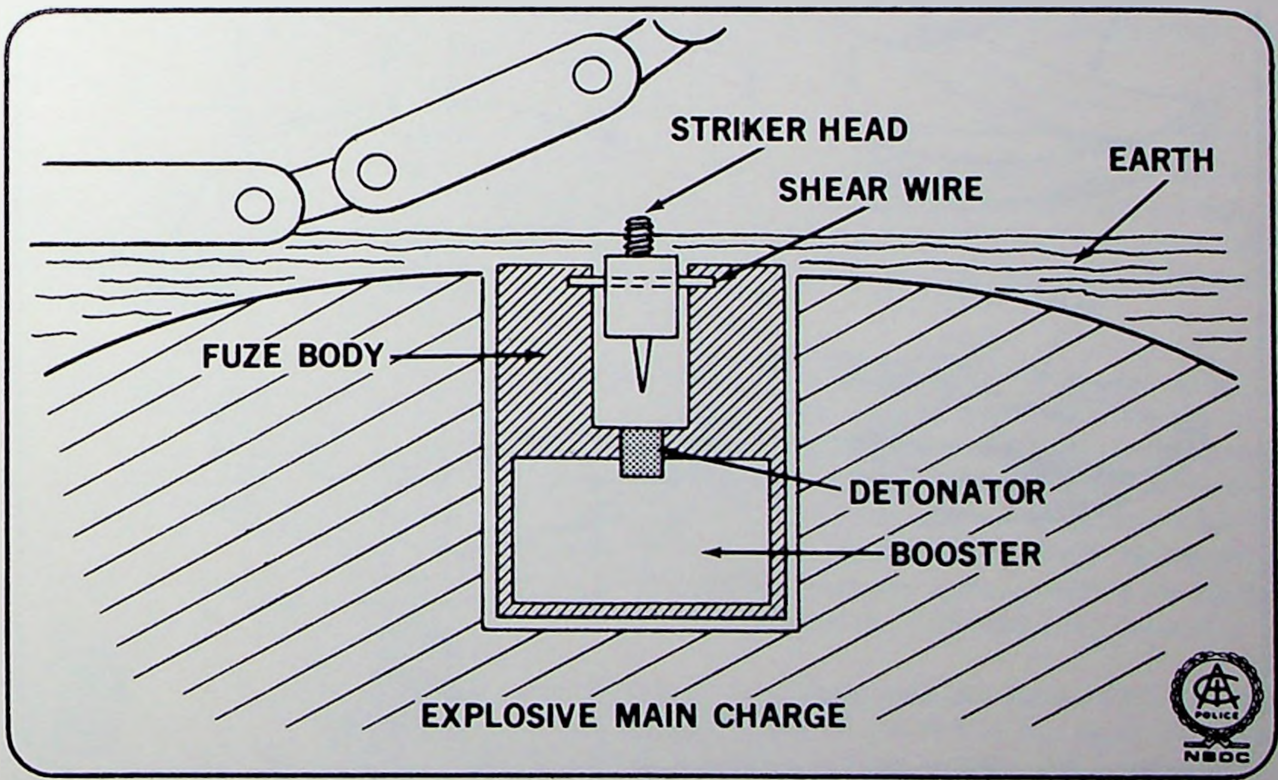


Figure 198
SHEAR WIRE ACTION PRESSURE-FUNCTIONED ANTI-TANK MINE FUZE

detonator and explode the mine. Figure 199 illustrates the operation of the Belleville spring action pressure-functioned land mine fuze.

Chemical Action. Pressure-functioned land mine fuzes in some cases employ chemicals which, when crushed together, produce a hypergolic reaction. The flame produced by this reaction is used to detonate the mine. The operation of a chemical action fuze is shown in Figure 200.

Electrical Action. Electrical pressure mats, which are normally employed to open doors in supermarkets and department stores, are currently being used as electrical, pressure-functioned land mine fuzes. These fuzes employ a battery power supply to detonate an electric blasting cap in the land mine when the pressure mat contacts are closed by the target's weight. Some pressure mats employed as mine fuzes will function when only a few pounds of pressure are applied, while other versions require several hundred pounds to close the electrical switch.

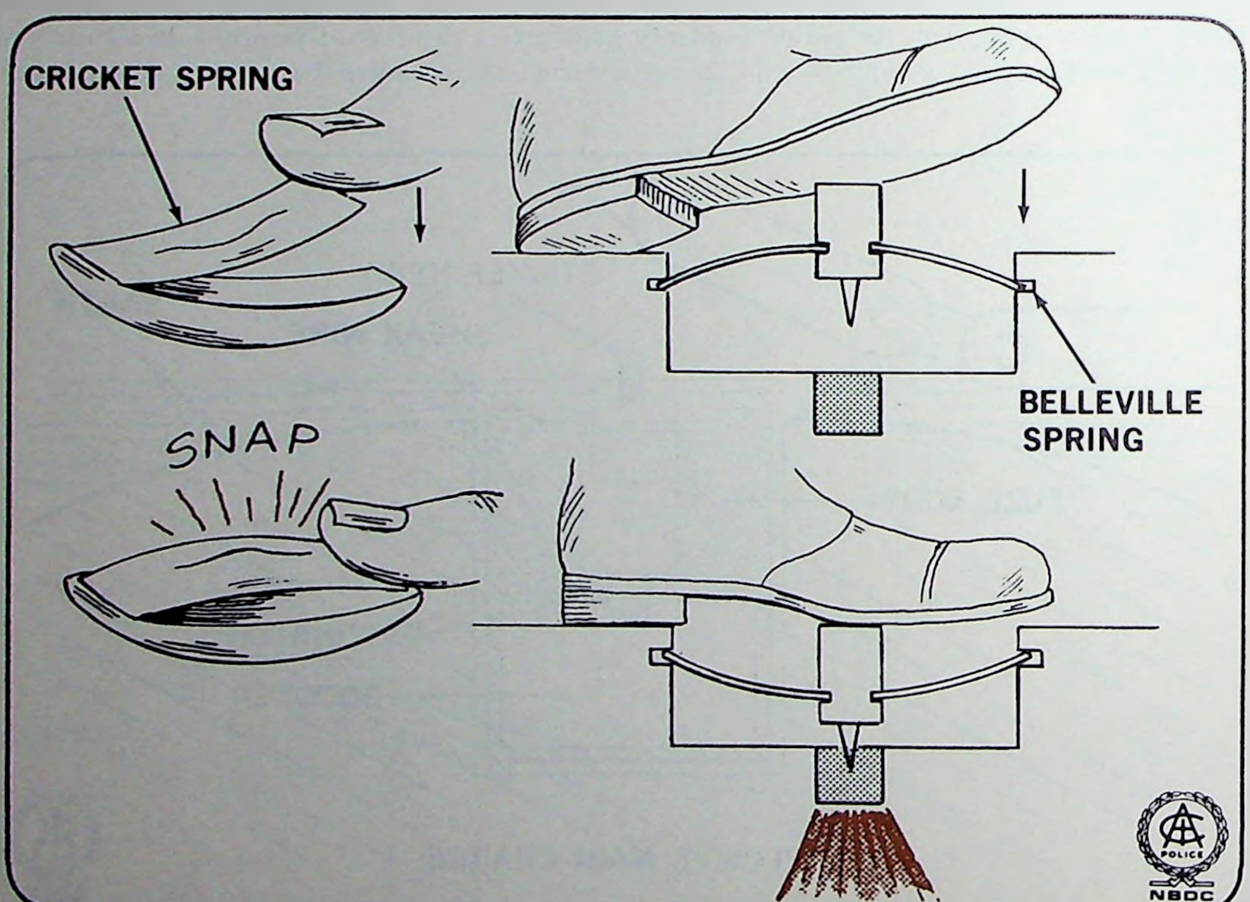


Figure 199
BELLEVILLE SPRING ACTION PRESSURE-FUNCTIONED FUZE

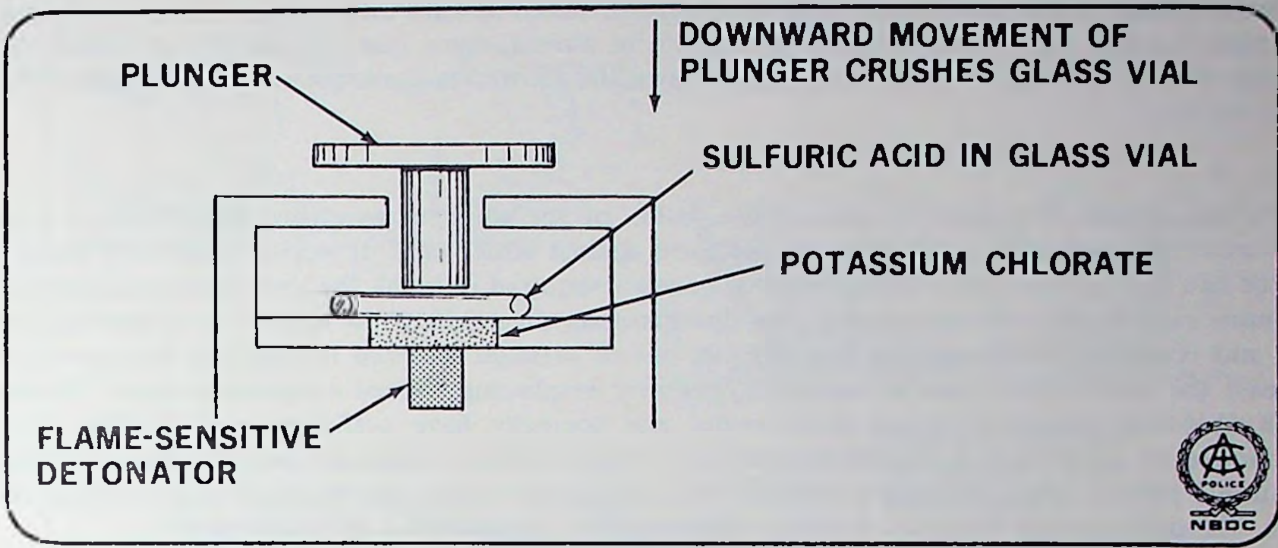


Figure 200
CHEMICAL ACTION PRESSURE-FUNCTIONED FUZE

Pneumatic Action. The same action that causes a bell to ring when an automobile is driven into a gas station and passes over a small rubber hose is also employed by the military to detonate land mines. Pressure-functioned pneumatic action land mine fuzes are a recent U.S. development and appear to be a promising and versatile fuzing system.

Tilt Rod Action. While direct pressure-functioned land mine fuzes are the type of fuze most commonly employed, they have one primary disadvantage in that they require the tank's weight to be applied (through the tank tracks or treads) directly to the mine fuze. Because only a portion of the tank's total width contacts the mine (the tank treads), it is possible for the tank to straddle a pressure-fuzed land mine without producing detonation.

The U.S. military M607 tilt rod fuze employed with the M21 "Killer" anti-tank mine was developed to detonate a land mine should *any portion of the tank's entire width* pass over the mine. The tilt rod fuze will detonate a land mine when it contacts any portion of the tank's undercarriage or treads. The tilt rod fuze is equipped with an extension rod which, when assembled to the fuze, protrudes to a height of 24 inches above the buried M21 anti-tank mine. Any contact with this extension rod which exerts a force of approximately 4 pounds and causes it to tilt 20 degrees or more will detonate the mine. When the extension rod is tilted, pressure is exerted upon the head of the Belleville spring-mounted striker causing it to "snap" and drive the striker into the detonator.

The firing of the detonator of the U.S. M607 tilt rod fuze employed in a buried M21 anti-tank land mine first ignites a black powder expelling charge located on the top of the mine. This black powder expelling charge explodes and clears away the tilt rod fuze and the dirt or camouflage material between the mine and the "soft" underside of the tank. Explosion of the black powder charge also drives a second striker into a primer and starts a short pyrotechnic delay train. After a 0.15-second delay (just long enough to clear away the dirt or camouflage), the 11-pound main explosive charge is detonated and a thick steel plate is driven upward into the tank body, producing extensive damage which incapacitates the vehicle in almost every case. Figure 201 illustrates the construction of the M607 tilt rod fuze, while Figure 202 illustrates the sequence of operation of the mine and fuze.

Varying Weight Required for Detonation. Some of the shear wire, spring, and chemical type pressure-functioned mine fuzes may be employed against either tank or vehicle targets by varying one of two fuze components. The amount of pressure required to break the shear wire and detonate the mine may be varied by employing a smaller diameter shear wire if the mine is to be used against cars and trucks. Another way to vary the amount of pressure required to function the fuze is to increase the total surface area of the striker head by employing a screw-on pressure plate. While a small (1/4-inch diameter) striker head would not normally have sufficient surface area to be functioned by a vehicle tire, the installation of a larger diameter, screw-on pressure plate provides additional surface area, allowing a vehicle tire to cause the shear wire to break and function the mine. The use of a large diameter, screw-on pressure plate is illustrated in Figure 203.

Another method of varying the amount of pressure required to cause detonation of the mine fuze involves positioning a protective crush dome over the fuze. The crush dome is a sturdy unit made of heavy gauge sheet metal which is placed over the pressure mine fuze to increase the weight required

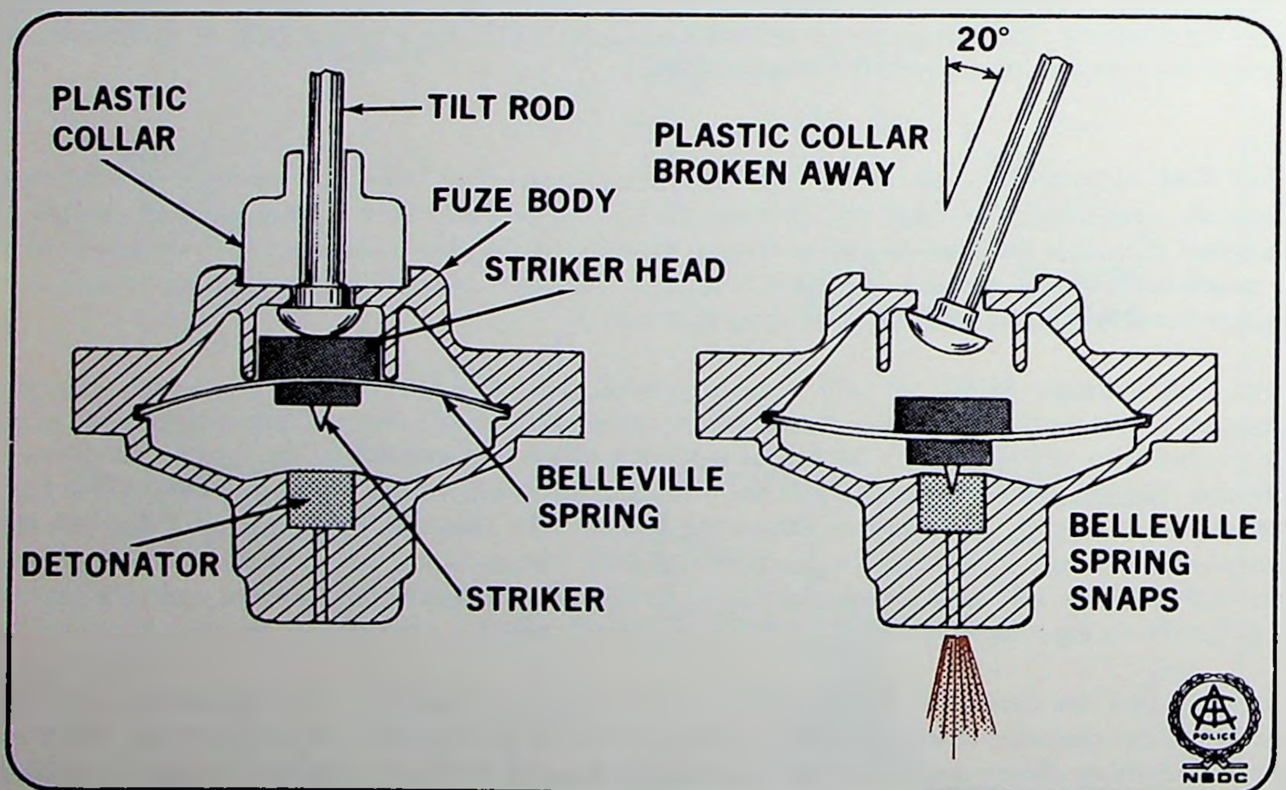


Figure 201
U.S. MILITARY M607 TILT ROD FUZE

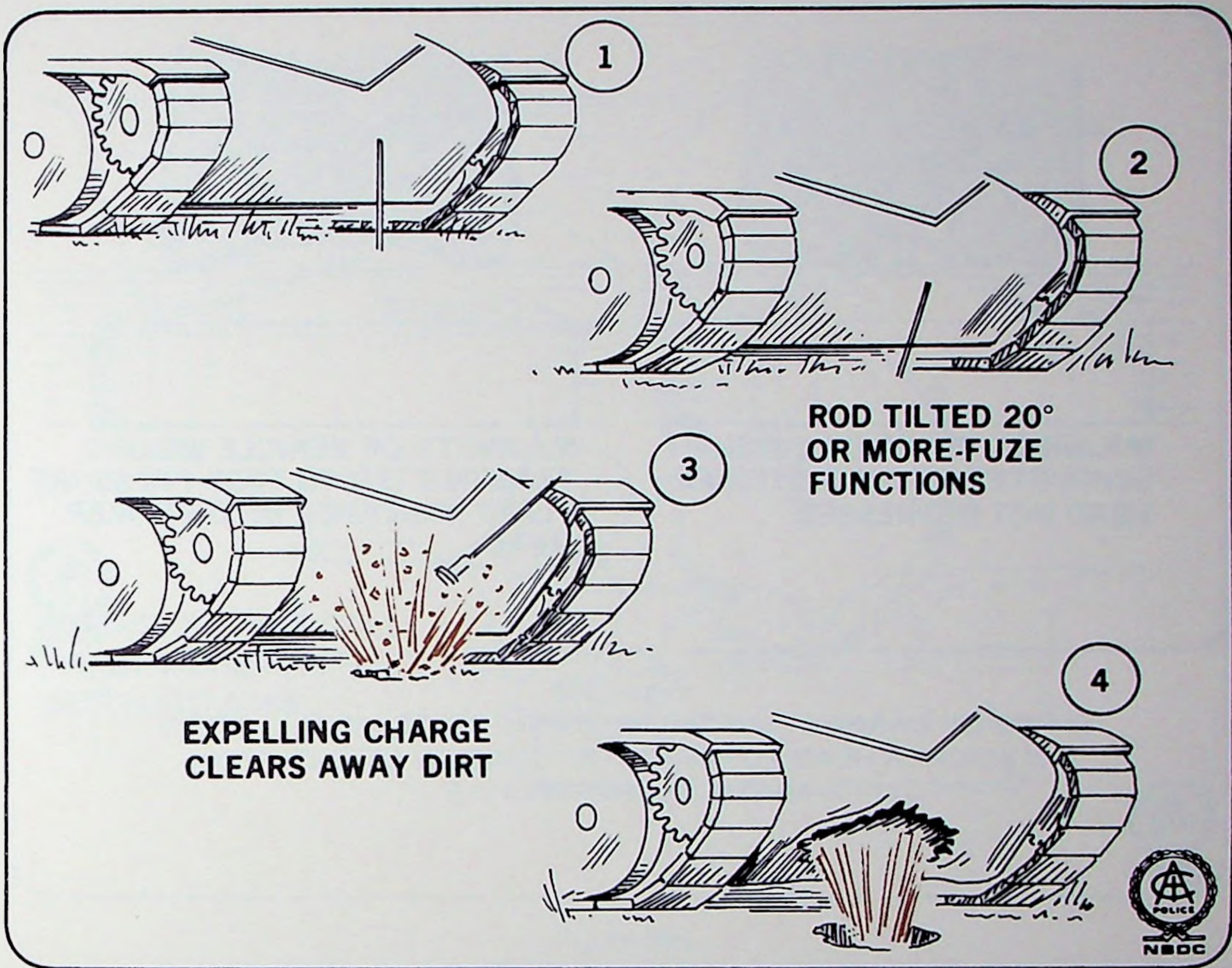


Figure 202
SEQUENTIAL OPERATION OF U.S. MILITARY M21 "KILLER"
MINE EMPLOYING AN M607 TILT ROD FUZE

to function the fuze. It is constructed so that only the much heavier weight of the tank will cause it to collapse and crush down on the fuze striker head, detonating the mine. If the mine is to be employed against light vehicles, the crush dome is not installed when the mine is planted in the ground. Figure 204 illustrates the crush dome which is sometimes employed with pressure-functioned land mines.

Some land mines are equipped with a removable *pressure spider* or pressure plate which allows for some decrease in the weight required to function the fuze. The pressure spider increases the total fuze striker head surface available to be depressed by the target vehicle. They are constructed of heavy gauge metal which is usually stamped into a ridged form for increased strength. The pressure spider often is hooked underneath the body of the mine to take advantage of the lever action caused by pressure being applied to only one side of the pressure spider. Typical pressure spiders and their functioning are illustrated in Figure 205.

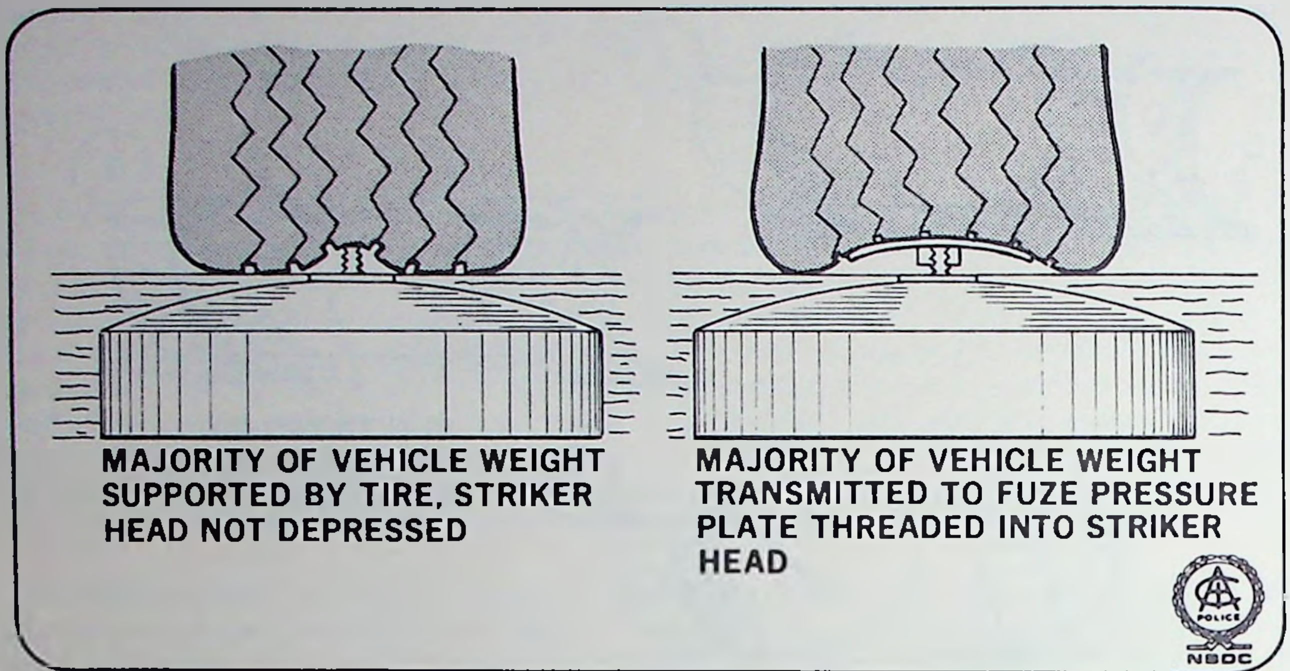


Figure 203
SCREW-ON LARGE DIAMETER PRESSURE PLATE INSTALLATION ON STRIKER HEAD TO PERMIT DETONATION OF ANTI-TANK MINE BY LIGHT VEHICLE

Controlled Firing Fuzing

Another method of detonating land mines is to employ an operator to physically detonate the mine at the most opportune time. This method of mine fuzing is generally referred to as a *controlled firing fuze system.* The majority of control-fired mines are detonated electrically because of the instantaneous response provided by the electrical system. The electrical, controlled firing system may consist of nothing more than a battery, a length of wire, and an electric blasting cap inserted into the explosive charge. When the target reaches a point close to the mine, the operator completes the electrical circuit and detonates the mine, illustrated in Figure 206.

More elaborate controlled firing systems such as radio control or radio command firing have been in existence since the early 1940's and are employed by the United States and other countries as mine and remote demolition charge firing systems. Radio controlled firing systems have the disadvantage of being expensive and in the past have had a degree of unreliability associated with their use. Fuzes of this type have a practical maximum range of approximately 5 miles direct line-of-sight and the operator must be able to see the mine and the target in order to effect detonation at the correct instant. Radio controlled firing systems are extremely valuable to terrorists because they are untraceable and permit extremely accurate targeting.

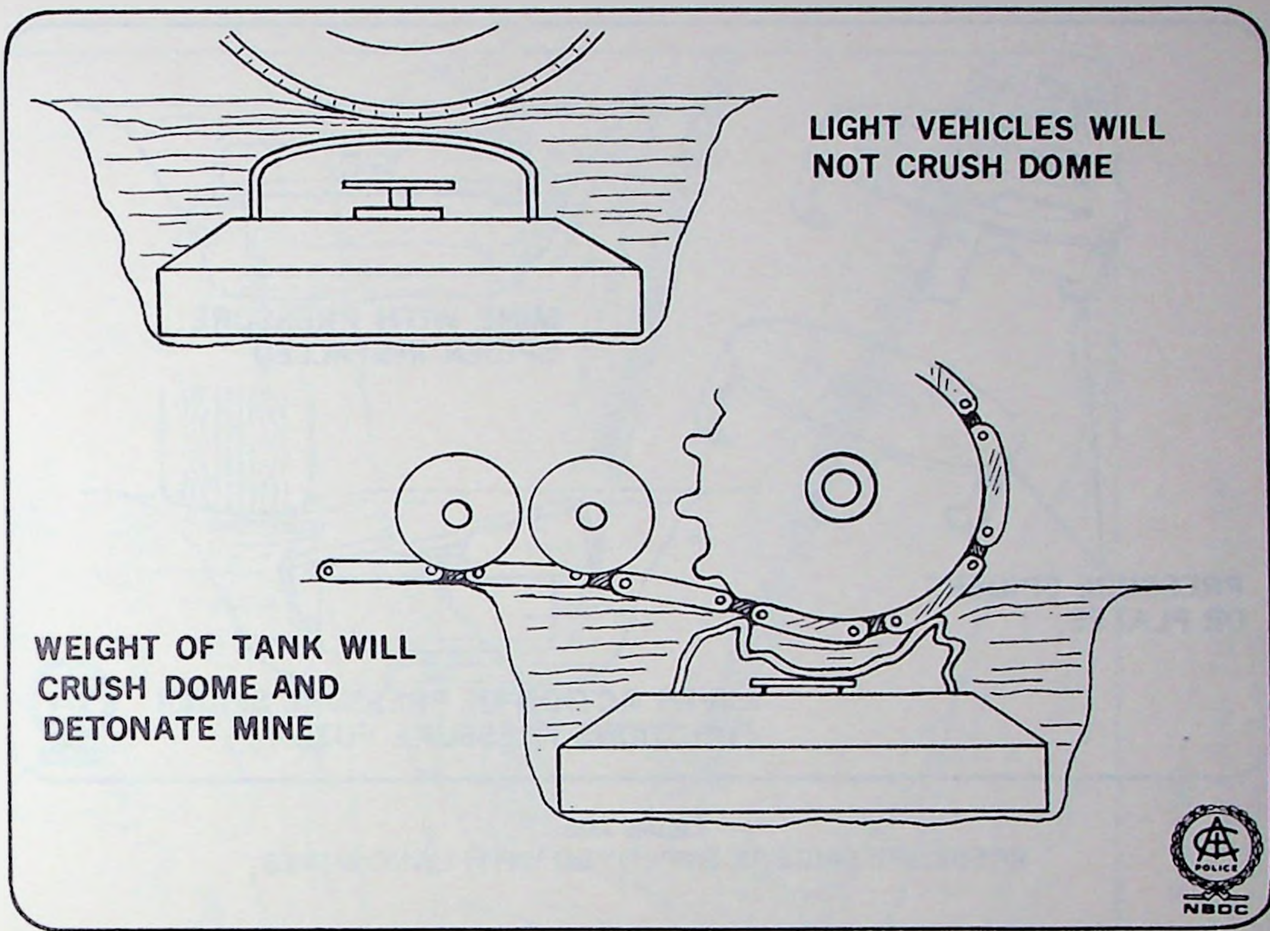


Figure 204
USE OF CRUSH DOME TO INCREASE AMOUNT OF WEIGHT REQUIRED TO FUNCTION A PRESSURE FUZE

Secondary (Booby Trap) Firing Devices

As previously noted, the military land mine is a defensive weapon primarily employed to deny an area to the enemy by making his progress through the mined area costly in terms of equipment, personnel, and time. Most mine fields are of the mixed type, with both anti-tank and anti-personnel mines combined. This mixing of mine types is done to prevent tanks (followed by troops) from leading the way through anti-personnel mine fields and to prevent troops (followed by tanks) from finding a path through anti-tank mine fields.

In warfare, armored vehicles, which are essentially mobile gun platforms, generally have more overall tactical value than small numbers of troops. It is therefore a common practice when a mine field is encountered to have select crews of men ("sappers") clear a path through the mine field so that the vehicles may advance. Anti-tank mines, with their pressure fuzes normally requiring 200 to 500 pounds of pressure to detonate, create little danger for a careful soldier engaged in locating and clearing them. With the assistance of magnetic mine detectors and land mine probes, a good crew

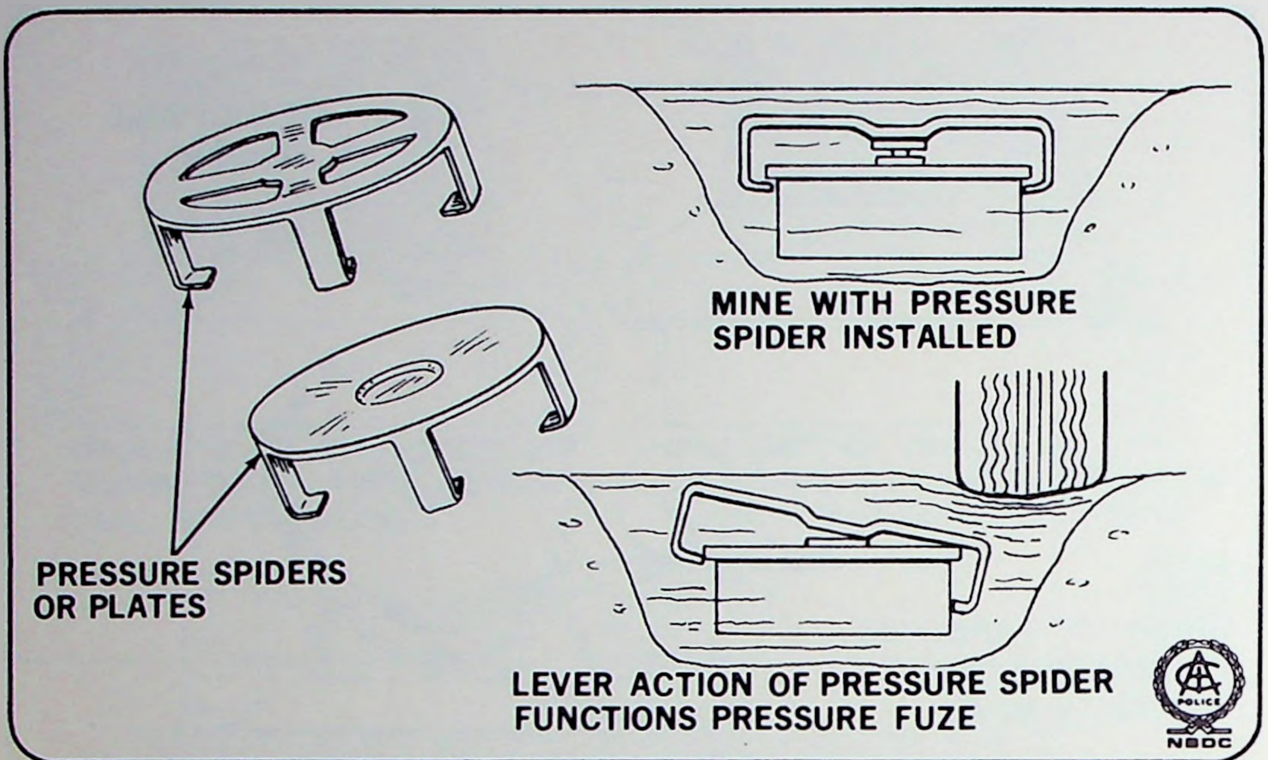


Figure 205
PRESSURE SPIDERS EMPLOYED WITH LAND MINES

could clear a path through a mine field wide enough for the passage of tanks in a reasonably short period *if* all they had to be concerned with were the anti-tank mines.

By mixing anti-personnel mines with the anti-tank mines, the clearing crew is forced to work more slowly and carefully in the interest of their own safety. While clearing a path through a purely anti-tank mine field might take a crew only an hour, the addition of anti-personnel mines will increase the working time to perhaps 2 or 2 1/2 hours. The increased time expended in clearing the path is spent neutralizing and removing the anti-personnel mines with their more sensitive fuzes.

The far less sensitive anti-tank mines and fuzes could, when located, be simply jerked from the ground and placed along the pathway. In order to prevent this from happening, both anti-tank and anti-personnel mines are often equipped with additional or secondary fuze wells into which may be fitted a variety of small fuzes that will cause detonation of the mine if careless or hasty removal is attempted.

The fuzes which are fitted to anti-tank mines, and some anti-personnel mines, are generally referred to as *firing devices or booby trap fuzes.* These sensitive firing devices or booby trap fuzes are standard items in all countries which employ land mine warfare. The firing devices themselves are designed to function with the application of one, or a combination of several actions, such as pull, pull or release of pull, pressure, release of pressure, and so forth. Each nation has these standard

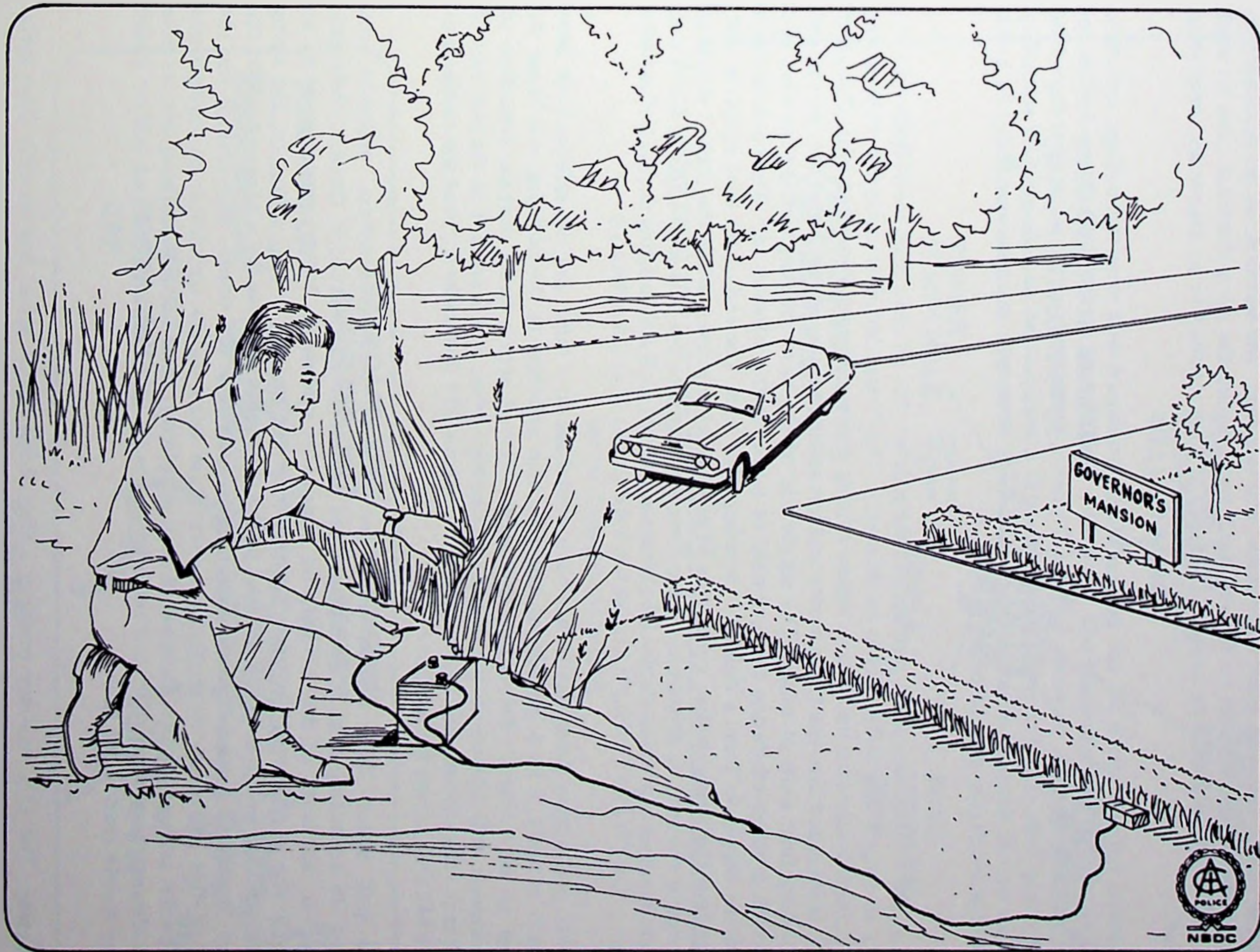


Figure 206
ELECTRICAL CONTROLLED FIRING FUZE SYSTEM
USED TO DETONATE A MINE

firing devices which are useful not only in conjunction with land mines and land mine fields, but are of equal value in booby trapping, guerrilla warfare, and sabotage. The addition, or the possibility of the addition, of these firing devices to the anti-tank mine causes the mine clearance crew to work with utmost care and will double or triple the amount of time required to neutralize and remove an individual mine.

Underdeveloped nations which do not possess highly developed land mine technology, terrorists, guerrilla warfare agents, and saboteurs will frequently manufacture or improvise firing devices for their use. In basically agrarian societies such as Vietnam, yesterday's rabbit snare is today's land mine or booby trap fuze. The following paragraphs will identify standard U.S. military secondary firing devices as well as describe selected improvised firing devices in common use today by bomb builders in the United States and elsewhere.

Pull Action. The U.S. military M1 pull action firing device has an olive drab metal body which is 3 5/16 inches in length and 9/16 inches in diameter. The firing device is equipped with a base coupling unit which is standard on all U.S. military firing devices. The base coupling unit, illustrated in Figure 207, is threaded into the firing device and has additional threads so that it may be screwed into the secondary fuze wells of mines. The nipple end of the base coupling unit is protected by a plastic cap which is removed during the assembly of a nonelectric blasting cap. The blasting cap is crimped onto the nipple to form a rigid and weatherproof unit. The end of the base coupling unit, which threads into the firing device, contains a large percussion primer. When the cocked striker of the firing device is released, it drives onto the primer, causing it to fire and send a spit of flame into the nonelectric blasting cap which detonates the mine. The M1 pull action firing device is illustrated in Figure 208.

When the M1 pull action firing device has been assembled to a mine and the safeties have been removed, a pull of only 3 to 5 pounds on the trip wire attached to the pull ring will cause the cocked striker to be released, detonating the mine. All pull action firing devices, regardless of external appearance, will operate in the same basic manner—when pull is applied to the pull wire or ring, the striker is released and the device functions. Figure 209 illustrates some of the methods of employing the M1 pull action firing device.

Improvised pull action firing devices are often used by terrorist bombers, militants, and revolutionaires. In an entrapment bombing directed against police officers in Omaha, Nebraska, which resulted in the death of one officer and injuries to others, the bomb was triggered by an improvised pull action device of the type illustrated in Figure 210. A pull action on the string fastened to the wooden wedge between the jaws of the clothespin removes the wedge and allows the jaws to close, completing an electrical circuit and detonating the bomb. Instructions on the manufacture of this and many other firing devices have been widely circulated in underground newspapers, books, and pamphlets. Because of their simplicity, these improvised firing devices have been used in almost every revolution and terrorist campaign since World War I and will no doubt continue to be widely used in the future.

Pressure Action. The U.S. military pressure action firing device M1A1 has an olive drab metal body which is 2 3/4 inches in length and 5/8 inches in diameter. A metal extension rod and a three-pronged head are supplied with the firing device, allowing it to be planted underground with

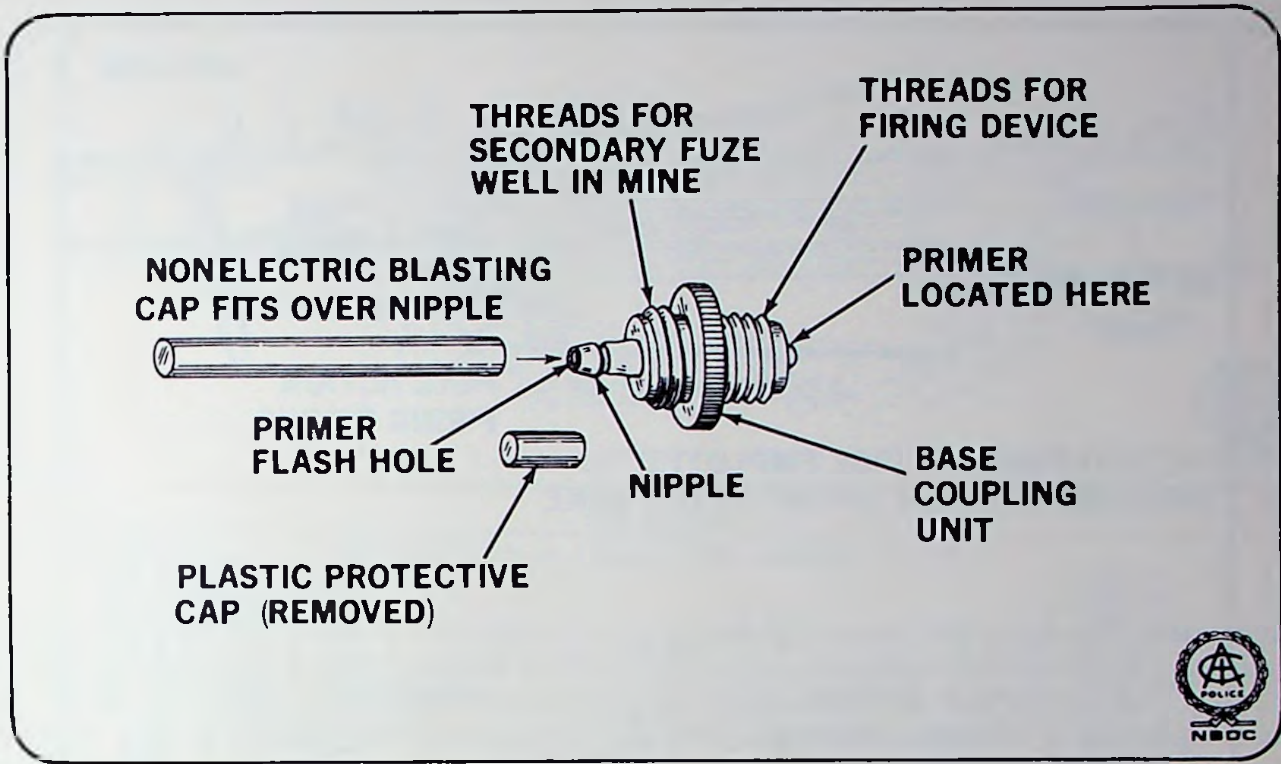


Figure 207
STANDARD U.S. MILITARY BASE COUPLING EMPLOYED
WITH FIRING DEVICES

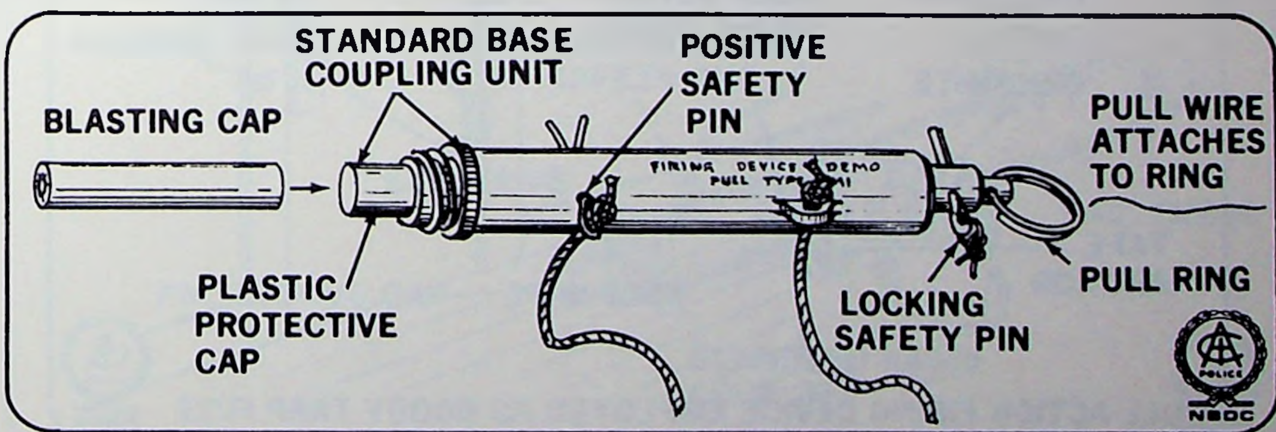


Figure 208
U.S. MILITARY M1 PULL ACTION FIRING DEVICE

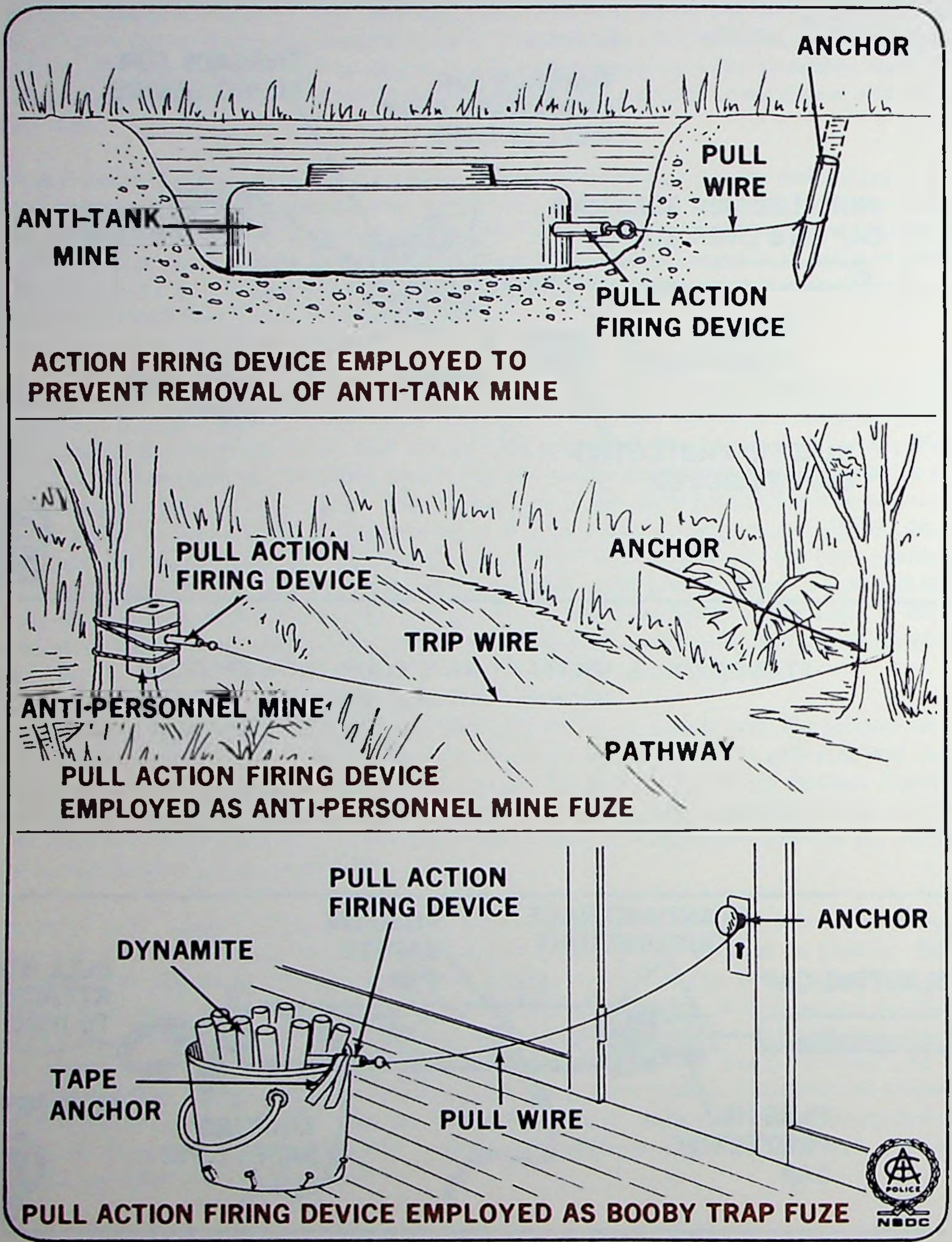


Figure 209
EMPLOYMENT OF PULL ACTION FIRING DEVICE

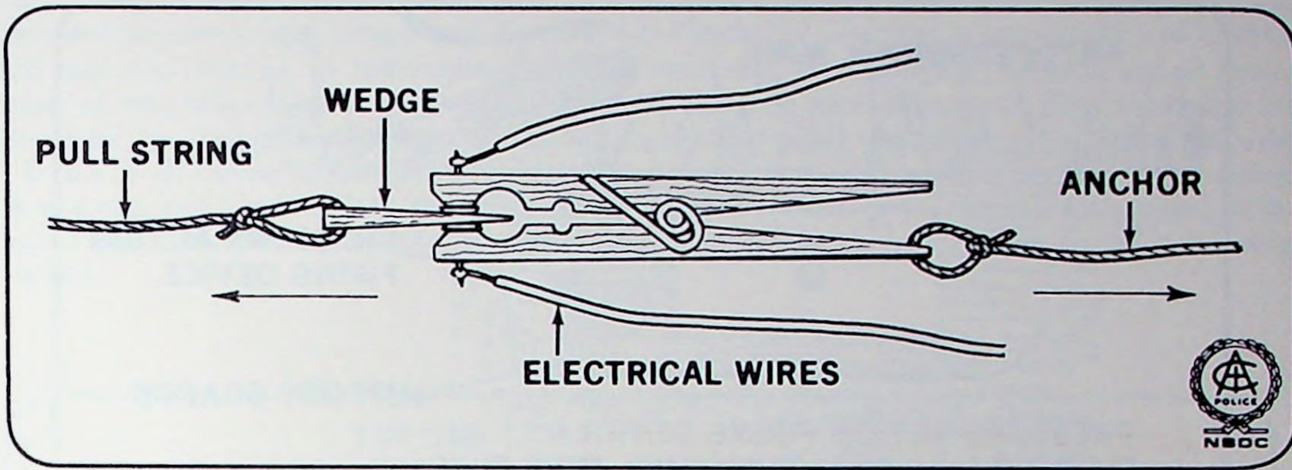


Figure 210
IMPROVISED PULL ACTION FIRING DEVICE

the pressure-sensitive prongs extended above the surface of the earth. After removal of the safeties, 20 or more pounds of pressure applied to the pressure cap or extension prongs of the firing device will release the cocked striker and detonate the mine to which it has been assembled. Figure 211 illustrates the U.S. military M1A1 pressure action firing device, while Figure 212 shows how it may be employed.

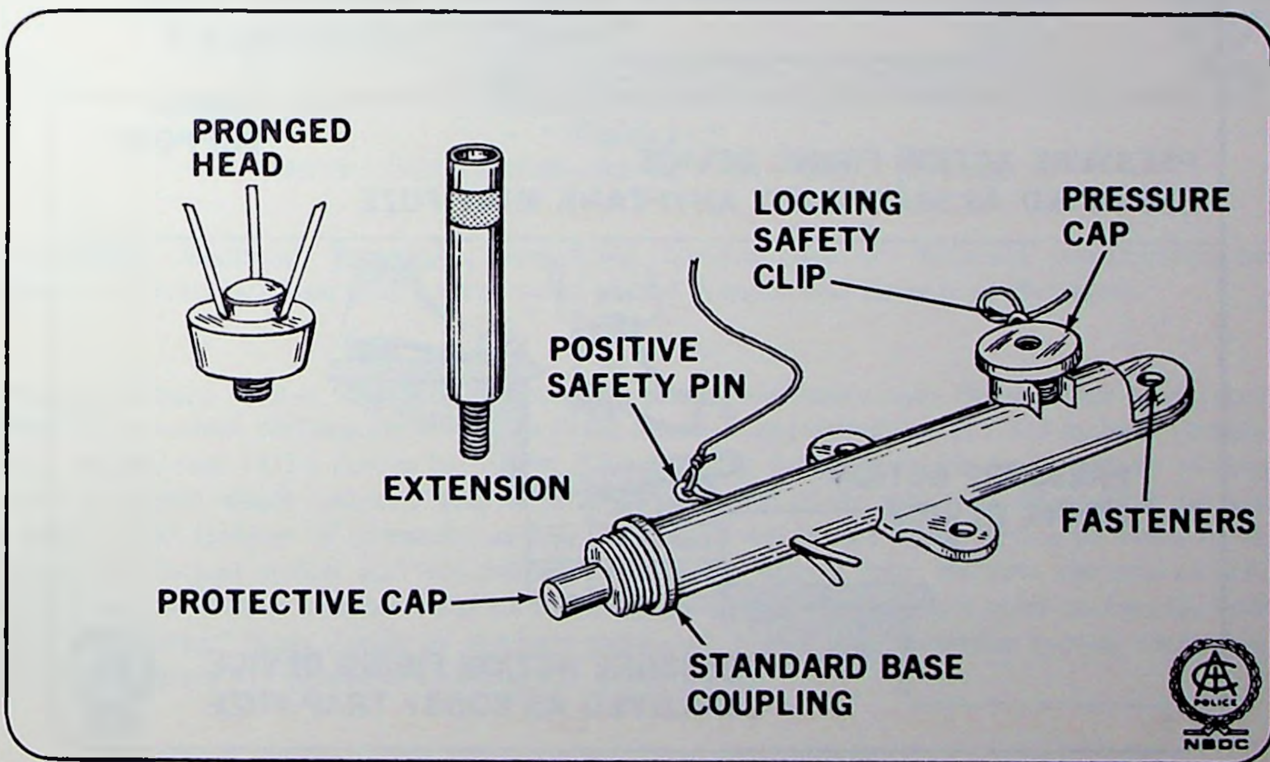


Figure 211
U.S. MILITARY M1A1 PRESSURE ACTION FIRING DEVICE

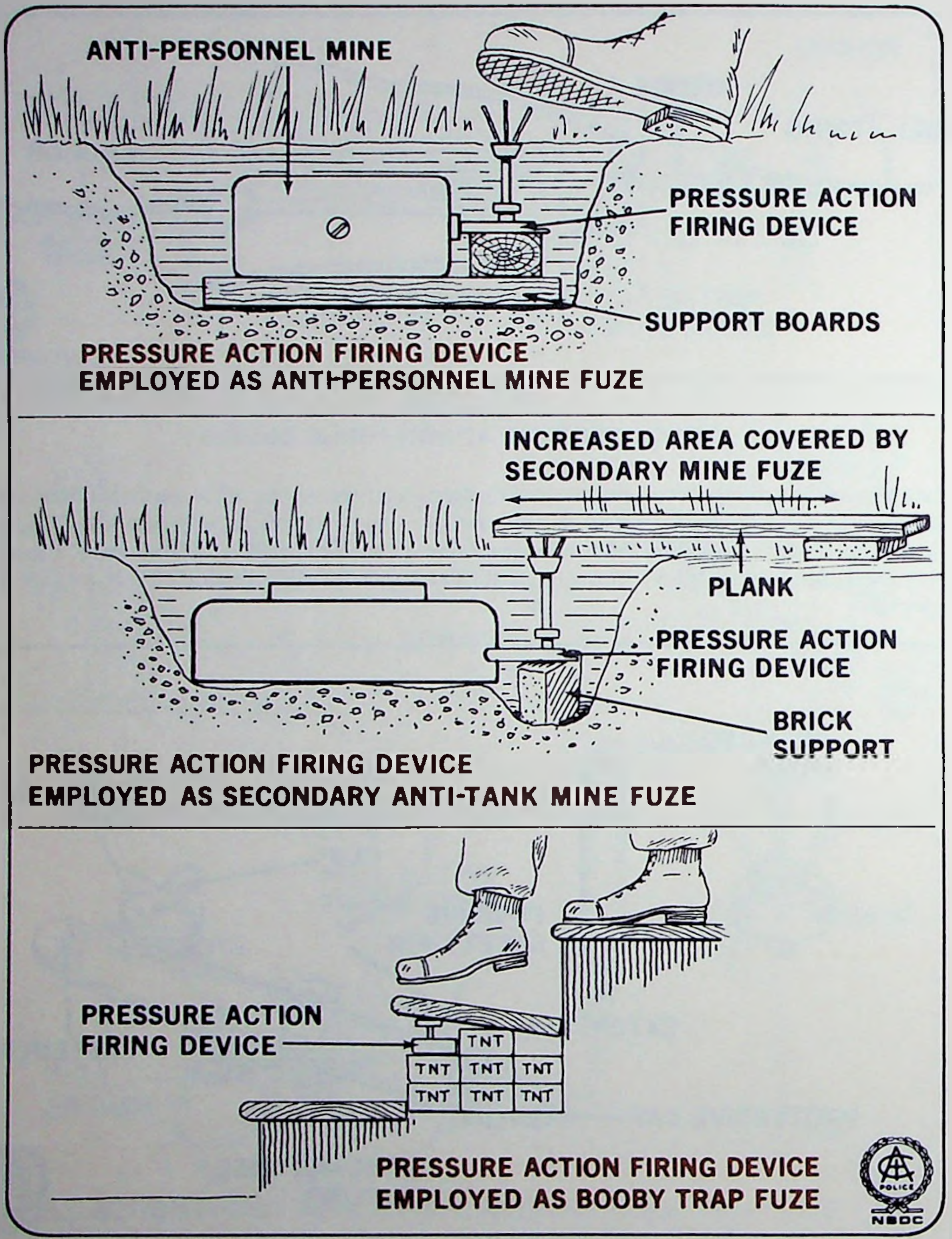


Figure 212
EMPLOYMENT OF PRESSURE ACTION FIRING DEVICE

Improvised pressure action firing devices are also commonly employed by terrorists. The improvised pressure action firing device illustrated in Figure 213 is similar in construction to a device which was employed in an Indianapolis, Indiana bombing. This electrical, pressure action device consists of two tin can lids through which holes are punched with a large nail. Electrical wires are soldered to the lids to form an electrical switch. A piece of heavy craft paper is placed between the lids to act as an electrical insulator. The assembled device is then concealed under some covering, such as a rug, and connected to the bomb. When the victim steps on the rug, the sharp edges of the punched nail holes cut through the insulating paper and complete the electrical circuit, detonating the bomb.

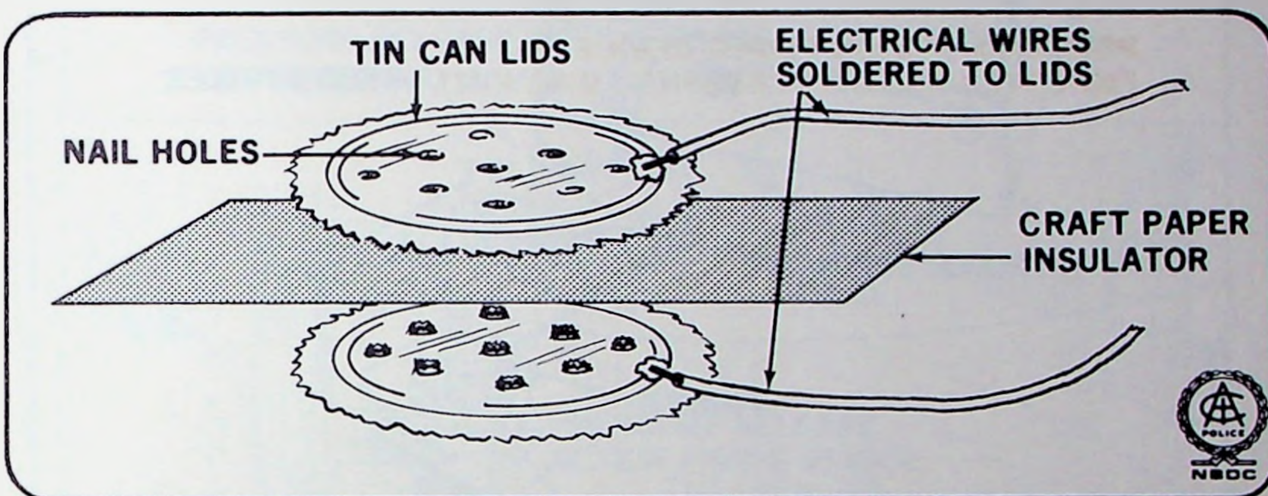


Figure 213
IMPROVISED PRESSURE ACTION FIRING DEVICE

Improvised, electrical, pressure action firing devices have of different construction been employed in Southeast Asia to detonate mines placed in roads and along road shoulders.

Pressure-Release Action. The U.S. military M5 pressure-release action firing device, illustrated in Figure 214, is a steel, rectangular box. The firing device is unpainted and is 1 3/4 inches in length, 1 inch in width, and 11/16 inches in height. This military firing device is employed by placing it beneath an object which weighs 5 pounds or more. Removal of the weighted object after the device has been armed (release of pressure) causes the hinged lid of the firing device to move upward, releasing the cocked striker and detonating the mine or booby trap. Because the cocked striker swings in an arc with an action similar to that of a rodent trap, this device is more commonly known as the "mousetrap" firing device by military personnel. Figure 215 illustrates typical employment of the U.S. military M5 pressure-release action firing device.

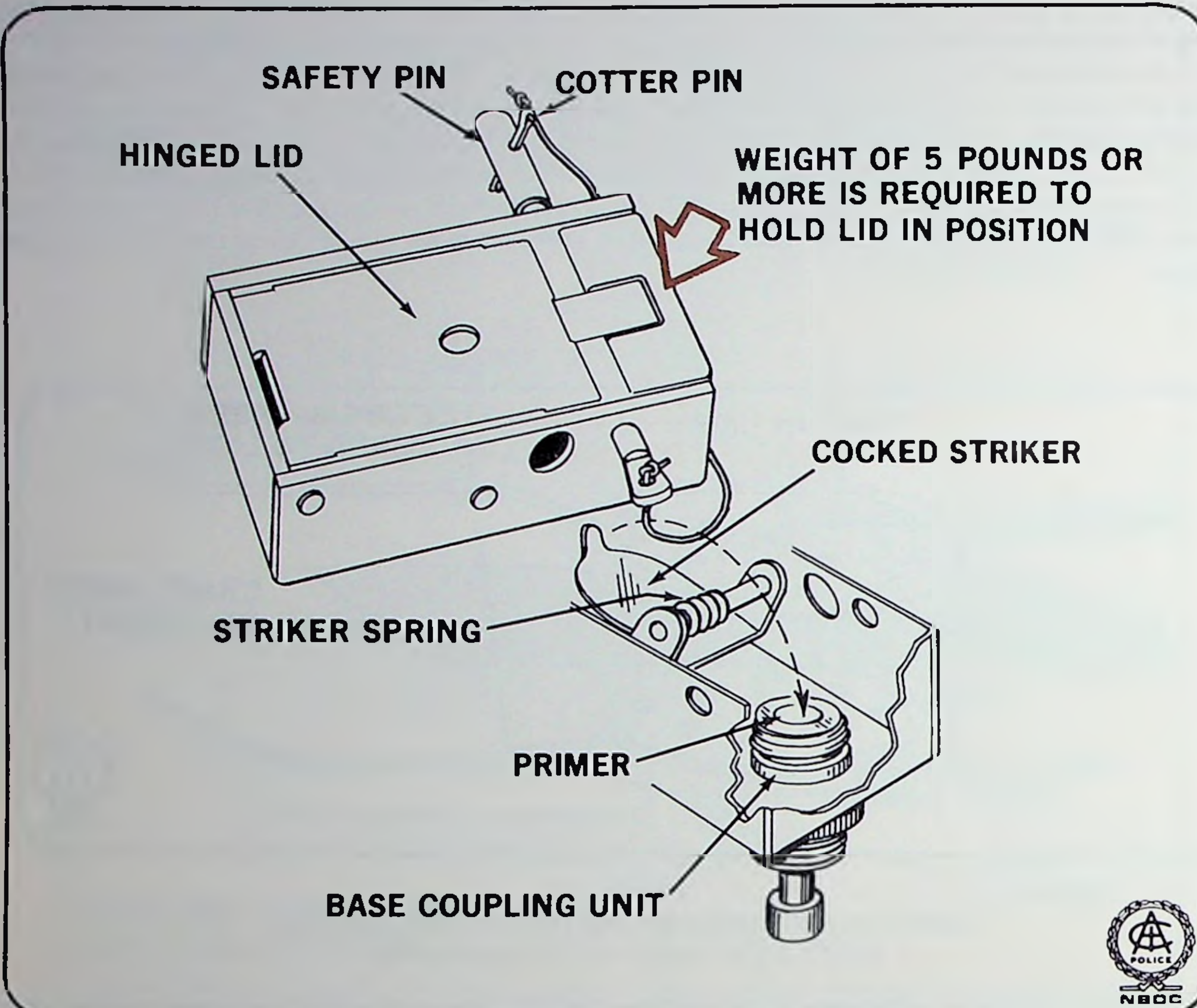


Figure 214
U.S. MILITARY M5 PRESSURE-RELEASE ACTION FIRING DEVICE

Improvised pressure-release action firing devices are most commonly constructed from rodent traps or mousetraps because these devices may be easily converted to a mechanism capable of detonating a bomb through the release of pressure. By soldering a striker to the snap bar of a mousetrap, it may be employed to mechanically fire a percussion primer and thereby detonate a blasting cap. Figure 216 illustrates the more commonly used, electrical conversion of an ordinary mousetrap to a pressure-release action firing device. The electrical, pressure-release action, firing device illustrated has been employed as a bomb fuze in almost every violent revolution of the past 50 years and, like the pull action devices, it will continue to be used in the future. Construction details associated with this device have been widely circulated in the underground press throughout the United States and traveling teams of militant instructors have stressed its use in booby-trapping during clandestine training sessions in several states.

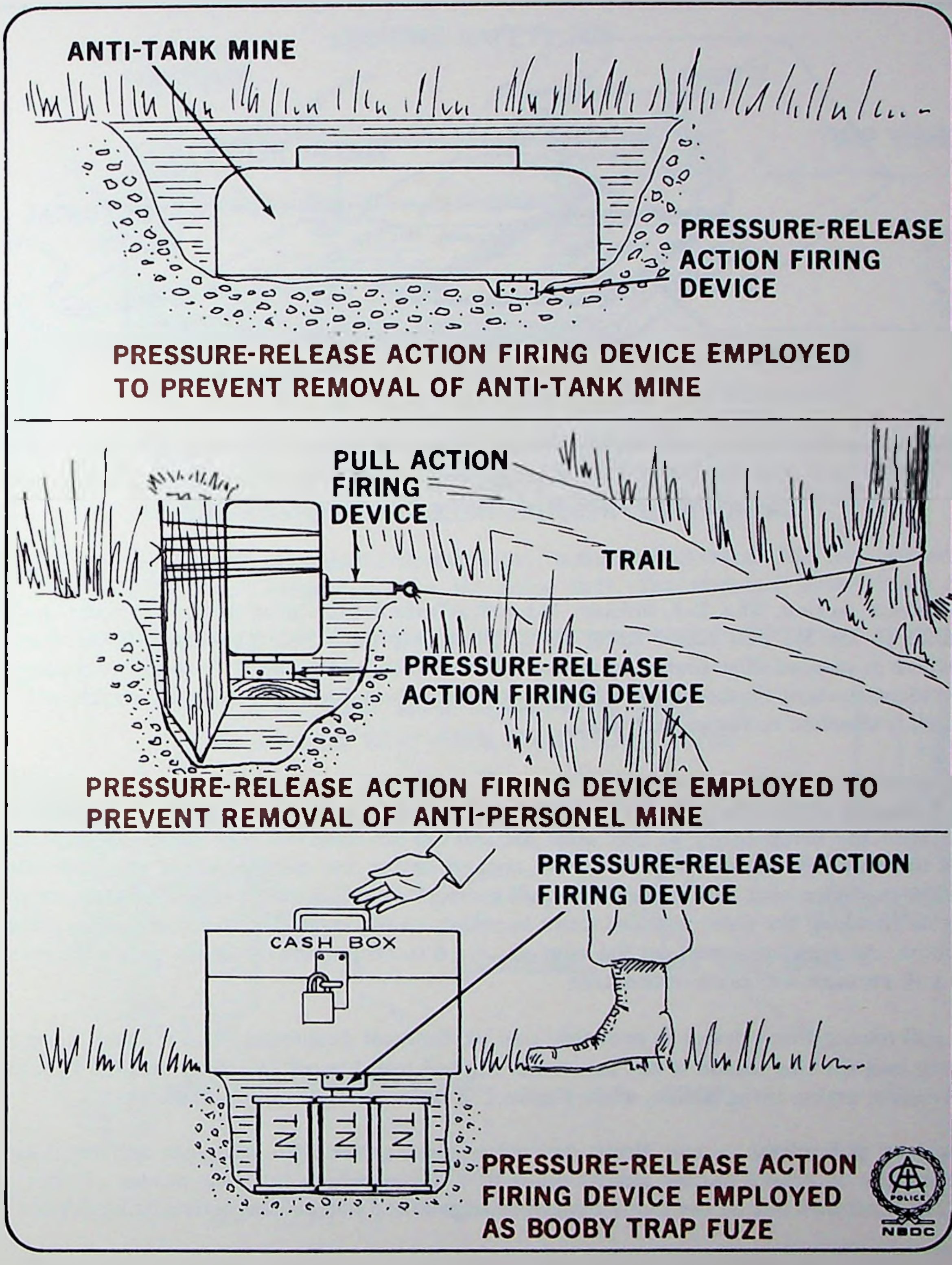


Figure 215
EMPLOYMENT OF PRESSURE-RELEASE ACTION FIRING DEVICE

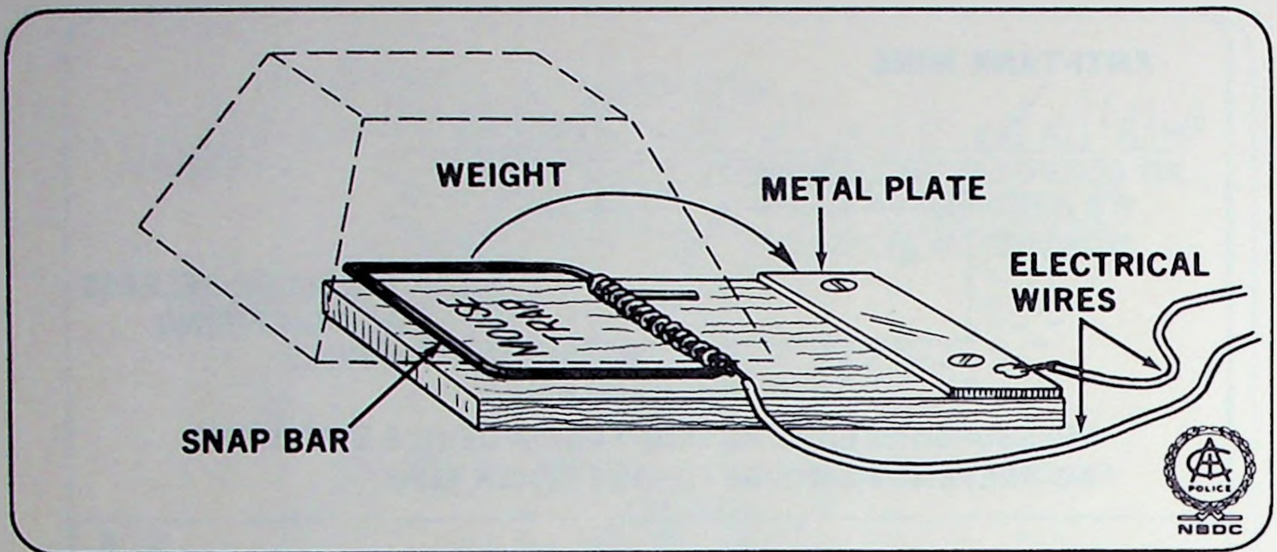


Figure 216
IMPROVISED PRESSURE-RELEASE FIRING DEVICE

Pull-Release Action. The U.S. military M3 pull-release action firing device is similar in size and appearance to the M1 pull action firing device previously described. The firing device has a metal body, which is painted olive drab, and measures 4 inches in length and 9/16 inches in diameter. The primary identification feature of the M3 pull-release action firing device is the winch and ratchet unit which is attached to the metal body.

The square-shaped winch and ratchet unit is employed to draw the trip or pull wire to an extremely taut position when the firing device is installed in a mine. Drawing the wire into this taut position arms the firing device so that after the safeties are removed, any additional tightening (or pull) on the wire will result in release of the cocked striker and detonation of the mine. Once the wire has been drawn taut and is exerting a pull pressure on its anchor, a release of this pull pressure (cutting or breaking the wire) will also result in release of the cocked striker and a subsequent firing of the mine. An additional pull on the wire of only 6 to 10 pounds *or* the release of the previously applied pull pressure will cause detonation.

This pull-release firing device is probably one of the most dangerous of all military firing devices to employ and for this reason it has somewhat limited use. Figure 217 illustrates the U.S. military M3 pull-release action firing device, while Figure 218 illustrates its employment.

Improvised pull-release action firing devices are unpopular with militants and revolutionaries because of the increased danger associated with a device which has two modes of functioning. Figure 219 illustrates one of the rarely employed improvised pull-release action firing devices.

Time Action. Time action devices cause the detonation of a mine after the expiration of a preselected delay time. By employing time action fuzes, a pressure-fuzed anti-tank mine may, for

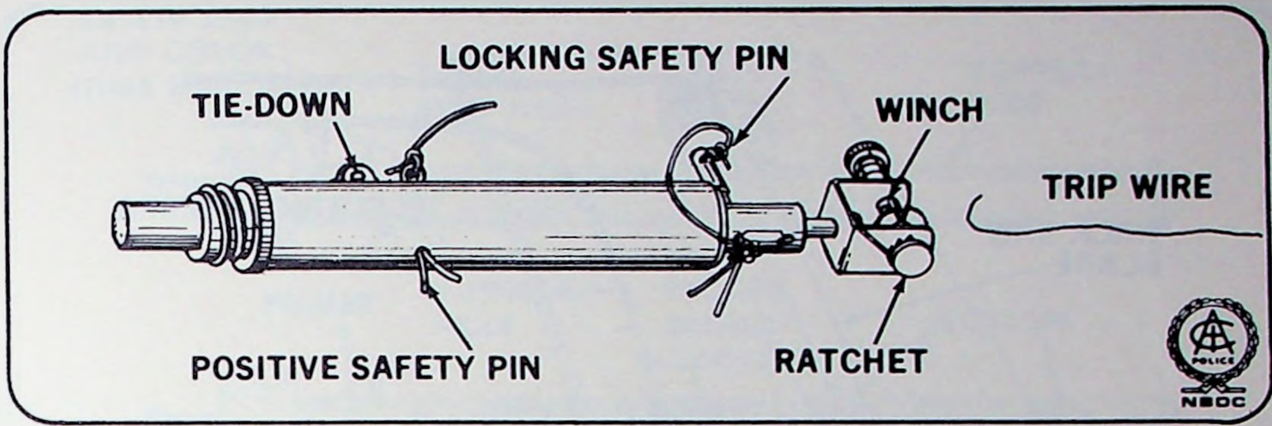


Figure 217
U.S. MILITARY M3 PULL-RELEASE ACTION FIRING DEVICE

example, be placed on a narrow mountain road where its detonation under a tank would block the route of travel. Should no tank detonate the mine at the end of the selected time delay, the mine would be detonated by the time action fuze and would crater the road to impede traffic.

Time action fuzes may be clockwork, electrical, mechanical, or chemical. The U.S. Armed Forces employ a time action fuze identified as a *M1 delay fuze*. This chemical delay device is more

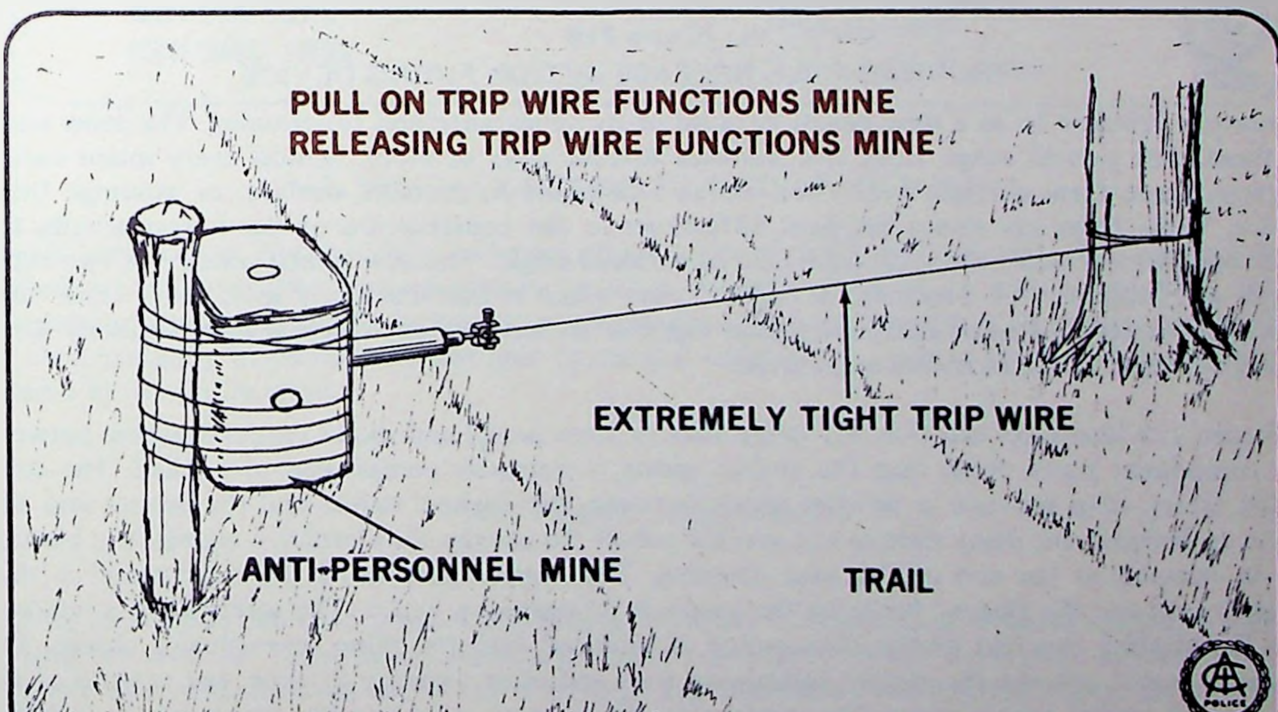


Figure 218
EMPLOYMENT OF PULL-RELEASE ACTION FIRING DEVICE

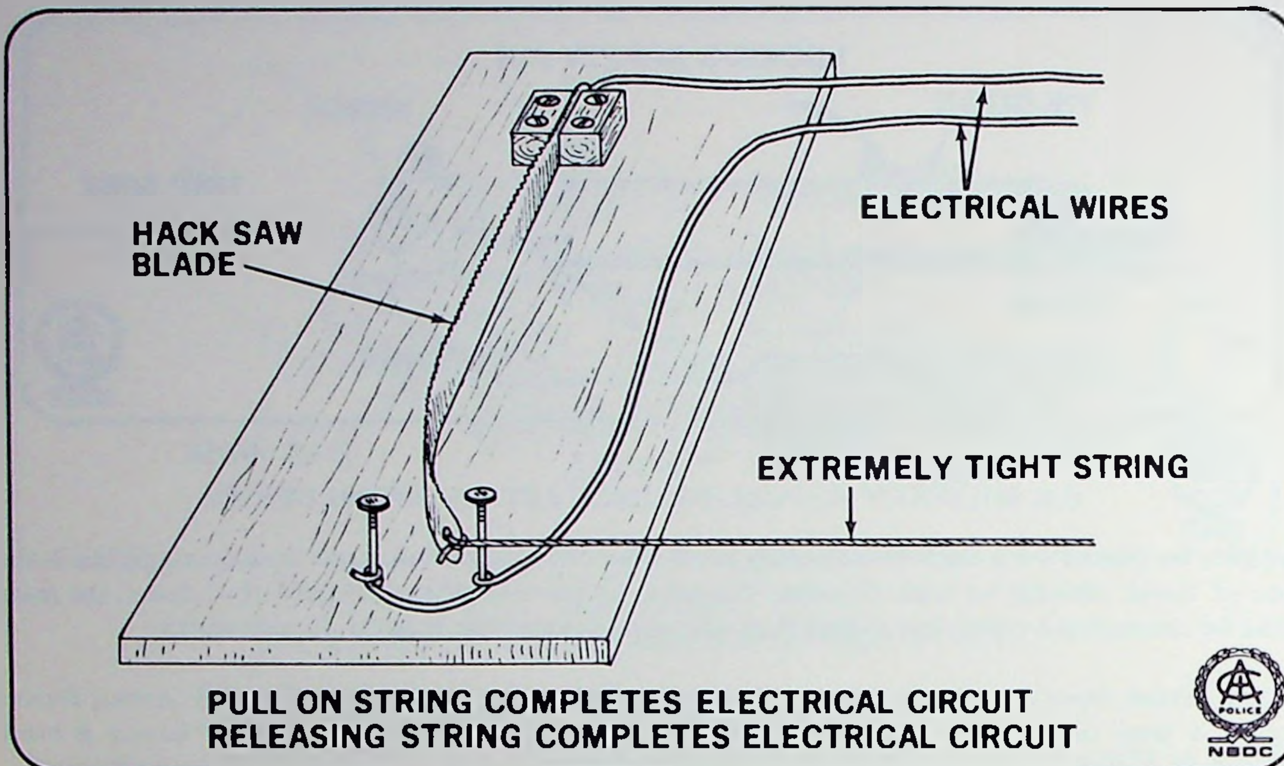


Figure 219
IMPROVISED PULL-RELEASE ACTION FIRING DEVICE

commonly referred to as a *time pencil* because of its appearance and functioning. The delay times of these time pencils range from five minutes to nine days or more. Almost every major nation employs some form of time pencil for use as a demolition, guerrilla warfare, or sabotage firing device. While there are minor physical differences in the construction of these time pencils, the basic operation remains the same regardless of national origin. The time pencil consists of two tubes which are friction-fitted together. A copper tube, which is thin and fairly soft, and a brass tube, which is heavier and more rigid, are joined together to form a unit which is approximately 4 1/2 inches in length and 5/16 inches in diameter.

Figure 220 illustrates the U.S. M1 delay fuze or time pencil and shows the relationship between the component parts. Note that the striker spring is normally compressed or cocked. The color coded safety strip provides a positive block between the cocked striker and the primer and also serves to indicate the delay time of the specific pencil. To use the time pencil, a nonelectric blasting cap is crimped to the end of the base coupling. The copper portion of the time pencil is then crushed between the fingers, breaking the ampoule of corrosive liquid. The safety strip is removed and the blasting cap end of the time pencil is threaded into the mine or explosive charge. The corrosive liquid attacks the striker restraining wire and after a period of time, the tension of the compressed striker spring causes the weakened wire to part, releasing the striker which is driven forward to strike the primer. The flash from the firing of the primer functions the nonelectric blasting cap and detonates the mine.

Other Types of Actions. The four basic actions—pull, pressure, pressure-release, and pull-release—which are used in the standard U.S. military firing devices are employed in most types of firing

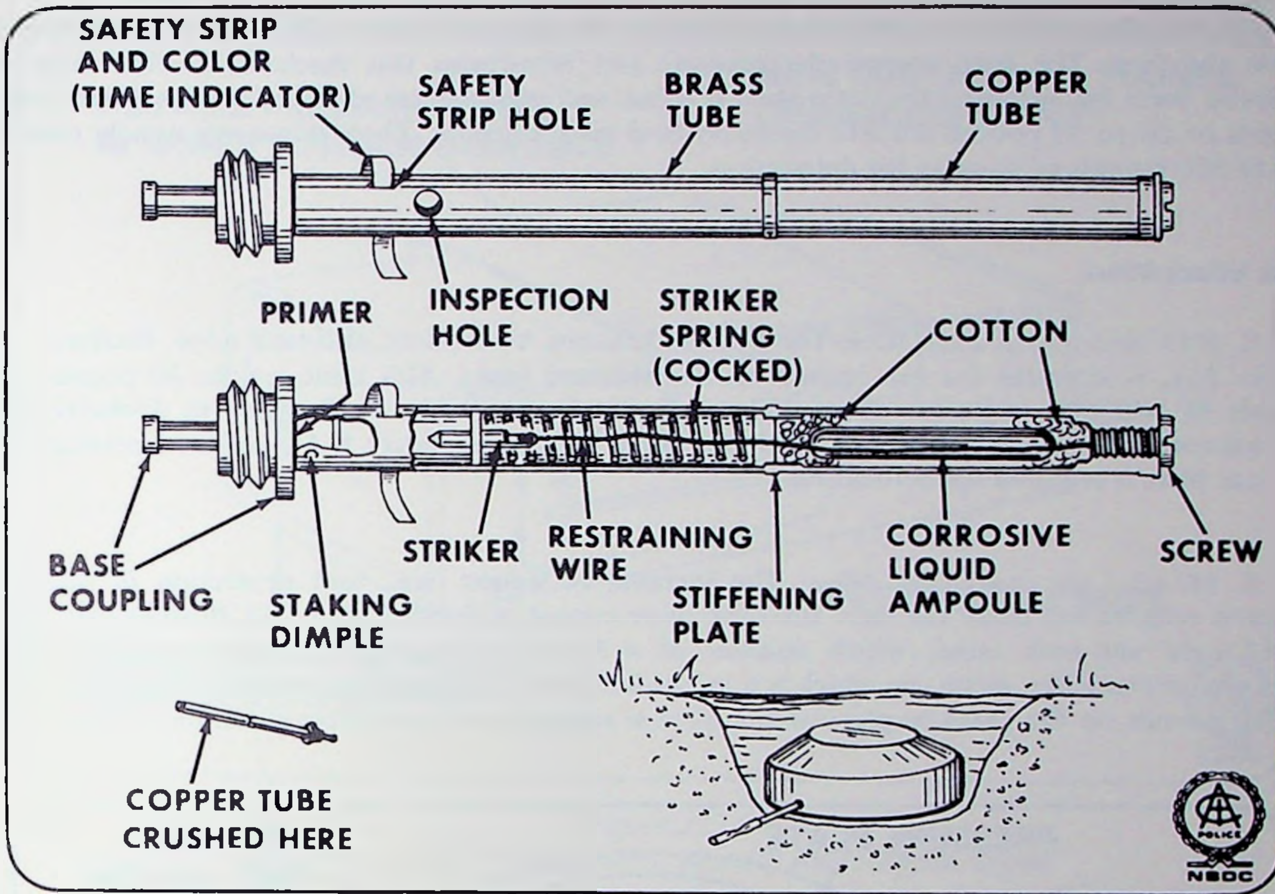


Figure 220
U.S. MILITARY M21 DELAY FUZE (TIME PENCIL)

devices used in the world today. Although other types of firing devices exist, they are primarily limited to military use. Devices which function through chemical or mechanical time delay, temperature change, magnetic influence, or vibrations have been developed by various nations, but are used generally in clandestine sabotage operations only. These types of firing devices will not be covered in this publication.

ANTI-TANK LAND MINES

Anti-tank mines are used primarily to limit or obstruct the movement of tanks and other tracked or wheeled vehicles. These mines are usually laid on or slightly below the surface of the earth. The majority of anti-tank mines are of the blast type and depend on the explosive force developed by detonation for their destructive effect.

The two general military classifications for anti-tank mines are *heavy* and *light*. The classification is determined by the total weight and size of the mine and the amount of pressure required to depress or function the fuze. The fuze pressure plate of an anti-tank mine is often an integral part of the upper section of the mine body and is designed to distribute the weight of the tank uniformly across the fuze. The fuze accepts the pressure and transforms this mechanical action into an explosive force by initiating the detonator, booster, and main charge of the mine. Mines with total weights of 20 to 30 pounds fall into the heavy land mine category. These mines will usually require 300 to 500 pounds of pressure for detonation.

Blast Effect Mines

U.S. M15 Heavy Anti-Tank Mine. The U.S. M15, heavy, blast effect, anti-tank mine, illustrated in Figure 221, is intended for use against heavily armored tanks. This mine weighs 30 pounds, 22 pounds of which is explosive charge. The cylindrical mine body is 13 inches in diameter and approximately 5 inches in height. A minimum force of approximately 565 pounds of pressure on the fuze plate is required for detonation.

U.S. M7A2 Light Anti-Tank Mine. The increase in weight, size, and protection of modern armored vehicles has made the light anti-tank mine almost obsolete. Figure 222 illustrates the U.S. M7A2 light anti-tank mine, which consists of a 3.6-pound explosive charge of tetrytol in a quart-size, rectangular, metal can which is 6 inches long and 3 inches wide. A minimum force of 140 to 240 pounds on the pressure plate of the mine is required to cause detonation. Used singly, this

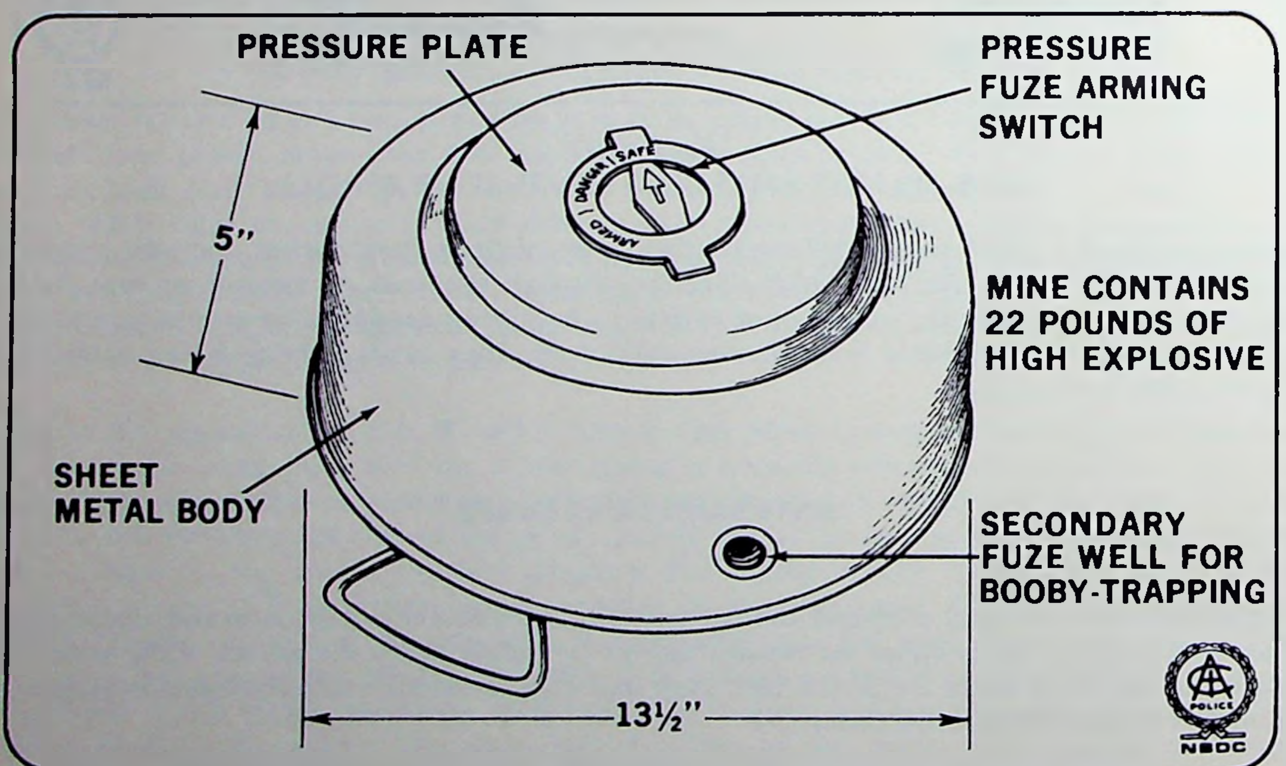


Figure 221
U.S. MILITARY M15 HEAVY BLAST ANTI-TANK MINE

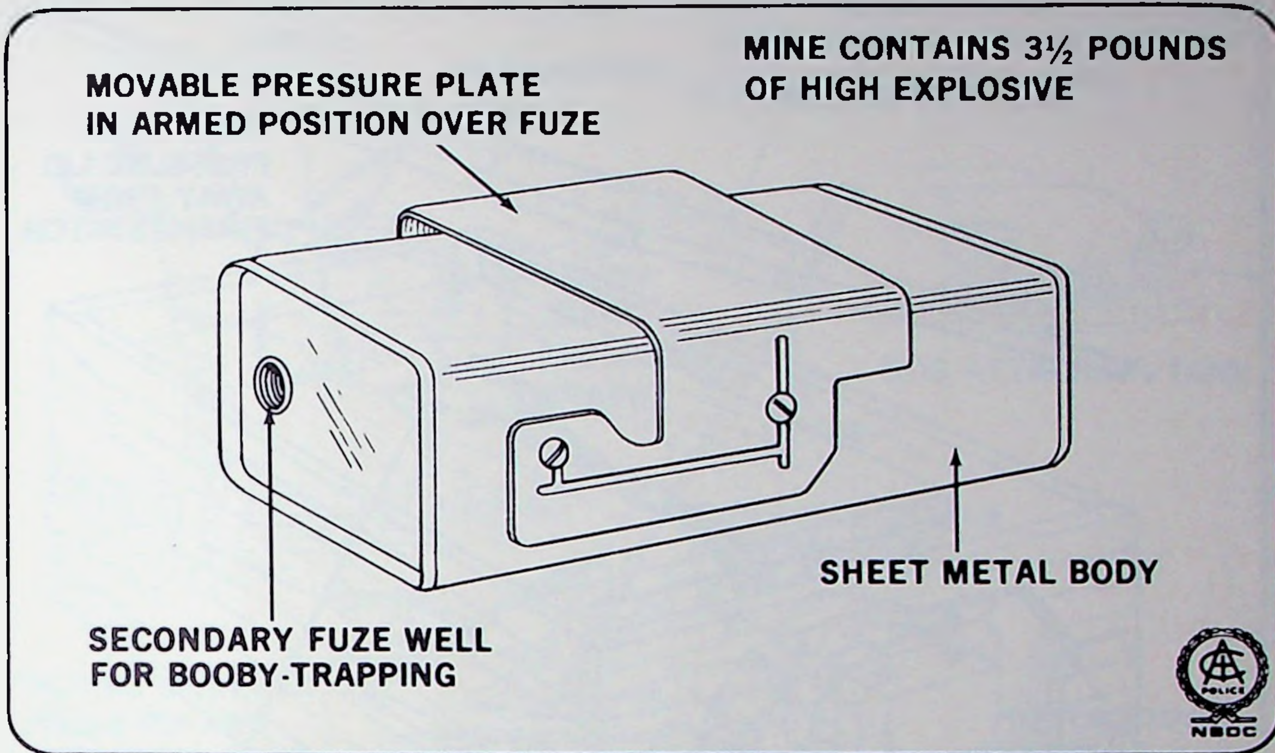


Figure 222
U.S. MILITARY M7A2 LIGHT BLAST ANTI-TANK MINE

mine will destroy a small unarmored vehicle. Two or more mines may be grouped together for use against larger and armored vehicles.

Improvised Blast Effect Mines. Improvised heavy blast effect land mines manufactured by revolutionary groups and terrorists follow no set style or pattern. The only criterion for improvised mine construction is simply to provide a container, usually a wooden box, for the explosive and fuze. Improvised blast effect anti-tank mines are often control-fired by an operator, thereby eliminating the need to construct a pressure action mine fuze. However, when a pressure action mine fuze is constructed and employed with the mine, it is frequently of the electrical type since construction of this kind of fuze does not require machined components. Figure 223 illustrates one type of electrical pressure action fuze employed to detonate an improvised anti-tank mine. No distinction between heavy and light blast effect anti-tank mines is made when mines are improvised.

Russian "Dog" Mine. The Soviet Union employs a unique blast anti-tank mine which, when armed and released, seeks out an enemy tank and destroys it. This mine is mounted on the back of a dog that has been trained to run under a tank to receive food. The dog wears a special canvas harness which contains 26 pounds of explosives and a lever action mine fuze, as shown in Figure 224. As the dog crawls under the tank, the low part of the tank body strikes the lever and pushes it

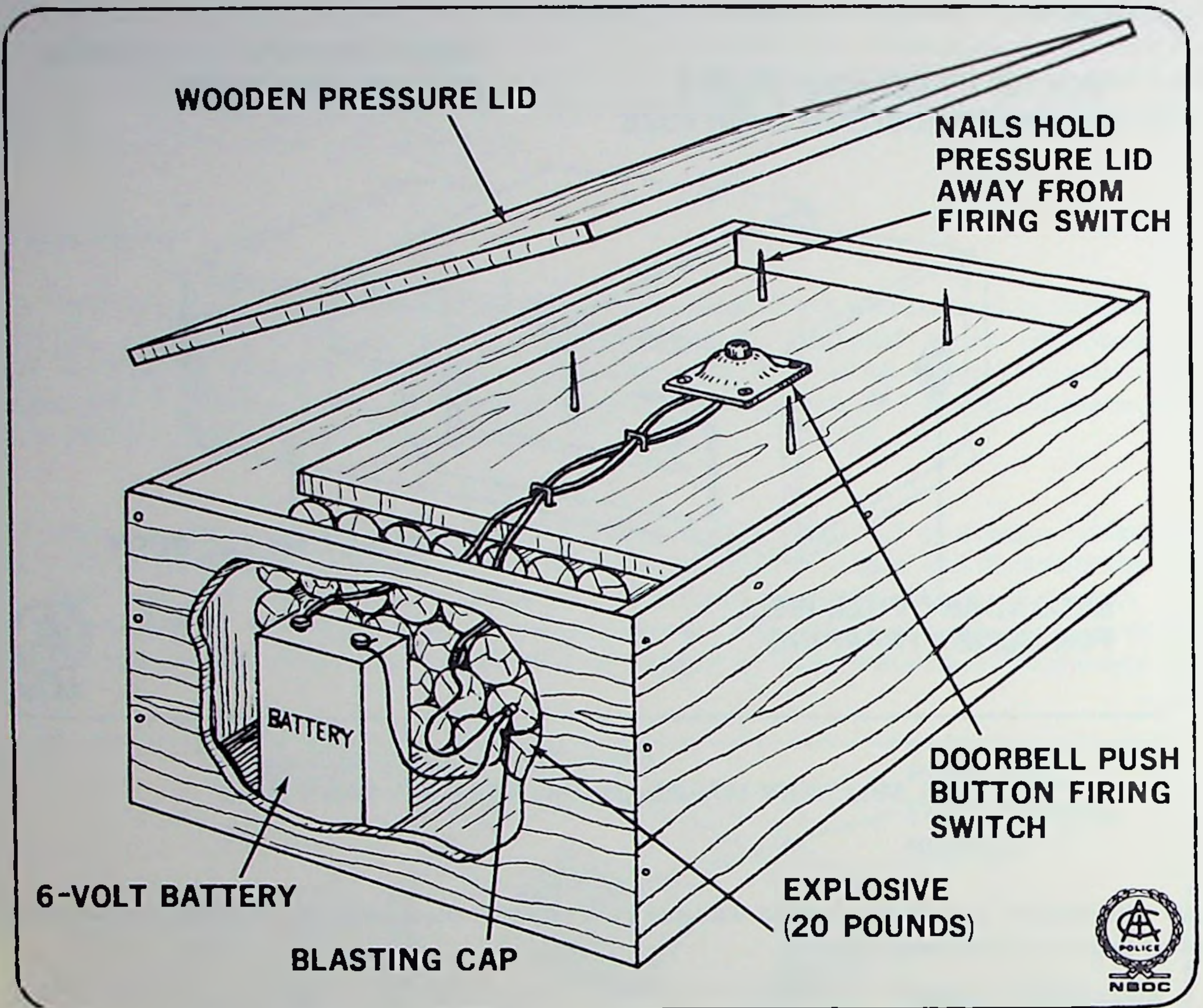


Figure 223
IMPROVISED ELECTRICALLY FIRED HEAVY BLAST LAND MINE

backward to detonate the mine and destroy the tank. Because dogs tend to react rather unpredictably under combat conditions of smoke, loud noises, and gunfire, it is doubtful that this mine has been widely used in combat. However, the technique could easily be adapted to terrorist activities for attacks against vehicles or difficult targets.

Special Effect Mines

Miznay-Chardin Mines. An anti-tank mine which employs the Miznay-Chardin or plate charge is truly a tank killer in every sense of the word. The Miznay-Chardin effect consists of explosively inverting a concave, 6- to 10-pound steel plate into a high velocity, convex-shaped projectile capable of penetrating the underside armor of any known tank. The inversion of the plate requires

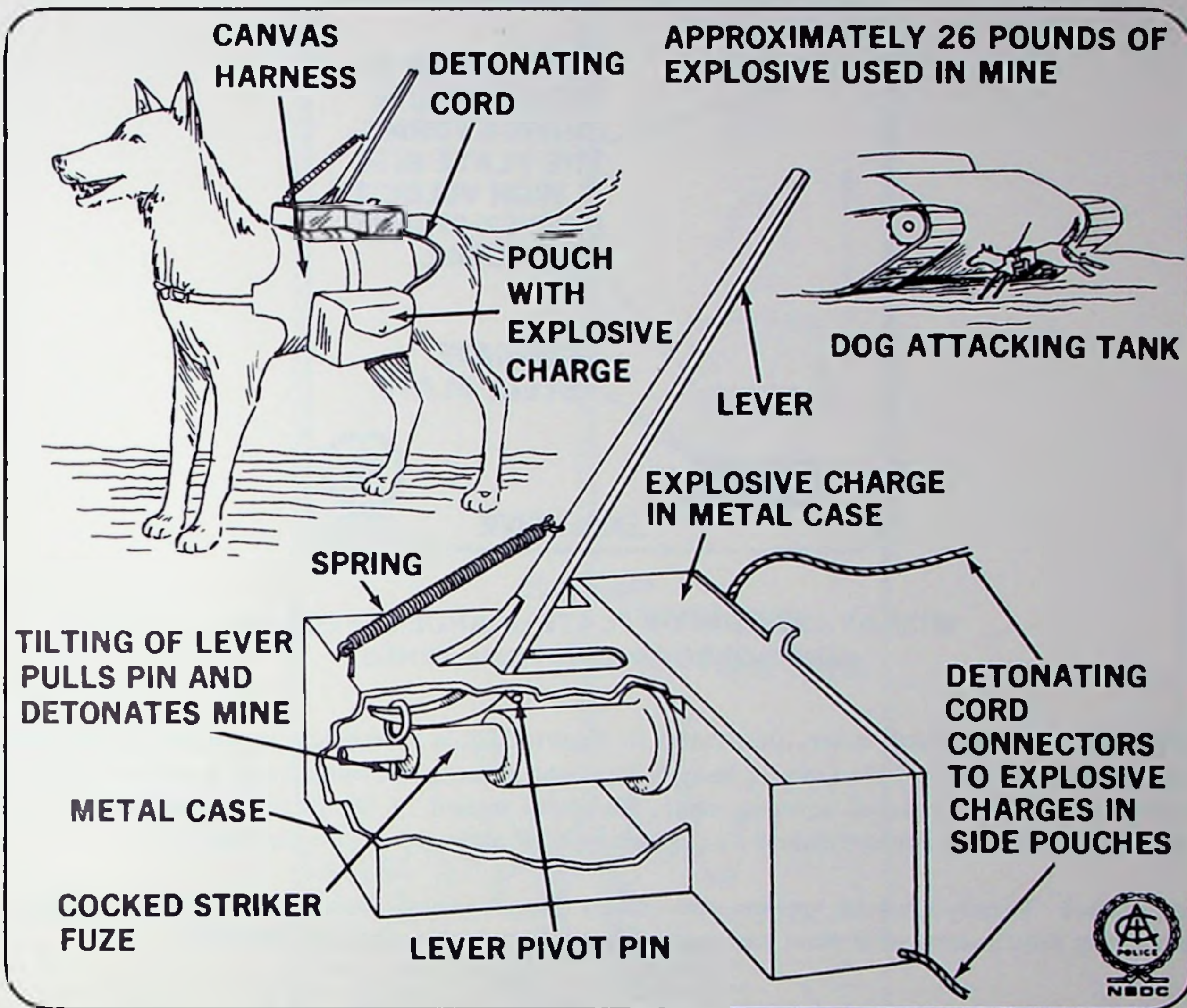


Figure 224
RUSSIAN DOG MINE (BLAST, ANTI-TANK)

approximately 18 inches of free and unobstructed air travel in order to properly form. The Miznay-Chardin effect is illustrated in Figure 225.

The U.S. military M21 "Killer" anti-tank mine employs the Miznay-Chardin or plate charge effect to destroy tanks. In order to provide for proper unobstructed formation of the plate, the M607 tilt rod mine fuze used in the M21 mine first fires a black powder expelling charge to clear away dirt or camouflage placed over the mine and, a fraction of a second later, explodes the main explosive charge, driving the plate into the underside of the tank. (See operation of U.S. M607 tilt rod fuze, pages 193-194 for additional details.) If a Miznay-Chardin land mine explodes beneath a tank's treads instead of its body, the plate does not form. However, the explosive force alone is sufficient to blow off a tank tread and cripple the vehicle.

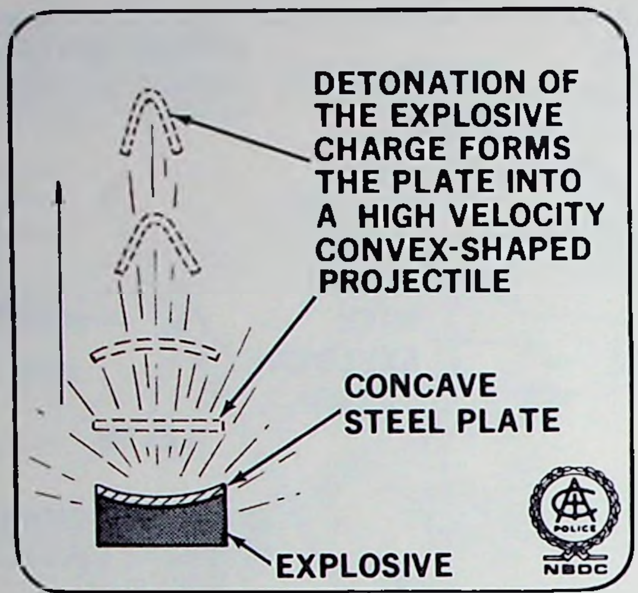


Figure 225
MIZNAY-CHARDIN OR PLATE CHARGE EFFECT AS EMPLOYED IN ANTI-TANK MINES

The U.S. M21 anti-tank mine, illustrated in Figure 226, is cylindrical in shape and measures 9 inches in diameter and 4 1/2 inches in height. The light sheet metal outer body is painted olive drab and is equipped with a canvas carrying strap. The total weight of the unfuzed land mine is 17 1/4 pounds and it contains approximately 11 pounds of high explosive (Composition H6).

Improvised Miznay-Chardin mines are rarely encountered because of the difficulty of constructing the concave steel plate and casting melted explosive along its underside.

Shaped Charge Mines. The employment of a cavity or shaped charge-equipped anti-tank mine is not a common military practice. A few nations do employ such land mines buried in the ground with the shaped charge pointed upward toward the target. When the mine functions, gases formed during the detonation of the shaped explosive charge form a high velocity jet capable of penetrating heavy layers or armor. Shaped charge anti-tank mines which are planted in the ground (under the tank) often employ an offset fuzing system so that when the tank strikes the mine fuze, the shaped charge jet strikes the underside of the tank in the vicinity of the fuel compartment or ammunition storage area.

A recently developed U.S. shaped charge anti-tank mine, the M24, is placed *off the road* approximately *10 to 100 feet* to the side of the anticipated route of travel of the enemy tank. This anti-tank mine consists of a 3.5-inch (bazooka) HEAT rocket projectile in a short launching tube. The mine is fired at the tank when the tank's treads strike a pneumatic pressure action fuze placed across the roadway. Actuation of the pneumatic mine fuze launches the rocket at the tank and, upon impact with the tank's body, the rocket fuze detonates the shaped charge, perforating the tank's armor.

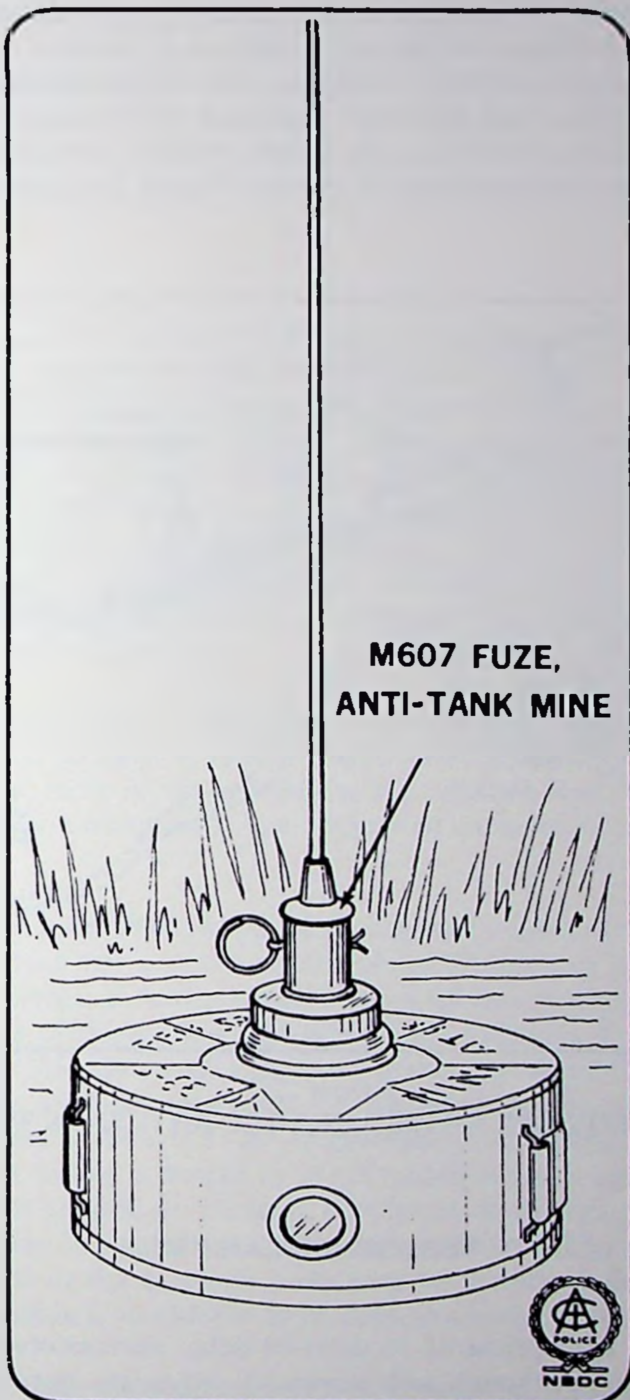


Figure 226
U.S. MILITARY M21 (MIZNAY-CHARDIN EFFECT) ANTI-TANK MINE
WITH M607 TILT ROD FUZE

Improvised shaped charge anti-tank mines are generally constructed from stolen or captured military demolition shaped charges which are employed in combat demolition operations. The stolen shaped charge is planted inverted in a roadway and a board or light metal plate is placed over the shaped charge cavity to prevent dirt from destroying the formation of the shaped charge jet. Shaped charge anti-tank mines of this type are usually control fired, although improvised pressure action mine fuzes have also been employed in the past. Figure 227 illustrates an improvised shaped charge anti-tank mine.

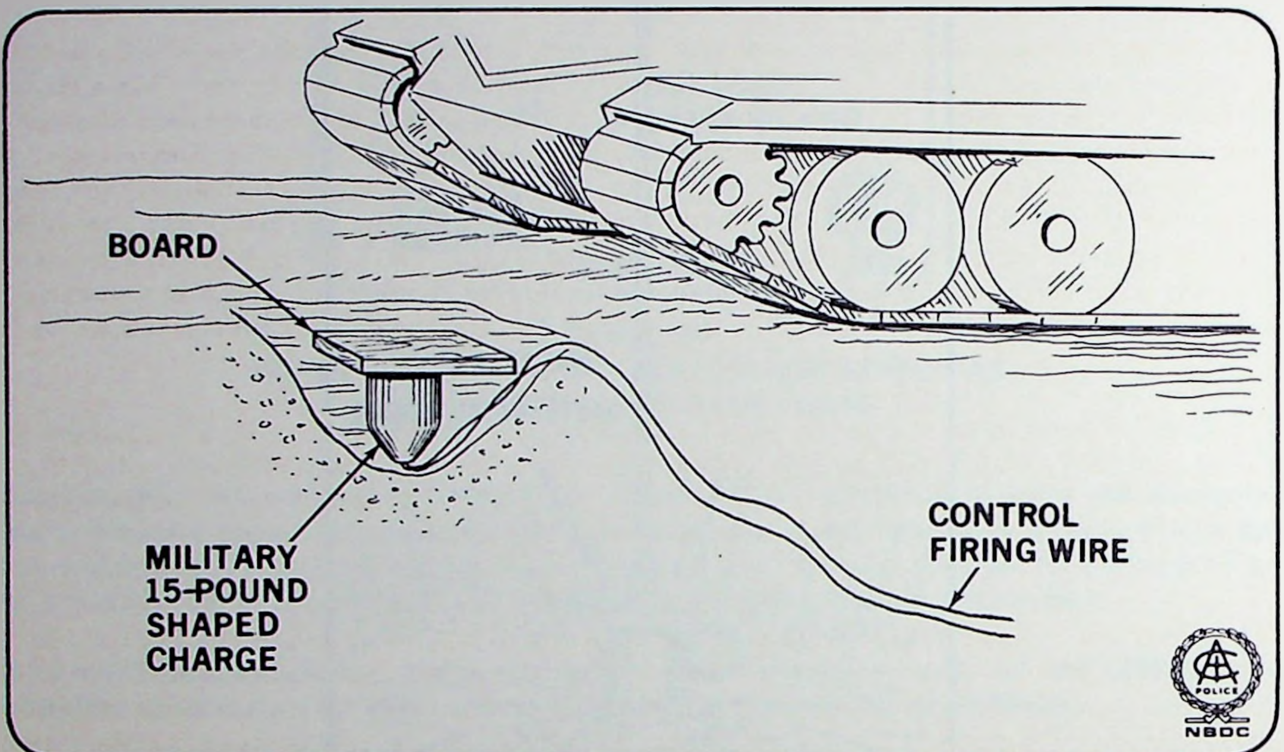


Figure 227
IMPROVISED SHAPED CHARGE ANTI-TANK MINE

ANTI-PERSONNEL LAND MINES

Anti-personnel mines are used primarily to deter or delay movements of foot troops by denying their access to certain areas. Although anti-personnel mines are not effective against armored vehicles, light, thin-skinned vehicles, such as trucks and jeeps, may be damaged or their occupants injured by the detonation of an anti-personnel mine. Anti-personnel mines are of two general types, *blast* and *fragmentation*. Fragmentation anti-personnel land mines rely upon the capacity to project high velocity fragments over a fairly wide area, while the smaller *blast* anti-personnel mines depend for the most part on direct explosive contact between the mine and the victim to produce casualties. Anti-personnel fragmentation mines are further subdivided according to the fragmentation action produced by the mine into the following sub-categories:

- Directional fragmentation
- Nondirectional fragmentation
- Bounding fragmentation

Fragmentation Mines

Directional Fragmentation. One of the most effective directional fragmentation anti-personnel land mines in use today is the U.S. M18A1 Claymore mine. The M18A1 Claymore has a curved, rectangular, fiberglass case, 8 1/2 inches long and 3 1/4 inches high. The fragmentation material of the mine consists of 700 steel spheres (ball bearings) imbedded in a plastic matrix. Horizontally, the matrix is convex to direct the fragments in a 60° arc; vertically, it is concave to control the vertical dispersion of the fragments. The M18A1 mine disperses its 700 steel fragments in a fan-shaped pattern, approximately 6 1/2 feet high and 60° wide at a range of 165 feet. These fragments are effective in producing casualties up to a range of approximately 325 feet and can be projected up to 500 feet from the mine. The mine may be initiated by the action of target personnel or by controlled firing, as illustrated in Figure 228.

Improvised Claymore anti-personnel mines have been *constructed* by some U.S. radical groups, but have not been *employed* to date. A typical improvised Claymore mine is illustrated in Figure 229. Although this type of mine is not as lethal as the military version, it would certainly be an effective anti-personnel weapon when used in an ambush or entrapment situation.

Nondirectional Fragmentation. Perhaps the most common fragmentation anti-personnel mine is the *nondirectional mine* which has a heavy metal body containing an explosive charge. The metal body may or may not be serrated. Anti-personnel mines of this type may be placed above, on, or slightly beneath the surface of the ground. When the mine explodes, fragments of the heavy metal case are projected at high velocity in all directions; hence, its identification as a nondirectional mine. Figure 230 illustrates an older nondirectional fragmentation anti-personnel land mine that is still in use by the U.S. military. This U.S. M3 fragmentation anti-personnel mine has a heavy cast iron body, measuring 5 3/4 inches in height by 3 1/2 inches in width and contains approximately 1 pound of TNT. The mine is planted by partially burying it or securing it to a tree, stake, or other immovable object. The mine is normally initiated by a pull fuze trip wire or by a pressure fuze. Upon detonation, fragments of the cast iron body may be thrown as far as 350 feet. The effective lethal casualty-producing radius is considered to be approximately 30 feet.

The U.S. XM61 linear fragmentation anti-personnel mine is a new concept in anti-personnel mines. This nondirectional mine consists of a 25-foot length of waterproof, 7/16-inch-diameter, flexible, explosive cord with approximately 150 coiled fragmentation ring units assembled to it. The entire mine is olive drab in color and bears no markings. Figure 231 illustrates the XM61 linear fragmentation anti-personnel mine and its employment. The fragmentation rings are made of square wire and are serrated on the inside to provide fragmentation upon detonation. The 1 1/4-inch-long fragmentation rings are spaced evenly along the length of the flexible explosive cord at 2-inch intervals. The XM61 anti-personnel mine may be shortened as required by cutting between the

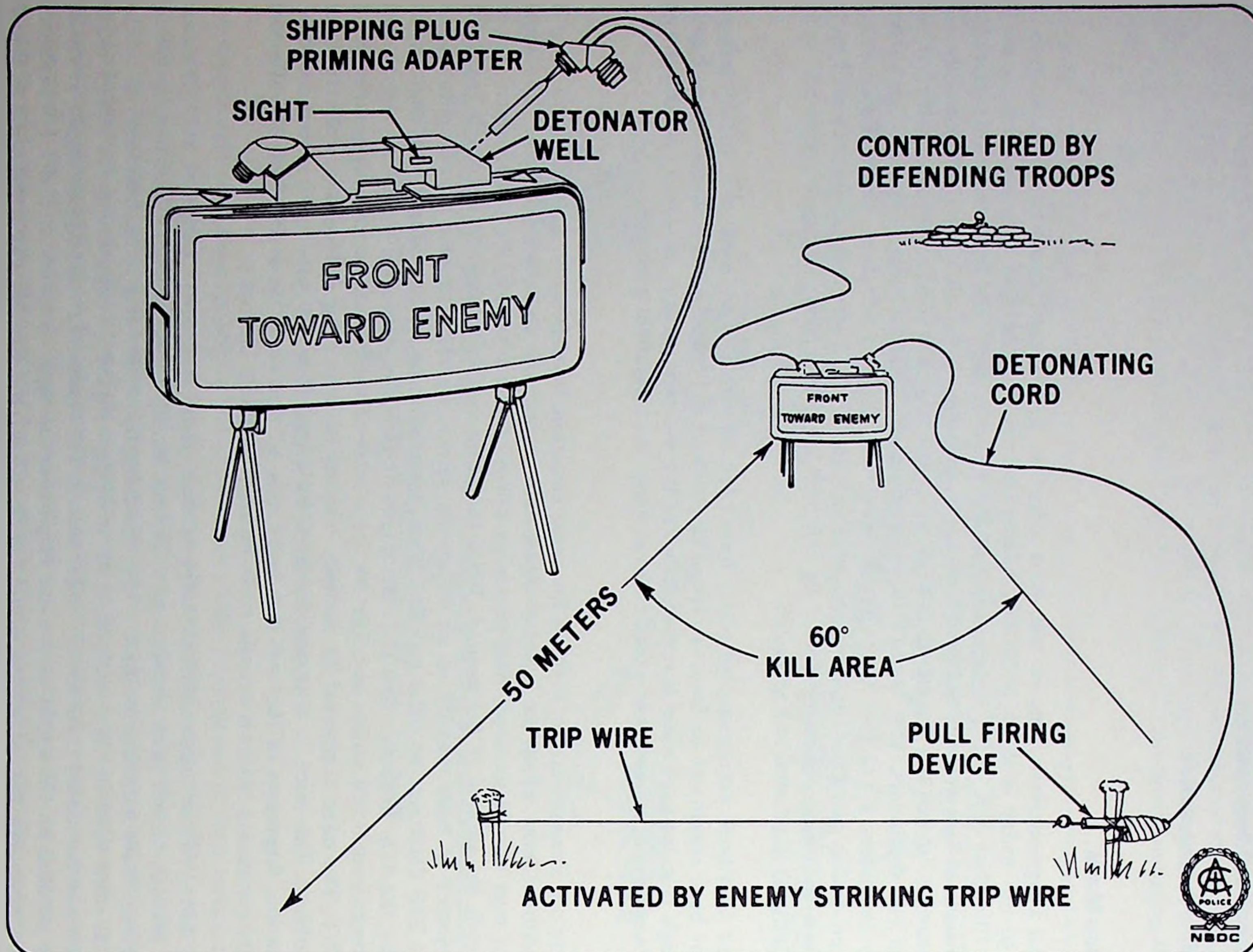


Figure 228
U.S. MILITARY M18A1, CLAYMORE FRAGMENTATION
ANTI-PERSONNEL MINE

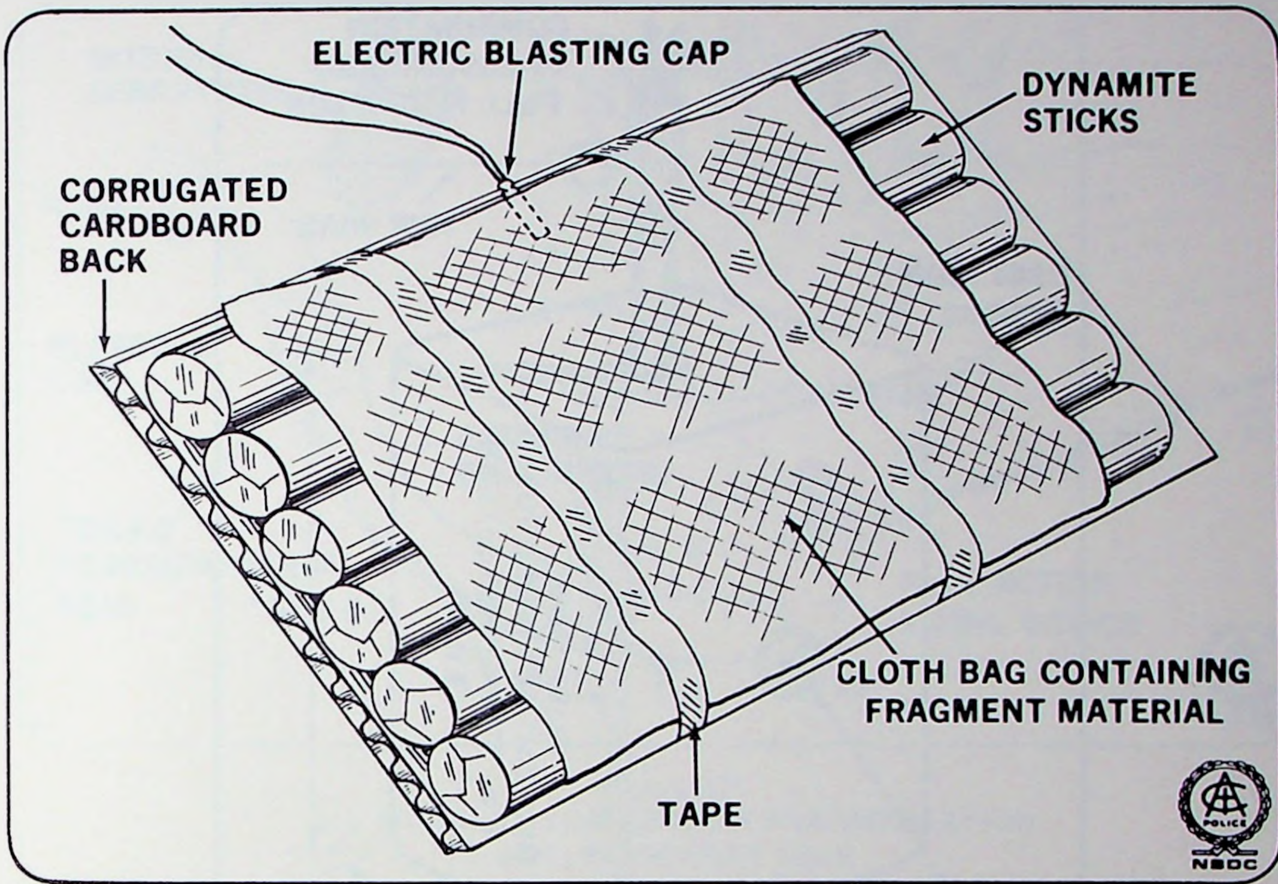


Figure 229
IMPROVISED CLAYMORE MINE

fragmentation rings, or if a longer mine is required, individual mine may be connected together with a metal coupling assembly.

Detonation of the mine is accomplished with a standard electric or nonelectric blasting cap which is either control fired or assembled to a standard firing device. Upon detonation of the mine, the serrated rings produce fragmentation covering a circular area along the entire length of the mine.

Improvised nondirectional fragmentation anti-personnel mines are perhaps the most common type of mine employed by terrorists and revolutionaries. Any of the improvised fragmentation hand grenades illustrated in Part I of this manual could be effectively employed as mines simply by changing the fuze action to meet the needs of an anti-personnel mine.

Bounding Fragmentation. A third type of fragmentation anti-personnel mine is one which bounds from the ground and detonates in the air, scattering fragments in all directions. This type of mine was known as a "Bouncing Betty" during World War II. These mines are very effective because the fragmentation pattern is not interrupted by the earth as with buried anti-personnel mines. Figure 232 illustrates the U.S. military M16A1 bounding fragmentation anti-personnel land mine. When

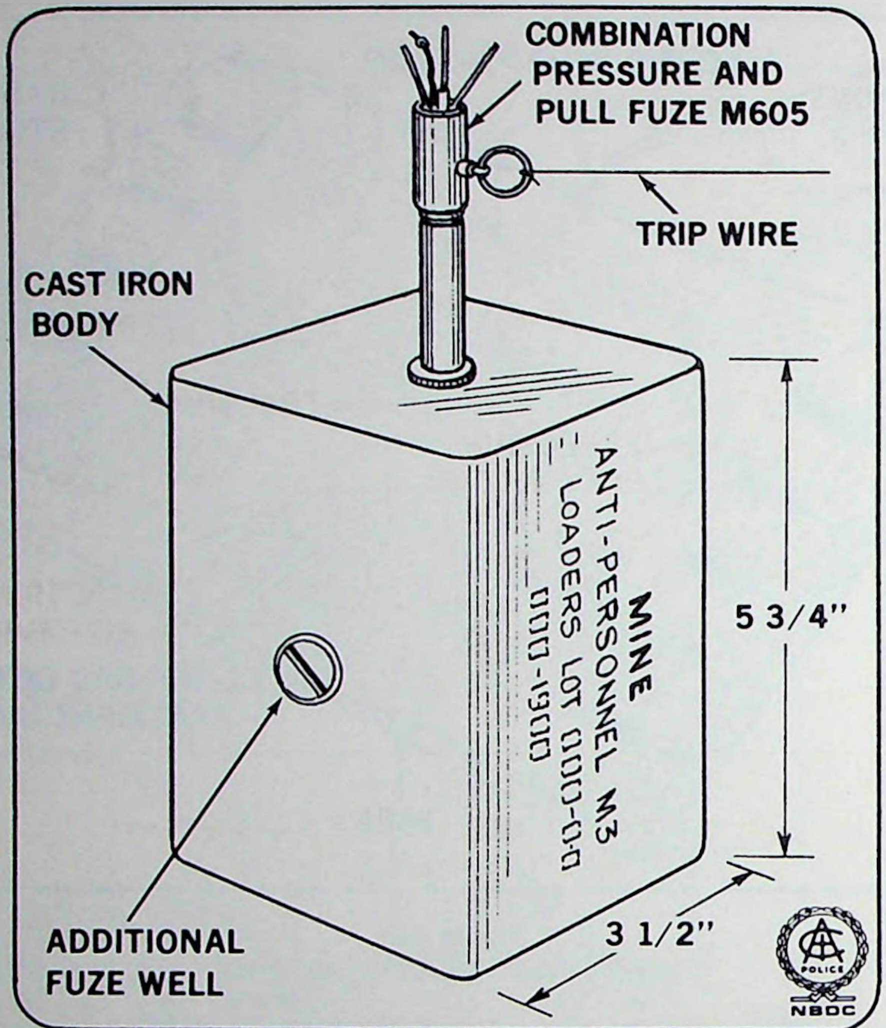


Figure 230
U.S. MILITARY M3 FRAGMENTATION ANTI-PERSONNEL MINE

the mine fuze is initiated by pressure or pull action, a high explosive-filled cast iron body is projected upward from the buried mine case to a height of approximately 4 feet, where it detonates and propels fragments in all directions. The M16A1 mine measures 4 1/6 inches wide by 4 3/4 inches in diameter. The sheet metal (tin can) outer body contains a black powder expelling charge and an inner fragmentation and explosive-filled projectile. The M16A1 is an effective bounding weapon and is capable of producing casualties at distances of 200 yards.

Bounding mines first came into widespread use in World War II and are now standard in most nations. Many variations of this type of mine exist. Some bounding mines employ preformed fragments (ball bearings) rather than a heavy cast iron body. The bounding mine is difficult to improvise and is not normally constructed by terrorists even though it is an extremely effective weapon. If terrorists feel that they must have mines of the bounding type, they are more likely to ambush a military unit or raid a military supply depot than attempt to construct them themselves.

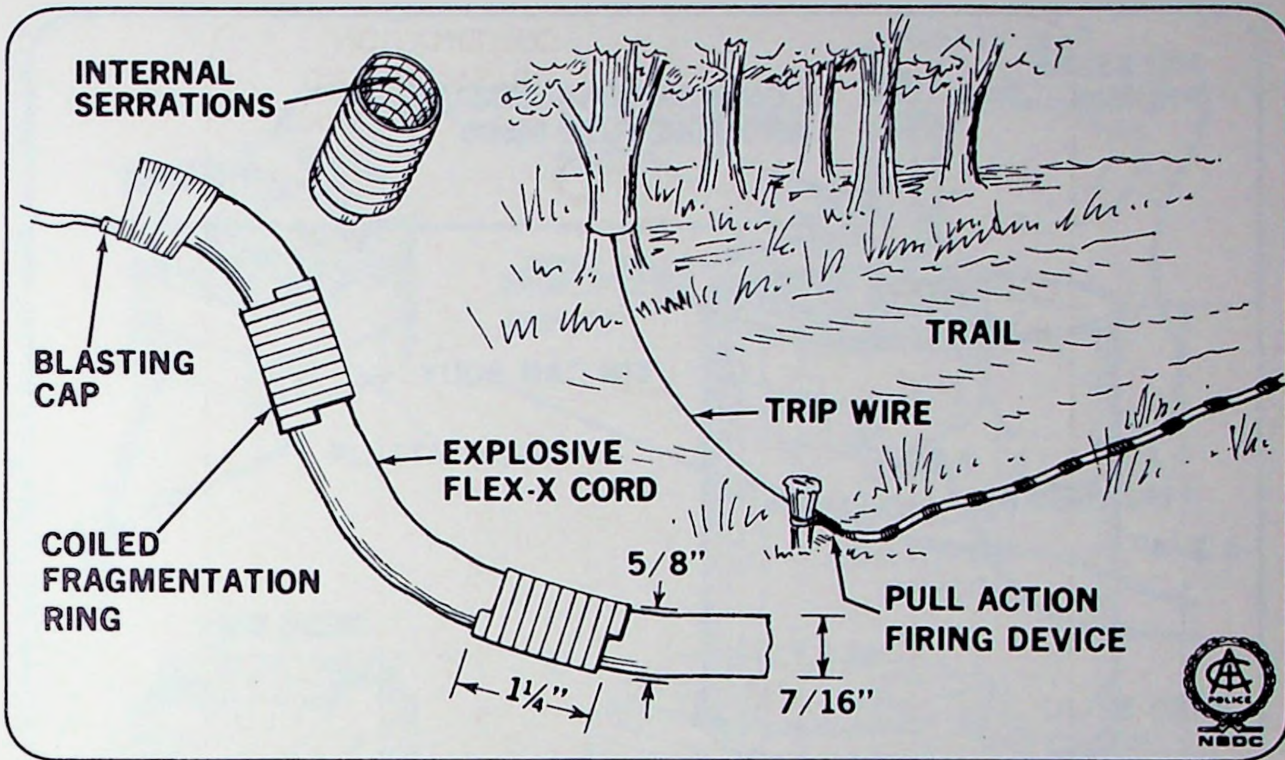


Figure 231
U.S. MILITARY LINEAR XM61 FRAGMENTATION
ANTI-PERSONNEL MINE

Blast Mines

Military blast anti-personnel land mines are generally small in size, easily and quickly placed, and are designed to wound rather than to kill. The military logic behind this is that a wounded man requires the assistance of others and providing this assistance occupies personnel and produces a definite psychological reaction. The injuries and the accompanying psychological effect serve to slow the advance of troops and create conditions of apprehension. Because the mine is in direct contact with the target (soldier) at the time of detonation, very small amounts of explosive (1 ounce or less) are capable of producing serious, but nonlethal injuries.

M14 Anti-Personnel Mine. Figure 233 illustrates a U.S. blast anti-personnel mine. This mine, the M14, is cylindrical in shape and measures only 1 1/2 inches in height by 2 3/16 inches in diameter. The body of the mine is constructed completely of olive drab-colored plastic and is not detectable with magnetic mine detectors. The mine contains approximately 1 ounce of tetryl, a powerful high explosive. Because the mine is small, it can be used in large numbers and may readily be concealed in grass, covered lightly with dirt or leaves, or buried flush with the surface of the ground. The M14 anti-personnel mine has a fuze permanently assembled to the mine body. A pressure of 10 to 35 pounds applied to the top of the mine causes a Belleville spring-mounted striker to snap and detonate the mine. Detonation of the mine will easily blow off a portion of the victim's foot.

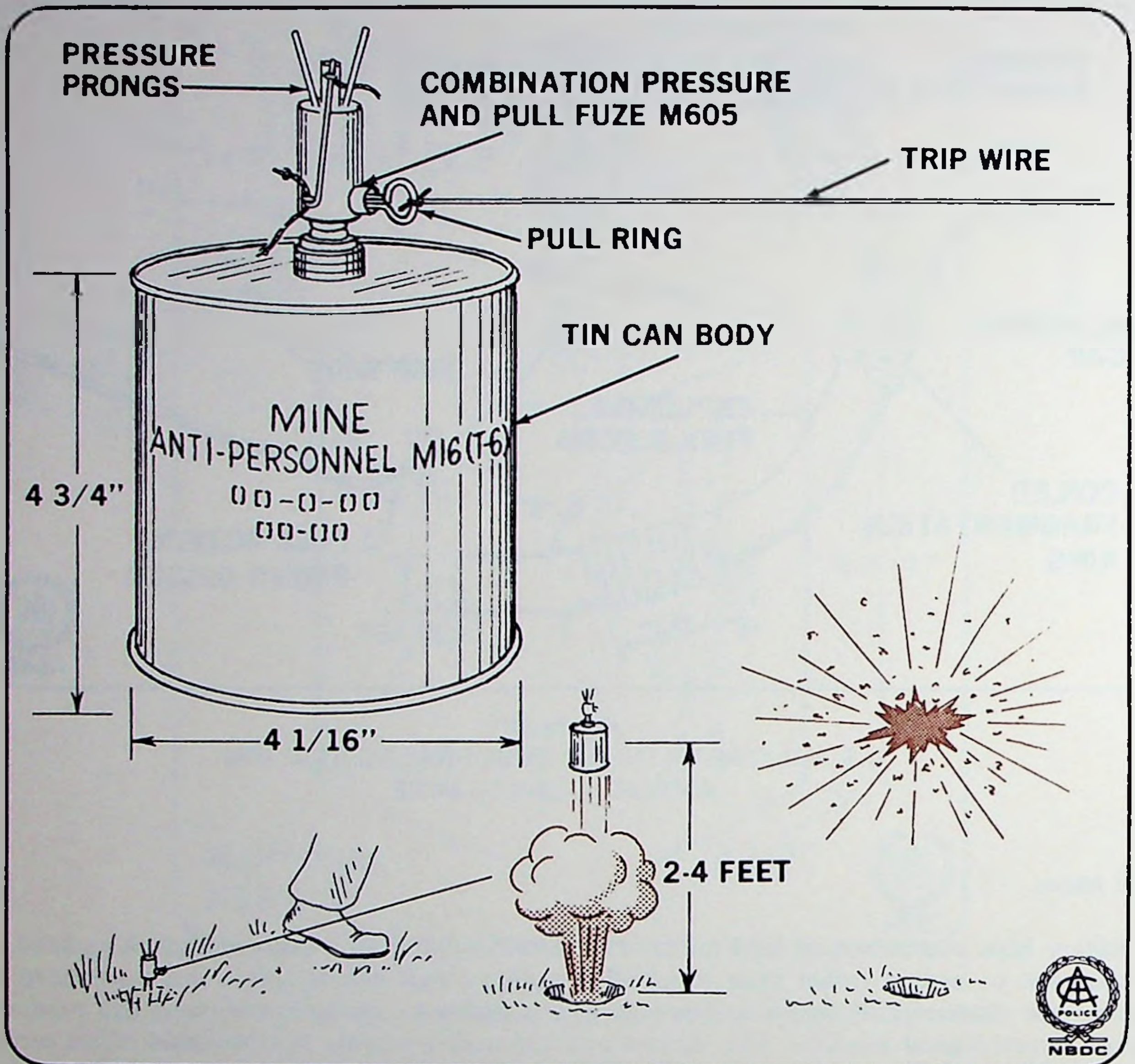


Figure 232
U.S. MILITARY M16 BOUNDING FRAGMENTATION ANTI-PERSONNEL MINE

U.S. M25 Anti-Personnel Mine. A second type of U.S. military blast anti-personnel mine is the M25 "Elsie." The "Elsie" mine contains 1/3 of an ounce of high explosive and requires only 17 to 22 pounds of pressure on the fuze to cause detonation. This mine is extremely effective because the small amount of explosive is formed into a shaped charge, which jets upward when the mine functions to completely pierce the victim's foot. If run over by a vehicle, the "Elsie" is capable of perforating a 12-ply truck tire. Figure 234 illustrates the "Elsie" anti-personnel mine. This mine is also constructed entirely of plastic and cannot be located with magnetic mine detectors.

Because of the difficulty of improvising small blast anti-personnel mines, they are not commonly constructed by terrorists. However, several instances of theft of quantities of M14 blast

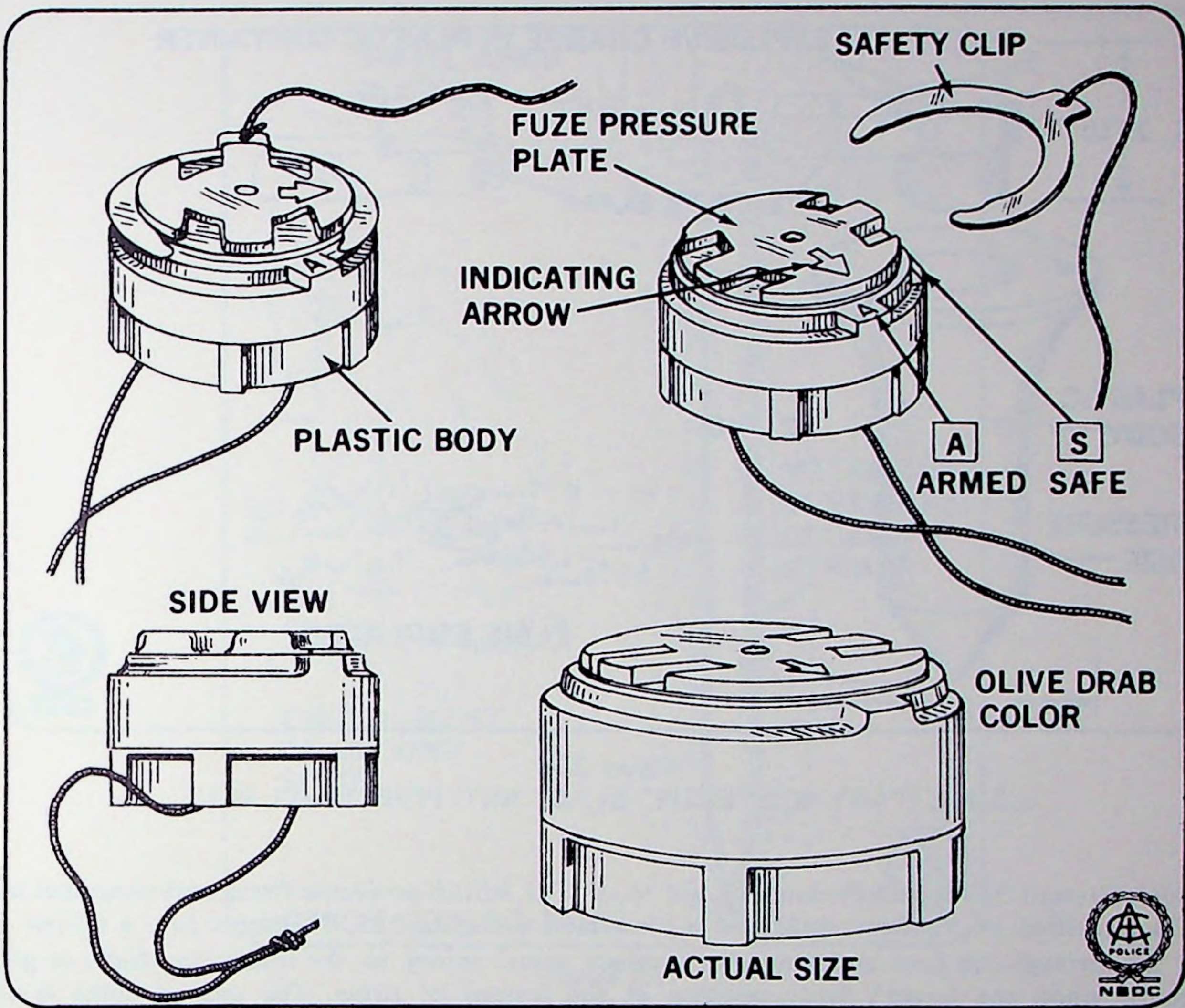


Figure 233
U.S. MILITARY M14 BLAST ANTI-PERSONNEL MINE

anti-personnel mines within the United States have been reported in recent years. The final disposition of the stolen mines remains unknown.

Projectile-Firing Mines

Military projectile-firing anti-personnel land mines are not commonly employed by most nations, although the British still list this type of mine as a limited service item. Anti-personnel mines in this category consist of a round of small arms ammunition which fits into a mechanism designed to fire when the victim's foot presses down on the bullet. These small anti-personnel mines are planted in the ground with the bullet point protruding above the surface of the earth.

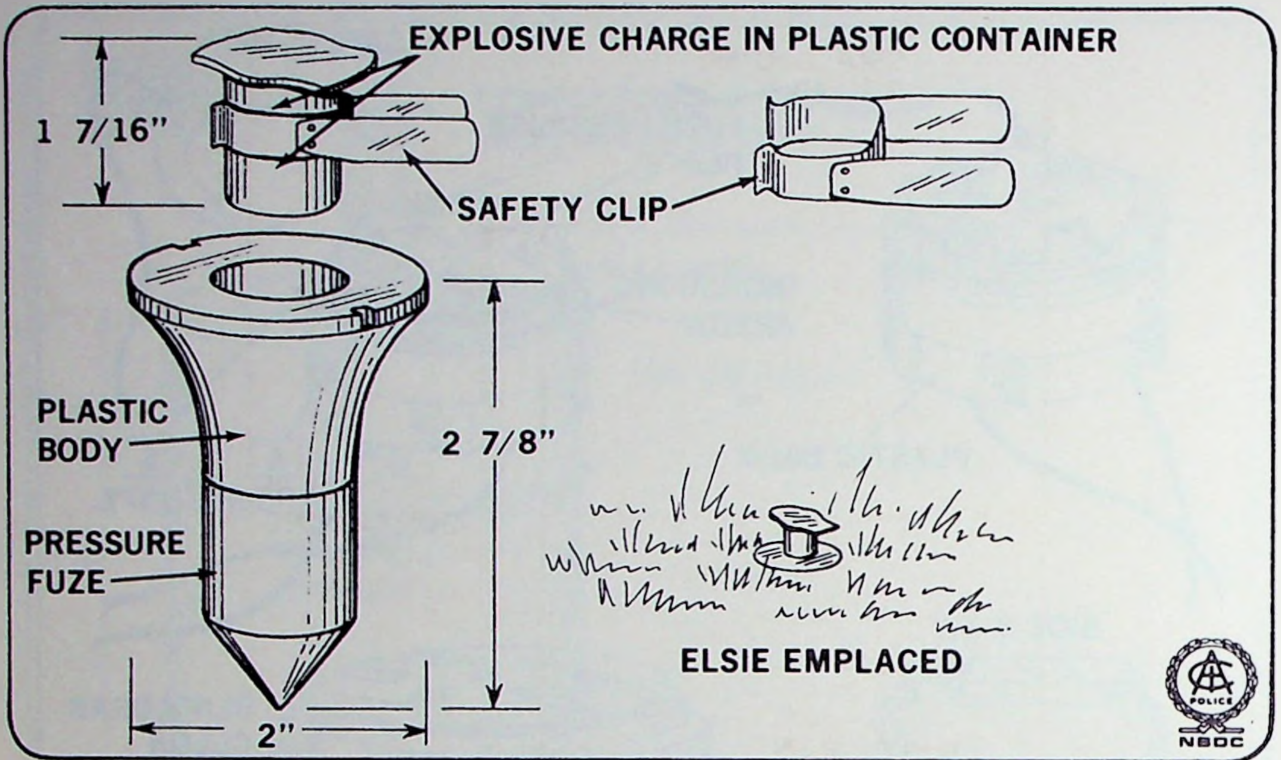


Figure 234
U.S. MILITARY M25 "ELSIE" BLAST ANTI-PERSONNEL MINE

British Ground Spike Anti-Personnel Land Mine. The British projectile-firing anti-personnel land mine is identified as a *ground spike* and is illustrated in Figure 235. This mine fires a caliber .30 bullet up through the foot and may also produce severe injury to the lower leg, thigh, or groin depending upon the target's body position at the instant of firing. The ground spike is also effectively employed against all types of vehicle tires. The British ground spike is approximately 5 3/4 inches in length (without bullet) and 3/8 inch in diameter with a 1-inch-diameter flange at its upper end. The lower end of the ground spike is pointed so that it may easily be pushed into the earth. A pressure of 4 pounds or more on the point of the bullet will release the cocked striker mechanism and fire the mine.

Improvised, projectile-firing anti-personnel mines have had widespread use in Southeast Asia since before Dien Bien Phu (1954). The Viet Cong manufacture a very simple land mine of this type by inserting a round of small arms ammunition inside a length of bamboo tubing with the bullet point protruding from the end of the tube, as it does in the British ground spike. A nail is driven through a block of wood so that the point protrudes from the wood block approximately 1/4 inch. A hole is dug in the earth and the wood block is placed in the bottom of the hole with the nail pointing upward. The bamboo tube containing the small arms round is placed in the hole with the primer of the cartridge case resting on the point of the nail. The bullet point is positioned slightly above the surface of the earth and the hole is then filled and lightly camouflaged, as shown in Figure 236. The weight of a man stepping on the point of the bullet forces the small arms round downward, causing the nail to fire the primer of the cartridge and projecting the bullet upward through the foot and

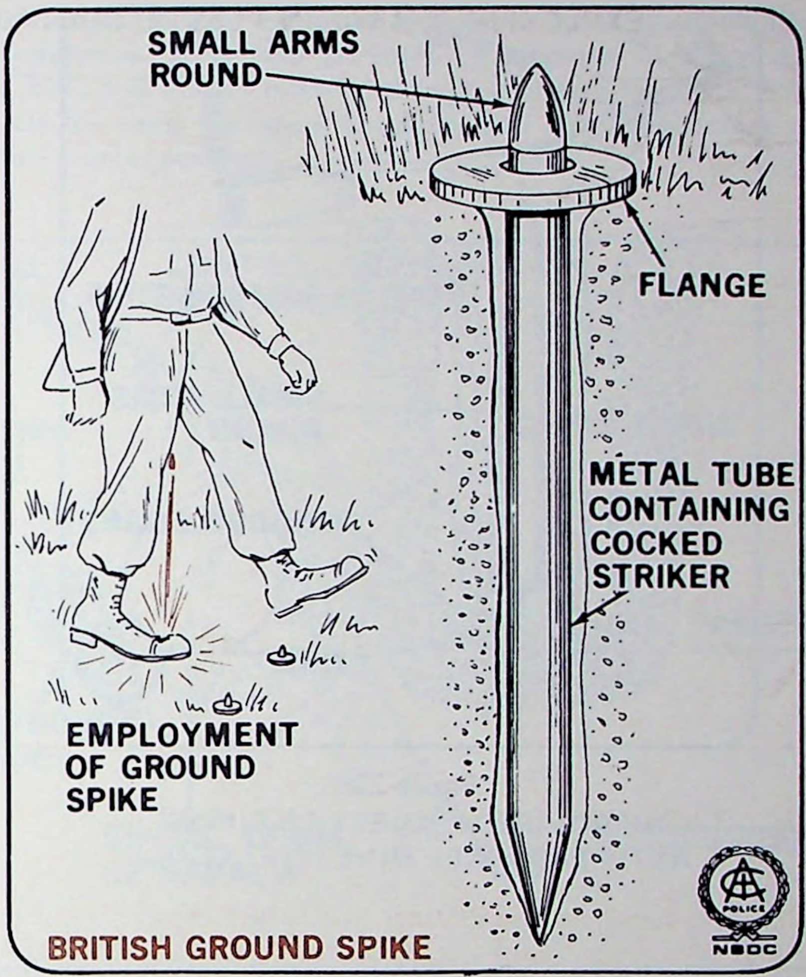


Figure 235
PROJECTILE-FIRING ANTI-PERSONNEL MINE

into the leg or groin. This small mine is extremely difficult to detect in grass, leaves, or light brush and is capable of inflicting serious and extremely painful wounds.

Fougasse Mines

The Fougasse is an improvised mine which is popular with the military as well as with terrorists. It consists of an explosive charge placed in a hole dug in the earth at an angle. The materials to be projected by the Fougasse mine are placed on top of the explosive charge and the entire assembly is camouflaged. Figure 237 illustrates the Fougasse being employed as a fragmentation anti-personnel mine. Rocks the size of a softball or larger are used as the fragmentation material. When properly constructed and detonated, a Fougasse mine will project the rocks 180 to 300 yards with a lateral dispersal of 40 to 55 yards, which makes it a very effective improvised anti-personnel mine.

A flame Fougasse mine which projects burning napalm may also be constructed in much the same manner, although it is normally placed on a hillside or in a narrow defile. Detonation of the

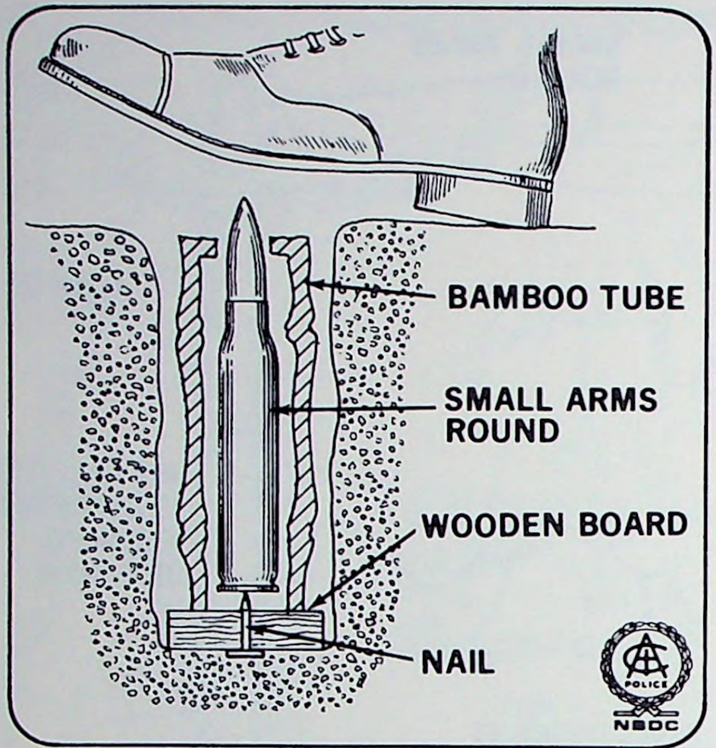


Figure 236
IMPROVISED PROJECTILE-FIRING
ANTI-PERSONNEL MINE (VIET CONG)

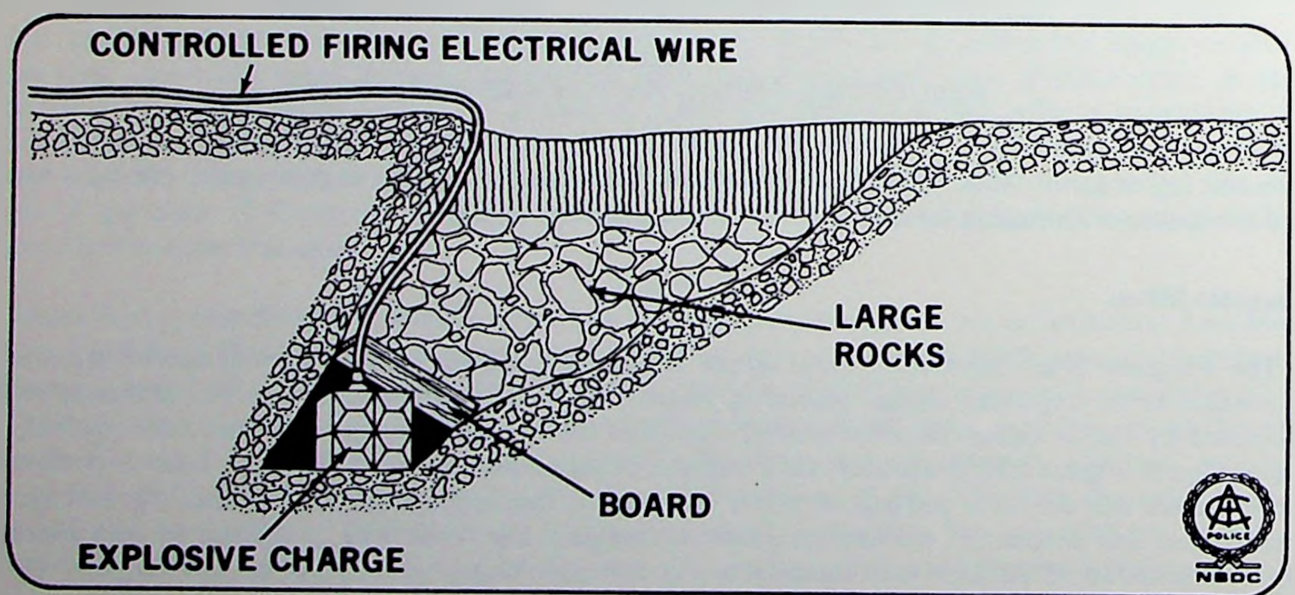


Figure 237
FOUGASSE ANTI-PERSONNEL FRAGMENTATION MINE

explosive charge spreads napalm over the target area and at the same time ignites it through the use of several white phosphorus (WP) hand grenades. A properly constructed flame Fougasse, as illustrated in Figure 238, will project burning napalm to ranges of 50 to 75 yards and disperse it laterally approximately 35 yards. Fougasse anti-personnel and flame mines are generally control fired electrically from a remote position.

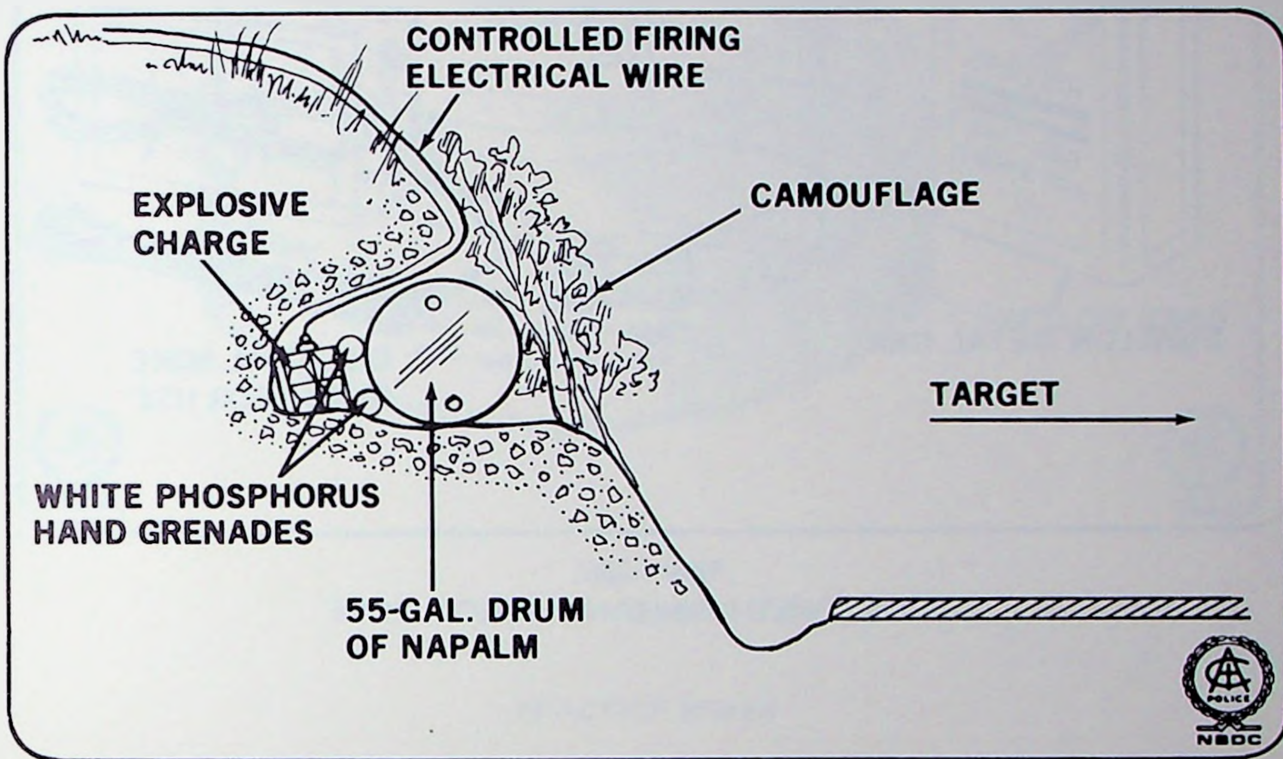


Figure 238
FOUGASSE FLAME MINE

CHEMICAL MINES

U.S. Chemical Land Mines

One of the standard U.S. military chemical (war gas) land mines is a rectangular, 1-gallon can containing a chemical agent in a liquid form. These mines are designed to disperse chemical agents to contaminate important areas and, in so doing, to reduce the enemy's mine-clearing ability. Chemical mines may be employed in combination with anti-tank mines or as anti-personnel mines. The mines are normally placed in the ground and covered with approximately 4 inches of earth. Initiation may be accomplished by the action of the enemy or by remote-control detonation. All chemical mines depend on blast effect for dispersing their chemical war gas agent. The U.S., 1-gallon chemical land mine is illustrated in Figure 239.

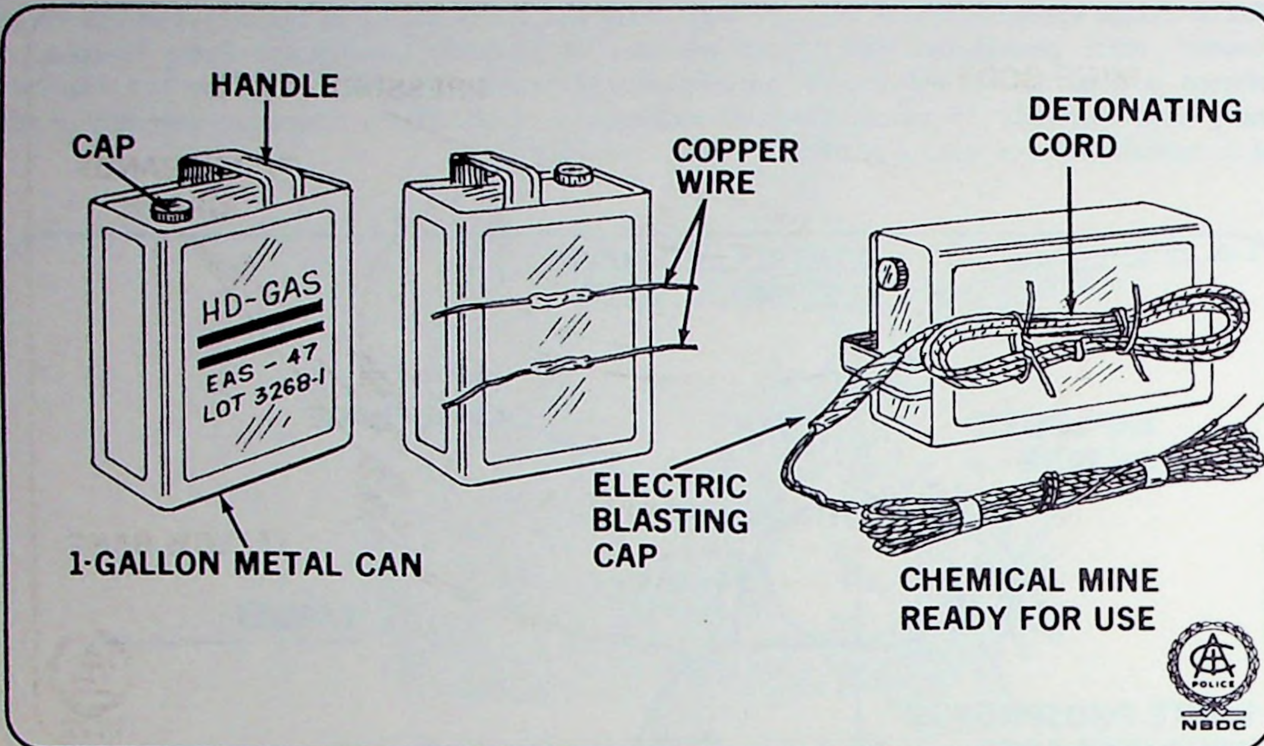


Figure 239
U.S. MILITARY 1-GALLON CHEMICAL MINE

The U.S. M23 chemical mine, illustrated in Figure 240, is prefilled and is employed to disperse a lethal chemical war gas against the enemy. Classified by the military as an anti-tank mine, the M23 disables the tank by causing casualties among the tank crew. The M23 mine may also be filled with white phosphorus (WP) and employed as an anti-personnel mine. The effective burst radius for the M23 chemical mine buried under 3 to 5 inches of earth is approximately 14 feet. Airborne contamination spread greatly increases the lethal range.

Improvised Chemical Mines

Improvised chemical mines are rarely employed by terrorists due to the handling dangers associated with poison gases and toxic liquids. Instances of terrorists attacking chemical storage warehouses and burning or detonating cylinders of chlorine as well as other chemicals are rare and do not conclusively indicate that a chemical or improvised gas attack was the primary intent. The last reported employment of chemical war gas was in Yemen during the three-year civil war (1962-65), where hundreds were reportedly killed in clandestine poison gas attacks. Prior to this instance, poison gas was last employed in the Nazi death camps of World War II.

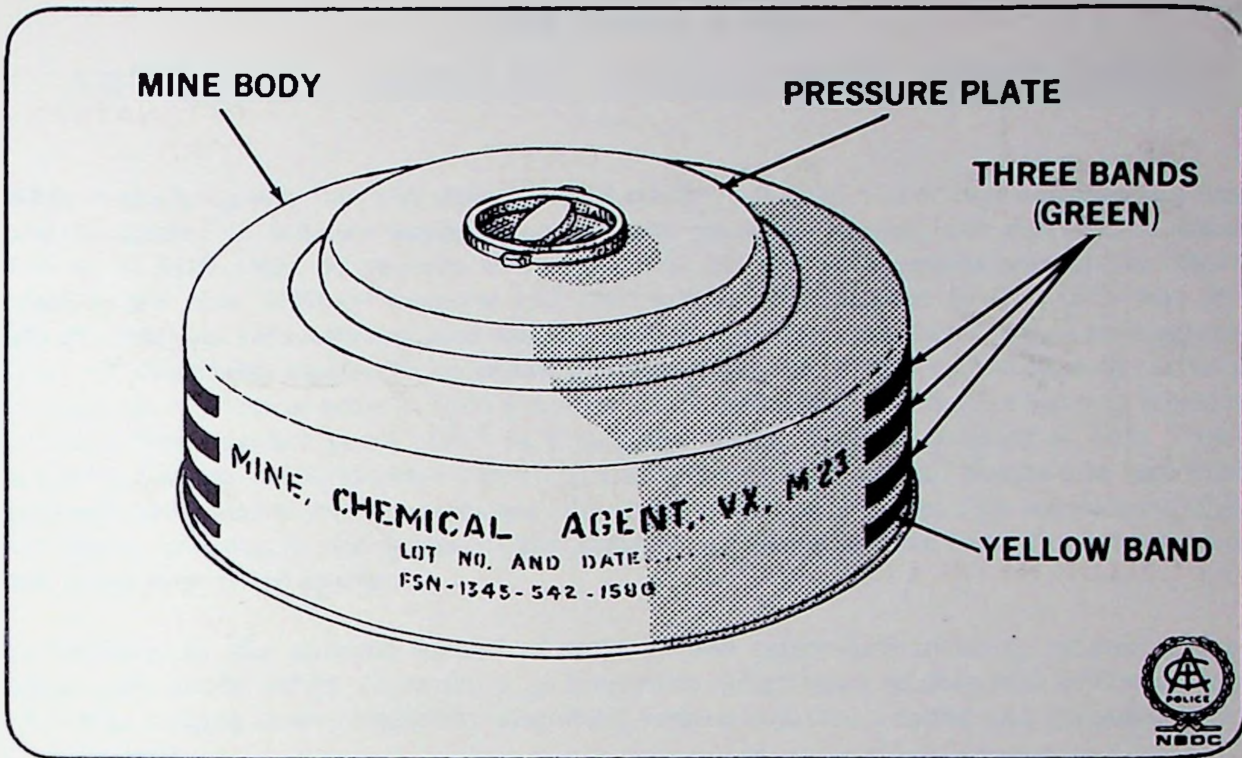


Figure 240
U.S. MILITARY M23 CHEMICAL MINE

PRACTICE MINES

Practice mines are used to familiarize military personnel with the proper care, handling, and use of live mines. They are generally of the same size, weight, and shape as live mines, but contain only a small smoke simulator and/or noise charge which consists of black powder or a pyrotechnic composition. Practice mine bodies are normally painted light blue and have stenciled markings in white paint. Like practice grenades, the practice mine could be loaded with high explosive and converted to an improvised and extremely dangerous device. Public safety personnel *should not* assume that blue painted mines are harmless.

SECTION TWO

ARTILLERY, MORTAR, AND ROCKET PROJECTILES

While it might appear that any discussion of artillery, mortar, and rocket weapons and their use would be limited to military applications of these machines of war, and that such a discussion would be of little value or concern to members of the law enforcement community, this is not necessarily the case. Military weapons and ammunition will continue to find their way into the hands of criminals, revolutionary and militant groups, and terrorists. Safe burglars have employed a military 20-millimeter cannon firing armor-piercing projectiles to blow open safes. A radical group has, as a form of political protest, fired a modified U.S. military rocket from a German World War II bazooka rocket launcher in an effort to attack the United Nations Building in New York City. Anti-Castro Cubans in Florida have converted sand-filled practice aircraft bombs into high explosive bombs and have used a military recoilless rifle in an attack on a Soviet ship near Miami. Even the White House grounds in the center of the District of Columbia have been subject to attempted attack by an improvised mortar.

In addition to the criminal misuse of military and improvised artillery, mortar, and rocket weapons, the public safety community is frequently called upon to deal with recovered souvenir ammunition ranging from completely assembled unfired rounds to rusted and corroded "duds" of unknown origin.

Only fully qualified military or civilian bomb technicians should attempt to disarm or dispose of any item suspected of being an explosive projectile. However, all public safety officers should be trained to recognize potentially dangerous items of ammunition and should have a general understanding of how artillery, mortar, and rocket weapons operate.

Special Terminology

The problem of terminology or the naming of components of military ordnance is one which can cause confusion. Each branch of the military service assigns or employs official and unofficial words and terms in describing their particular ordnance items and those who are not members of the military find that many ordnance terms are not in reference books. This publication has attempted to minimize the use of specialized technical terms and, instead, employ descriptive terminology whenever possible. For instance, those items fired from artillery, mortar, and rocket weapons are *all* referred to in this text as "projectiles." Regardless of what their specific technical names may be, they are still in fact projectiles and since the term "projectile" is a descriptive as well as a technical term, it has been employed throughout. Various charts are also provided which list projectiles by their standard military abbreviations and provide the meanings of those abbreviations so that the markings stenciled on the body may be directly translated without extensive research. Figures 241 and 242 illustrate typical artillery, mortar, and rocket projectiles and identify their component parts.

The following is a general listing of the standard component parts of artillery, mortar, and rocket projectiles:

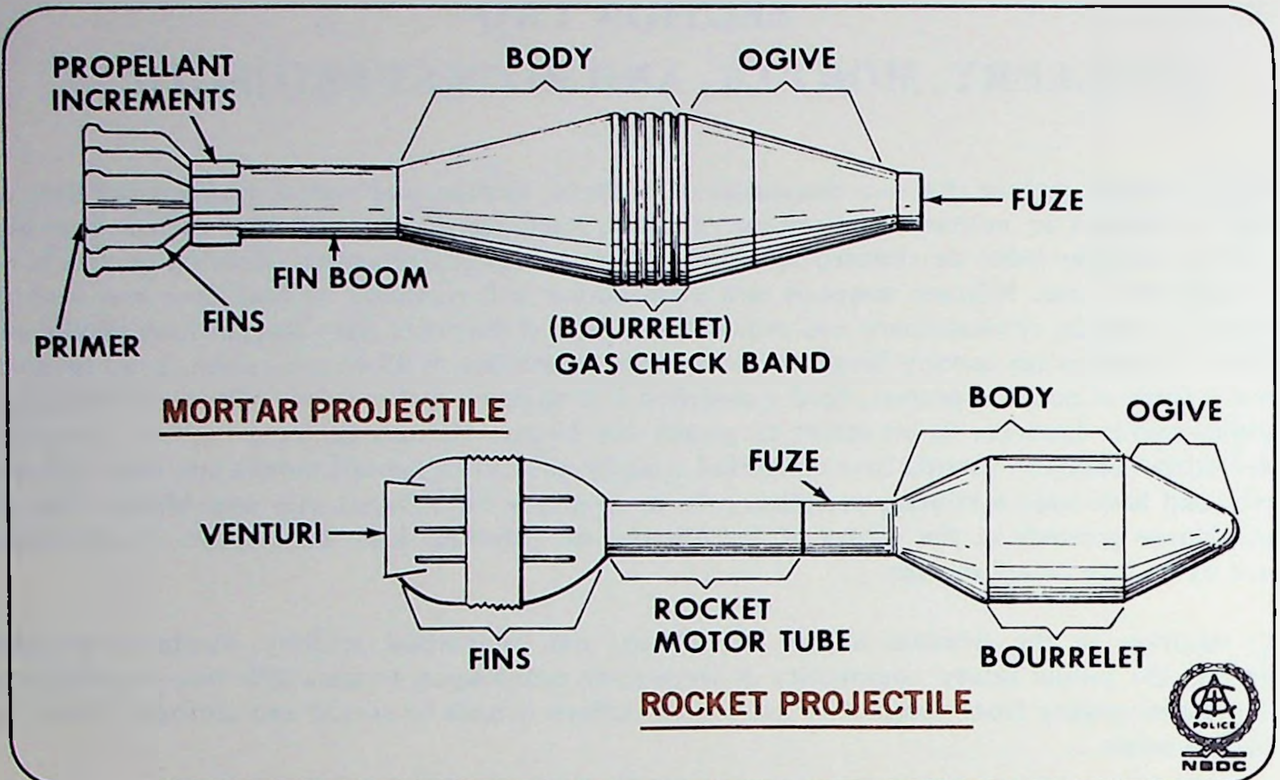


Figure 241
MAJOR COMPONENT PARTS OF MORTAR AND ROCKET PROJECTILES

- **Nose or Point.** The forward tip of the projectile is the nose or point. The nose may or may not contain a fuze.

- **Ogive.** The curved section of the projectile from the nose to the forward bourrelet is called the *ogive.* The length and shape of the ogive influences the ballistic characteristics and range of the projectile.

- **Bourrelet.** To the rear of the ogive is a machined bearing surface called the *bourrelet.* The bourrelet centers the artillery, mortar, or rocket projectile in the launching tube and provides a forward bearing surface for the projectile. Also, the bourrelet of a mortar is usually the gas check band area. The bourrelet of a rocket may extend the entire length of the enlarged portion of the projectile.

- **Body.** The section between the bourrelet and the rotating band, fins, or rocket motor is known as the *projectile body.* Smaller in diameter than the bourrelet, it is usually painted and stenciled with information relative to the size, type, weight, lot, date, and manufacturer of the projectile.

- **Rotating Band (Artillery Projectiles Only).** The rotating band is usually made of copper and is slightly larger in diameter than the bourrelet.

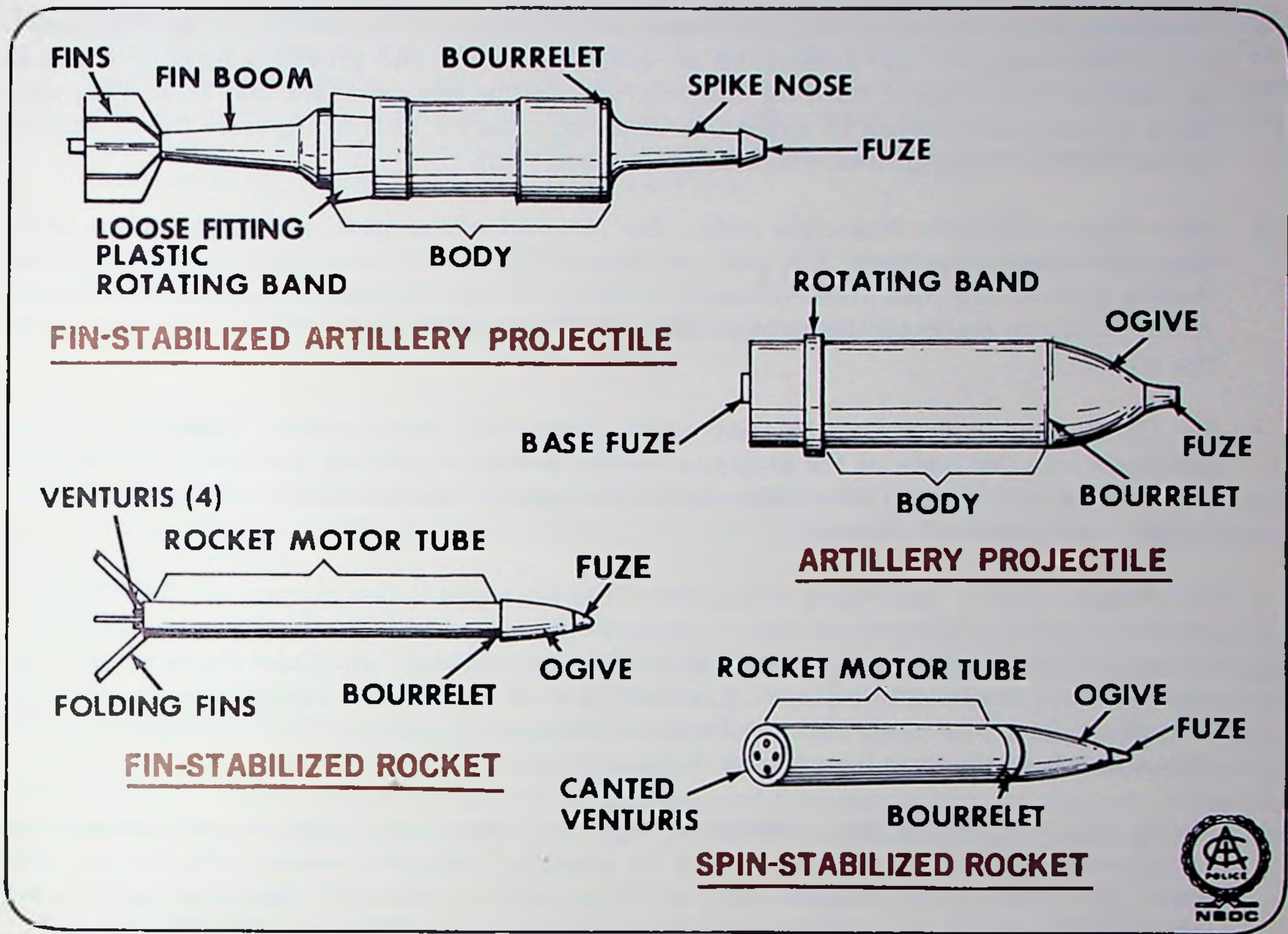


Figure 242
MAJOR COMPONENT PARTS OF ARTILLERY AND ROCKET PROJECTILES

The rotating band serves two purposes. It seals the propellant gases in the rear of the projectile and, because the spiral rifling of the gun cuts into the rotating band when the projectile is fired, it imparts spin to the projectile as it travels down the bore. This spin stabilizes the projectile in flight to the target. Some high velocity gun ammunition will employ rotating bands made of sintered iron in place of copper.

Projectiles used in recoilless rifles have pre-engraved rotating bands. Pre-engraving reduces the friction of the rifling which cuts into the rotating band and lessens the amount of propellant necessary to drive the projectile down the gun tube. In loading, projectiles with pre-engraved rotating bands must be carefully fitted into the weapon to properly align the engraving on the rotating band with the weapon's rifling. Some recoilless rifles employ projectiles which have loose fitting plastic rotating bands which seal the propellant gases to the rear, but, because they are loose on the projectile body, they *do not* impart spin to the projectile. This type of rotating band is common in fin-stabilized HEAT projectiles.

- **Cannalures (Artillery Projectiles Only).** Most rotating bands have etched rings which surround their outer circumference. These rings are called *cannalures* and provide a space into which the metal which is peeled from the rotating band by the weapon rifling may flow. They also act as an additional gas seal by expanding under gas pressure, thus fitting more tightly against the walls of the rifling grooves when the projectile is fired.

- **Flow Groove (Artillery Projectiles Only).** The rear edge of the rotating band sometimes has a ridge which slants backward. The body of the projectile at this point may or may not have a shallow groove. Together, these features provide an area for displaced rotating band material. As the projectile moves up through the gun bore, the displaced rotating band metal flows into this groove.

- **Gas Check Band or Obturator (Mortars Only).** Mortar projectiles employ a groove or grooves machined into the body of the projectile to trap propellant gases as they flow between the mortar tube and the projectile when the mortar is fired. The gas check band area of a mortar is often called the *bourrelet area.*

- **Fin Boom (Artillery and Mortar Projectiles).** The fin boom is that portion of a fin-stabilized artillery or mortar projectile which connects the fin assembly to the projectile body. The fin boom frequently contains the primer in its after end and may have holes drilled around the fins or along its length to insure that the flash or flame from the primer reaches the propellant. In mortar projectiles the fin boom may also be fitted with spring wires or metal clips which hold the propellant increments in place around the fin boom.

- **Motor Tube or Rocket Motor (Rockets Only).** A rocket motor tube is made of steel or aluminum and joins the projectile to the fin assembly and also contains the propellant and igniter. In spin-stabilized rockets where no fin assembly is employed, the rocket motor tube joins the projectile to the angled or canted nozzles or venturi of the rocket which impart spin. All rocket motors employ venturi through which the escaping propellant gases flow.

- **Venturi or Nozzle (Rockets Only).** The venturi or nozzle is that part of a rocket, normally the extreme rear, through which the escaping propellant gases exit from the rocket motor tube. The rocket may have a single venturi or numerous small venturis. *All venturis will have a tapered conical or funnel-shaped appearance.* The venturi provides one of the primary identification features of rockets.

- **Base Fuze (Artillery and Rocket Only).** The base fuze in artillery projectiles is located in the center of the base and may be equipped with a tracer. The base fuze in a rocket may be visible between the projectile body and the rocket motor or may be concealed in the base of the projectile and covered completely by the junction of the rocket motor to the projectile body.

- **Base (Artillery Projectiles).** The cylindrical part of the projectile base may or may not be used as a second bourrelet. The projectile base may be flat, round, recessed, or tapered, depending on the velocity of firing and the flight characteristics required for the projectile. The base may contain a base fuze and/or a tracer.

- **Base Cover Plate (Artillery Projectiles).** The base cover plate is a thin metal disc which is crimped, caulked, or welded to the base of the projectile. High explosive rounds are provided with base cover plates to give additional assurance that the hot gases of the propelling charge will not penetrate the base of the projectile through a metal flaw and come in contact with the explosive filler. In projectiles which have base fuzes, caulking or sealing rings, rather than base covers, are normally provided around the fuze.

ARTILLERY, MORTAR, AND ROCKET WEAPONS

Artillery Weapons

Artillery may be defined as a means of projecting missiles which are too heavy to be thrown by hand or launched by a rifle. Ancient "Engines of War" performed the function of what is now called modern artillery.

The Bible records the use of "engines" or "machines" of war mounted on the walls of Jerusalem eight centuries before Christ. In 54 B.C., Julius Caesar's Roman legions used *catapults* and *ballistas* to provide artillery support for their landing in Britain. The ballista fired large arrows in a flat trajectory directly at the enemy and was the forefather of the direct fire field gun. The ballista obtained its power from large twisted ropes of hair, hide, or sinew. Horizontal arms were set in these ropes and a cord similar to a bow string was fastened between the ends of the arms. When the arms were winched back and released, the large arrow was propelled straight ahead with terrific velocity.

The catapult was the mortar or howitzer of its day and could throw a 100-pound stone 600 yards in a high, arching trajectory. The catapult also employed huge twisted ropes as a power source and had a long boom or throwing arm. The boom was winched to a horizontal position and a large stone in a sling was hooked onto it. When the boom was released, it would whip upright and hurl the stone and sling at the target.

The *trebuchet* was another weapon of war used in the Middle Ages. It was essentially a huge form of seesaw with a weight attached to a short arm which, when it was released, whipped the longer throwing arm forward, propelling a 300-pound stone to a distance of 300 yards. The forerunners of modern artillery weapons are shown in Figure 243.

As ancient as these weapons may seem today, they are still used. The Viet Cong occasionally employ a catapult made of bamboo to lob large explosive charges at American troops in Southeast Asia, and a modified form of ballista is employed as an arrow-firing booby trap device.

Cannons apparently existed as early as the 12th century in China, but it was not until the knowledge of how to manufacture black powder had spread to Europe that they were used in the Western world. Edinburgh Castle's "Mons Meg" bombard cannon could project a 19 1/2-inch-diameter stone ball 2,800 yards in 1455. The largest bore cannon ever built was the great mortar of Moscow, built in 1525. It had a bore of 35 inches, was 18 feet long, and was designed to fire a stone

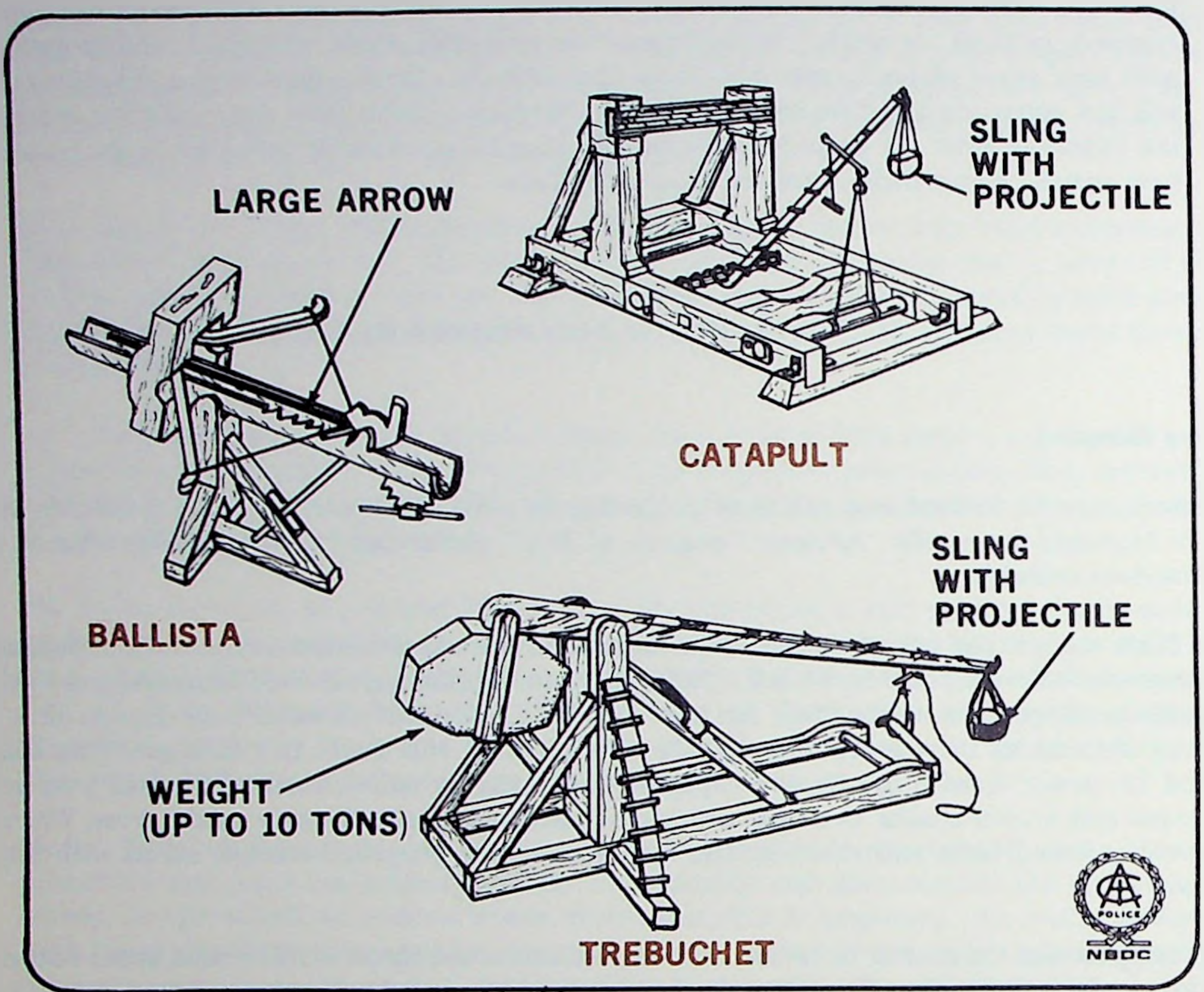


Figure 243
FORERUNNERS OF MODERN ARTILLERY WEAPONS

projectile weighing 2,000 pounds; this weapon was never actually used, however. Breech-loading cannons were developed as early as 1500 but were not widely used by the military until 1855, when the English Armstrong breech-loading cannon was introduced.

World War I medical records indicate that 75 percent of all battlefield casualties were caused by artillery-delivered munitions. The German army in their Paris offensive of August, 1914 actually shelled the city of Paris from a distance of 75 miles. The "Paris Gun," actually a battery of guns, did in 1914 what no artillery weapon can equal today, as shown by the range illustrated in Figure 244.

In World War II, the Germans modified a 150-millimeter artillery weapon to fire an artillery projectile an amazing distance of 92 miles, as shown in Figure 245. Artillery weapons in use today do not attain even half of this range but compensate in part for this by being quite accurate. The ranges of current U.S. military artillery weapons are illustrated in Figure 246.

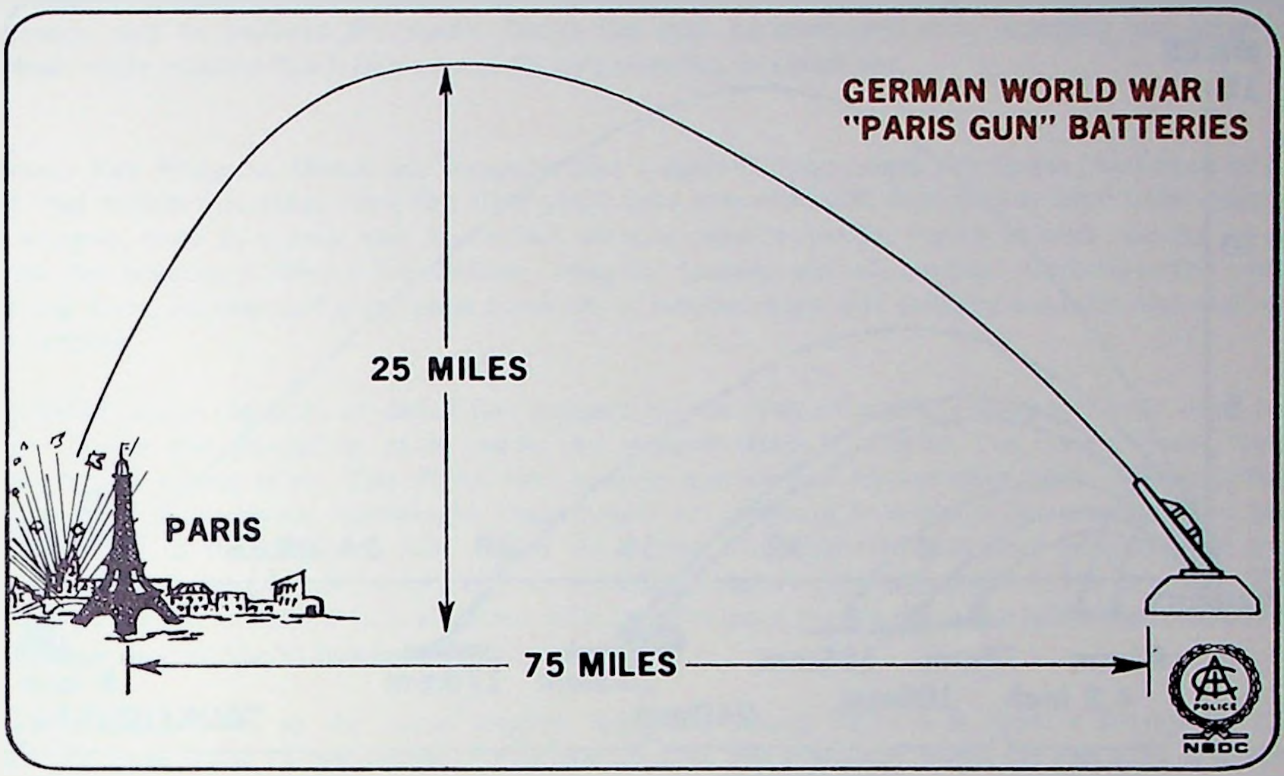


Figure 244
MAXIMUM RANGE OF ANY ARTILLERY WEAPON IN WORLD WAR I (1914)

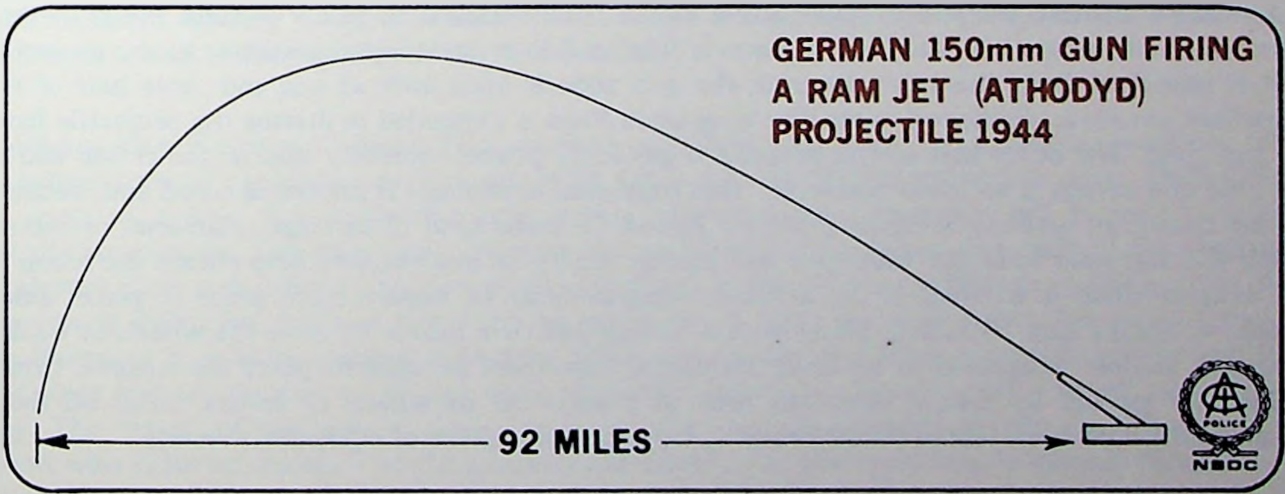


Figure 245
LONGEST RANGE EVER ATTAINED BY AN ARTILLERY PROJECTILE

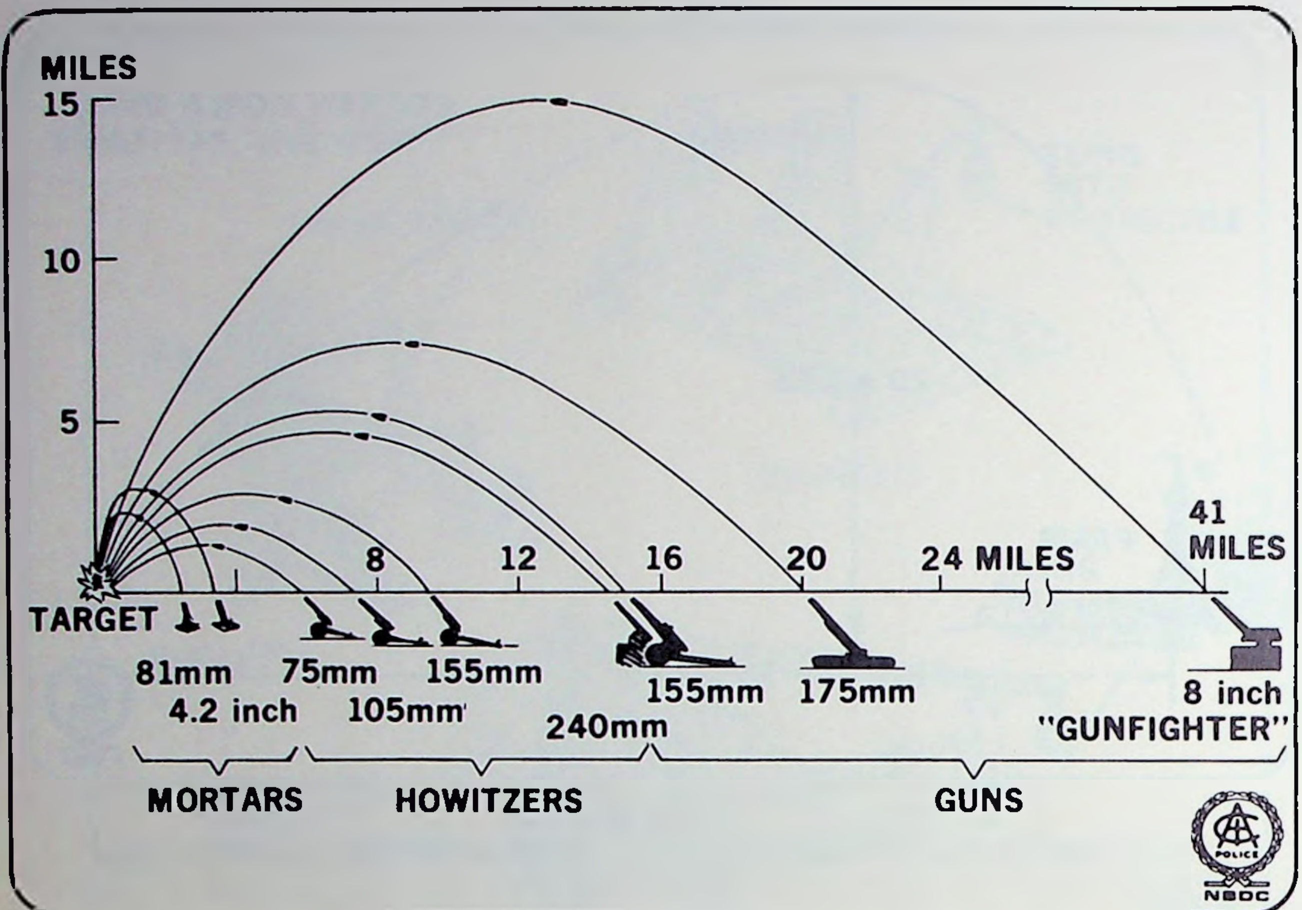


Figure 246
RANGES OF MODERN ARTILLERY WEAPONS (1972)

A modern artillery weapon is essentially a closed tube designed to safely contain the propelling gases which are generated when the weapon is fired and to provide initial guidance to the projectile as it is launched from the tube. Because the gun tube is open only at one end, only half of the propellant gas force developed when the weapon is fired is expended in driving the projectile from the gun tube. The other half of the propellant gas force pushes violently against the closed end of the tube and causes it to move rearward. This backward movement is known as *recoil* and, because of this recoil, an artillery weapon must be placed on some kind of carriage, platform, or mount which will not only hold the tube, but will permit the use of absorbers to help reduce the recoil of the weapon when it is fired. If the artillery weapon must be moved from place to place, axles, wheels, or tracks may be added, along with a towing bar or a motor to drive the wheels or tracks. When the mobile weapon is to be fired, stabilizing bars must be used to plant the weapon firmly against the ground so that it does not rock or bounce on its wheels or tracks. After all these requirements have been met, a rather heavy and cumbersome piece of equipment results.

Aside from their differences in size, almost all artillery weapons are constructed in approximately the same manner, but they are not all employed in the same way. Two distinct methods of tactical employment are in existence and they affect not only the design and size of the weapon, but also the design of projectiles and fuzes as well. The two methods of artillery employment are in a *direct fire* mode and an *indirect fire* mode. Direct fire may be compared to a smashing line drive in baseball, while indirect fire is like a long, fly ball traveling in a high arc.

Direct Fire Weapons. Direct fire weapons have a limited range, since the target itself must be in sight, but within this range they fire their projectiles low and hard. A projectile fired from a direct fire weapon, such as a tank gun at another moving tank in battle, travels at high velocity in an almost flat trajectory. Direct fire artillery weapons include aircraft cannon, tank-mounted guns, anti-tank guns, anti-aircraft guns, guns mounted on smaller ships, and artillery weapons mounted on light vehicles.

Included in the category of direct fire weapons is one type of artillery weapon which does *not* safely contain the propelling gases inside the weapon when it is fired, but instead vents them rearward in a strong blast. This direct fire weapon is known as the *recoilless rifle.* All direct fire weapons are of somewhat lightweight construction as compared to indirect fire weapons, but the lightest of all is the recoilless rifle. When the 57mm recoilless rifle was first developed, it was shoulder-fired by the gunner, who was able to hold the lightweight gun tube on his shoulder. The current size of the standard U.S. recoilless rifle has increased to 106mm and a lightweight mount is required to support the somewhat heavier gun tube.

The recoilless rifle, as the name implies, does not recoil. When it is fired, a portion of the propelling gases equal to the amount necessary to drive the projectile down the gun tube is vented rearward. The two propellant gas forces balance each other and the gun tube remains stationary. There is, of course, a terrific backblast caused by the escaping gases, but the tactical advantage of having an artillery weapon so lightweight and mobile is considered well worth the price of the undesirable backblast.

Direct fire recoilless rifles do not represent a new development in artillery weapons, but can be traced back to World War I when they were occasionally fired from large biplanes at ground troops. Since World War II, many of the earlier deficiencies of the weapons have been corrected and it is now a standard artillery weapon in most armies of the world. Figure 247 compares the functioning of a closed breech artillery weapon to a recoilless rifle.

Indirect Fire Weapons. Indirect fire weapons provide a long-range, heavyweight capability that can deliver tons of explosives on a target miles away and out of sight of the gun crew. While direct fire weapons cannot fire projectiles into enemy troops massing *behind* a hill because they are basically short-range, flat trajectory weapons not suited to high angles of fire, indirect fire weapons can elevate their gun tubes to an almost vertical position and drop projectiles beyond the crest of a hill without difficulty. Indirect fire weapons are generally large weapons which fire projectiles for long distances in a high, arching trajectory. They can usually fire from positions well behind the front lines and are capable of placing their projectiles with great accuracy on a target many miles away. The "eyes" of the indirect fire weapon are the forward observers in light aircraft or on the ground who radio information to the gunners and instruct the gun crew how to correct their fire.

Traditional indirect fire weapons are the big artillery guns and rifles like the 155mm, and 175mm, and the 8-inch, as well as large caliber naval guns. However, some artillery weapons may be

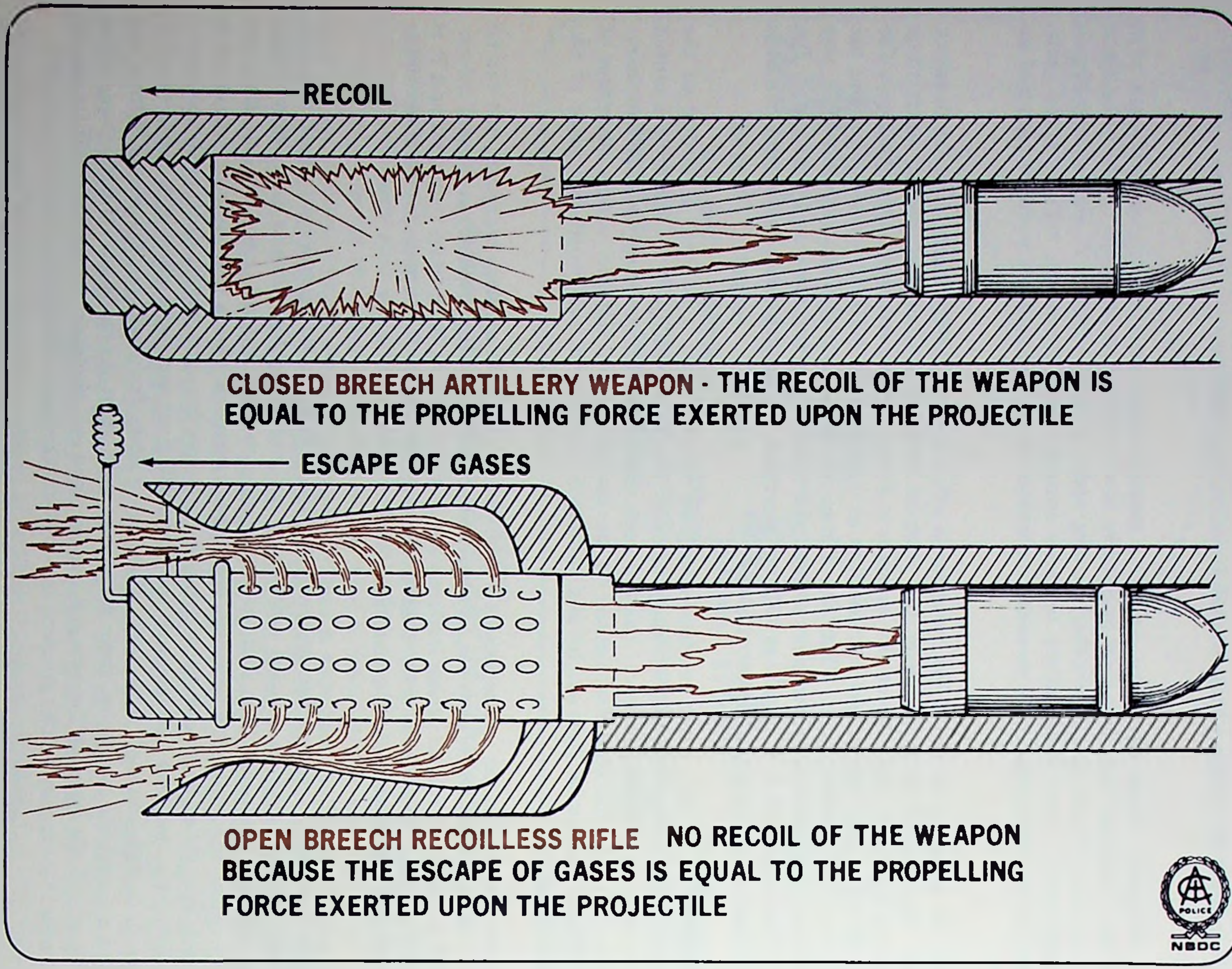


Figure 247
COMPARISON OF CLOSED BREECH AND RECOILLESS ARTILLERY WEAPONS

employed as both indirect and direct fire weapons; although when this is done, some of both characteristics are generally sacrificed. A family of artillery weapons known as *howitzers,* which are basically indirect fire weapons, can be used as direct fire weapons in an emergency by lowering the gun tube to a horizontal position. While they can physically lower the gun tube to fire directly at a target, the gun crew will have trouble aiming the weapon, particularly if the target is moving laterally. In addition, the howitzer projectile travels through the air at a moderate velocity because, in its normal employment, the weapon is designed to achieve range or distance rather than speed.

Direct fire weapons such as tank guns, on the other hand, can in some cases be elevated to fire at high angles. But without a forward observer to call the shots and without a stable gun platform, long-range accuracy is a problem. Additionally, tanks do not carry much ammunition (generally less than 30 rounds) and most of that ammunition is designed to be used against other tanks and is unsuited for indirect fire missions.

The majority of mortars are basically and primarily indirect fire weapons, although instances of their use, with special mortar projectiles, as direct fire weapons have been reasonably effective in Vietnam. (For example, the 81mm mortar deck-mounted aboard river patrol boats, firing APERS [anti-personnel] fletchette rounds.)

Rockets, depending on their type, are used as direct fire weapons (aircraft, helicopters, anti-tank weapons, and bazookas) or indirect fire weapons (barrage rockets) and generally cannot be interchanged.

Improvised Artillery Weapons. Improvised artillery weapons are not commonly employed by criminals and terrorist groups for two basic reasons. First, the use of bulky artillery weapons tends to limit the high degree of mobility necessary for escape and evasion actions. Secondly, the manufacture of improvised artillery weapons generally requires the use of a machine shop, high grade steel tubing, and an expert machinist just to *construct* the weapon. The manufacture of ammunition for an improvised artillery weapon is even more difficult. If artillery weapons are needed by the terrorist, he generally finds it more advantageous to utilize captured artillery weapons and ammunition. However, two types of weapons that could be loosely defined as "artillery" are sometimes manufactured and employed by terrorist groups as "one shot" weapons of ambush or entrapment. While it is difficult to clearly identify these devices as artillery weapons rather than mines, they seem to possess more of the identification and operational characteristics of the former.

As discussed previously, the recoilless rifle functions by venting half of the propelling gases rearward from the weapon while at the same time propelling the fired projectile down the gun tube toward the target. This very delicate balance results in no movement of the launching gun tube and permits construction of an artillery weapon which may be fired from the shoulder or a lightweight support, such as a caliber .30 machine gun mount.

Improvised recoilless rifles have been constructed from sturdy lengths of steel pipe, as illustrated in Figure 248. After placing the propelling charge in the exact center of the pipe, the projectile or fragment material is weighed and an equal weight of dirt is prepared for use in the weapon. The projectile is loaded into the "muzzle" end and the dirt is loaded into the "breech" end of the tube. When fired, the projectile is blown out the muzzle end of the tube while the dirt is blown rearward.

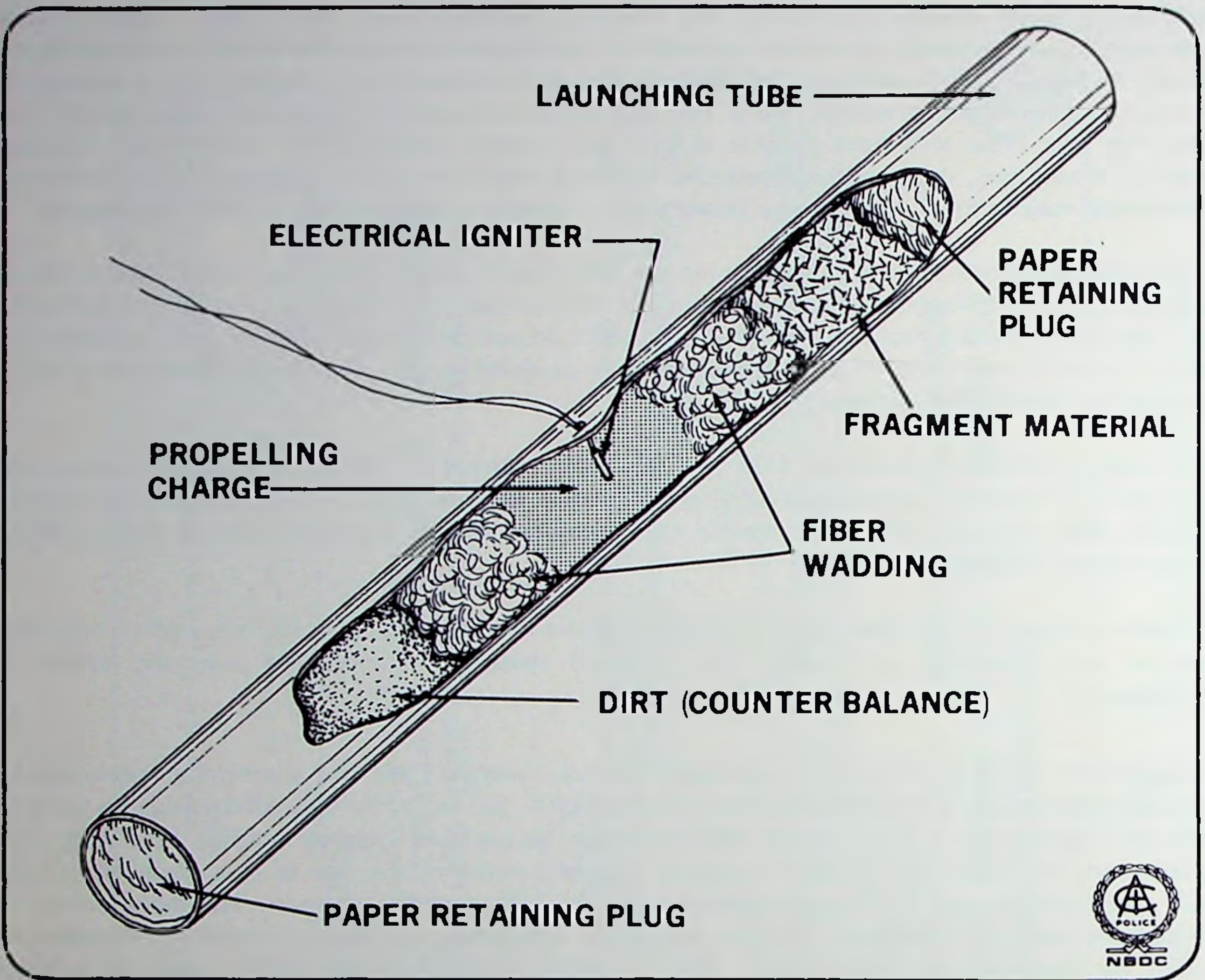


Figure 248
VIET CONG IMPROVISED RECOILLESS RIFLE

In theory, because the materials being projected have the same weight, the tube remains stationary. In actual practice, gas leakage, friction, and other physical forces upset the delicate balance required and the launching tube is whipped about the firing area. Although of rather crude construction, the weapon is quite effective, particularly in ambush situations. Figure 249 illustrates the functioning of an improvised recoilless rifle weapon.

Improvised cannon are more difficult to construct than recoilless rifles because of the recoil problem associated with their use. The Viet Cong are the most recent users of small improvised cannon, having developed a series of such weapons for use against helicopters and ground troops in Southeast Asia. These small artillery weapons, known as "Skyhorse" cannon, vary in size from approximately 2 inches to 6 inches in diameter and from 18 inches to 6 feet in length. The gun tube is made of any convenient length of tubing (fired rocket motor, shell casing, pipe) with the "breech" end welded closed and reinforced. The "Skyhorse" is usually equipped with a bipod welded near

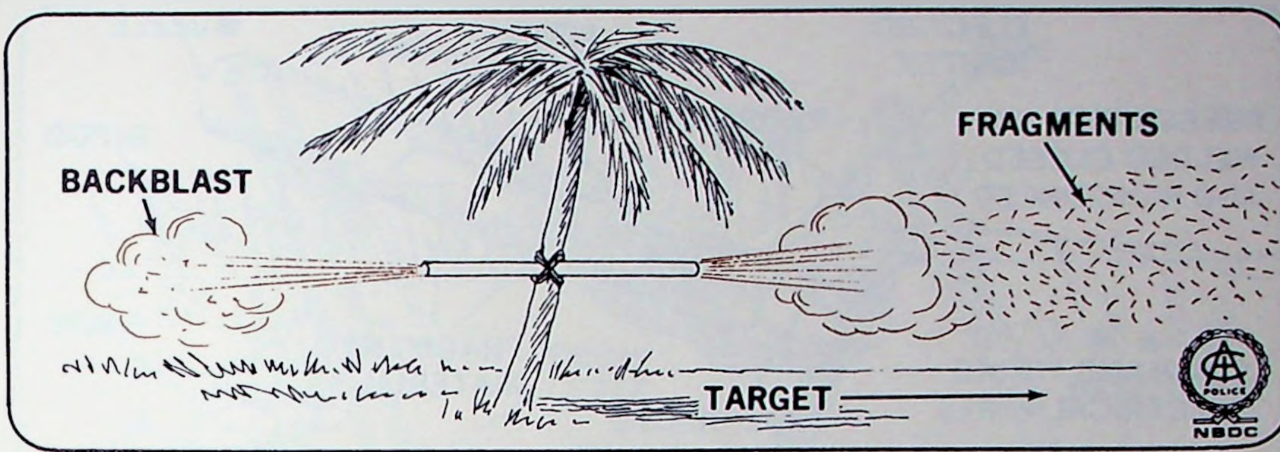


Figure 249
FUNCTIONING OF IMPROVISED RECOILLESS RIFLE

the muzzle to act as a forward support for the tube. The breech end of the tube is buried in the ground to prevent excessive recoil of the weapon. It is loaded exactly as any other muzzle loading cannon. The propelling charge is placed in the bottom of the tube and covered with wadding and then the projectile fragment material is loaded on top of the wadding. The "Skyhorse" may be fired by any convenient means, although electrical, controlled firing is most commonly employed. If, after firing, the cannon has not blown apart, it may be recovered and used again. Figure 250 illustrates a typical Viet Cong "Skyhorse" improvised cannon and its functioning.

Mortar Weapons

Mortar weapons are designed to provide close-in combat support to front line units. The mortars are essentially short-range, high angle of fire, low recoil weapons which are lightweight and require a short time to place and fire. The majority of mortars are smooth bore weapons which fire fin-stabilized projectiles. However, a few mortars have rifling and fire spin-stabilized mortar projectiles. While mortars are primarily indirect fire weapons, their lightweight, low recoil, and short length allow for their conversion to direct fire roles in some instances.

Mortar weapons break down into man-portable loads consisting of the mortar tube, the base plate, and the bipod. The U.S. 60mm mortar weapon has a total weight of approximately 46 pounds and breaks down into a 16-pound (tube), 17-pound (bipod), and 13-pound (base plate) load. A heavier U.S. mortar, the 81mm has a total weight of 137 pounds and breaks down into two 45-pound and one 47-pound load for carrying. Figure 251 illustrates these mortars. Both mortars have a maximum firing rate of 30 rounds per minute and a sustained rate of fire of 18 rounds per minute. A good mortar crew can have their weapon in place and firing within three minutes of arrival at a selected position.

Indirect Fire Applications. The normal firing procedures for the mortar involves simply dropping the mortar projectile (fins first) down the tube. Upon impact with the bottom of the tube, a firing pin fires an ignition cartridge (shotgun shell) which ignites the propellant increments attached

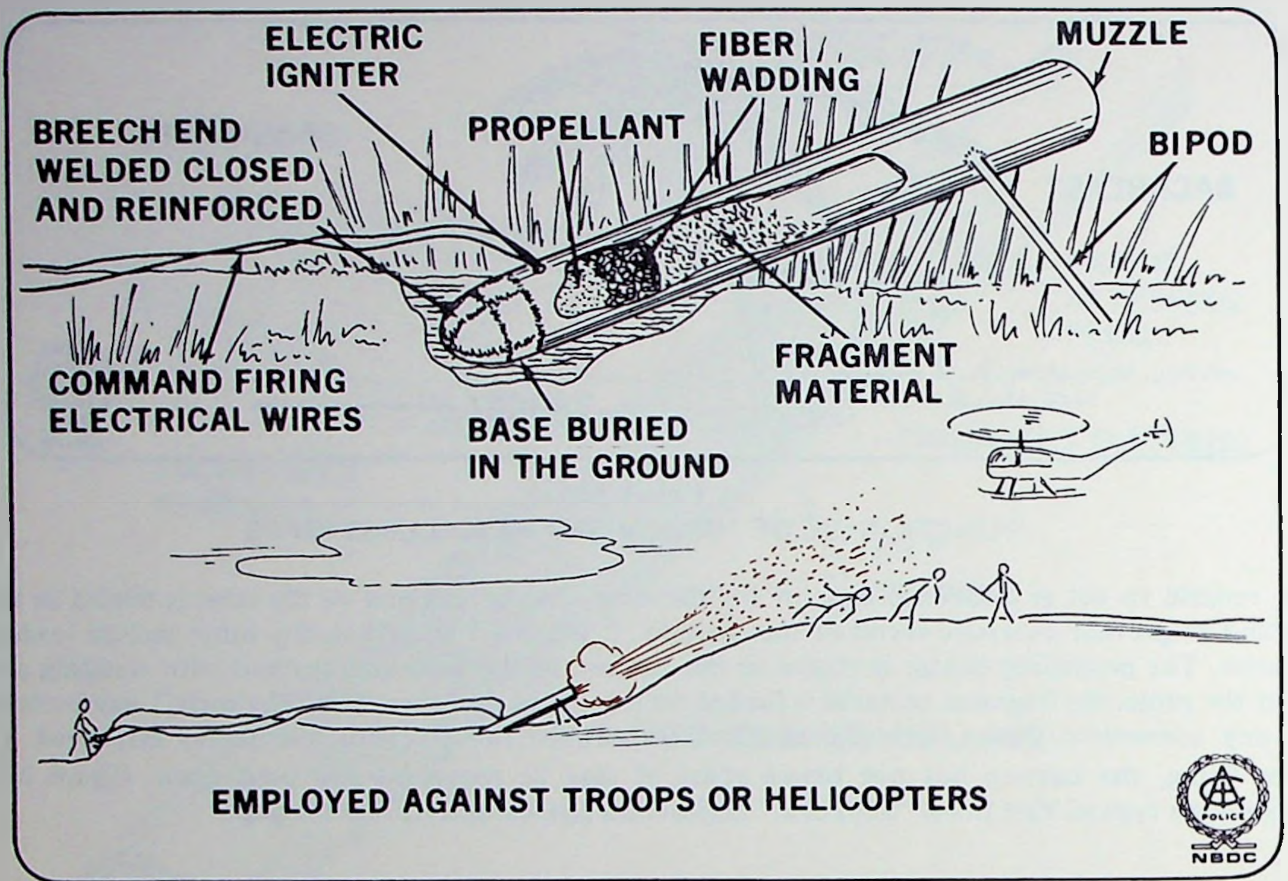


Figure 250
IMPROVISED ARTILLERY WEAPON VIET CONG
"SKYHORSE" CANNON

around the fin assembly. The burning gases from the propellant drive the projectile from the tube to the target in a high arc. The mortar weapon fills the gap and provides fire support between the maximum range of hand and rifle grenades and the minimum range of howitzers. The U.S. 60mm mortar has a maximum range of 1,984 yards (1.13 miles); the 81mm mortar has a range of 3,987 yards (2.27 miles).

Larger and heavier mortars, such as the 300-pound, U.S. 4.2-inch mortar, are employed to provide longer range fire support and to deliver larger projectiles to the target. What these weapons lose in mobility, they gain in fire power. The 4.2-inch mortar has a rifled tube and fires spin-stabilized mortar projectiles. The 4.2-inch projectiles are dropped down the rifled tube as in other mortars, but when the propellant is ignited, the gases expand a copper cup located at the base of the projectile, forcing its edges into the rifling and causing the projectile to rotate as it moves up the tube. The U.S. 4.2-inch mortar has a maximum range of 6,180 yards (3.51 miles).

Direct Fire Applications. Some mortar weapons are equipped with a firing lever mechanism which allows a mortar projectile to be placed in the tube and direct-fired by actuating the firing

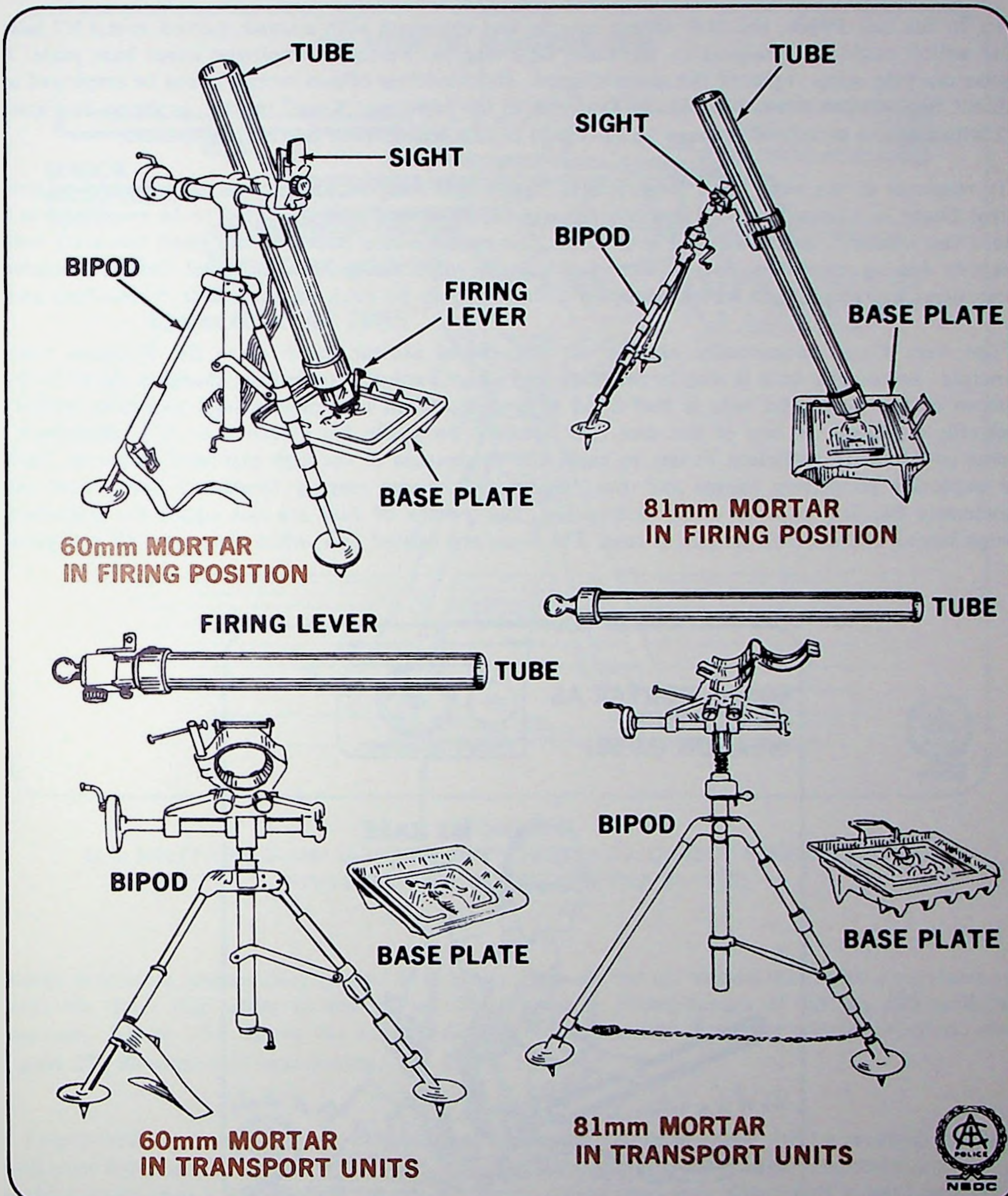


Figure 251
U.S. MILITARY 60MM AND 81MM INDIRECT FIRE WEAPONS

lever. In the late 1940s, the U.S. 60mm mortar was equipped with a small, curved, metal M1 base plate which could be attached to the tube, replacing the normally employed larger base plate. A canvas carrying strap replaced the mortar bipod. This modified 60mm mortar could be employed as a direct fire weapon in exactly the same manner as the Japanese "Knee" mortar, as shown in Figure 252 which is also described on page 155 in Part I of this series, *Hand and Rifle Grenades.*

In response to the need for a large caliber, lightweight weapon which could be mounted on river patrol boats in Vietnam, an 81mm mortar was modified and post-mounted to be employed as a direct fire weapon, as shown in Figure 253. This modification provided the small rivercraft with weapons having excellent fire power (particularly when firing anti-personnel fletchette-loaded projectiles), low recoil, and which occupied no more space on deck than a caliber .50 machine gun.

The Viet Cong occasionally employ an improvised mortar based upon the Fougasse mine principle. An angular hole is dug in the earth and a high explosive propelling charge is placed in the bottom of the hole. The hole is half-filled with dirt and an unexploded high explosive artillery projectile is placed on top of the dirt. The artillery projectile has attached to it a "piggyback" charge of explosive sufficient in size to cause the detonation of the high explosive projectile. Both the explosive propelling charge and the "piggyback" charge employ lengths of safety fuse and nonelectric blasting caps to effect detonation; the lengths of fuse are not equal, the propelling charge having the shortest length of fuse. The fuses are lighted and, when the explosive propelling

Figure 252
U.S. MILITARY 60MM AS A DIRECT FIRE WEAPON

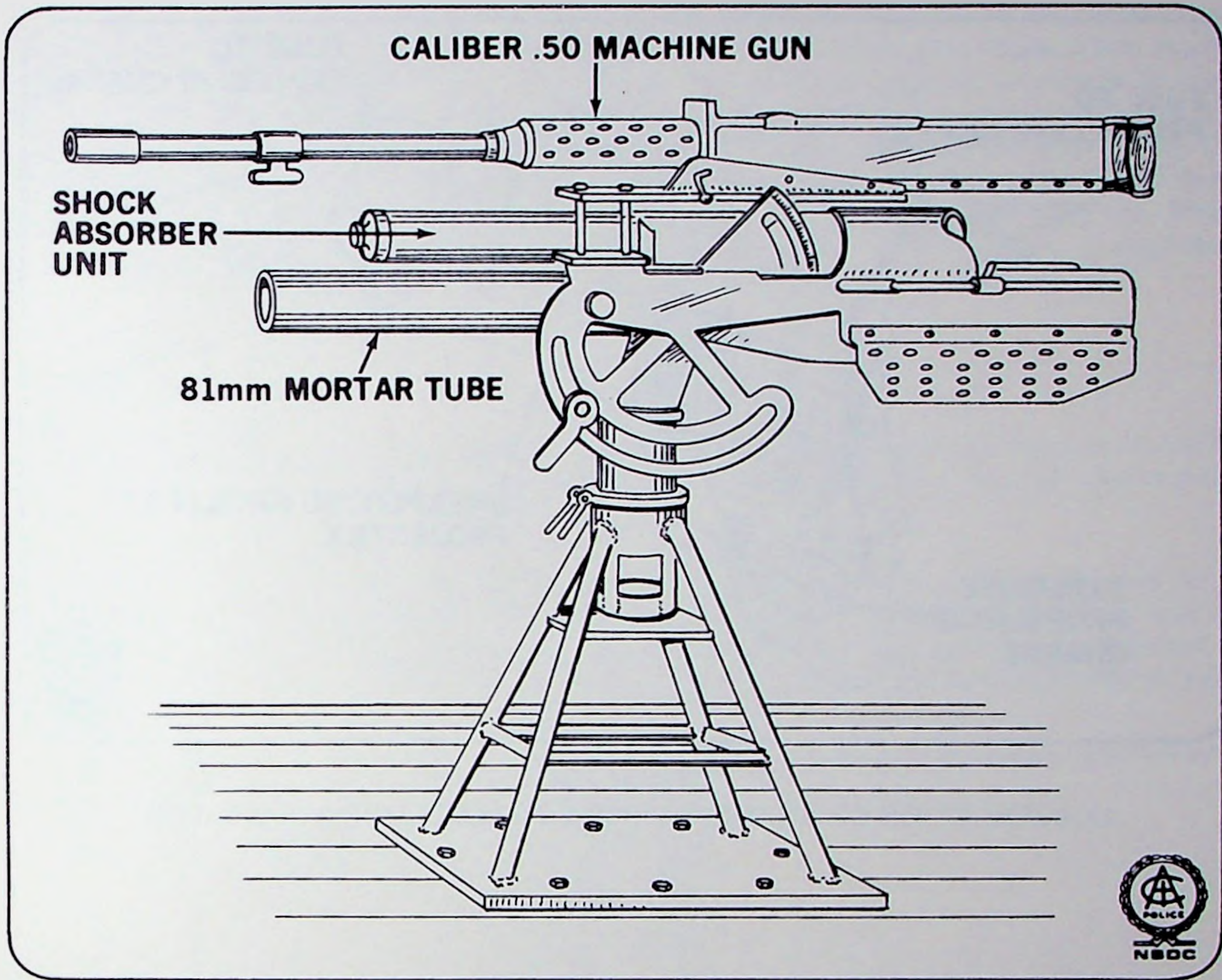


Figure 253
U.S. MILITARY 81MM MORTAR EMPLOYED AS A DIRECT FIRE WEAPON ON RIVER PATROL BOATS (VIETNAM, 1972)

charge detonates, the artillery projectile is blown through the air toward the target area, where the projectile detonates either in the air or on the ground. Firing ranges of 100 to 300 yards are common. Figure 254 shows the construction of an improvised Fougasse mortar weapon, while Figure 255 illustrates its functioning.

Improvised Mortars. Hundreds of what may be considered improvised mortar weapons are used each year for peaceful purposes in Fourth of July fireworks displays. These fireworks mortars are nothing more than a short length of smooth, heavyweight steel pipe fitted with a solid closing cap or plug which is cast into a block of reinforced concrete. Fireworks mortars are used to project heavy cardboard pyrotechnic-filled saluting charges several hundred feet into the air, where they burst in a shower of color and noise.

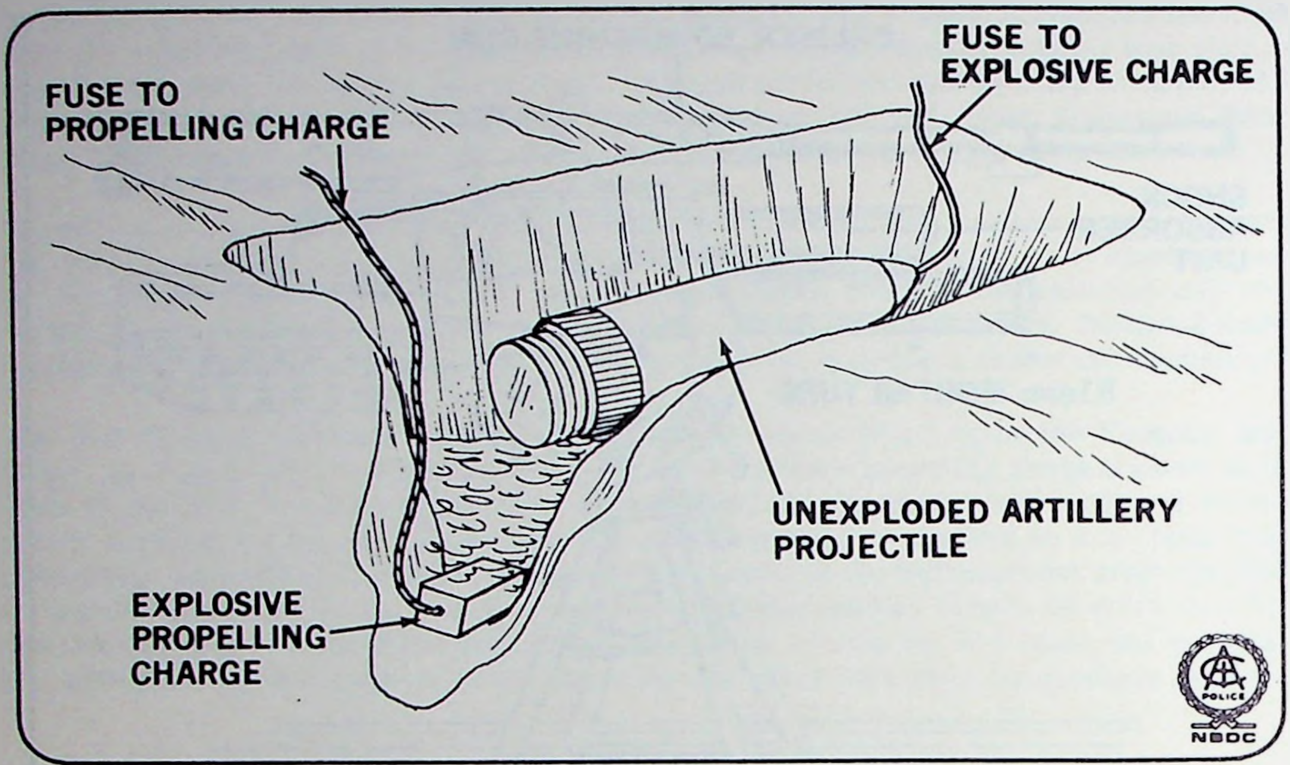


Figure 254
CONSTRUCTION OF AN IMPROVISED FOUGASSE MORTAR WEAPON

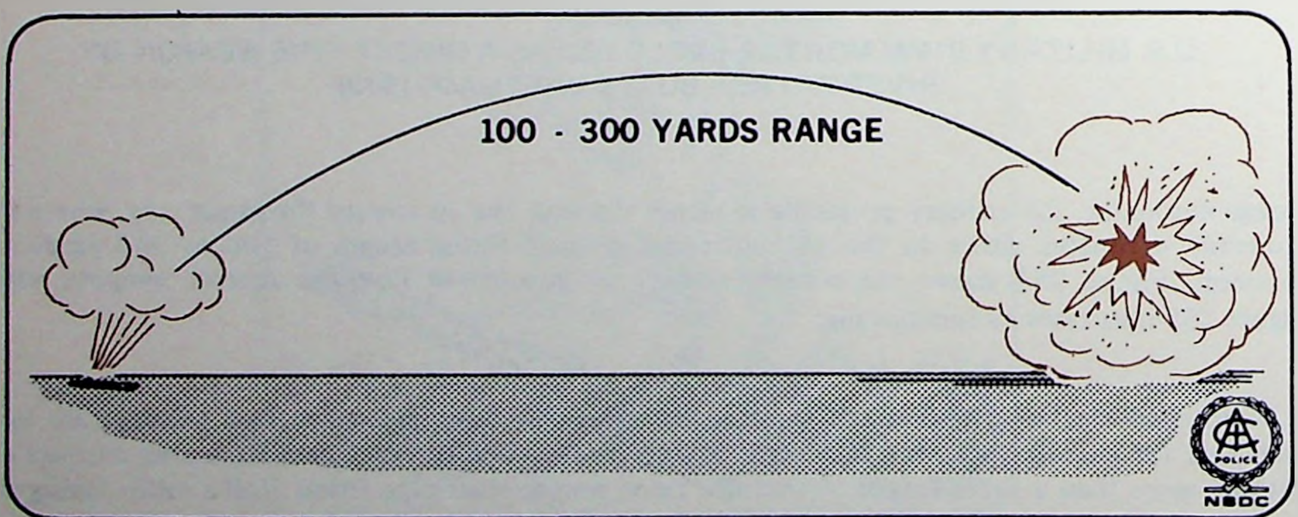


Figure 255
FUNCTIONING OF AN IMPROVISED FOUGASSE MORTAR WEAPON

The same basic fireworks mortar could, with very little modification, be employed to project explosive or incendiary charges. A few years ago, the National Minutemen Organization placed and fired the mortar and projectile illustrated in Figures 256, 257, and 258 from an alley in Washington, D.C. The projectile contained leaflets denouncing the United States' involvement in the United Nations. The Minutemen improvised mortar weapon was constructed along the same general lines as a fireworks mortar. While placing and angling the mortar so that, when fired, the projectile would eject its leaflets near the White House, it was positioned inside an unstable trash can. When the mortar fired, the trash can was upset, deflecting the projectile and bringing to a close the first mortar attack attempted against Washington, D.C. since the Civil War.

Rocket Weapons

A rocket is a projectile which is propelled by the *reaction* of discharging gases produced by the burning of a propellant contained within a tube which is closed on one end and open at the other end.

Rockets were used by the Chinese over a thousand years ago as fireworks and to signal movements to ground troops engaged in combat. Tamerlane used rockets as artillery weapons in 1399 in the siege of Delhi, India. By the 1790s, rockets were used almost daily in wars, with some armies having as many as 5,000 men assigned to rocket firing units. Rockets of this period were

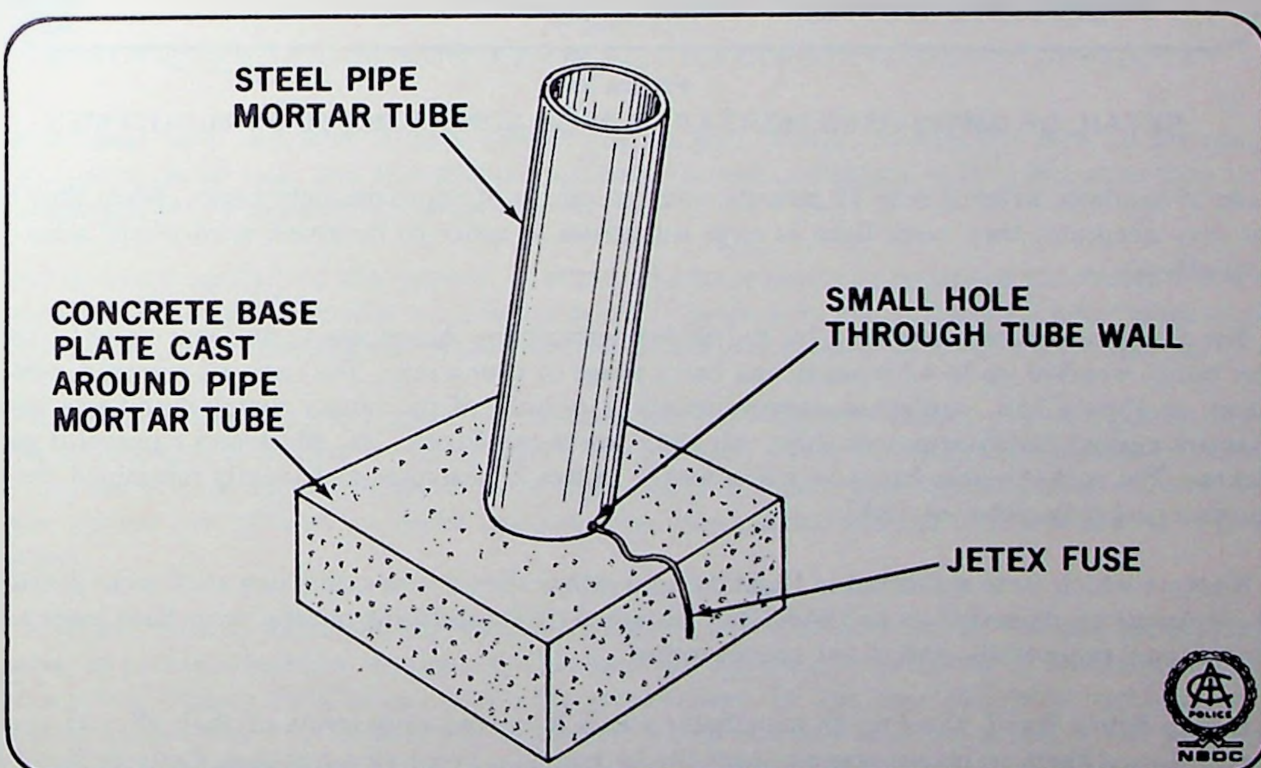


Figure 256
IMPROVISED MORTAR WEAPON CONSTRUCTED BY MINUTEMEN

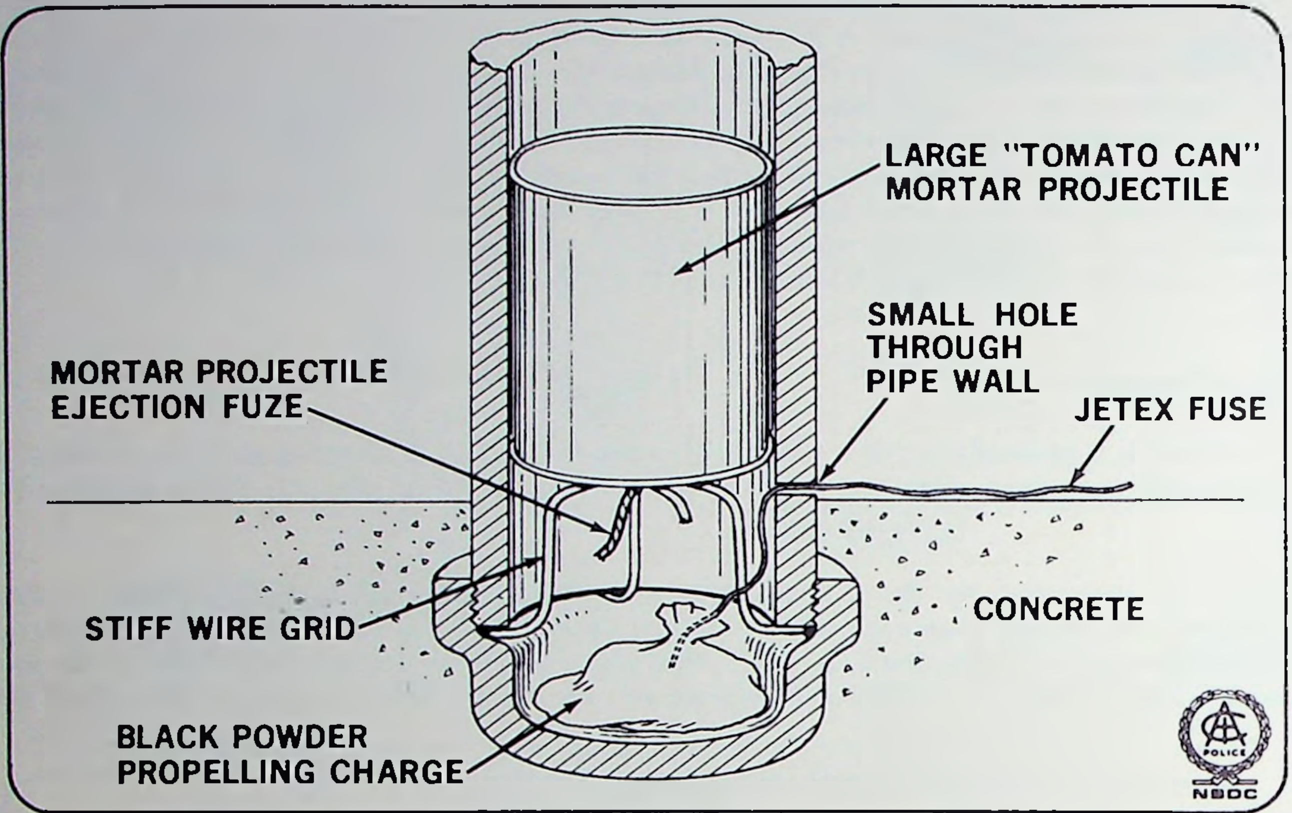


Figure 257
DETAIL OF IMPROVISED MORTAR WEAPON CONSTRUCTED BY MINUTEMEN

made of bamboo, weighed 6 to 12 pounds, and had ranges of approximately a mile. While they were not very accurate, they were fired in large quantities in order to bombard enemy-held areas with great effect.

The Congreve rocket employed by the British against the Americans in the War of 1812 had an iron body, weighed up to 42 pounds, and had a range of over a mile. The rocket's warhead, which is shown in Figure 259, contained approximately 7 pounds of incendiary material and was equally effective against fortifications or ships. An 1865 wood cut, Figure 260, illustrates a peaceful use for rockets. The rocket whale harpoon was about 4 inches in diameter and greatly resembled the U.S. bazooka rocket launcher of 1942.

Rockets which were stabilized in flight by spin rather than a long stabilizing stick were developed by an American named Hale in 1846. They obtained their rotation from the propellant gases acting upon curved vanes at the end of the rocket motor.

During World War I, the French launched rockets from the wing struts of their aircraft and the Germans used them to propel grapples over the barbed wire protecting trenches. Early in World War II rockets fired straight up from the coast of England trailed lengths of piano wire which helped to defeat the German Luftwaffe by slicing off the wings and fouling the propellers of aircraft. Later in World War II, the development and use of the bazooka enabled infantrymen to attack and destroy

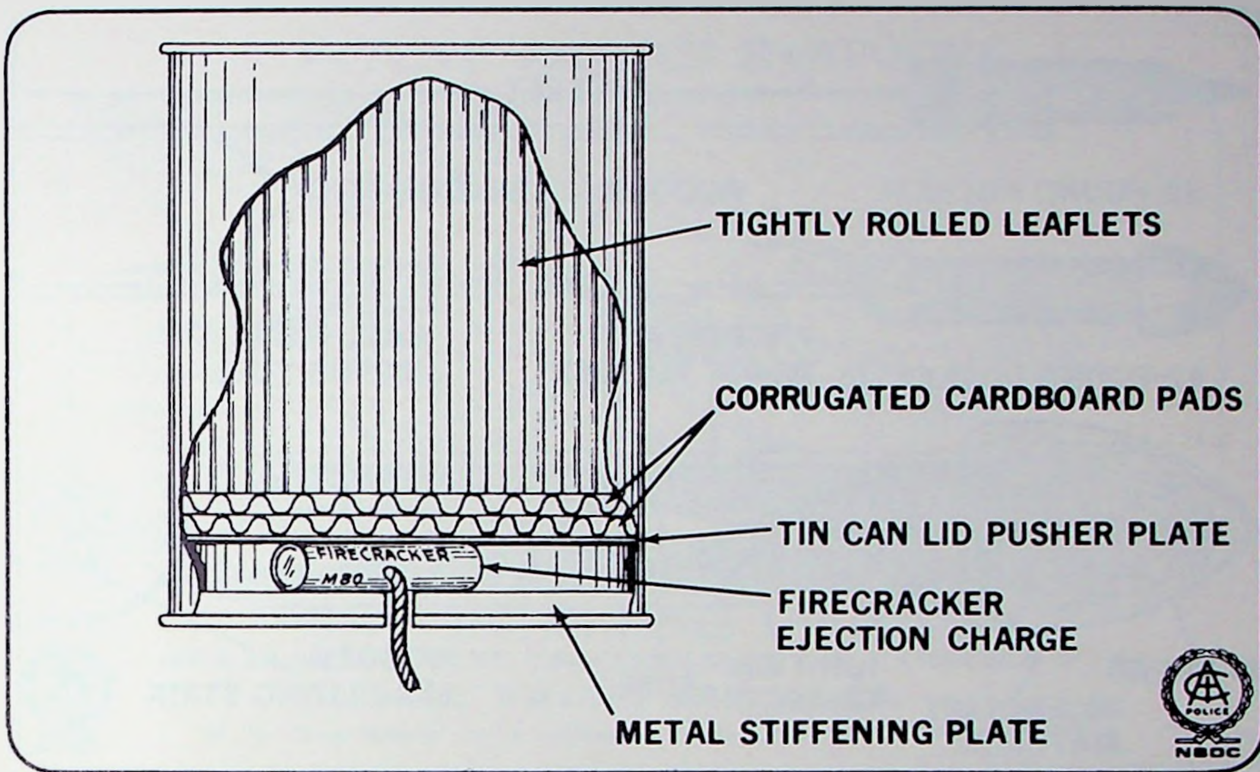


Figure 258
IMPROVISED EJECTION MORTAR PROJECTILE CONSTRUCTED BY MINUTEMEN

armored tanks with one shot from a lightweight weapon. Today, rockets put men on the moon, seed clouds to make rain, and still produce brilliant fireworks displays as they did when they were first employed over a thousand years ago.

Rockets are propelled by the *reaction* of expanding gases from the nozzle of the rocket motor. It is a common misconception that rockets are pushed forward by the action of the hot gases on the surrounding air, but rockets function even in a vacuum where there is nothing to push against.

To understand how a rocket operates, consider a closed tube into which a gas under pressure has been introduced, as is shown in Figure 261A. The pressure of the gas against all interior surfaces is equal and the system is in equilibrium. If the right end of the tube were removed (Figure 261B), the pressure against the left end would be unopposed or unequalized and the tube would tend to move to the left.

In a rocket motor, sufficient confinement of the gases produced by the burning propellant is necessary to permit a buildup of pressure. This buildup of pressure is achieved by restricting the size of the opening (Figure 261C) from which the gases escape. In this case, the useful rocket thrust is the difference between the force acting on the left end of the tube and that acting on the right end. With this type of design, however, considerable turbulence is caused by the flow of gas through the opening, with a consequent loss of available energy. This turbulence can be greatly reduced by adopting a design similar to that illustrated in Figure 261D.

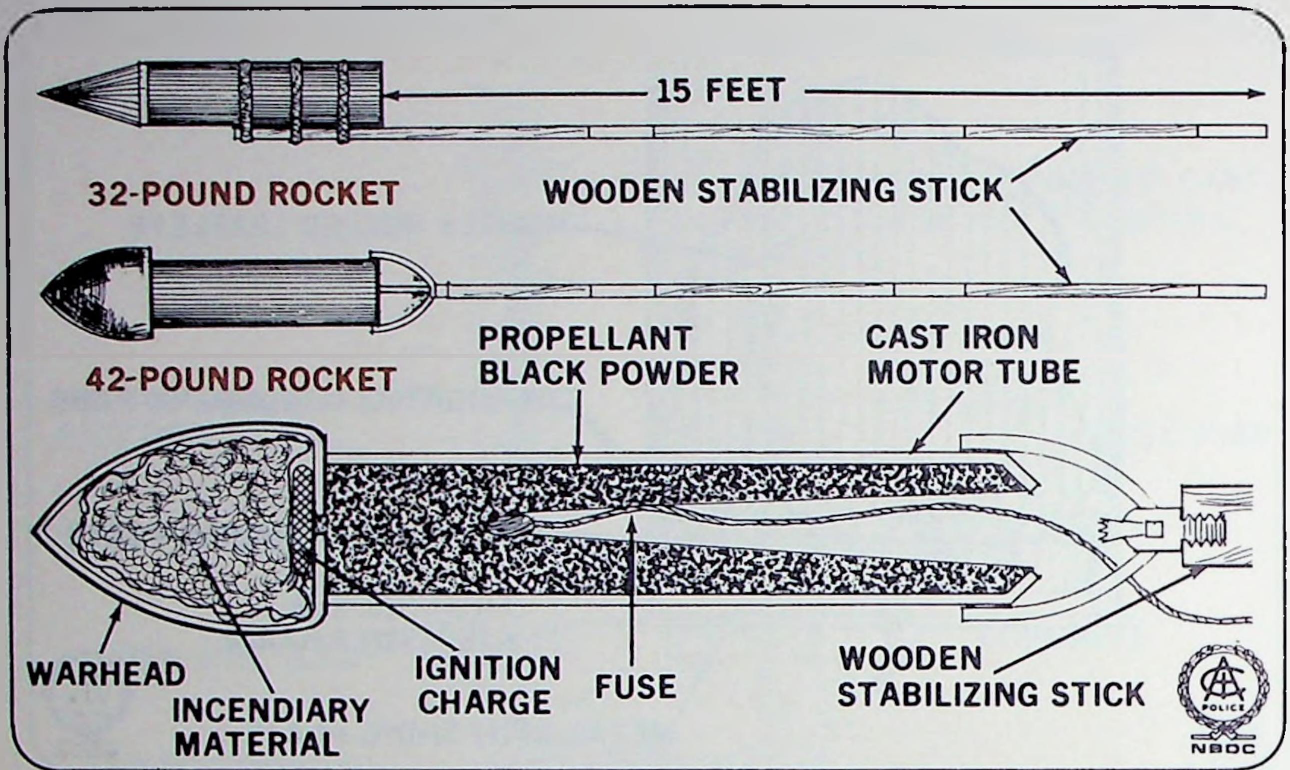


Figure 259
CONGREVE INCENDIARY ROCKET OF WAR (1830)

If a divergent expansion section is added (Figure 261E), the force of the expanding gases acting on the walls of this section provides additional thrust by utilizing the lateral expansion of the gases as they exit the motor tube. This configuration is known as a *nozzle* or *venturi*.

Rocket weapons in use today by the military are tactically employed as either direct or indirect fire weapons. Direct fire weapons include the bazooka, LAW, or aircraft launched types, while indirect fire weapons are of the barrage rocket type. Rockets in flight are stabilized by fins or by a spin action imparted by angled rocket nozzles. Rockets 70mm in size (2.75 inches) and smaller are usually fin-stabilized while the larger rockets are often stabilized by spin. The most commonly employed rockets used by the U.S. Armed Forces today are of the fin-stabilized, direct fire type.

Direct Fire Weapons. A typical direct fire weapon is the U.S. light anti-tank weapon (LAW), a 66mm HEAT rocket launching system which incorporates the rocket projectile and a lightweight throw-away launcher as one unit. The LAW rocket system is employed primarily against armored targets. The launcher with its contained HEAT rocket projectile is cylindrical in shape and measures 25 inches in length and approximately 2 3/4 inches in diameter. The entire LAW weapons system weighs only 4 3/4 pounds. The HEAT rocket projectile is capable of penetrating the armor of any known tank. The weapon's light weight, ease of firing, and kill power make it one of the most effective anti-tank weapons in use by the U.S. military.

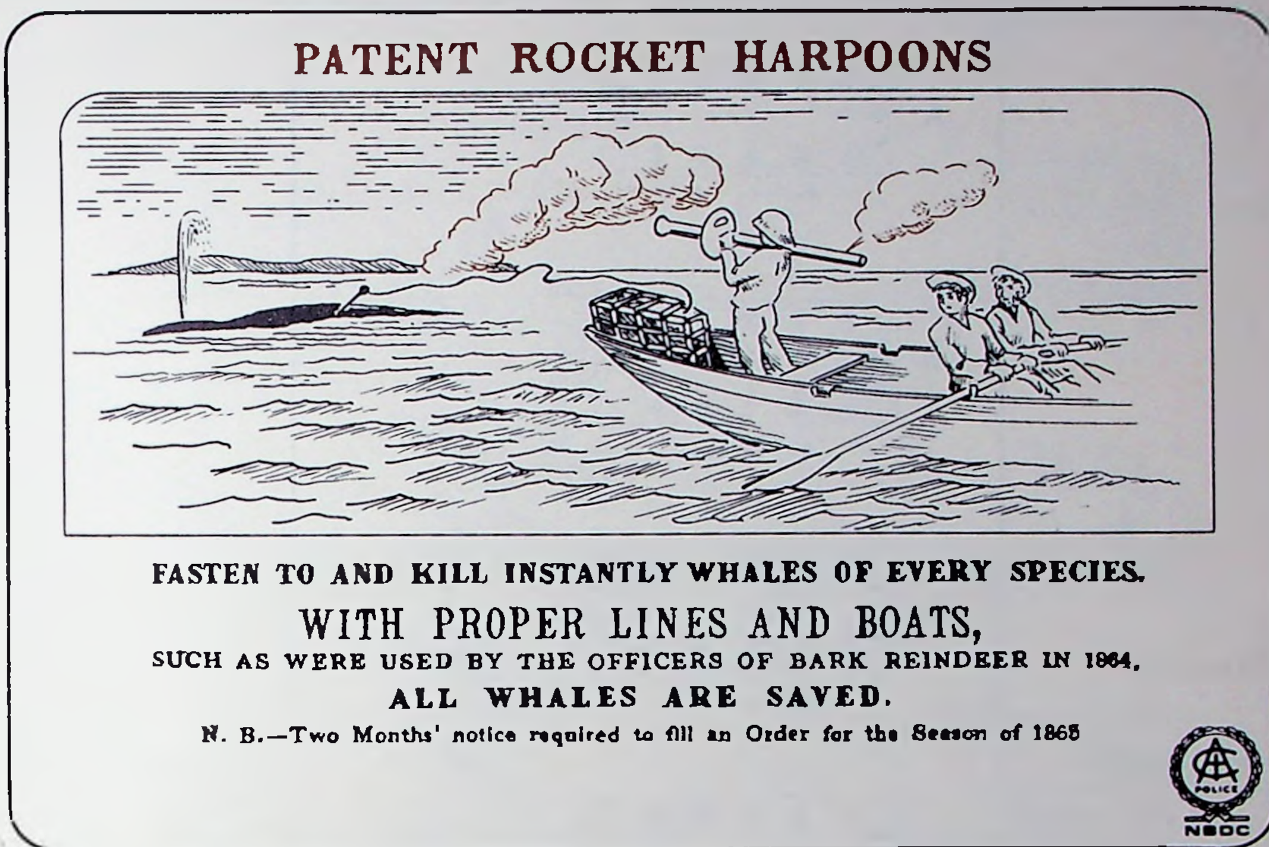


Figure 260
"BAZOOKA" USED TO HARPOON WHALES (1864)

The LAW has a telescoping launching tube which is extended to a length of 35 inches prior to firing. Extending the launching tube cocks the weapon's firing trigger and allows the launcher's sights to flip up, ready for use. When the rocket is fired, the rocket motor burns out *before* the rocket reaches the end of the launcher so that no rocket backblast strikes the person firing the weapon. The maximum effective range of the LAW when employed against tanks is approximately 218 yards. The HEAT rocket projectile has a maximum range of approximately 1,093 yards and may also be employed against secondary targets such as machine gun positions and bunkers with excellent effect. The rocket's initial velocity at launch is 475 feet per second. Figure 262 illustrates the LAW launcher, while Figure 263 illustrates the 66mm HEAT rocket projectile fired by the LAW weapons system.

Numerous thefts of LAW rockets from military installations have been reported in the last few years. On one occasion, two or three LAW weapons were recovered in a dry river bed in California. Attempts had been made to arm and fire the LAWs, but a lack of knowledge about proper firing procedures resulted in only partial arming of the weapons and they were apparently abandoned when attempts to fire the devices failed. Weapons such as the LAW in the hands of criminals or revolutionaries would equip them with tremendous fire power presently unequaled by law enforcement.

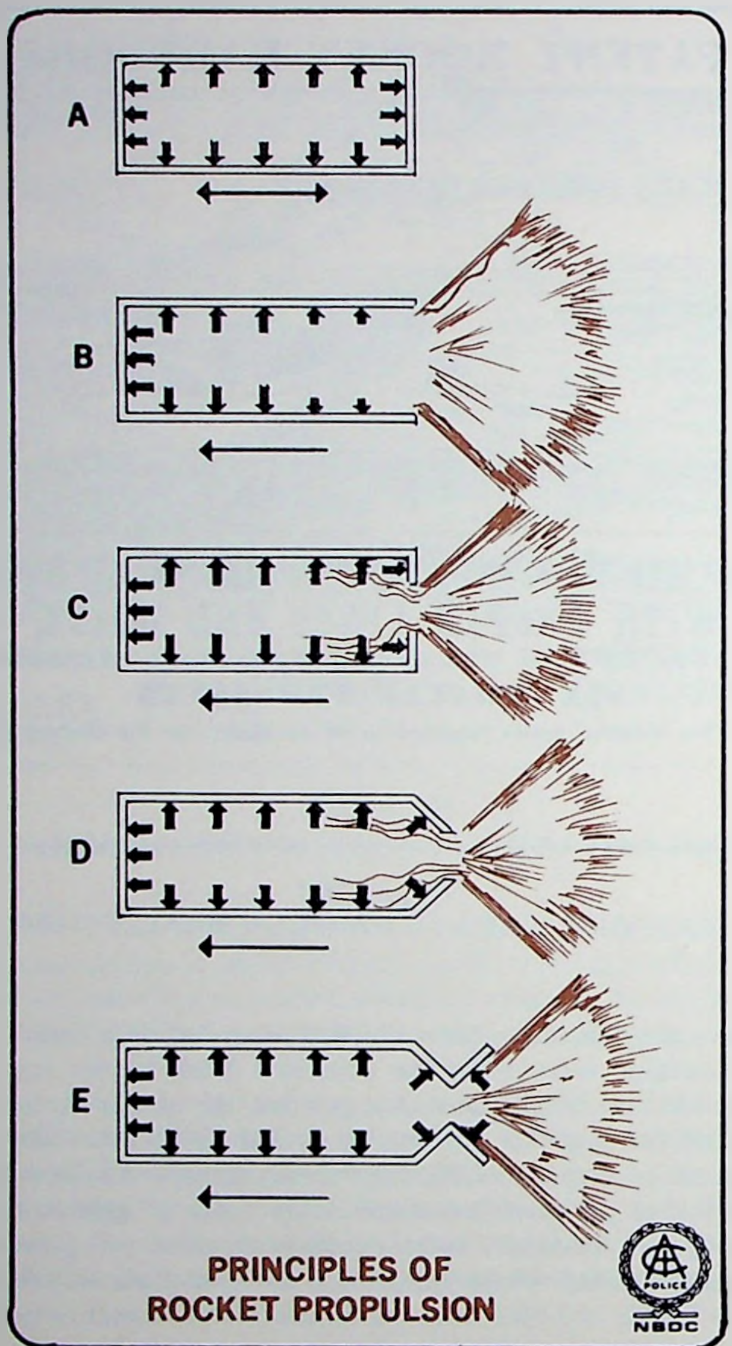


Figure 261
PRINCIPLES OF ROCKET PROPULSION

Another example of a direct fire rocket weapon is the 2.75-inch folding fin aerial rocket (FFAR) system. The FFAR was originally developed as an air-to-air rocket, but changing military requirements and combat conditions have caused it to be modified into a dual-purpose weapons system having application in air-to-ground combat as well.

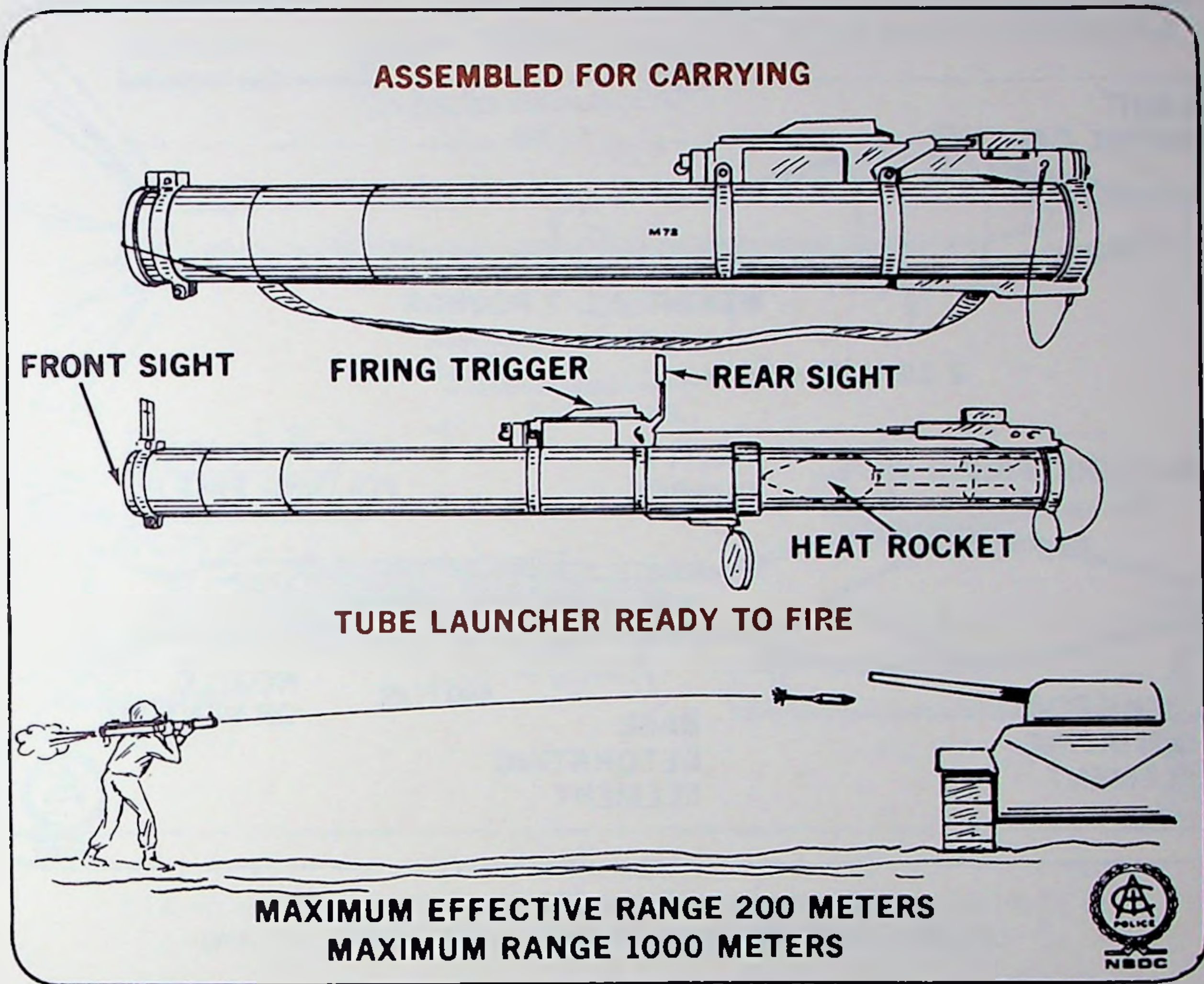


Figure 262
U.S. MILITARY 66MM LIGHT ANTI-TANK WEAPON (LAW)

The rocket itself is equipped with four folding stabilizing fins which open as the rocket leaves its aircraft or helicopter launching tube. The rocket is 53 to 63 inches in length (there is a difference in the length of some projectiles), 2 3/4 inches in diameter, and weighs 21 to 28 pounds depending upon the type of warhead attached to the rocket motor. The wide variety of rocket warhead projectiles, including HE, HEAT, APERS, and WP, which may be used with the rocket makes it an extremely versatile weapons system. Figure 264 illustrates the 2.75-inch FFAR rocket and some of the rocket warhead projectiles employed with the system. When fired, the rocket has a maximum range of approximately 3,280 yards for area targets and an effective range of 1,640 yards for point targets. The rocket's velocity is better than 2,100 feet per second at launch.

Indirect Fire Weapons. Larger caliber barrage rockets are primarily employed in amphibious landing operations to destroy enemy fortifications and force the enemy to take cover as the slow

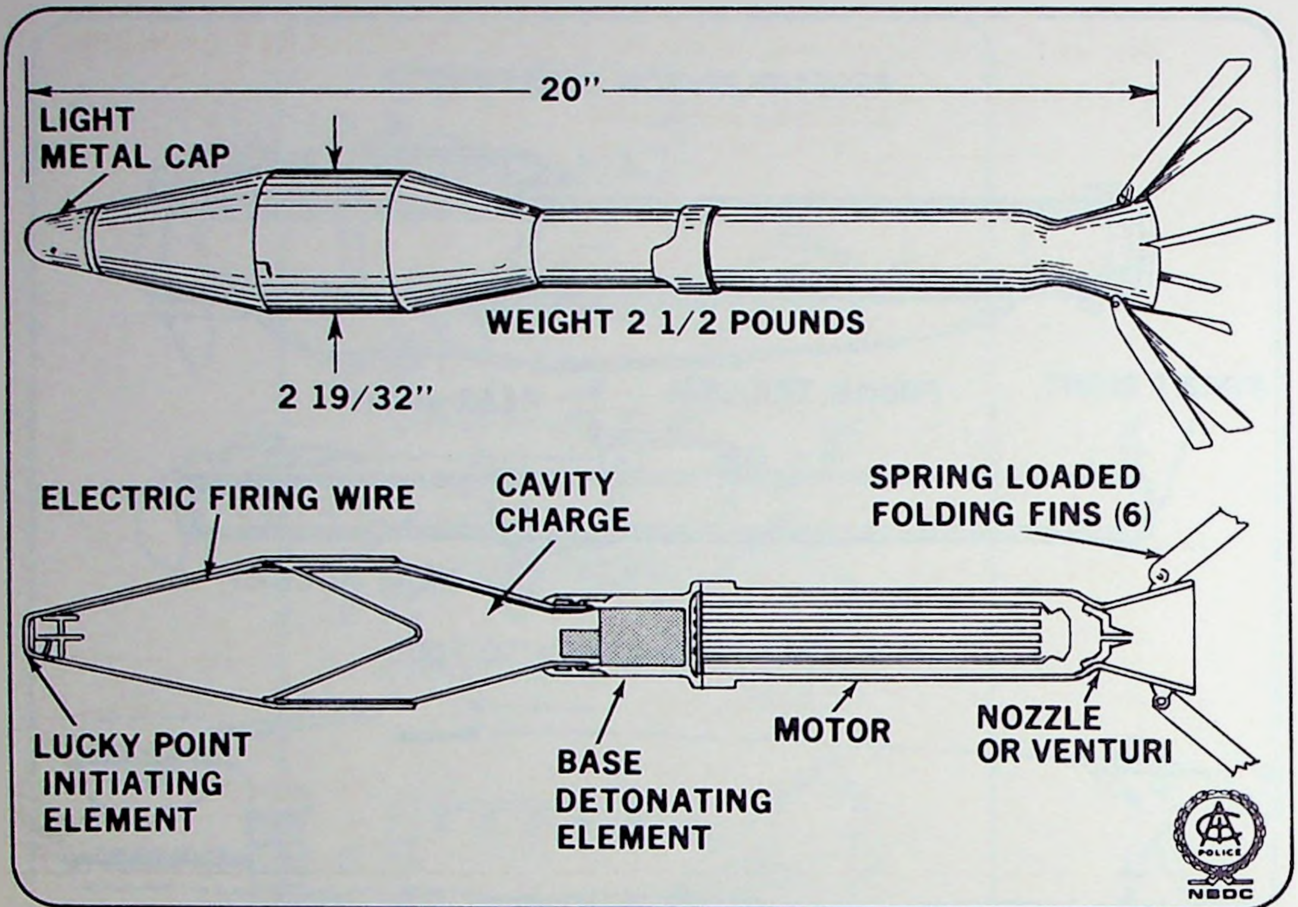


Figure 263
U.S. MILITARY 66MM HEAT ROCKET PROJECTILE (LAW)

and vulnerable landing craft move to the beach. Barrage rockets mounted on ships or directly on landing craft have the advantage of being relatively simple in operation, have no recoil force, and are able to deliver a high volume of fire from a lightweight launcher system. Barrage rockets are not as accurate as artillery weapons, but this disadvantage is more than offset by their ability to provide a volume of fire at a low cost in space and weight. They are intended to saturate an area with explosive projectiles rather than strike at pinpoint targets. Figure 265 illustrates barrage rockets being employed in support of amphibious landing operations. Barrage rockets may be launched from tube or parallel guide rail launchers which are automatically reloaded after each launch.

A typical indirect fire barrage rocket system is the U.S. Navy 5-inch spin-stabilized rocket (5"SSR). As the name implies, this rocket is stabilized in flight by spin action in much the same manner as an artillery projectile. Its spin, however, is derived by canting the rocket motor's venturi (each rocket has from 4 to 8 venturi), causing the escaping gases to impart rotation to the rocket. Figure 266 illustrates a typical canted venturi configuration employed with spin-stabilized rockets.

The U.S. Navy 5-inch spin-stabilized rocket (SSR) is actually a family of rockets, each member of which has a different maximum effective range. Rocket firing may, therefore, start from a distant

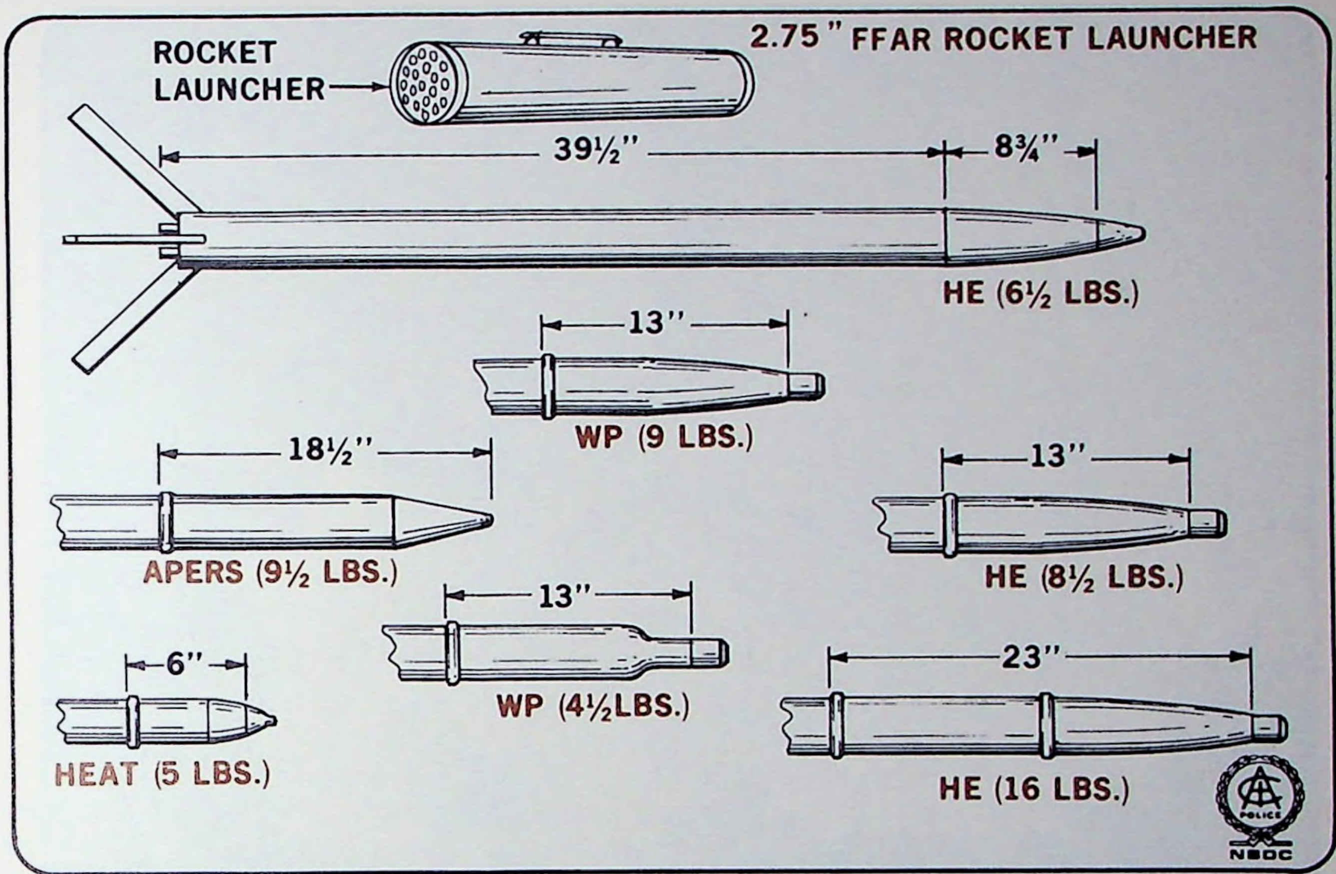


Figure 264
2.75-INCH FOLDING FIN AERIAL ROCKET (FFAR) AND A VARIETY OF WARHEAD PROJECTILES

point and remain continuous, even though the rocket launching ship is steadily drawing nearer to the troop landing area. Those rockets launched from the most distant range will of course have larger rocket motors and proportionally smaller payloads than those launched at closer ranges. As the range of the rocket decreases, the size of the explosive warhead increases. Figure 267 illustrates the U.S. Navy 5-inch SSR family of rockets and provides range information and explosive warhead weights.

Improvised Rocket Weapons. While improvised rocket weapons are cheap to manufacture, effective, and easily constructed and employed, they are for the most part overlooked as weapons by terrorists and revolutionaries. The 32-pound Congreve incendiary rocket (Figure 259) and warhead of the 1800's could be constructed with ease today from a few scraps of pipe and would be a reliable weapon. The black powder propellant and the incendiary material in the rocket warhead could be mixed from common ingredients obtainable at a local supermarket or drug store and the launcher could be improvised from a length of pipe or two boards nailed together to form a trough. Figure 268 illustrates an improvised rocket employing these construction techniques.

Figure 265
BARRAGE ROCKETS EMPLOYED IN SUPPORT OF AMPHIBIOUS LANDING OPERATIONS

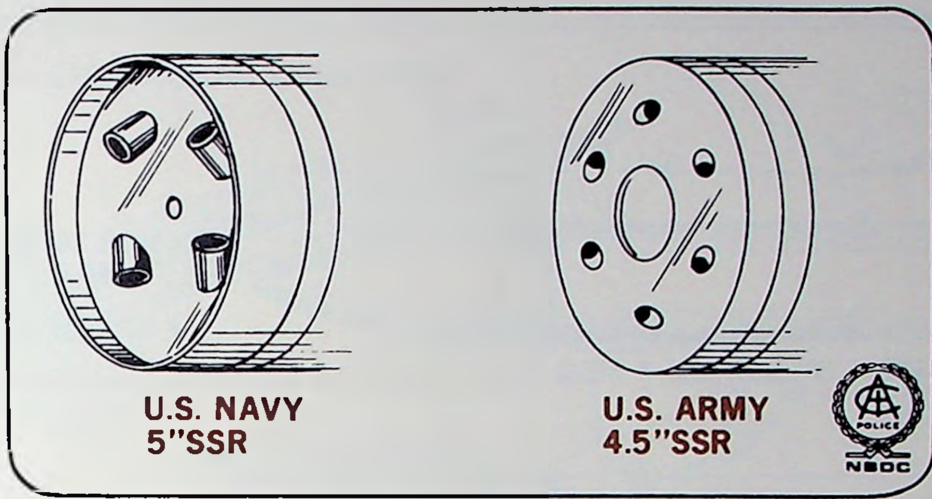


Figure 266
TYPICAL CANTED VENTURI CONSTRUCTION DESIGNED TO IMPART SPIN-STABILIZATION TO ROCKETS

Nevertheless, the rocket weapon does not seem to appeal to those intent upon attacking society. Each year, two or three improvised rockets are encountered by bomb technicians or investigators around the country, but thus far they have been of very amateur construction and very unreliable. Improvised rocket weapons have almost no history of criminal use in the United States.

INTRODUCTION TO AMMUNITION

A complete round of military ammunition consists of three basic parts. All artillery, mortar, and rocket ammunition will have these three major components in some form even though their physical assemblies may vary widely:

- **The Projectile.** The projectile is designed to carry a payload to the target.
- **The Propelling Charge.** The propelling charge provides the force necessary to carry the projectile from the weapon to the target.
- **The Primer or Igniter.** The primer provides the necessary ignition of the propelling charge at the desired moment.

There are four different and distinct types of complete rounds of ammunition. The four types of complete rounds are identified as fixed, semi-fixed, separated, and separate loading. The difference between these complete rounds is in the relationship between the *projectile*, the *propellant*, and the *primer*.

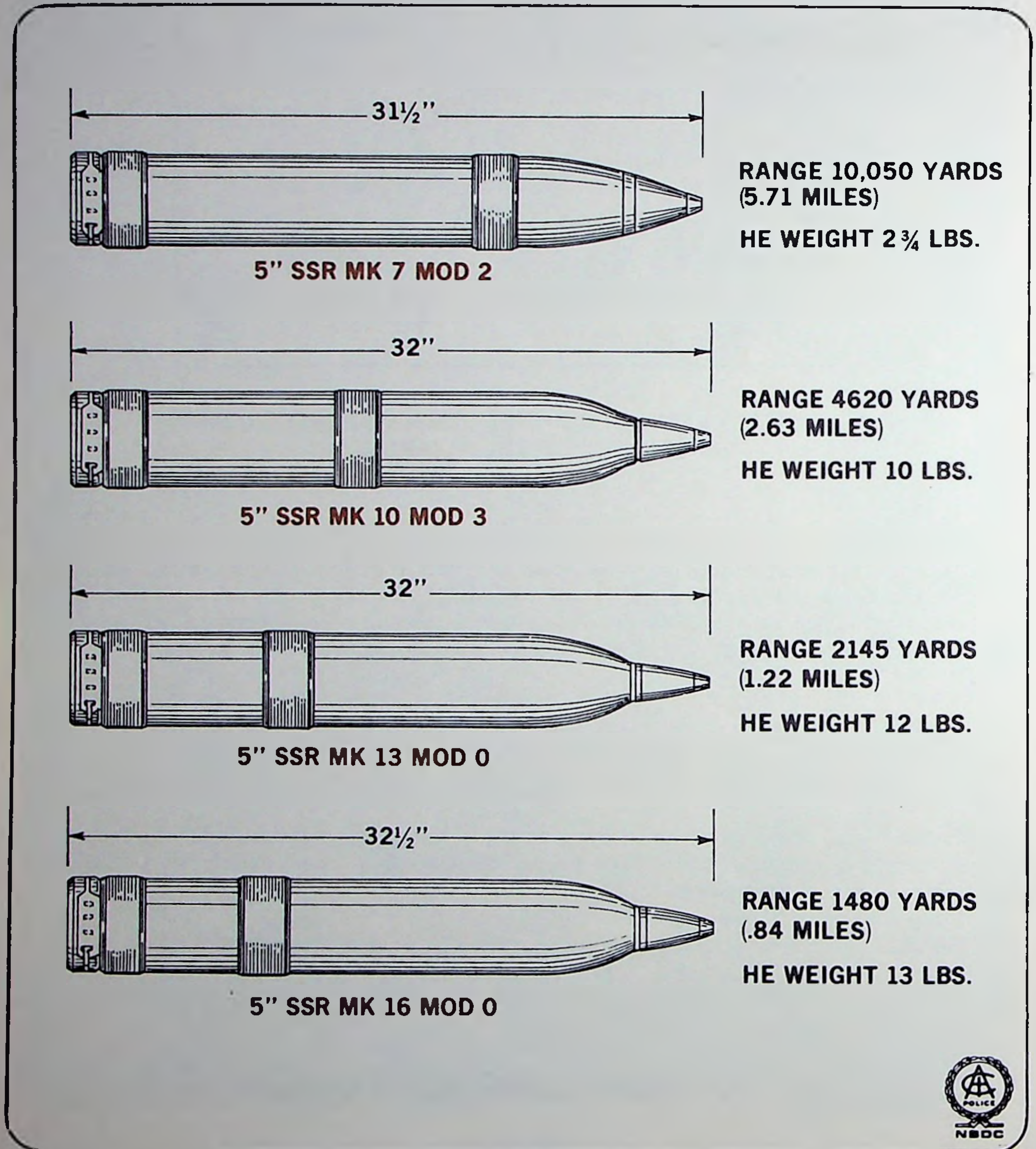


Figure 267
U.S. NAVY 5-INCH SPIN-STABILIZED ROCKET (SSR) FAMILY

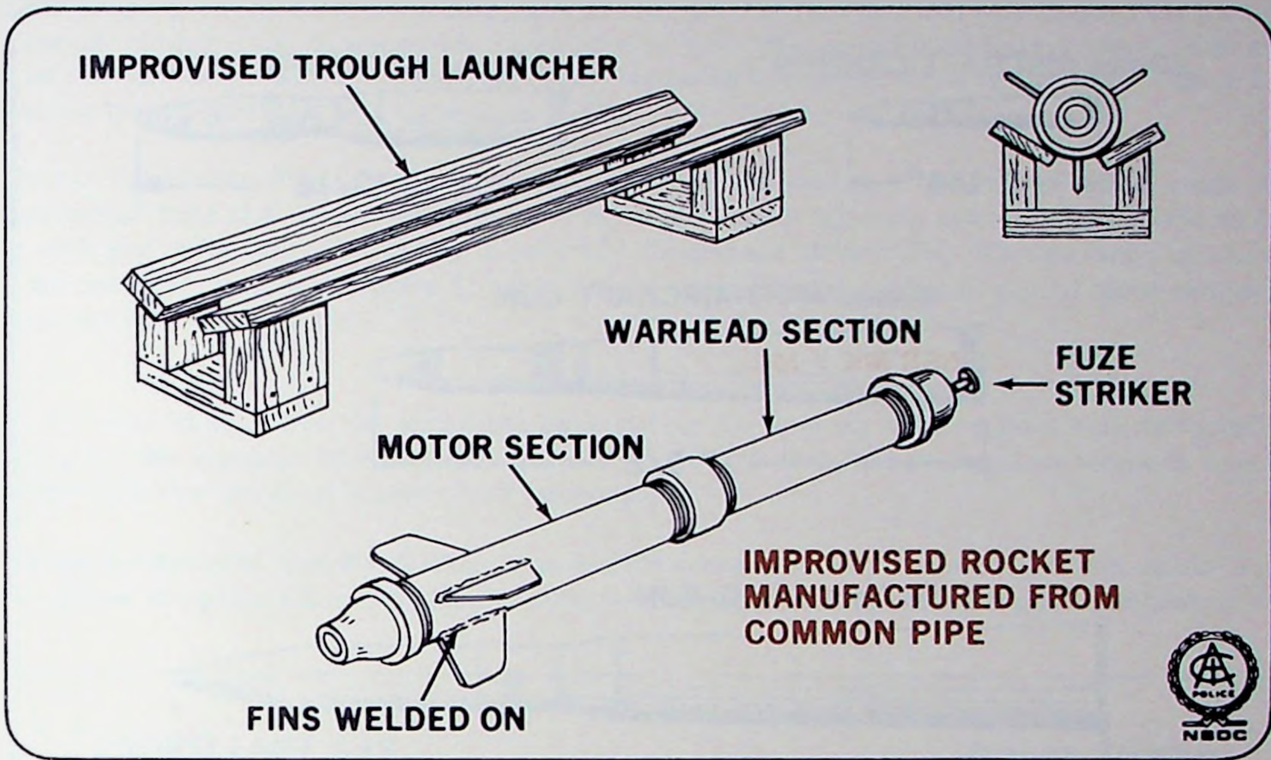


Figure 268
IMPROVISED ROCKET PROJECTILE AND WOOD LAUNCHER

Basic Complete Rounds

Fixed Ammunition (Artillery and Rocket Only). With fixed ammunition, the propellant employed to deliver the projectile to the target *cannot be adjusted or changed* by those firing the weapon. Some types of artillery ammunition and all types of rocket ammunition are of the fixed type. Fixed ammunition is rigidly assembled, with the projectile, propellant and primer or igniter married together into one unit.

Fixed artillery ammunition consists of a propelling charge contained in a brass, aluminum, steel, or combustible cartridge case. A primer is fitted into the base of this cartridge case and a projectile is inserted and *crimped* to the open end. Fixed artillery ammunition is complete in one unit and normally resembles an oversized rifle bullet. Various rounds of fixed artillery ammunition are illustrated in Figure 269.

Recoilless rifle ammunition is also fixed ammunition in that the cartridge case, propelling charge, and projectile are fitted together as one unit. Cartridge cases for recoilless rifle ammunition, however, have a large number of perforations through the case walls for most of its length. These perforations are sealed with a form of cellulose which holds the propellant grains within the cartridge case during normal handling and loading. When the weapon is fired, heat and flame from the burning propellant ignites and burns away the cellulose, closing the holes in the cartridge case

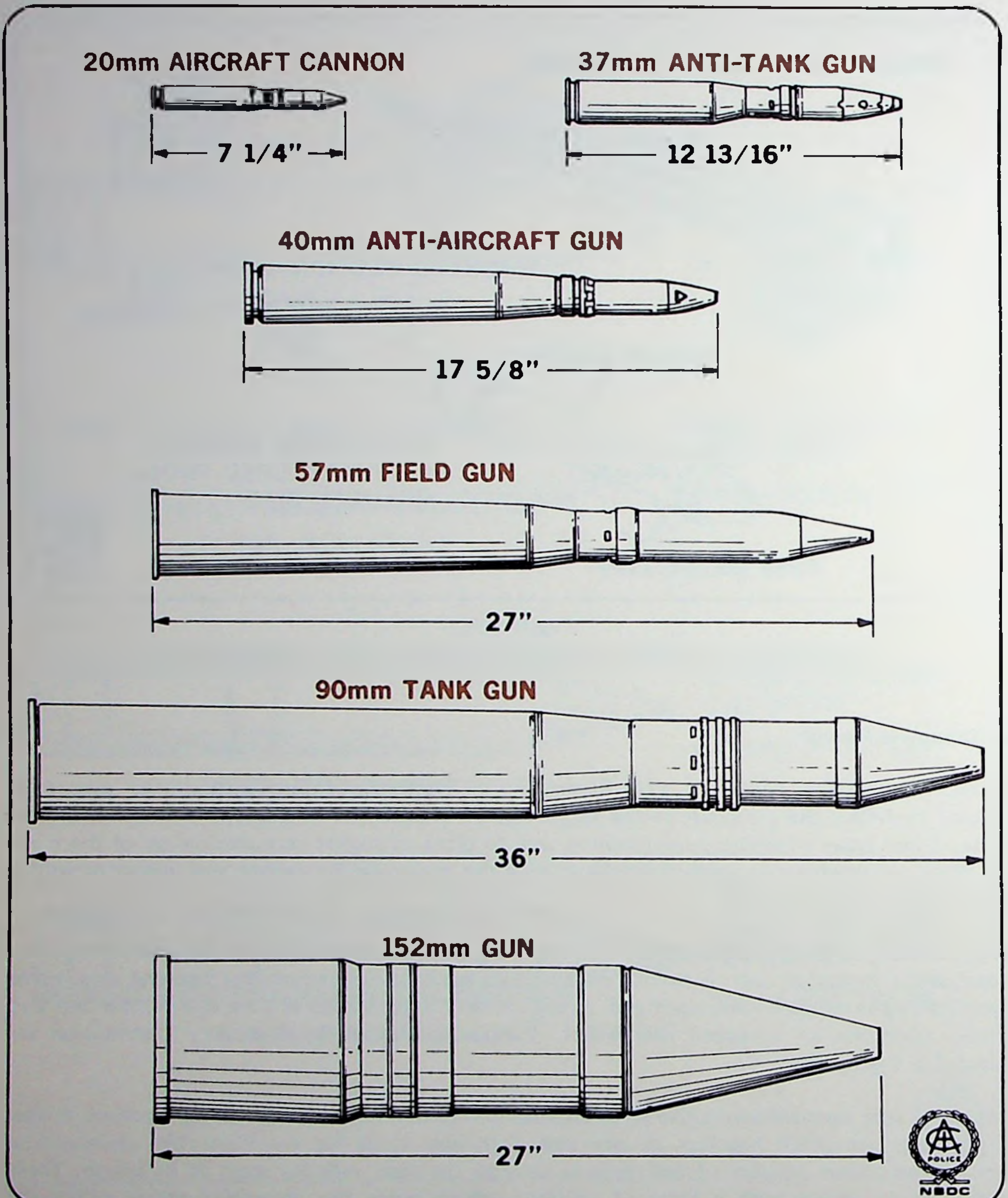


Figure 269
FIXED ARTILLERY AMMUNITION ROUNDS

and allowing a portion of the propelling gases to vent into the chamber and exit through the ports in the breech closing plug. Some newer types of recoilless rifle ammunition have a plastic blow-out disc in the base of an aluminum cartridge case, replacing the perforations in the sides. Figure 270 illustrates typical recoilless rifle fixed ammunition.

Rocket ammunition is also of the fixed type since the rocket propellant is sealed inside the rocket motor tube and cannot be adjusted. The rocket motor igniter is assembled inside the motor tube with the propellant. The igniter is generally functioned electrically, although one U.S. rocket (the 66mm light, anti-tank weapon [LAW]) employs a percussion igniter similar to those employed in most artillery ammunition.

Semi-Fixed Ammunition. In semi-fixed ammunition the amount of propellant may be varied or adjusted by the weapons crew depending upon the desired firing range. Artillery weapons such as howitzers and mortars employ semi-fixed ammunition.

Complete rounds of semi-fixed artillery ammunition resemble fixed ammunition but, unlike fixed ammunition, the projectile is *not* crimped into the cartridge case. The projectile is assembled so that

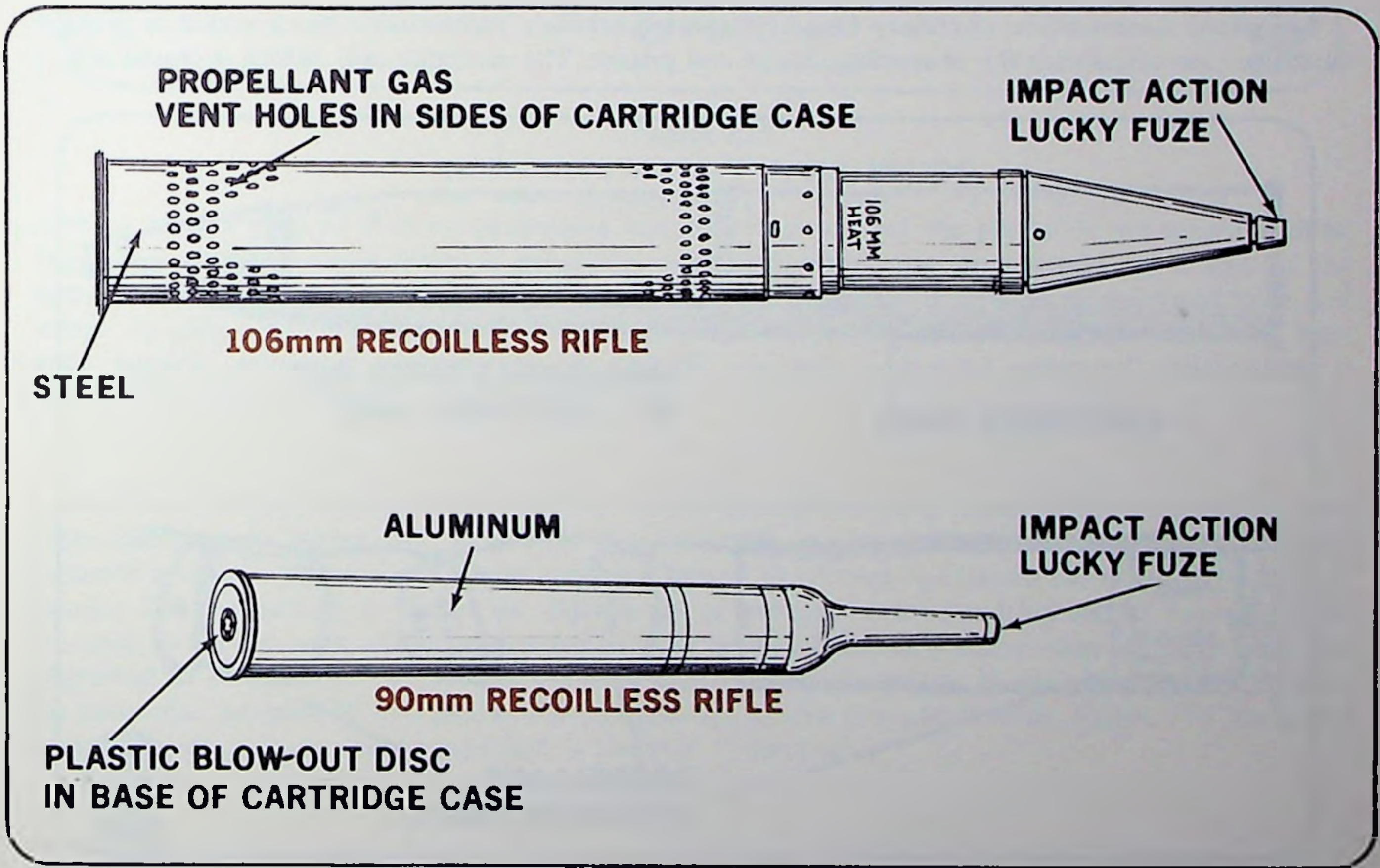


Figure 270
RECOILLESS RIFLE FIXED AMMUNITION

it can be removed in order to provide access to the propelling charges contained within the cartridge case. The propelling charges are usually assembled in separate cloth bags called *increments.* By removing one or more of the propellant increments, the range and velocity of the projectile can be adjusted when the weapon is fired without having to change the position of the gun tube.

Standard gunnery tables for the firing of these weapons have been prepared for use when propellant increments are removed. A weapon firing a projectile which has four propellant increments could, for example, with the weapon *at one fixed angle,* fire a projectile to 5,000 yards if all increments were used. If only three increments were used, the range would might decrease to 4,000 yards. With only two increments, the range would fall to 3,000 yards. This decrease or increase in range through the use of selected propellant increments is known as "zone firing" and increases the versatility of the artillery weapon. Howitzer ammunition, which is of the semi-fixed type, is illustrated in Figure 271.

All mortar ammunition is also of the semi-fixed type. By removing various propellant increments contained in plastic or cloth bags fixed to the fin boom, zone firing adjustments may be made as they are with howitzer ammunition. Typical semi-fixed mortar ammunition is illustrated in Figure 272.

Separated Ammunition (Artillery Only). Separated artillery ammunition has a sealed or plugged cartridge case containing the propelling charge and primer. The cartridge case, which is closed with a

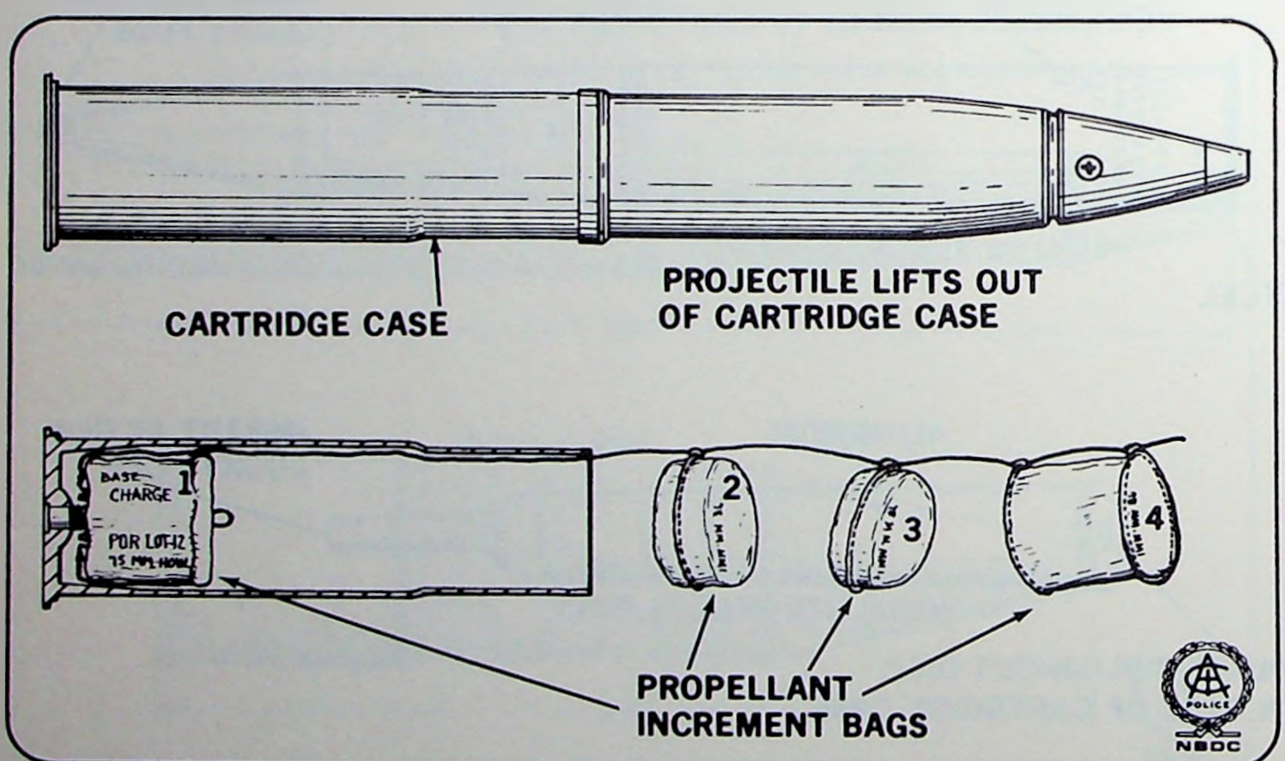


Figure 271
SEMI-FIXED ARTILLERY AMMUNITION

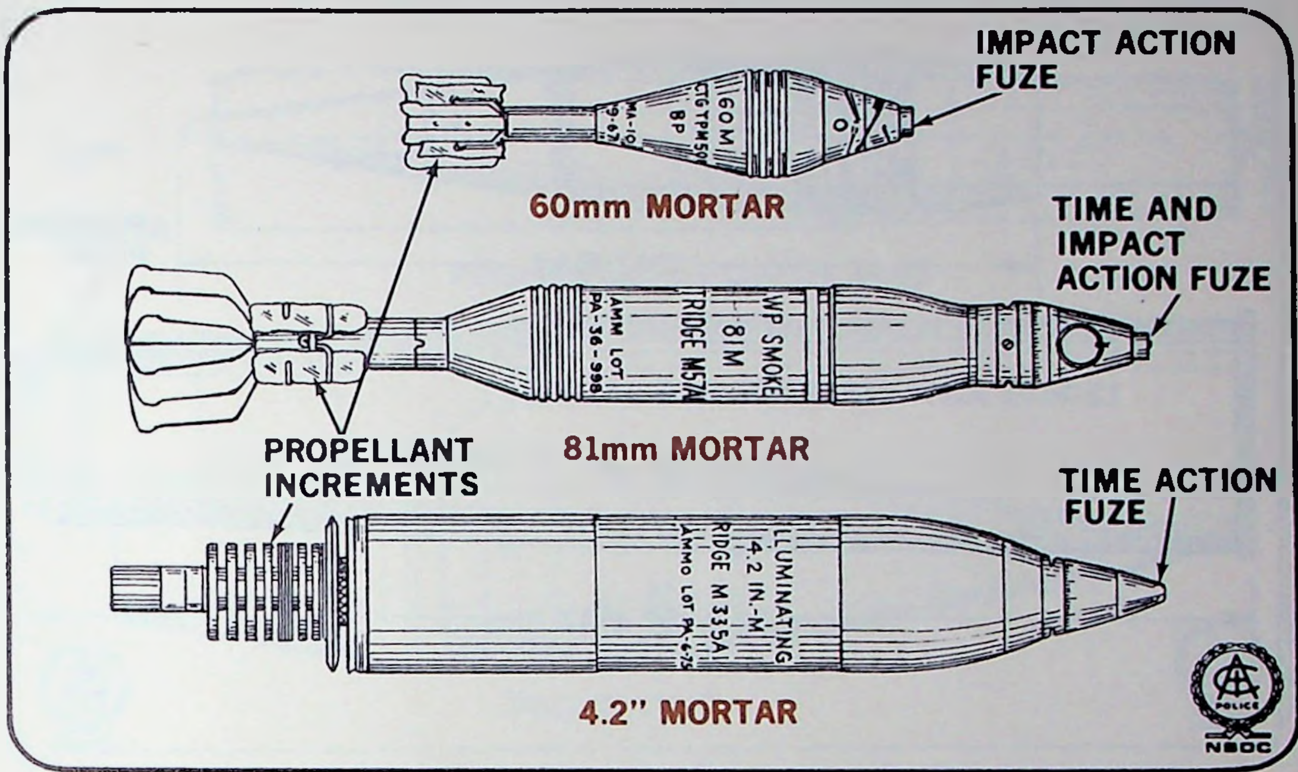


Figure 272
SEMI-FIXED MORTAR AMMUNITION

cork or plastic plug so that no propellant can be removed, and the projectile are separate units. Separated artillery ammunition is generally employed where the size, weight, or length of the complete round of ammunition would cause handling problems if it were of the fixed type and where no zone firing adjustments are required. Large caliber anti-aircraft guns, anti-tank and tank guns employ separated ammunition. A typical complete round of separated ammunition is illustrated in Figure 273.

Separate Loading Ammunition (Artillery Only). Separate loading ammunition is associated with large caliber guns where the weight of the projectile and propellant pose handling limitations. Separate loading ammunition usually employs several cloth bags to contain the required propellant charge. The propellant is placed in cloth bags to provide easier handling of the heavy charges required to propel large caliber projectiles to their targets. Separate loading ammunition is generally employed in weapons of 155mm and above in size. It is called separate loading ammunition because the projectile, propellant, and primer are handled and loaded as separate units. Figure 274 illustrates separate loading ammunition employed in the U.S. 175mm gun.

Projectiles

Regardless of what type of weapons system is employed to propel it to the target, the projectile that is launched is designed to perform a particular function or produce a particular effect. When

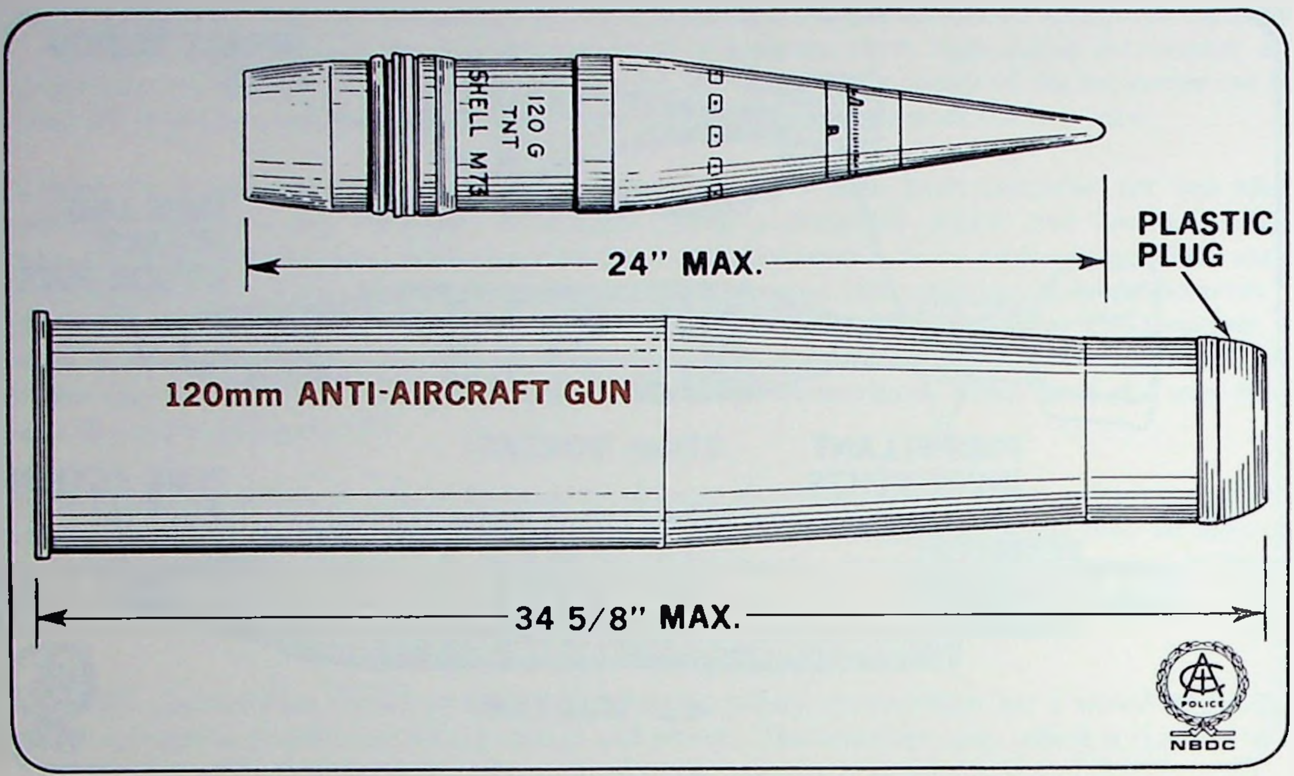


Figure 273
SEPARATED ARTILLERY AMMUNITION

these projectiles function, the vast majority will produce one of three basic actions. They will either *burst, eject,* or *pierce* the target. While these three basic functional categories certainly do not encompass every projectile manufactured, they do account for better than 95 percent of all those in use today and will form the basis for classification and identification in this manual. Those special projectile types not covered by the three basic action classifications will be described separately.

Bursting Action Projectiles. A bursting action projectile is defined as an artillery, mortar, or rocket projectile which, upon being functioned by its fuze, explodes in such a manner as to violently rupture the projectile body. Bursting action projectiles include those types listed in Figure 275.

High explosive (HE) projectiles probably make up better than 50 percent of all the projectiles employed by the military. Every artillery weapon or mortar and rocket system employs bursting HE-filled projectiles. When detonated, the high explosive fillers of the projectiles produce both fragmentation and blast to damage or destroy the target. Figure 276 illustrates the number and size of fragments produced by a typical high explosive-filled artillery projectile. Comparable fragmentation is produced by the detonation of mortar and rocket projectiles.

Because of the extremely large variety of sizes and shapes of HE projectiles, it is impossible to provide detailed recognition features for all of them. However, those employed by the U.S. military

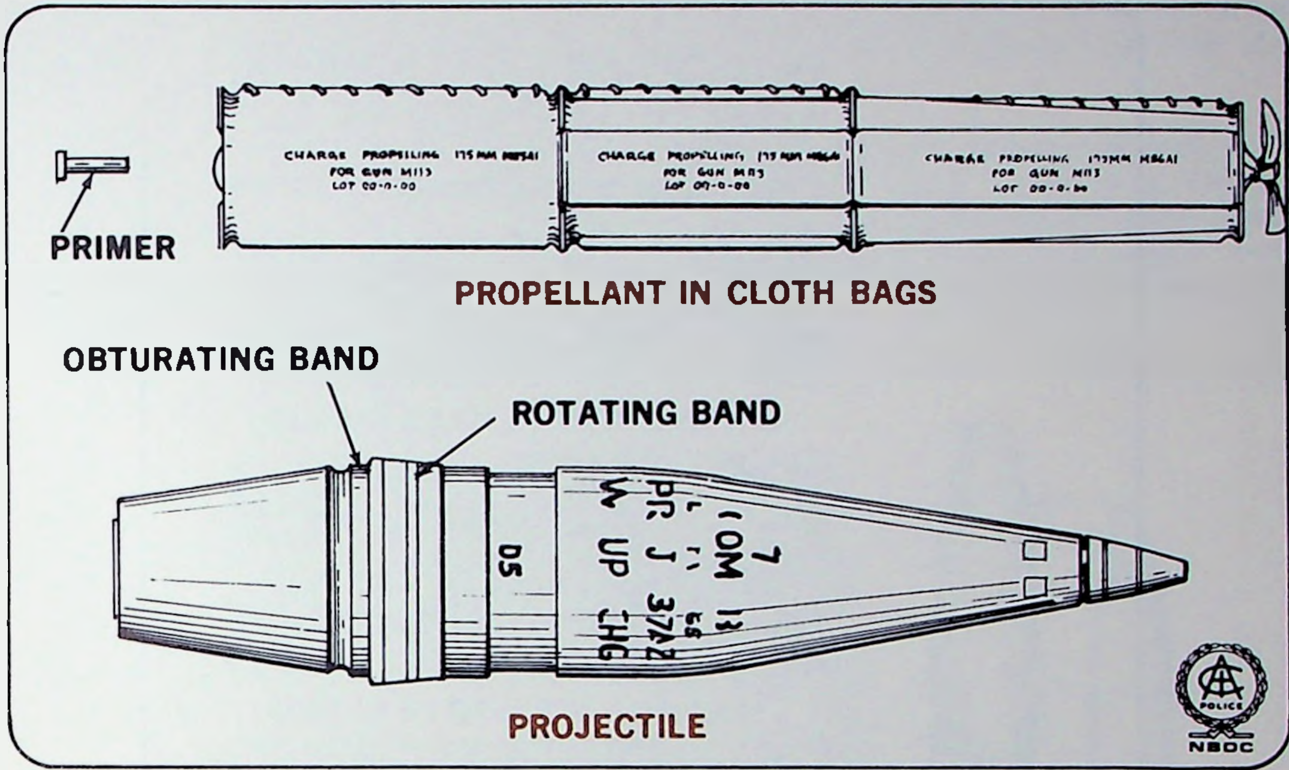


Figure 274
SEPARATE LOADING ARTILLERY AMMUNITION

ABBREVIATION	TYPE OF PROJECTILE
HE	High Explosive
HE-I	High Explosive-Incendiary (20mm)
HEAT	High Explosive Anti-Tank
APHE	Armor-Piercing High Explosive
HEP	Heat Explosive Plastic
SMOKE (WP)	White Phosphorous (WP)
CHEM. or GAS	War Gas (Lethal and Non-Lethal)

Figure 275
TYPES OF BURSTING ACTION PROJECTILES

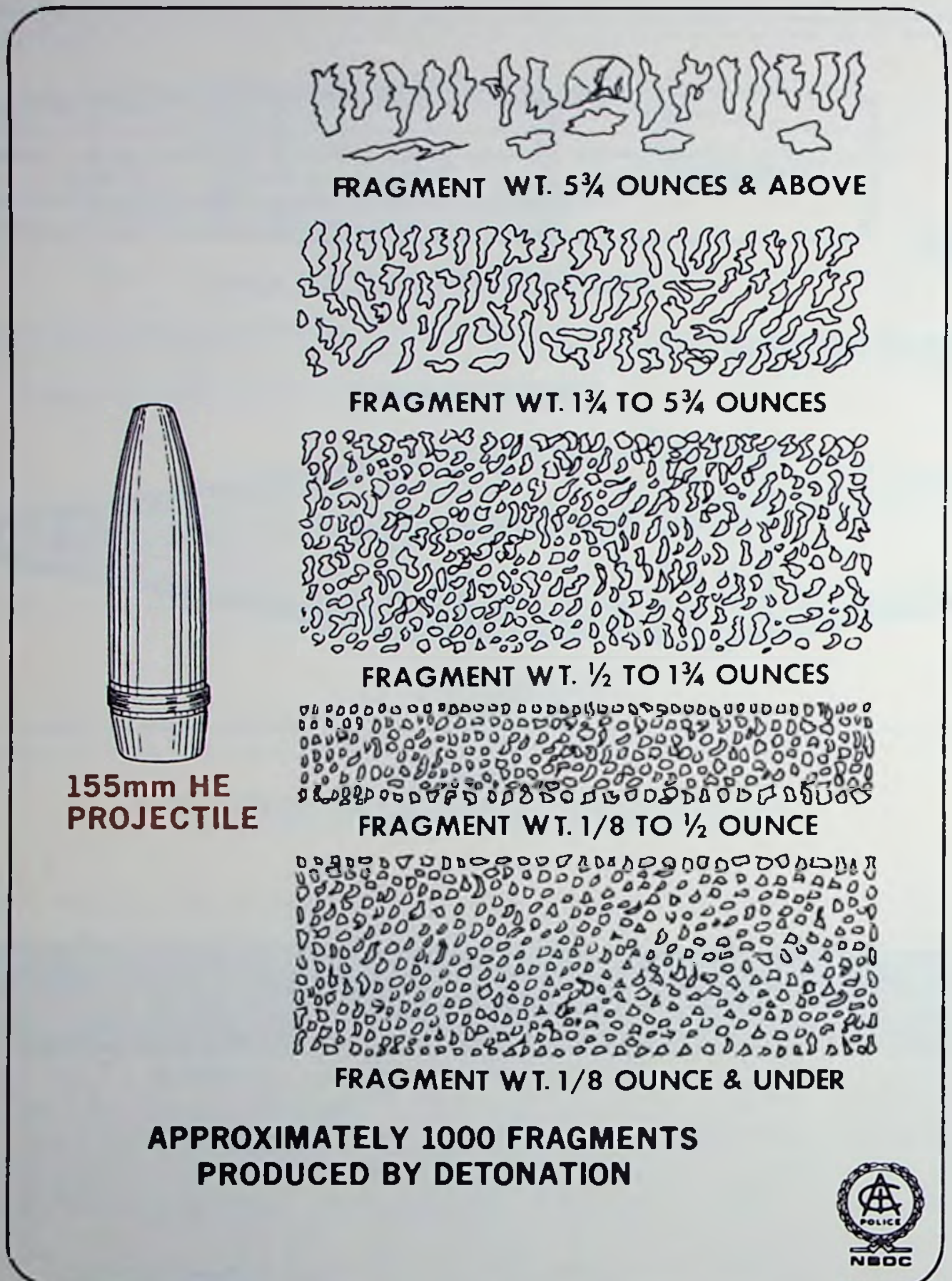


Figure 276
TYPICAL FRAGMENTATION PRODUCED BY HIGH EXPLOSIVE (HE)
ARTILLERY PROJECTILES

incorporate a system of color coding which, while not totally conclusive, is worthy of note. Additionally, U.S. military ordnance is almost always marked by stenciling on the body of the projectile, which also serves to indicate its type and size.

High explosive-filled projectiles which have been manufactured from World War II to the present are painted olive drab and have markings stenciled on the body in yellow paint. Those HE projectiles manufactured prior to World War II were generally painted bright yellow and had markings stenciled on the body in black paint. Complete color coding charts for artillery, mortar and rocket projectiles may be found in the recognition section on pages 301-304. Figure 277 illustrates a variety of U.S. military HE projectiles.

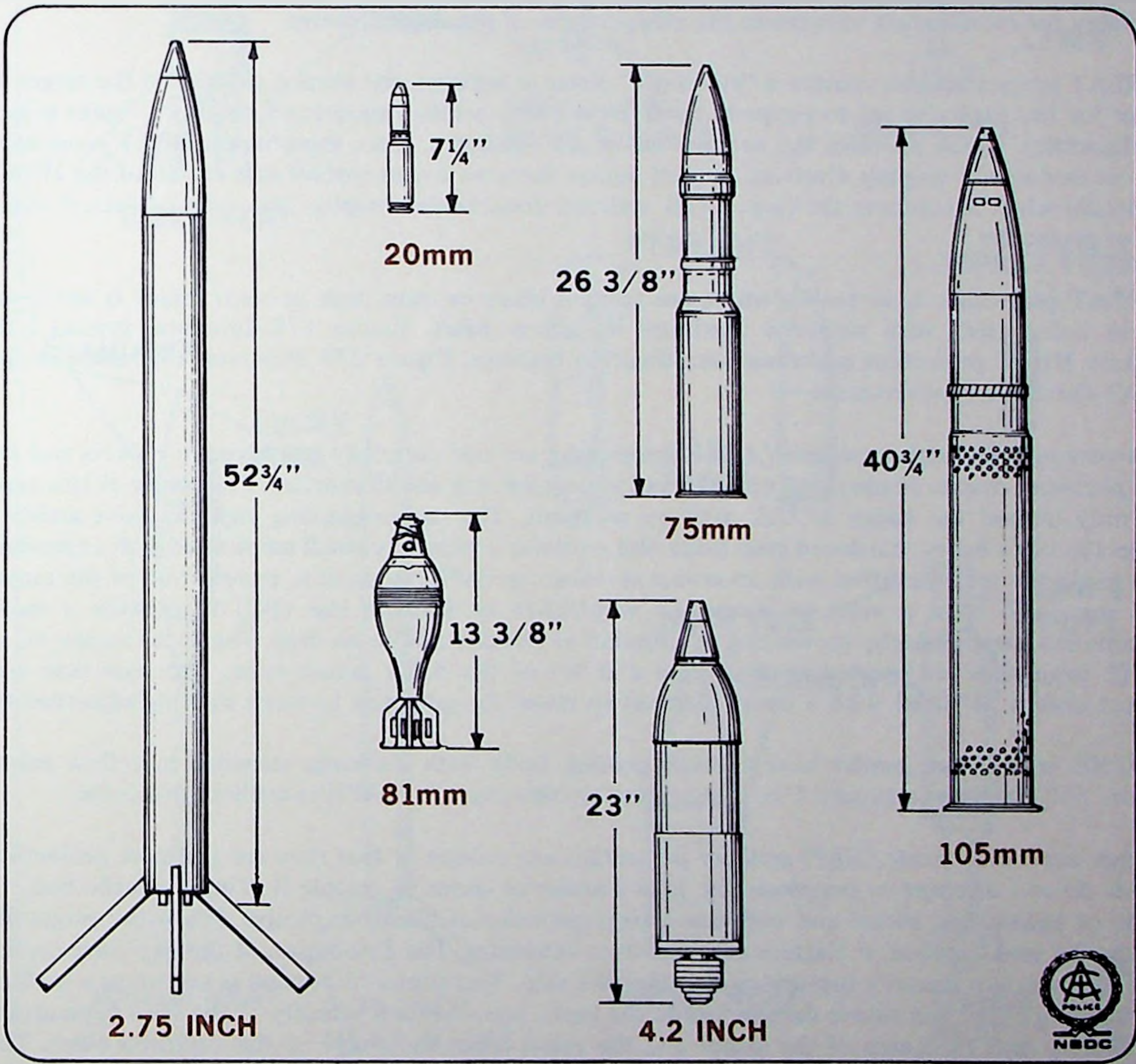


Figure 277
TYPICAL U.S. MILITARY HIGH EXPLOSIVE (HE) PROJECTILES

High explosive anti-tank projectiles (HEAT) are employed only in artillery and rocket weapons. Due to the low velocity and high trajectory of mortar projectiles, it is not practical to employ HEAT rounds in mortar weapon systems.

HEAT projectiles contain an explosive charge which is shaped to produce, upon detonation, a jet of super-heated gases which are directed against the target's armor, penetrating and destroying it. HEAT projectiles are, as their name indicates, primarily employed against armored vehicles or tanks. Artillery projectiles of the HEAT type in recent years have begun to convert from spin stabilization in flight to fin stabilization because it has been determined that rapid rotation tends to prevent complete and effective formation of the explosive jet upon detonation due to centrifugal force acting upon the jet particles. Thus, the majority of U.S. military HEAT projectiles now employ a fin assembly for stabilization to increase the effectiveness of the shaped charge.

HEAT projectiles also require a "stand off" distance between the shaped charge and the target in order for the explosive jet to properly form. Newer U.S. artillery projectiles employ a "spike nose" configuration which provides the proper "stand off" distance. Also, these newer HEAT projectiles almost exclusively employ electrical impact action fuzes to insure instant detonation of the HEAT projectile when it contacts the target. U.S. military rockets also employ this type of fuze in some newer projectiles.

HEAT projectiles have bodies which are painted black or olive drab in color, black is the most recent color used, with stenciled markings in yellow paint. Figure 278 illustrates typical U.S. military HEAT projectiles and their identification features. Figure 279 illustrates U.S. and Foreign HEAT (bazooka-type) rockets.

Armor-piercing high explosive (APHE) projectiles are not currently employed in rockets and are not practical, due to inadequate velocity and trajectory, for use in mortars. Projectiles of this type see only limited use today in U.S. artillery weapons. The armor-piercing high explosive artillery projectile has a heavy, hardened steel body and contains a relatively small amount of high explosive. The projectile may be fitted with an *armor-piercing cap* (APC) to assist in penetration of the target and may also have a steel or aluminum windshield or *ballistic cap* (BC) to provide a more streamlined shape, thereby preventing a reduction in velocity due to air drag. The fuzes employed in APHE projectiles are located in their base and are of the delay action type. The base fuze will almost always be fitted with a tracer element to allow the gun crew to make sighting adjustments.

APHE artillery projectiles have a black painted body with markings stenciled in yellow paint. Figure 280 illustrates a typical U.S. armor-piercing high explosive (APHE) artillery projectile.

High explosive plastic (HEP) artillery projectiles are unique in that they are anti-tank projectiles which *do not attempt to penetrate* the tank's armor in order to cripple it. The projectile body is made of lightweight metal and contains a large quantity of plastic explosive. When the projectile strikes the tank's armor, it flattens out and then detonates. The detonation of the explosive on the face of the armor causes a rupture on the opposite side. This ruptured portion is known as a *spall* or as a *spalling effect* and causes damage inside the tank. The mass and velocity of the spall depends on the quality and thickness of the armor and the mass, type, and shape of the explosive filler. The HEP projectile has not yet been fully developed and is currently a classified item. Figure 281 illustrates the functioning principle of high explosive plastic (HEP) artillery projectiles. HEP artillery projectiles are painted black with markings stenciled on in yellow paint.

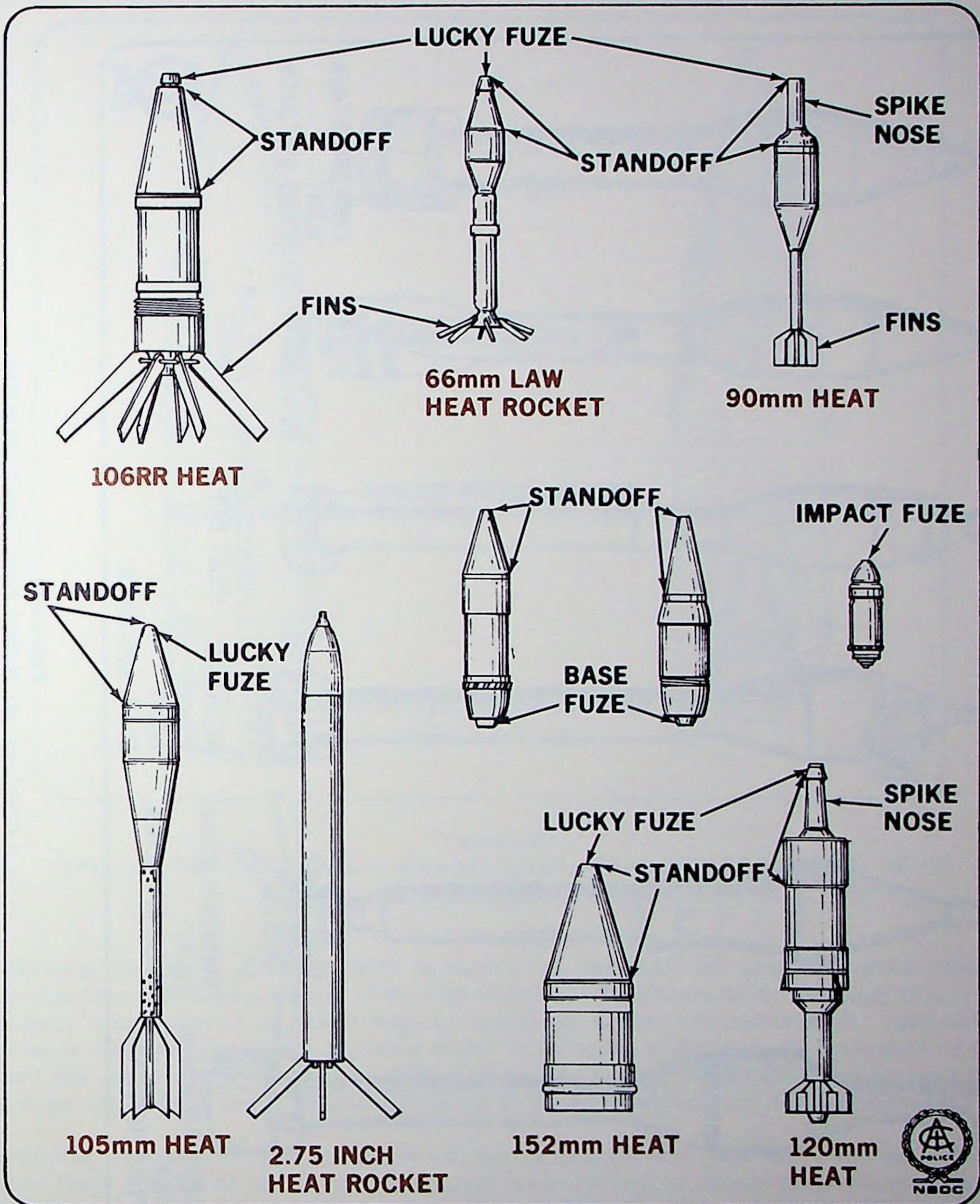


Figure 278
U.S. MILITARY HIGH EXPLOSIVE ANTI-TANK (HEAT) PROJECTILES

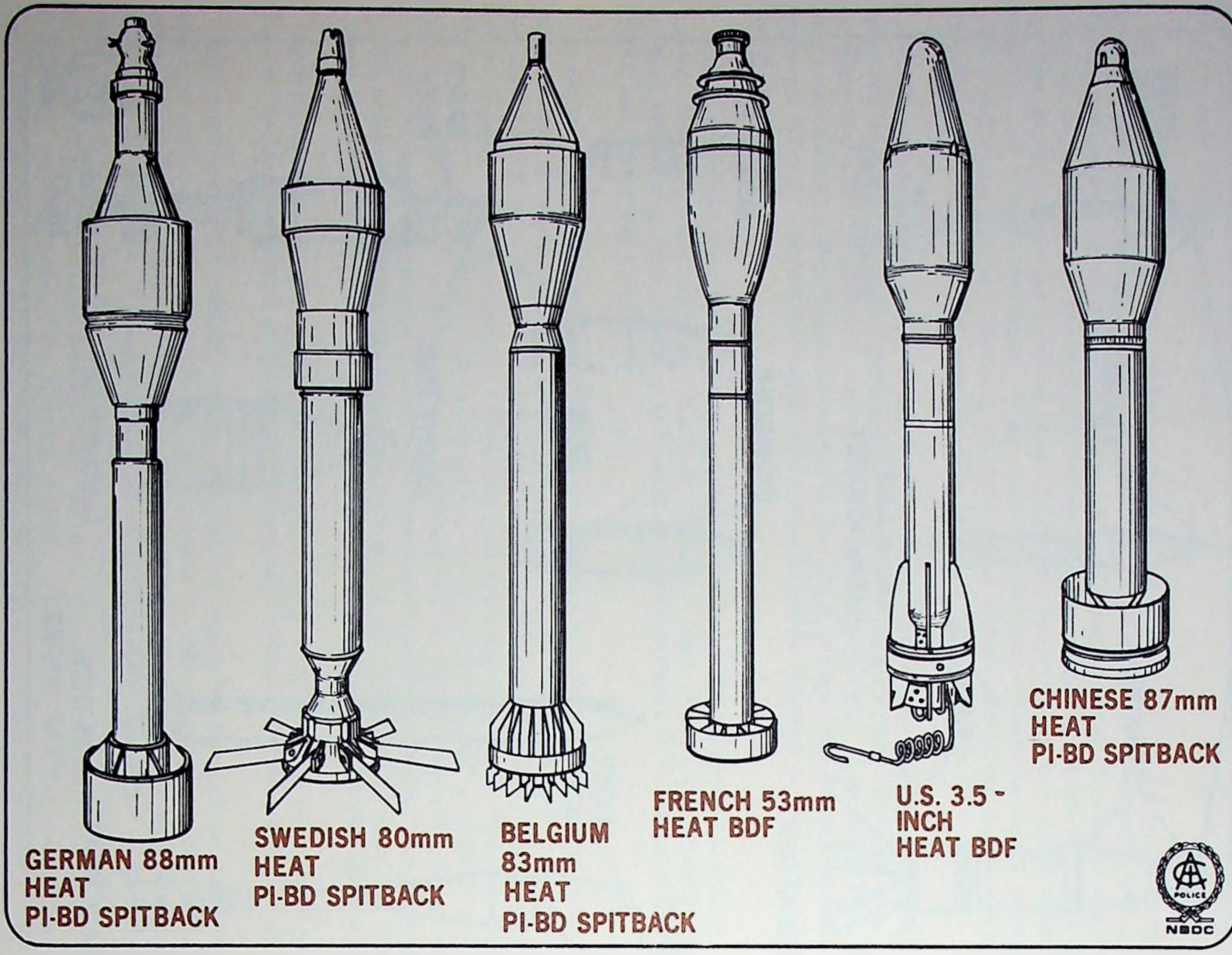


Figure 279
U.S. & FOREIGN (BAZOOKA-TYPE) HEAT ROCKETS

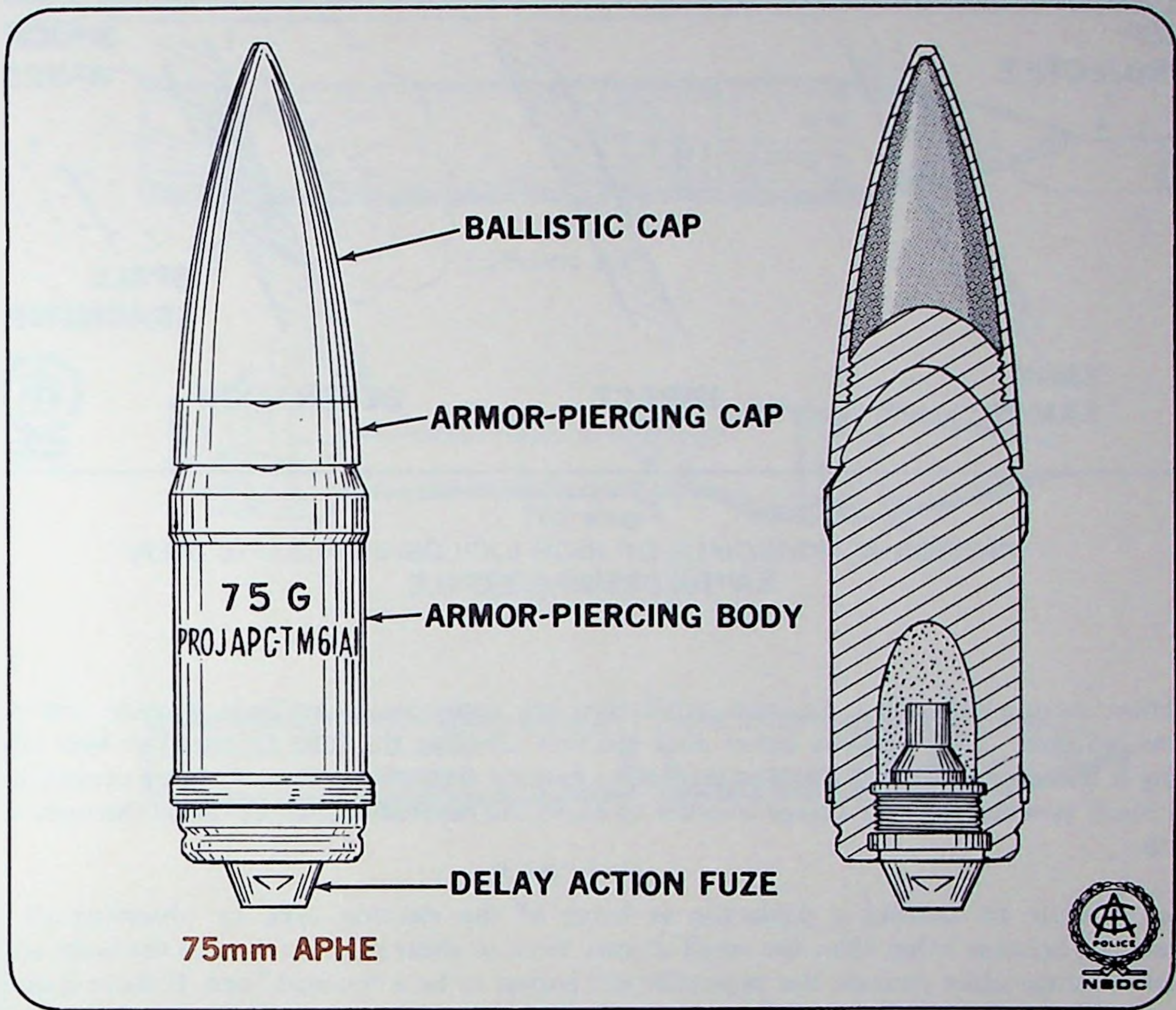


Figure 280
TYPICAL ARMOR-PIERCING HIGH EXPLOSIVE ARTILLERY PROJECTILE (APHE)

Bursting chemical and smoke (WP) projectiles are essentially HE projectiles which have a different filler. Although a portion of the high explosive filler remains in the projectile to rupture the body upon approach or impact with the target, the explosive is contained in a tube and is known as a *burster*. The burster is located in the center of the projectile body surrounded by the liquid war gas or white phosphorus (WP). Except for the color of the body and the stenciled markings, it is difficult to tell HE projectiles from those containing bursting chemicals and smoke.

Bursting chemical (war gas) projectiles will have a grey painted body with markings in red or green. There will also be one or two red or green bands present on the grey body. Bursting smoke (WP) projectiles will have a grey body color with one yellow band and markings in yellow *or* a light green body color with a yellow band and markings in light red. Typical U.S. military bursting chemical (war gas) and smoke (WP) projectiles with their markings are illustrated in Figures 282 and 283.

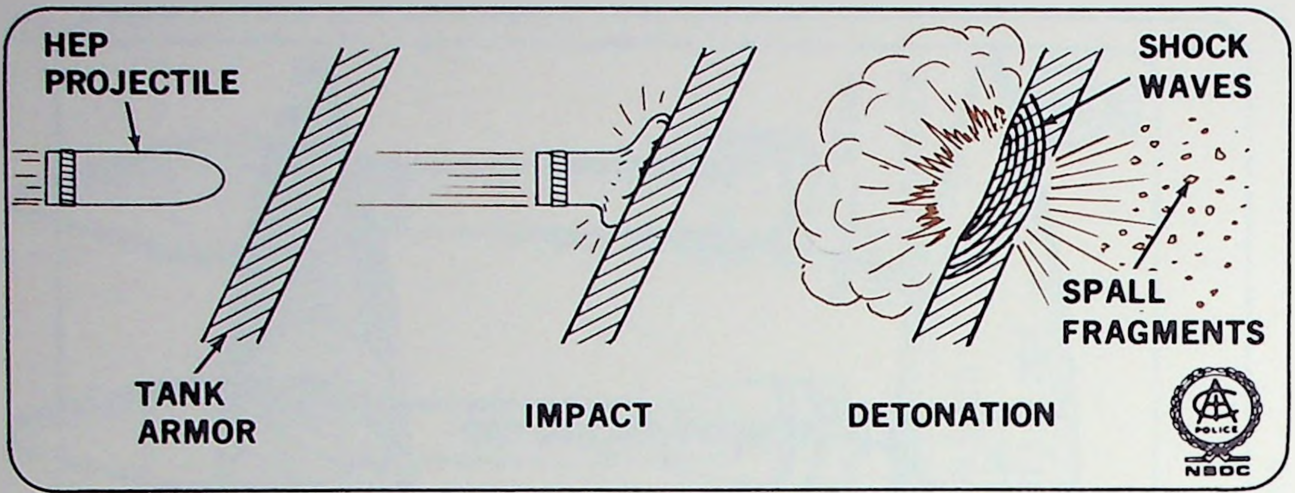


Figure 281
FUNCTIONING PRINCIPLE OF HIGH EXPLOSIVE PLASTIC (HEP)
ARTILLERY PROJECTILE

Ejection Action Projectiles. Ejection projectiles are common to artillery, mortar, and rocket weapons systems. They may be either nose ejection (ejecting the filler forward) or base ejection (ejecting it rearward in flight). Ejection projectiles employ time action fuzes working in conjunction with a black powder ejection charge in order to expel the payload contained inside the body of the projectile.

It is difficult to identify a projectile as being of the ejection type by observing its body construction, because other than the small copper twist or shear pins which hold the body sections together on some older rounds, the projectile will appear to be a "normal" one. If there is doubt as to the exact identification of the projectile, it should be, for the sake of safety, assumed to be high explosive filled. The various types of ejection projectiles are listed in Figure 284.

Ejection illuminating projectiles deploy a parachute-suspended, illumination flare which is intended to provide battlefield illumination. They are employed in artillery, mortar, and rocket projectiles. Artillery and mortar projectiles generally utilize a base ejection system in illumination rounds, while rockets are limited to forward ejection because of the rocket motor located to the rear of the projectile.

Leaflet ejection projectiles, used to disseminate such materials as propaganda leaflets and surrender passes, are generally fired from artillery and mortar projectiles to base eject high above the target area so that their payload is dispersed over a large area.

Chaff ejection, sometimes called "window," consists of small pieces of aluminum foil which are normally ejected from an artillery or rocket projectile to create a cloud of radar-reflecting material between the enemy and the target. By suspending the chaff in the air, the enemy radar cannot "see" what is happening beyond the highly reflective material, thus decreasing the effectiveness of radar-controlled guns and guided missiles.

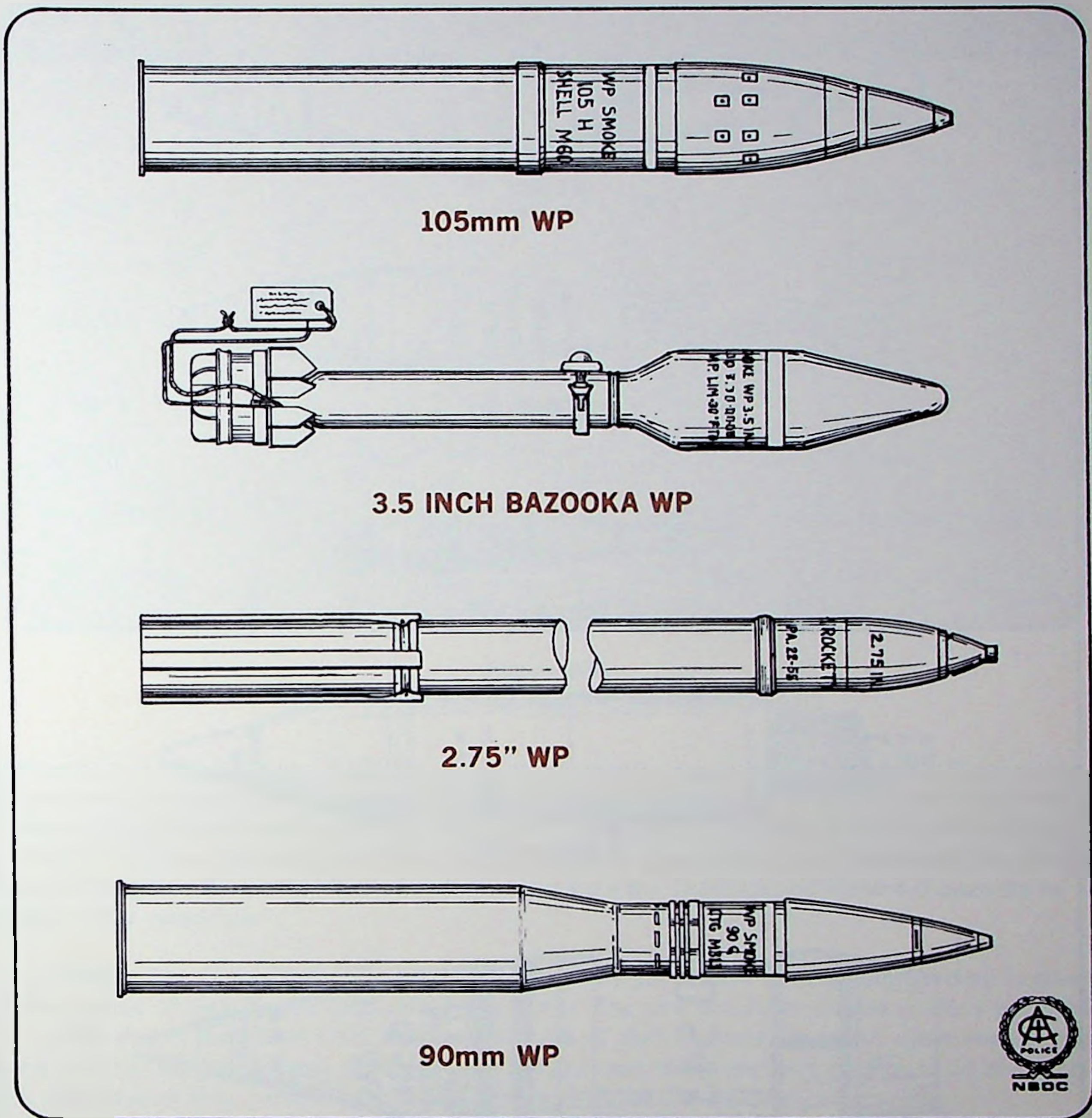
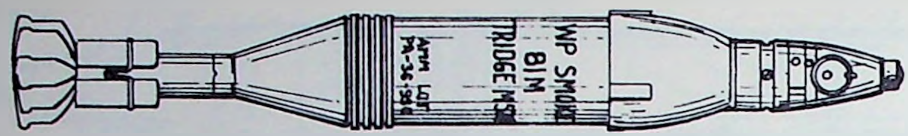
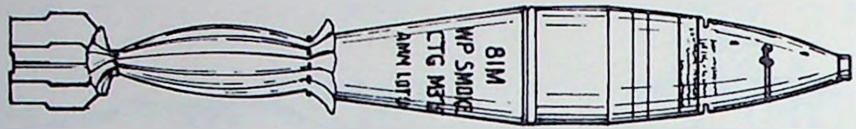


Figure 282
TYPICAL U.S. MILITARY SMOKE (WP) PROJECTILES

Chemical and smoke ejection canisters of tactically employed burning tear gas (CS) or war gas are used as the payload in artillery and mortar projectiles. These canisters are both ejected and ignited by the functioning of the ejection charge and fall to earth over the battlefield area. Canisters employing burning smoke (HC), which is used for screening purposes, function in the same manner.

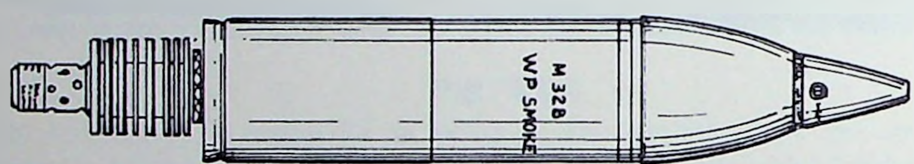


81mm WP

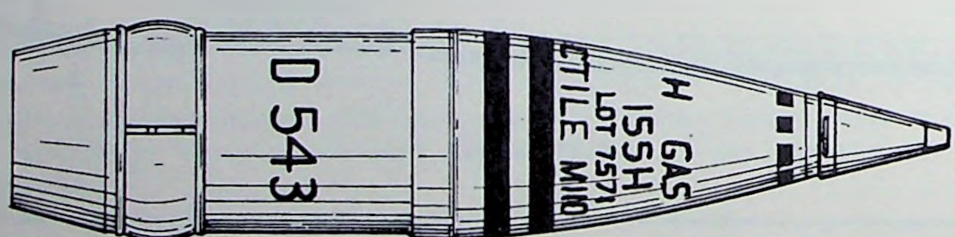


81mm WP

60mm WP



4.2mm WP



155mm GAS

Figure 283
TYPICAL U.S. MILITARY BURSTING CHEMICAL (WAR GAS) AND SMOKE (WP) PROJECTILES

ABBREVIATION	TYPE OF PROJECTILE
ILLUM	Illuminating
LEAF BE	Leaflet, Base Ejection
CHAFF or W	Chaff or Window (Anti-Radar)
CHEM or Gas	War Gas (lethal and non-lethal)
CS TAC	Tactical CS (Tear Gas)
SHRAP or SPNL	Shrapnel
APERS	Anti-Personnel (Fletchettes)
HC SMOKE BE	HC Smoke (Cannister) Base Ejection
HE APERS	High Explosive Anti-Personnel (Sub-Bomblets)

Figure 284
TYPES OF EJECTION ACTION PROJECTILES

Shrapnel and anti-personnel (APERS) ejection projectiles employed in World War II consisted of steel projectile bodies containing large ball bearings and nose fuzes. An ejection charge was located in the base of the projectile body and was connected to the time action nose fuze. When the projectile was fired, it traveled toward the enemy troops until the time action fuze functioned the ejection charge, causing the shrapnel balls to be ejected in a forward direction and dispersed laterally by the spinning of the projectile.

Since World War II this type of nose ejection artillery projectile has been improved by loading it with thousands of tiny finned nails called *fletchettes.* The new fletchette-loaded artillery projectiles were renamed anti-personnel (APERS) and because of their devastating effect upon enemy troop concentrations, they were also developed for rockets and for a specially employed 81mm mortar which was used on river patrol boats in Viet Nam as a direct fire weapon.

Figure 285 illustrates typical U.S. APERS projectiles and their functioning. APERS projectiles have an olive drab body with markings in white paint. A band of white diamonds is stenciled around the body to indicate that the ejection projectile is an APERS type, containing fletchettes.

High explosive anti-personnel (HE APERS) ejection projectiles are *not* fletchettes, they are small bomblets or sub-projectiles carried to the target area by artillery, mortar, and large rocket (unguided missiles) projectiles and ejected over a wide target area, causing many small, high explosive fragmentation detonations. These individual bomblets or sub-projectiles are covered in Section III of this manual.

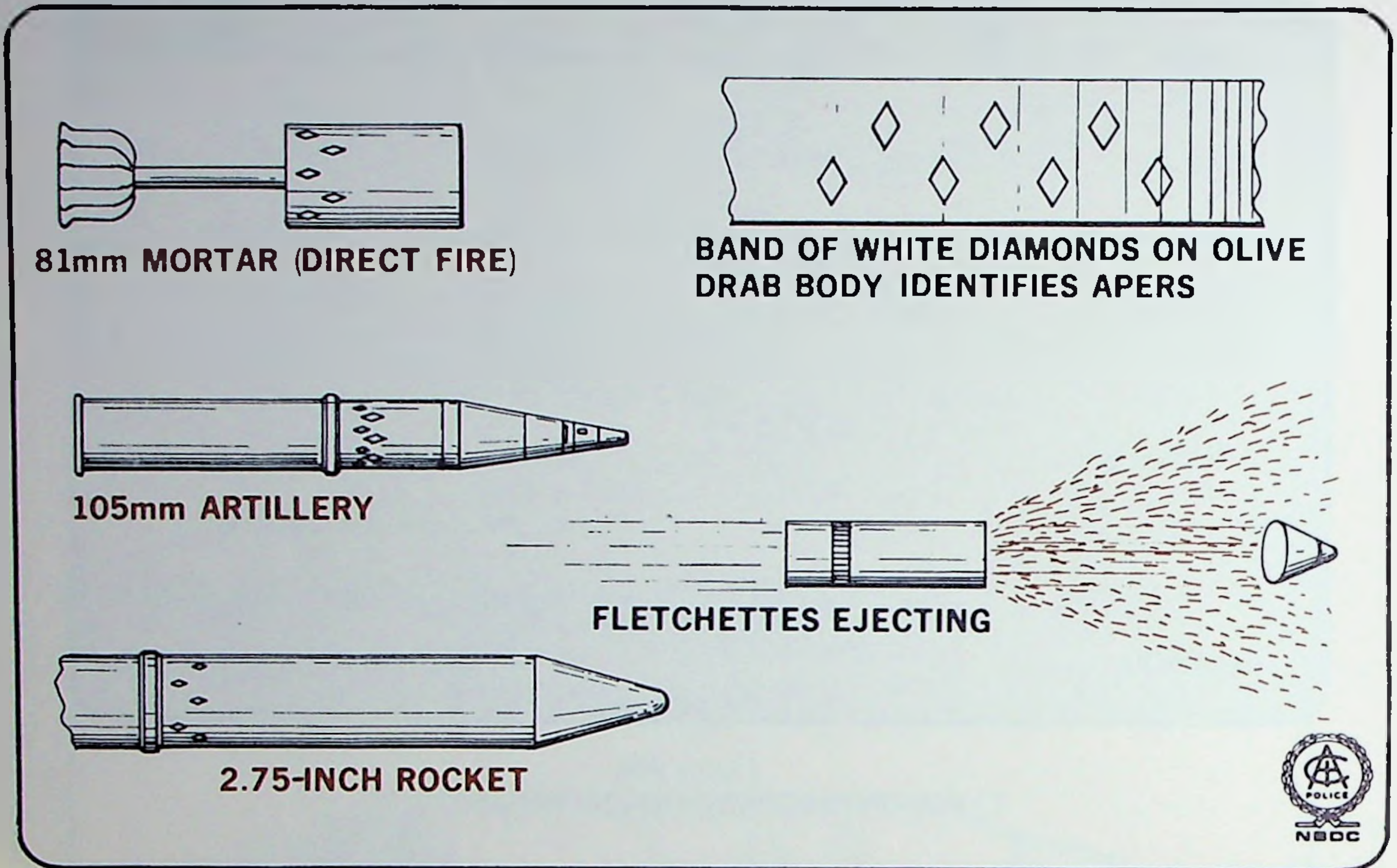


Figure 285
TYPICAL U.S. MILITARY ANTI-PERSONNEL (APERS) PROJECTILES

Projectiles carrying HE APERS bomblets are generally painted an olive drab color with markings stenciled on the body in yellow paint. A band of white diamonds around the body of the projectile in conjunction with a yellow band indicates that the payload is high explosive anti-personnel bomblets or sub-projectiles.

Piercing Action Projectiles. Piercing action projectiles are primarily artillery projectiles employed against armor. The U.S. military no longer uses piercing action rockets against ground and sea targets and mortar projectiles are not suited for piercing functions because of low velocity and high trajectory. The various types of piercing projectiles are listed in Figure 286.

Older types of armor-piercing (AP) artillery projectiles were simply heavy, solid steel slugs fired at the highest velocity possible, so as to penetrate the enemy (ship or tank) armor. When the "face hardening" of armor became a common practice (the armor was made super-hard on the outside face), an *armor-piercing cap* (APC) projectile came into use. The armor-piercing cap helped to defeat face-hardened armor by "cracking" it and allowing the heavy slug to penetrate the target. Because the armor-piercing cap was rounded and blunt, a ballistic cap (BC) or windshield was added to the projectile to make it more streamlined and reduce air drag, as illustrated in Figure 287.

ABBREVIATION	TYPE OF PROJECTILE
AP	Armor-Piercing
APC	Armor-Piercing, Capped
APC BC	Armor-Piercing, Capped/Ballistic Cap
HVAP	Hypervelocity Armor-Piercing
HVAP-DS	Hypervelocity Armor-Piercing-Discarding Sabot
HVAP-DS-FS	Hypervelocity Armor-Piercing-Discarding Sabot-Fin-Stabilized

Figure 286
TYPES OF PIERCING ACTION PROJECTILES

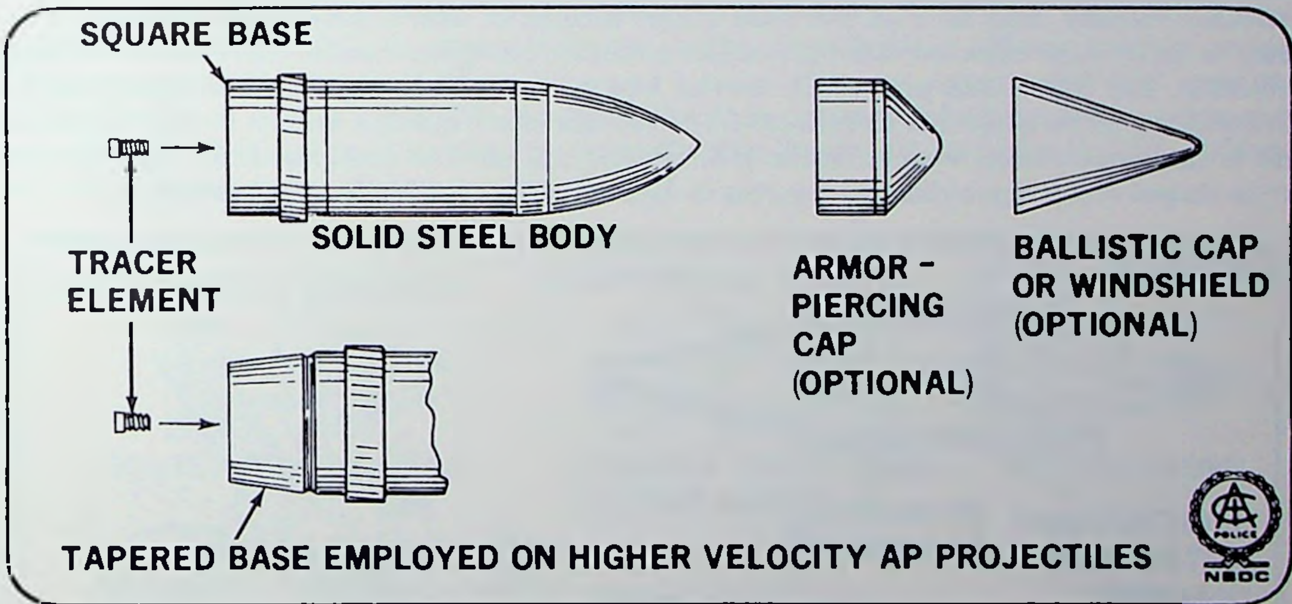


Figure 287
COMPONENT PARTS OF AN ARMOR-PIERCING (AP) ARTILLERY PROJECTILE

As tank armor became thicker, projectile design became lighter so that the initial velocity could be raised to a point where a smaller and extra hard slug of tungsten carbide carried inside the lightweight metal body of the projectile (carrier or sabot) would be able to penetrate the armor. The reduction in total weight of the projectile allows the propellant to impart a higher velocity without causing the gun tube to burst. This type of projectile is known as a hypervelocity armor-piercing (HVAP) projectile and has a velocity of about 3,500 feet per second (fps). Figure 288 illustrates a HVAP projectile and its functioning.

Further increases in velocity are made possible by discarding the carrier or sabot (projectile body) shortly after the projectile leaves the gun tube, thereby reducing air drag as the slug travels to the target. For example, discarding the sabot, a 3-inch gun can use its propellant force to drive a 1-inch projectile at hypervelocity. The hypervelocity armor-piercing discarding sabot (HVAP-DS) projectile traveling at about 4,800 fps is extremely effective against armor and is popular with anti-tank gun crews because of its killing ability. Figure 289 illustrates a HVAP-DS projectile and its functioning.

Other Velocity Increasing Systems. Other systems for increasing velocity incorporate the same basic principles previously illustrated. The German taper bore projectile employed two metal skirts on the projectile body. When the projectile was fired, these were squeezed down to reduce its total diameter in a tapered and smooth portion of the barrel at the muzzle and increase projectile velocity while reducing air drag. In the Soviet Arrowhead projectile, so called because of its shape, a large section of unnecessary metal has been removed from its body to reduce its weight and allow an increase in velocity. The HVAP-DS-FS (Arrow projectile) functions as any other HVAP-DS round except that additional stability is provided in flight through the use of fins (FS, fin-stabilized) instead of relying on spin alone. Figure 290 illustrates these armor-piercing projectiles.

Increased Range Projectiles. All of the HVAP and HVAP-DS projectiles will, because of their increased velocity, also have an increased range. Because of this, it has become practical in some cases to create high explosive-filled-projectiles patterned along the lines of the HVAP-DS-FS Arrow projectile. The U.S. 8-inch gun, which fires an 8-inch hypervelocity high explosive discarding sabot fin-stabilized arrow projectile (HVHE-DS-FS) to ranges of 41 miles, is known as the "Gunfighter" and is the longest range weapon in the U.S. artillery arsenal. The projectile fired from this gun is arrow-shaped and is approximately 3 inches in diameter after its sabot has been discarded.

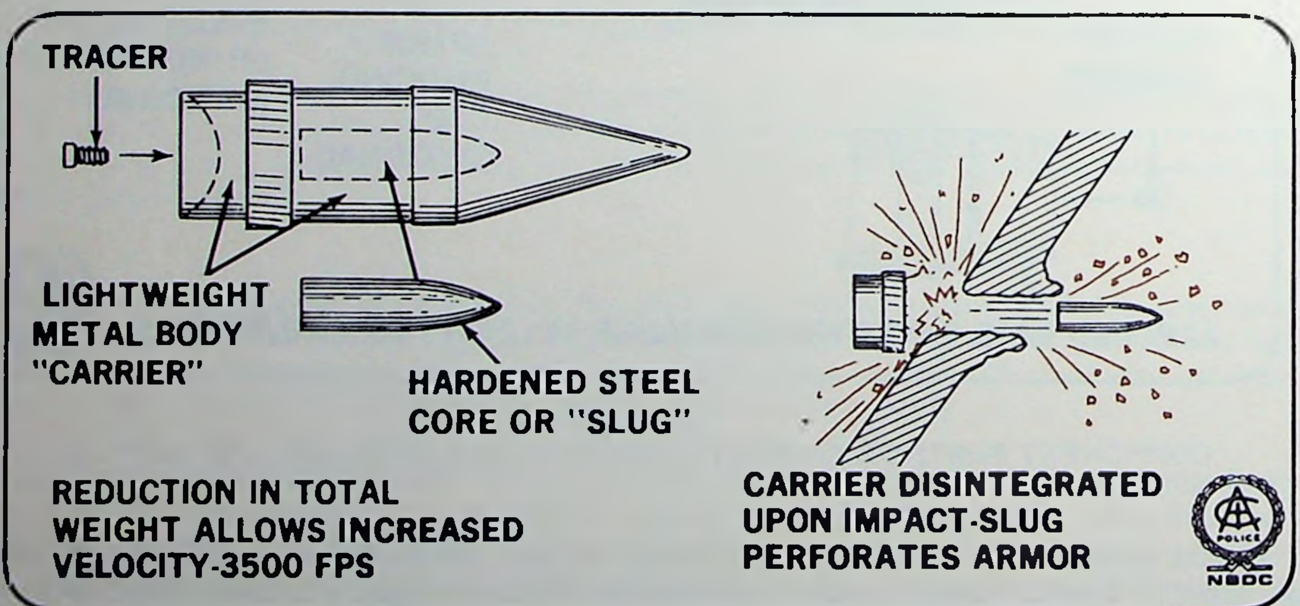


Figure 288
HYPERVELOCITY ARMOR-PIERCING PROJECTILE (HVAP)

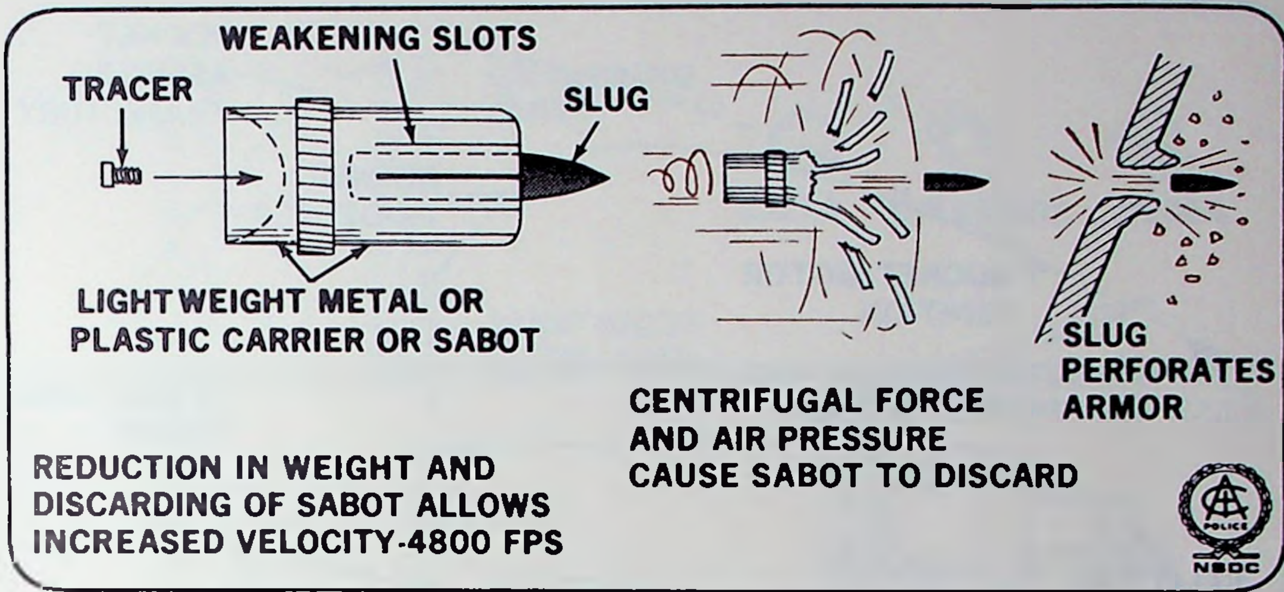


Figure 289

HYPERVELOCITY ARMOR-PIERCING DISCARDING SABOT PROJECTILE (HVAP-DS)

Rocket-Assisted Range Increase. Another system of increasing the range of projectiles is used by the French in a spin-stabilized mortar projectile and by the U.S. in the 105mm howitzer projectile. As the name implies, this projectile incorporates a rocket motor to impart additional range to the projectile after it is fired from the gun tube. The U.S. round is a high explosive rocket-assisted projectile (HE RA) and has proved to be quite effective. Figure 291 illustrates the U.S. 105mm HE RA projectile and its functioning.

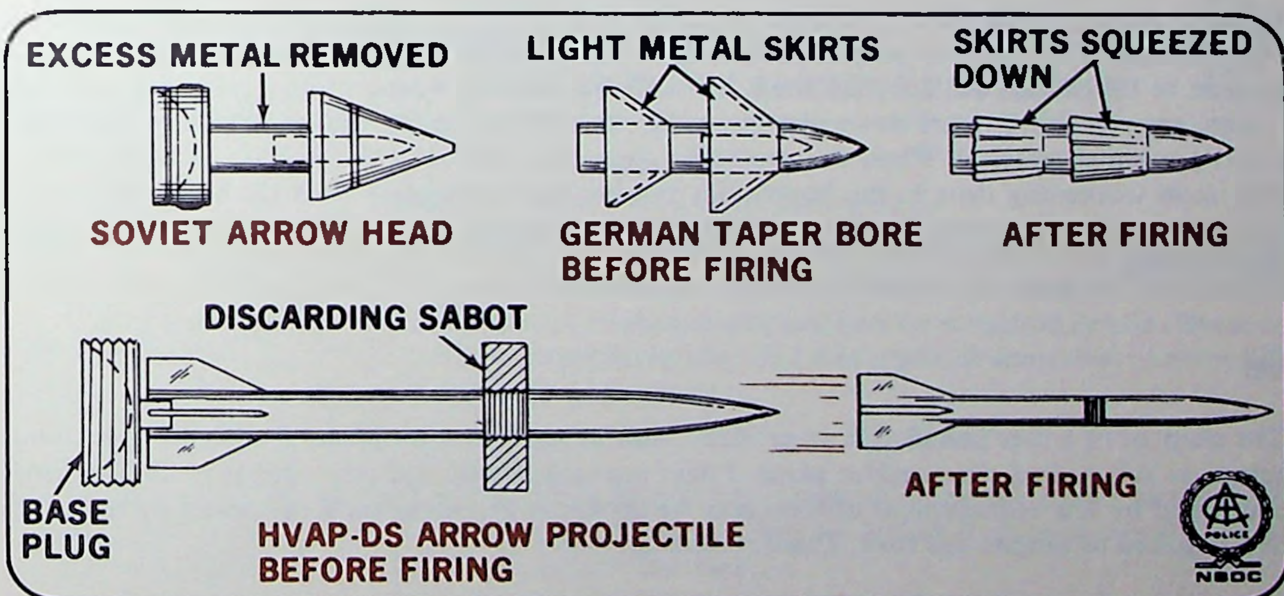


Figure 290

OTHER METHODS OF INCREASING VELOCITY OF AP PROJECTILES BY SIZE (SUBCALIBER) OR WEIGHT REDUCTION

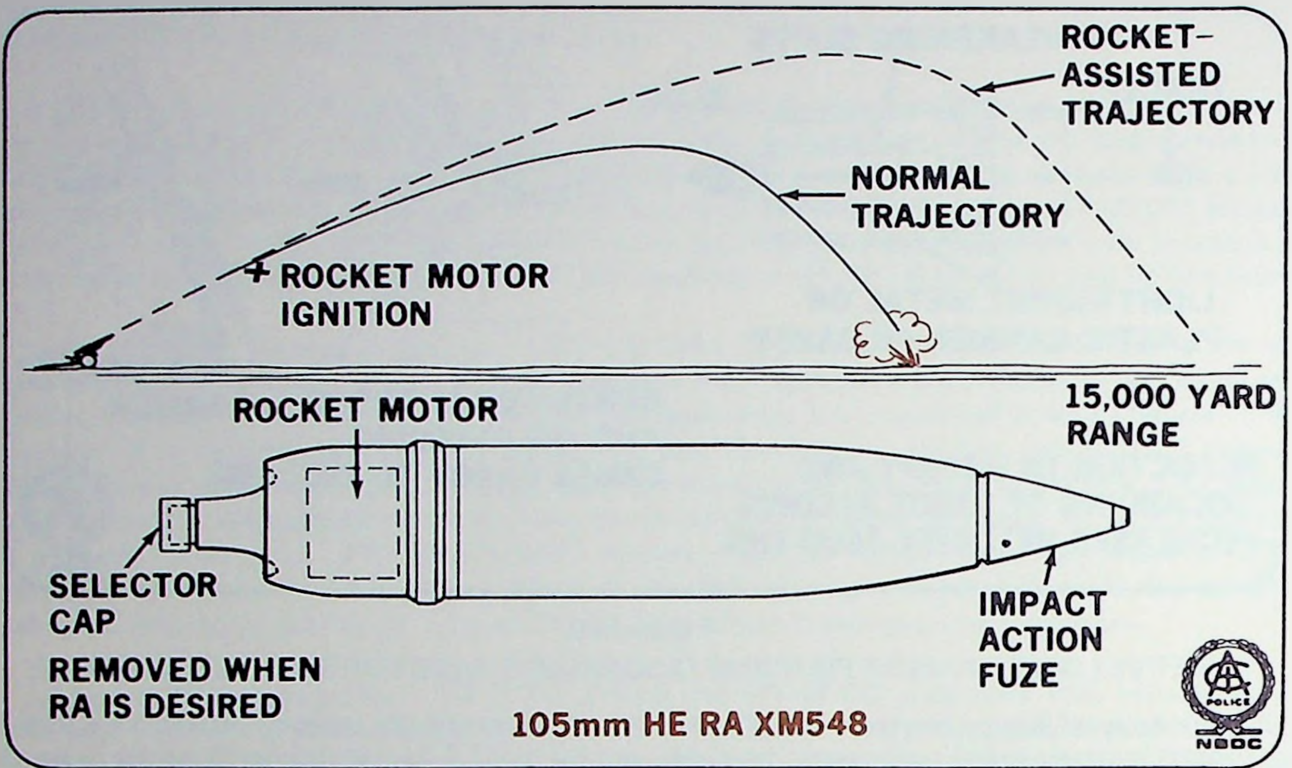


Figure 291
U.S. MILITARY 105MM HOWITZER HIGH EXPLOSIVE ROCKET-ASSISTED PROJECTILE (HE RA)

Canister Action Projectiles. A canister projectile is intended for direct fire use against personnel at close range. The canister projectile is a light sheet metal can filled with steel balls, cubes, cylinders, or fletchettes which, when fired, converts the artillery weapon into a giant shotgun. When the canister projectile is fired down the gun tube, the rifling imparts spin to the tin can containing the anti-personnel material. When the projectile clears the muzzle of the weapon, centrifugal force, acting upon weakening slots in the body, plus muzzle blast, tear away the light body and blow the fragments toward the enemy. Figure 292 illustrates the canister projectile, its fragment material and its functioning.

Fuzes

The purpose of a fuze installed in an artillery, mortar, or rocket projectile is to cause the round to function at the desired time and/or place. Fuzes associated with military ordnance items normally encountered by law enforcement officers may be broken into four general categories by the type of action required to initiate the fuze. These actions include:

- Impact Action
- Delay Action
- Time Action
- Proximity Action

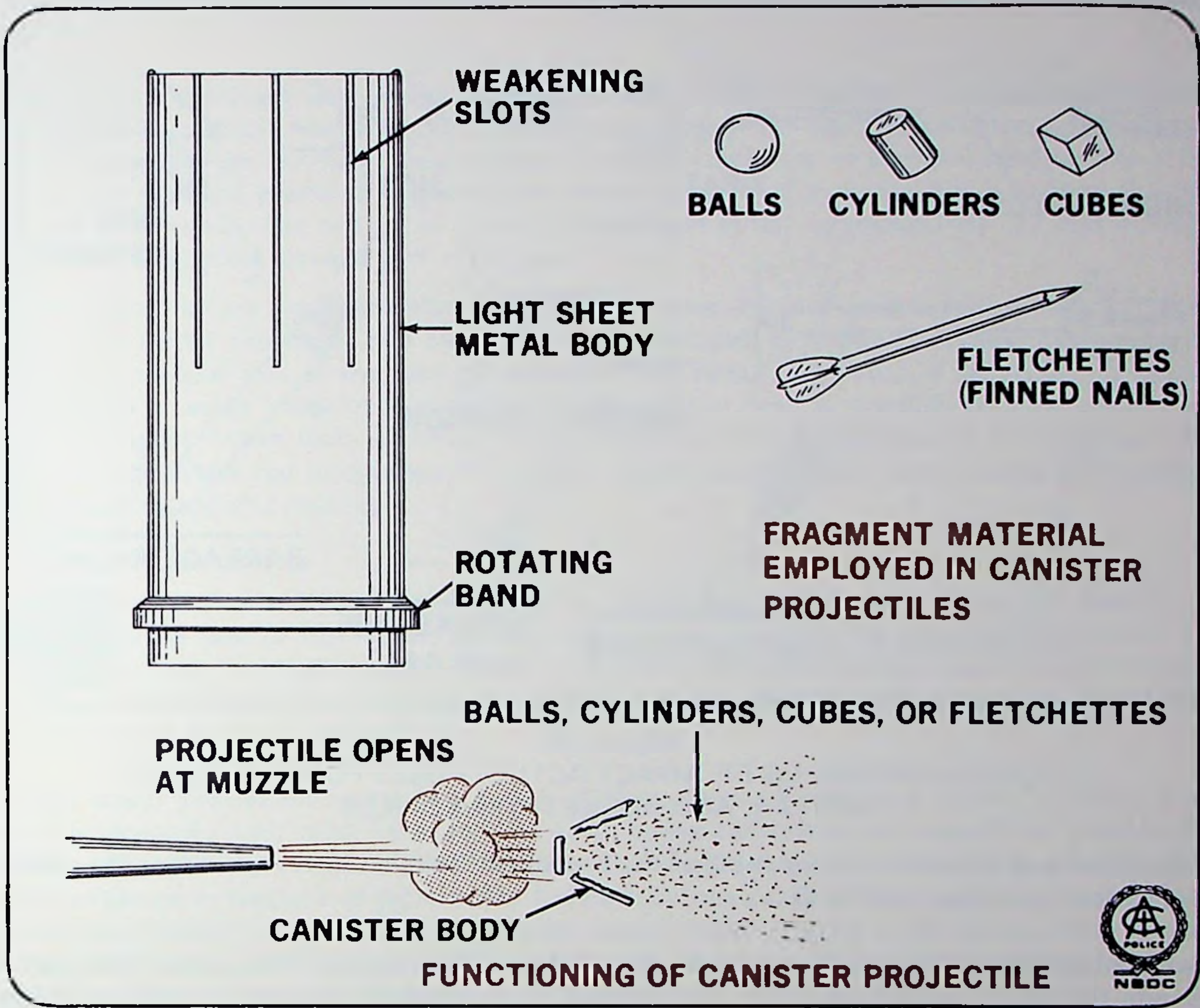


Figure 292
CANISTER ARTILLERY PROJECTILE

This system of fuze recognition is not by any means a perfect system, but it has been developed for the purpose of this manual because it allows maximum recognition coverage without requiring exact and detailed analysis of specific military employment and fuze construction details. The serious student of military fuze construction or engineering may find this approach somewhat oversimplified and direct, but accuracy has not been sacrificed in any case.

Impact Action Fuzes. Impact action fuzes, as the name implies, cause the round to which they are assembled to function upon impact with the target. Impact action fuzes make up the majority of fuzes employed by the military in all of their munitions.

Figure 293 illustrates typical employment and functioning of a variety of impact action fuzes. The impact action fuze may also be incorporated *as a portion of another type of action fuze* to

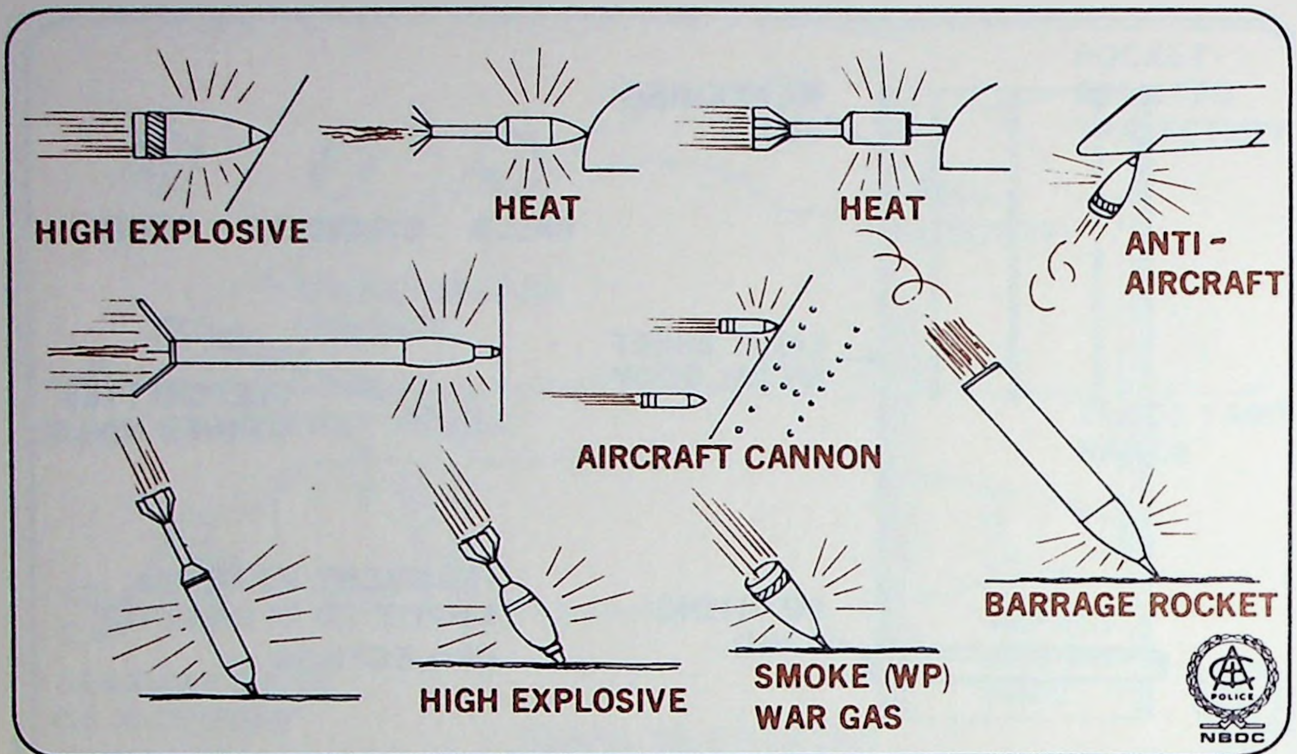


Figure 293
TYPICAL FUNCTIONING OF IMPACT ACTION FUZES FOR ARTILLERY, MORTAR, AND ROCKET PROJECTILES

provide a back-up system which insures that the round will function in the event that the primary action (delay, time, proximity) fails.

Some impact action fuzes will also possess pyrotechnic delay elements which allow the round to penetrate the target before functioning and others are equipped with mechanical or Piezo electric crystal mechanisms which insures that the round will function within the first instant of contact with its target.

Impact action fuzes employed in 20mm aircraft cannon projectiles, for example, are designated as "supersensitive" and will cause functioning of the high velocity projectile should it contact even the thin aluminum skin of an aircraft. In reality, these fuzes are no more sensitive than the impact action fuze in a mortar projectile which functions when it simply falls to earth. Fuze sensitivity is a relative thing, determined by velocity, mass, target material, angle of impact, and design but these matters have little to do with recognition of a fuze by type of functioning action.

Almost all impact action fuzes display one or two features which enable them to be correctly identified. Impact action fuzes will, in the vast majority of cases, have as their most forward part a *closing disc* or a *protruding plunger* which is directly attached to the striker. The closing disc is nothing more than a thin sheet of copper, brass, aluminum, or occasionally plastic about the thickness of this sheet of paper, which covers the striker located directly beneath it. Impact action with the target causes the disc and the striker to be driven inward, functioning the fuze. This, of course, happens at the instant of impact since target impact occurs first at the most forward portion of the fuze.

The protruding plunger is in reality the striker itself, extended beyond the configuration of the fuze body to a position where it will be the first portion of the fuze to strike the target. Impact action fuze bodies are normally constructed of metal (aluminum or stamped steel) and in a few instances are made of plastic or a material similar to bakelite. If a closing disc is employed in the fuze, it is more often than not set in a brass or aluminum section approximately 1/2 inch in length and located at the most forward part of the fuze.

Those impact action fuzes which are electrical in nature (Piezo electric crystal or "Lucky" fuzes employed in HEAT projectiles and rockets) are more difficult to recognize because the fuze bodies are often an integral part of the forward portion of the round. In general, if the artillery projectile or rocket has a "spike" nose or a metal cap on the point or nose, it probably employs an electrical ("Lucky") impact action fuze. Electrical impact fuzes are not employed with mortar projectiles. Figure 294 illustrates the recognition features of typical impact action fuzes employed in artillery projectiles, mortars, and rockets.

Delay Action Fuzes. Delay action fuzes in artillery projectiles and direct fire rockets are positioned in the base of the round. Because they are not located in the nose or point, they do not make initial contact with the target. Delay action fuzes generally work on an inertia principle with the striker continuing to move forward at the flight velocity when the round strikes the target. Base fuzes are extremely rare in mortars.

Fuzes which depend on inertia as a means of firing do not function as quickly as impact fuzes since the projectile itself must begin to slow down before the striker can move. Thus, it can be said that there is an inherent mechanical delay generally associated with their functioning which allows the projectile some measure of penetration before it detonates. The delay, and hence the projectile penetration, is often further increased by allowing the striker to ignite a pyrotechnic delay element upon target impact. The delay element burns as the projectile penetrates deeper and deeper and eventually detonates the round well within the target.

Delay action fuzes may also be employed to provide a form of air burst by ricochetting them from the ground into the air, where they detonate above the target. Some delay action base fuzes are constructed so that very little penetration of the target occurs. In the case of the 3.5-inch bazooka, anti-tank rocket (HEAT), the base fuze will cause detonation of the rocket almost at the instant of impact with the target. If such an impact were observed on high speed film, it could be seen that only 1 inch of the heavy sheet metal nose of the rocket is crushed before the delay action base fuze causes the detonation of the shaped charge rocket head. Although the delay action base fuze provides an extremely short delay in this case, there will still be a delay of some sort because the fuze is located in the base of the rocket and must therefore function through inertia. Typical delay action fuze functioning is illustrated in Figure 295.

Because delay action fuzes are located in the center of the base of artillery projectiles, they frequently have a tracer element incorporated into their fuze bodies. The purpose of a tracer element is to allow the gun crew of a direct fire weapon to observe the path of the shell in flight so that aiming corrections can be made if necessary before the weapon is fired again. Some anti-aircraft

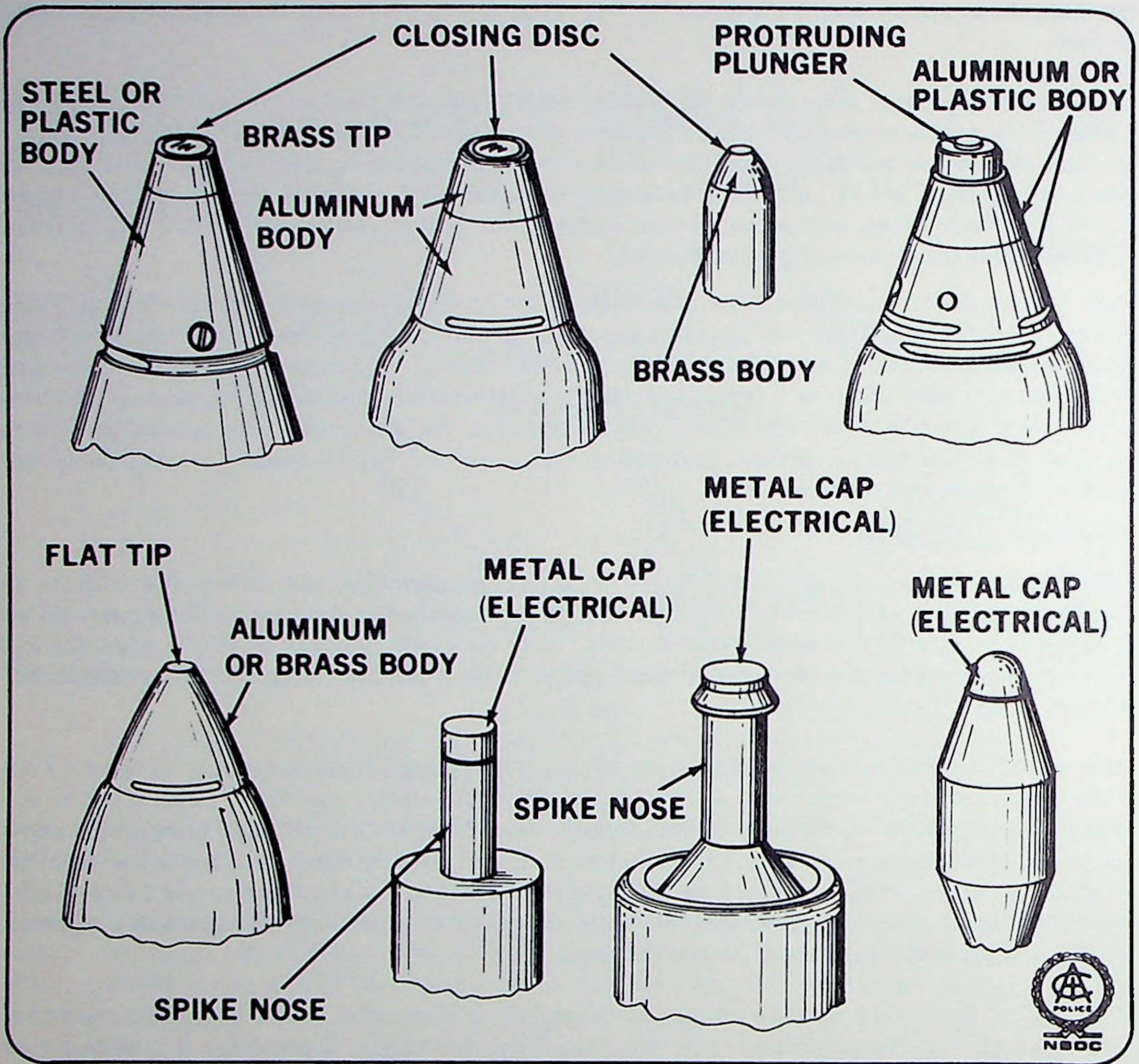


Figure 294
RECOGNITION FEATURES OF IMPACT ACTION FUZES EMPLOYED IN ARTILLERY, MORTAR, AND ROCKET PROJECTILES

projectiles employ a very bright tracer ("headlight" tracer) not only for purposes of adjusting their fire, but as an additional psychological weapon directed against the pilots of aircraft. The pilot who looks down and can see what he knows is an artillery projectile brightly burning its way up toward his aircraft is likely to be less than enthusiastic about continuing a straight and level bombing run and making himself an easier target for the anti-aircraft gun crew.

Tracer elements are usually located in the base fuze body simply as a matter of convenience, but in a few cases the tracer element is directly connected to the base fuze's internal parts and acts as a

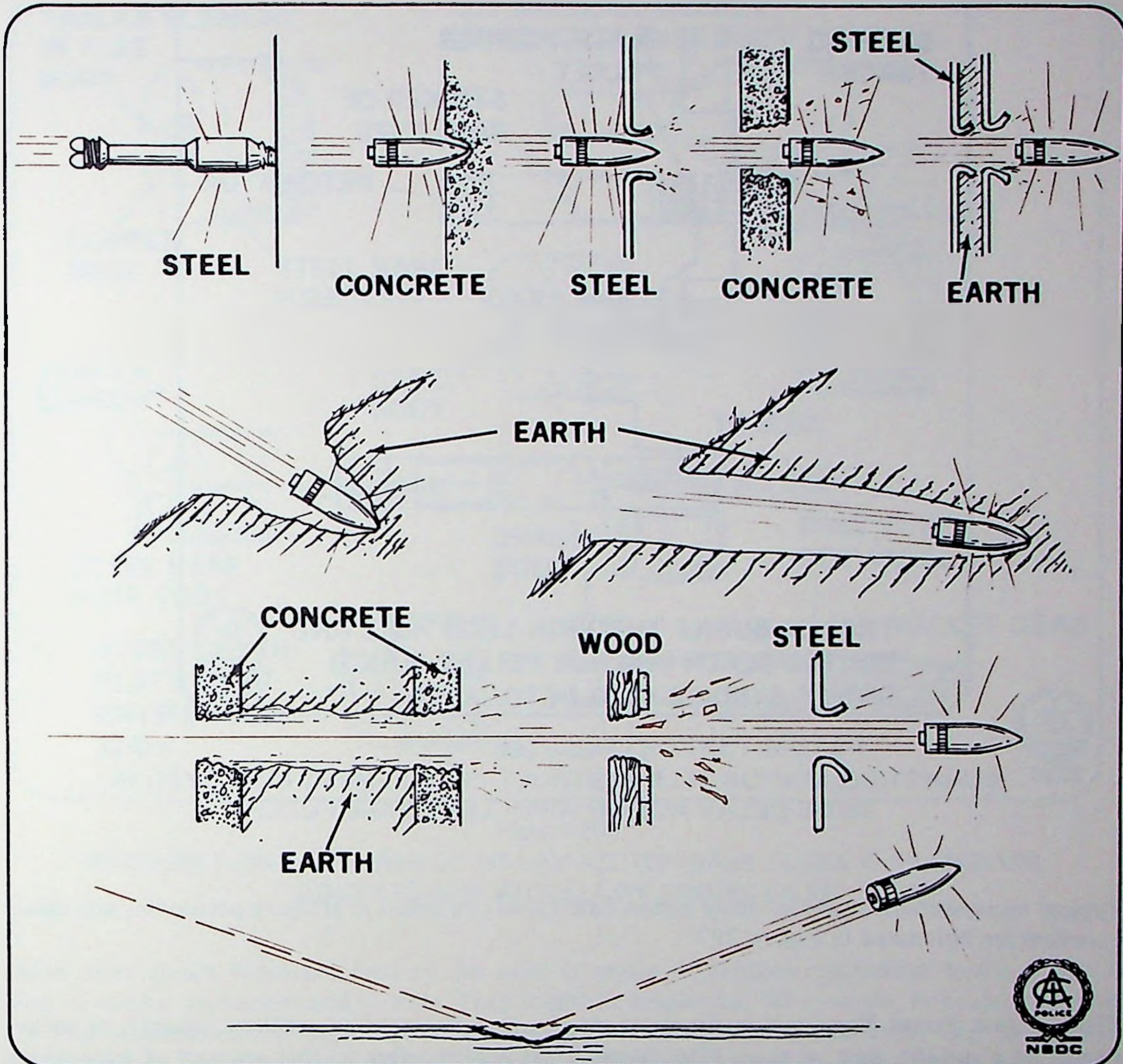


Figure 295
TYPICAL DELAYED ACTION FUZES FUNCTIONING ILLUSTRATING VARIATIONS IN DELAY ACTION DEPENDENT OF INTERNAL FUZE CONSTRUCTION

backup to positively insure that the round will detonate in the target or, in the case of the anti-aircraft projectile, to insure that the projectile does not return to earth on top of the gun crew. Tracers employed as fuze insurance elements are generally known as "burn through" tracers or tracer self-destruct (SD) elements and cause the fuze to detonate when the burn time of the tracer expires, as illustrated in Figure 296. If an unfired or fired artillery projectile is recovered, care should always be taken to prevent accidental ignition of any tracer element.

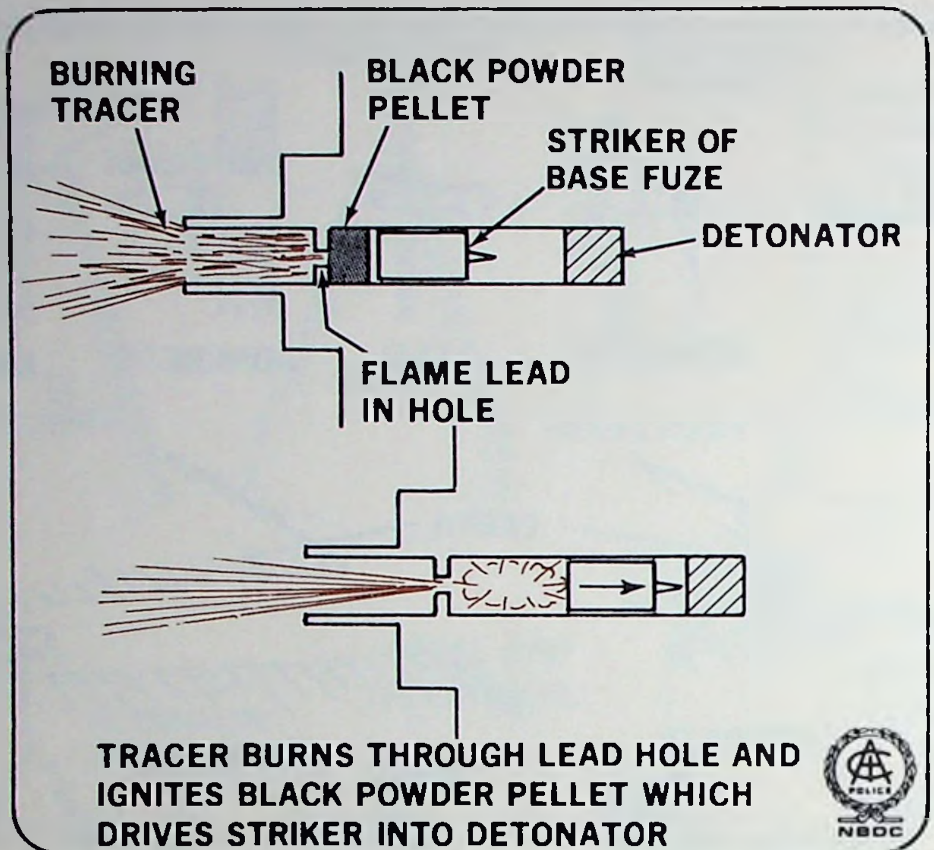


Figure 296
"BURN THROUGH" OR SELF-DESTRUCT (SD) ELEMENT EMPLOYED IN SOME DELAY ACTION ARTILLERY BASE FUZES

Typical recognition features of delay action base fuzes employed in artillery projectiles and direct fire rockets are illustrated in Figure 297.

Time Action Fuzes. Time action fuzes are designed to function an artillery, mortar, or rocket projectile at a specific time or place after firing. Time action refers to that amount of time which the gunner has calculated it will take the projectile, traveling at a known velocity, to reach a specific target or place. Just as an alarm clock is set to go off at a certain time, the gunner sets his fuze to go off at a certain time. Both the alarm clock and the time action fuze are adjustable time instruments and, like the alarm clock, the time fuze also has a time setting dial or ring. *The presence of this time setting ring (or calibration ring) is the primary recognition feature of time action fuzes* and it will be present on the vast majority of time action fuzes.

The internal mechanism of a time action fuze may consist of a simple pyrotechnic delay ignited when the round was fired, a clockwork mechanism, or an electrical timer; or it may obtain its time delay from a burning rocket motor or simple gas pressure buildup. Figure 298 illustrates the recognition features of typical time action fuzes.

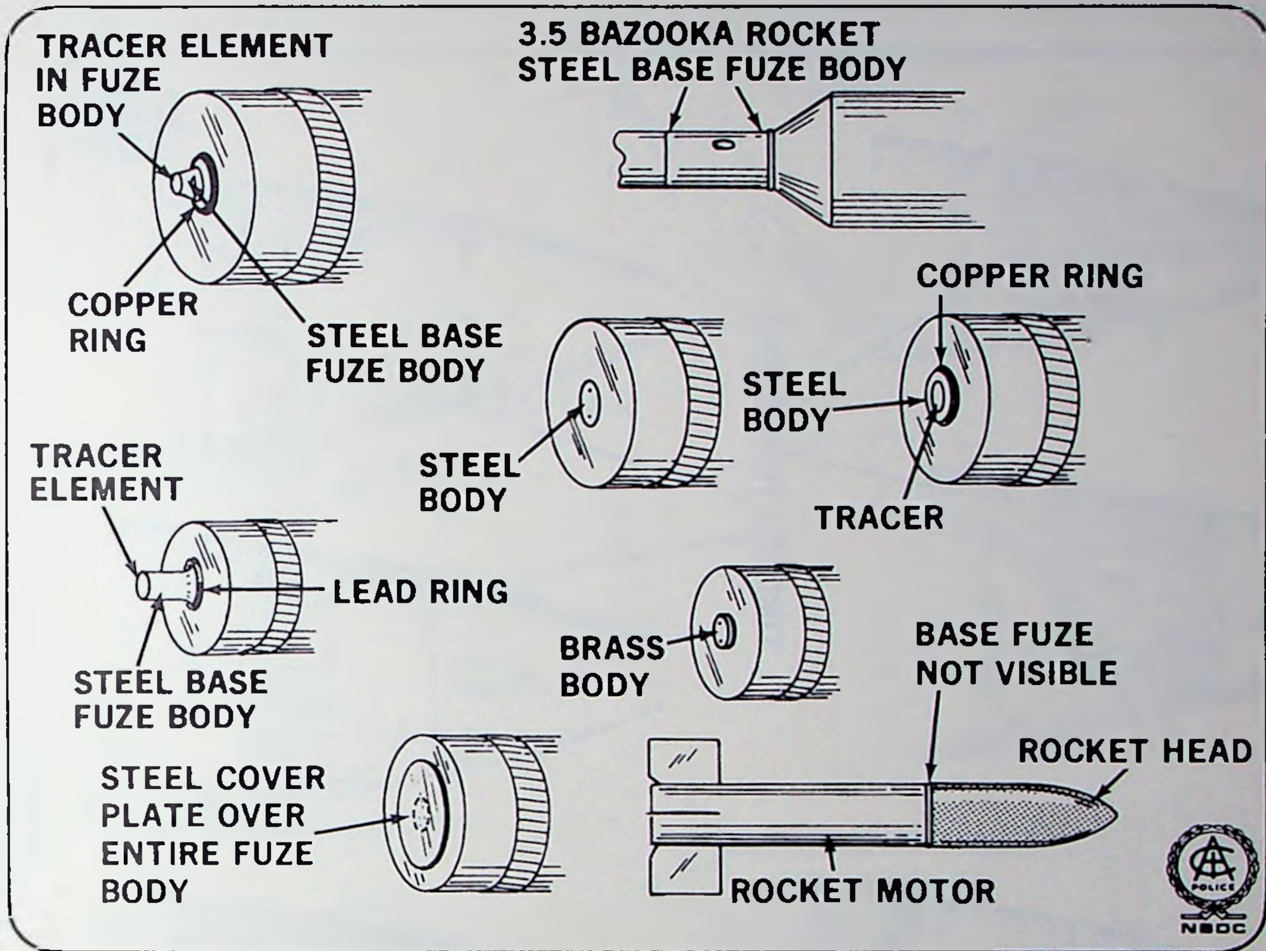


Figure 297

RECOGNITION FEATURES OF DELAY ACTION BASE FUZES EMPLOYED IN ROCKETS AND ARTILLERY PROJECTILES

Most time action fuzes are used in the nose or point of artillery projectiles, but may also be found in mortar projectiles and rockets. They might be employed, for example, to cause detonation of a high explosive-filled projectile at a point above the ground, thus improving its casualty-producing ability by allowing it to drive its fragments straight down into the enemy's trenches and foxholes. Time action fuzes are also employed to cause chemical smoke (WP) or war gas-filled rounds to burst above the ground and to detonate anti-aircraft projectiles near enemy aircraft. In addition to causing a projectile to burst, a time action fuze may cause a projectile to eject its filler. Ejection may be employed to spread propaganda leaflets, war gas, canisters, provide battlefield illumination, jam radar (chaff), dispense sub-projectiles or bomblets over a wide area, provide smoke cover over a portion of the battlefield, or to explosively eject anti-personnel flechettes (finned nails) at an advancing enemy. Figure 299 illustrates typical functioning actions of artillery projectiles, mortars, and rockets employing time action fuzes.

Time action fuzes frequently employ an impact action fuze element in their construction to insure that the fired round will function either after a time delay or, should that fail, upon impact.

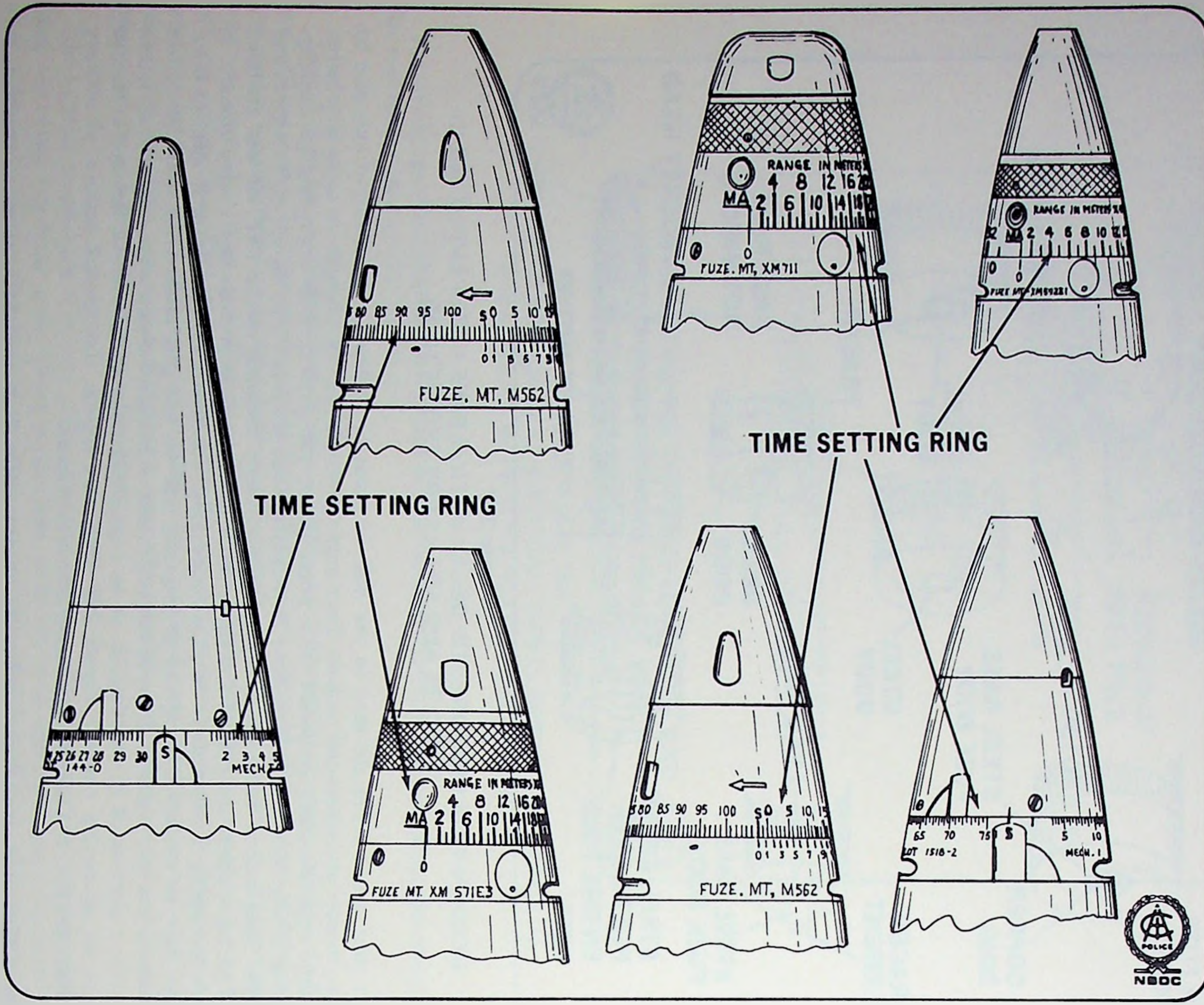


Figure 298
RECOGNITION FEATURES OF TIME ACTION FUZES

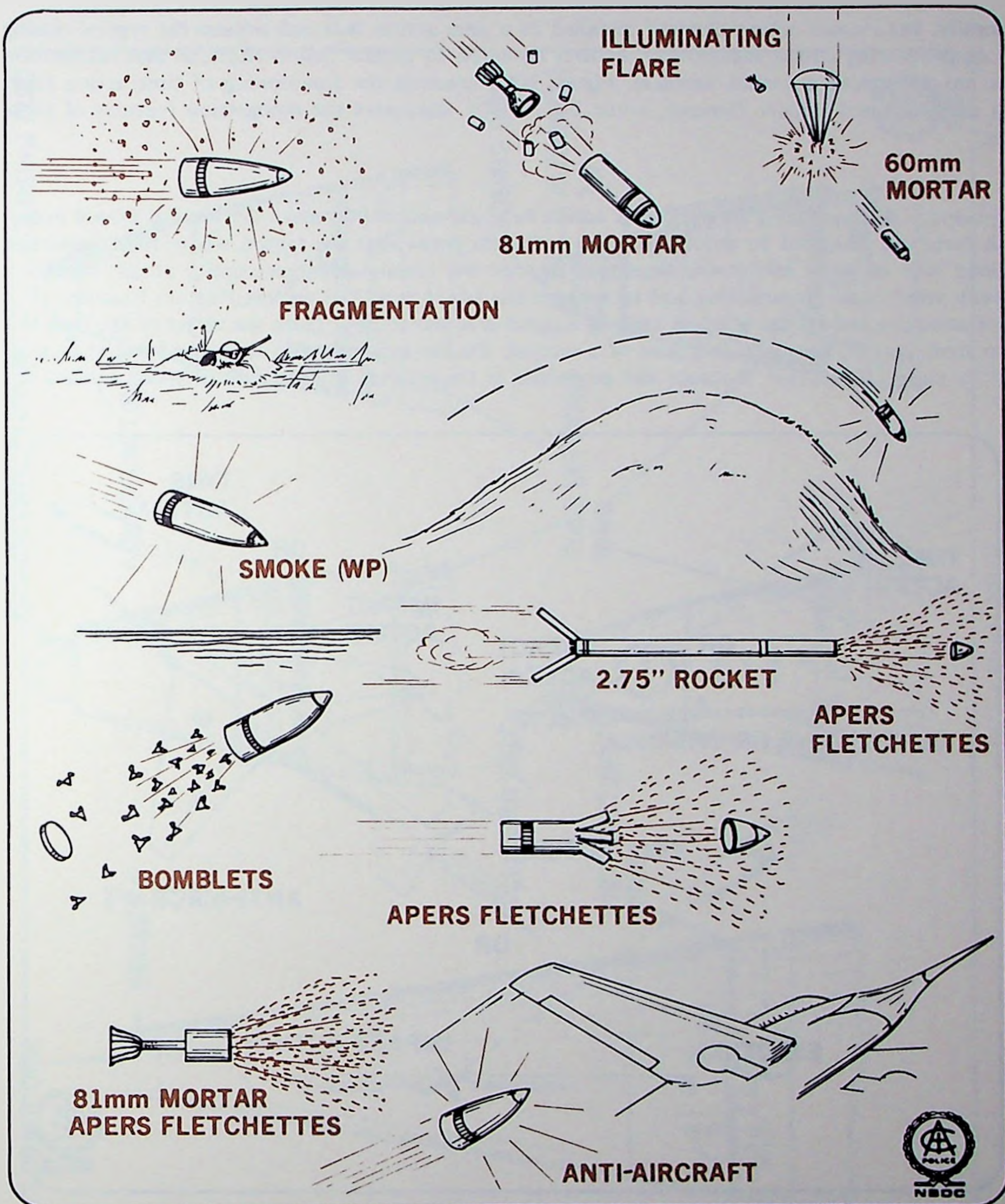


Figure 299
TYPICAL FUNCTIONING OF TIME ACTION FUZES EMPLOYED IN ARTILLERY, MORTAR, AND ROCKET PROJECTILES

Generally, the impact action element installed in a time action fuze will possess the typical closing disc or protruding striker recognition features common to impact action fuzes, so that recognition does not constitute a serious problem. Figure 300 illustrates the functioning of time action fuzes with an additional impact element, while Figure 301 illustrates the recognition features of these fuzes.

Proximity Action Fuzes. A proximity action fuze self-determines when detonation should occur. Such fuzes are designed to detonate at the optimum point near the target, where their particular payload will be most effectively employed against the enemy. Most proximity action fuzes are actually small radio transmitting and receiving units which send out signals that are bounced off a target and returned to the receiver unit. If a signal is reflected back from the target to the fuze in a given time period, normally fractions of a second, the distance between the round and the target may be clearly identified. Because the projectile is traveling at a fixed rate of speed toward the

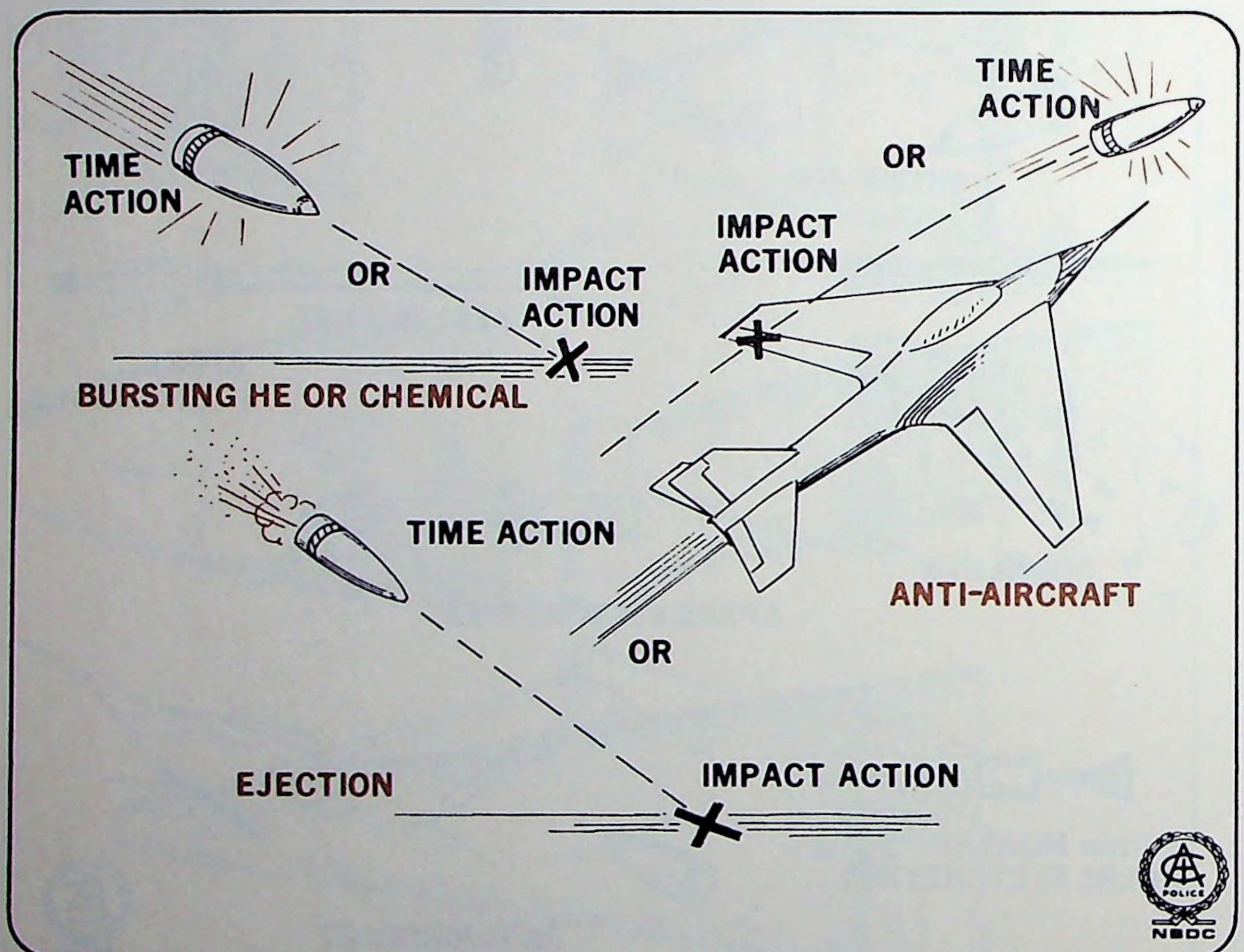


Figure 300
TYPICAL FUNCTIONING OF TIME ACTION FUZE WITH AN ADDITIONAL IMPACT ELEMENT

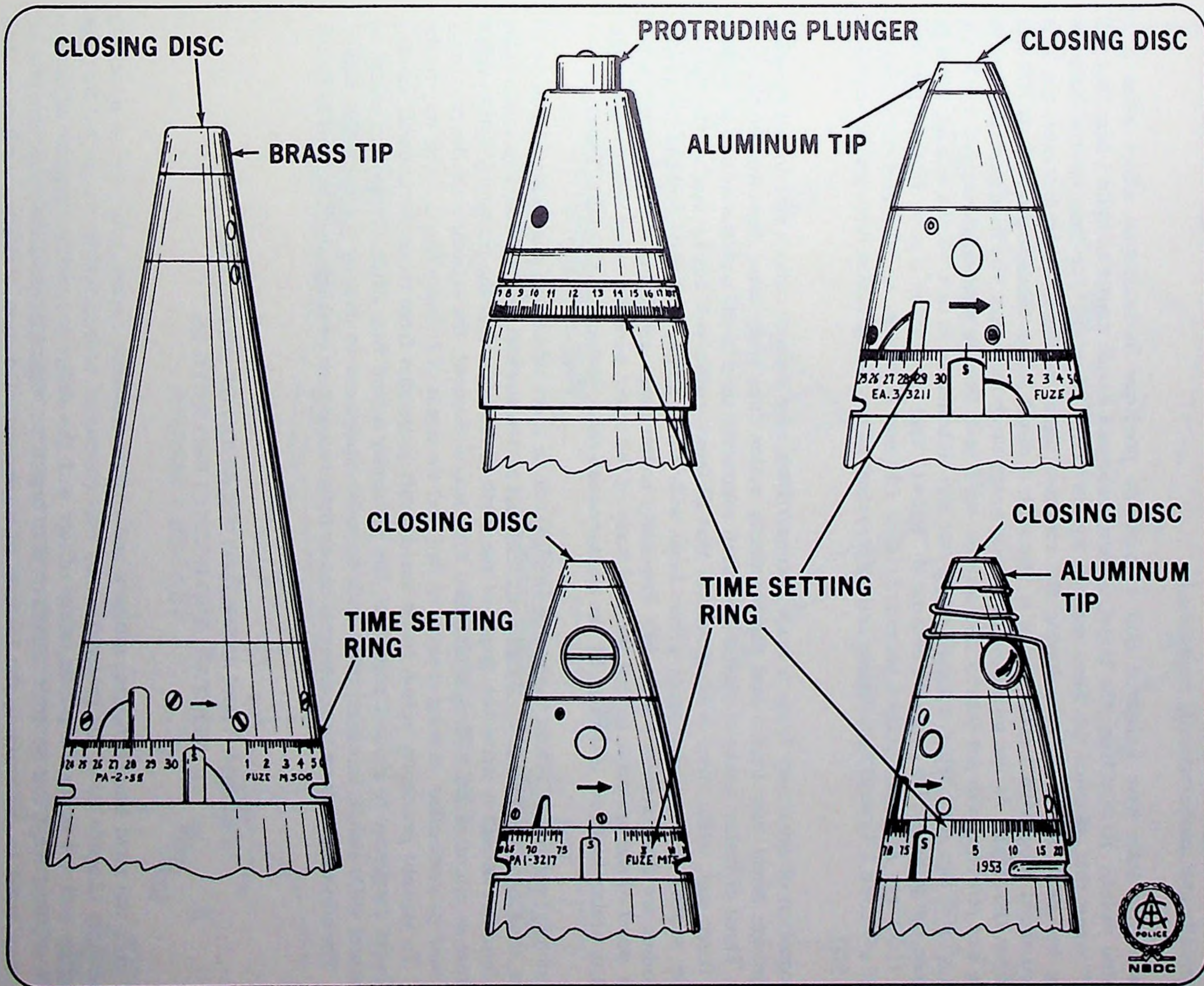


Figure 301
RECOGNITION FEATURES OF TIME ACTION FUZES WITH AN ADDITIONAL IMPACT ELEMENT

target and the speed of a radio wave is known, it is possible to send out a signal and "count" how long it takes the signal to bounce back. The distance between round and target can therefore be electronically and mathematically established.

If scientific tests have indicated that a projectile produces its maximum effect when it is detonated exactly 10 feet from the target, it then becomes a simple matter to build a fuze that will "sense" when that distance has been reached by correctly "counting" the time interval between sending the radio signal out and having the reflected signal received. If, for instance, the first reflected signal is received 1 second after it was sent, it might tell us that the projectile is 100 feet away from the target. As the projectile continues to approach the target, the time interval between sending and receiving will get shorter and shorter, until such time as a signal is received 1/10 of a second after it was sent. When a signal is sent out and reflected back in 1/10 of a second, the fuze will cause the projectile to detonate because it "knows" that its position is now 10 feet from the target. (100 feet distance equals 1 second; 1/10 of 100 feet is 10 feet, so 10 feet distance equals 1/10 of a second.) Typical functioning and employment of proximity action fuzes are illustrated in Figure 302.

Recognition of proximity fuzes is made comparatively easy because radio waves do not transmit well through metal fuze bodies and the proximity action fuze body must therefore be made of plastic. Three different colors of plastic have been commonly used in the construction of proximity action fuzes and, while there is no guarantee that different colors will not be used in the future, they are worthy of note. Proximity action fuzes with black, green, and white to light tan plastic fuze bodies are illustrated in Figure 303. Proximity action fuzes are almost always located in the nose or point of the projectile so that the steel body of the round does not cause radio interference. Proximity action fuzes are identified by the military code abbreviation, VT (Variable Time).

Frequently, proximity action fuzes also employ one or more additional fuze action elements to broaden their functioning ability. By adding an impact action element to the proximity action fuze, it will function should it strike the target or the earth in the event that the proximity action failed to operate as intended. By adding a modified time action element, the activation of the proximity action may be controlled, making it safer to fire over the heads of friendly forces on its way to the enemy. To prevent proximity action fuzed anti-aircraft projectiles from returning to earth, causing an air burst dangerous to ground personnel, the proximity action fuze often employs an electrical self-destruct (SD) switch in conjunction with its radio equipment to destroy the projectile high in the air. The addition of these fuze elements causes little recognition problem, as illustrated in Figure 304.

RECOGNITION AND IDENTIFICATION OF ARTILLERY, MORTAR, AND ROCKET PROJECTILES

Not even the most knowledgeable military and civilian ordnance experts can hope to positively and correctly identify all of the projectiles they may encounter, so it should be recognized that this publication will not equip the public safety officer with the ability to quickly recognize all or even most projectiles. What can be done, however, is to organize a logical information collection process which may assist in determining the identity of an encountered item of military ordnance. This information collection may be recorded on a form similar to the one illustrated on pages 324-325.

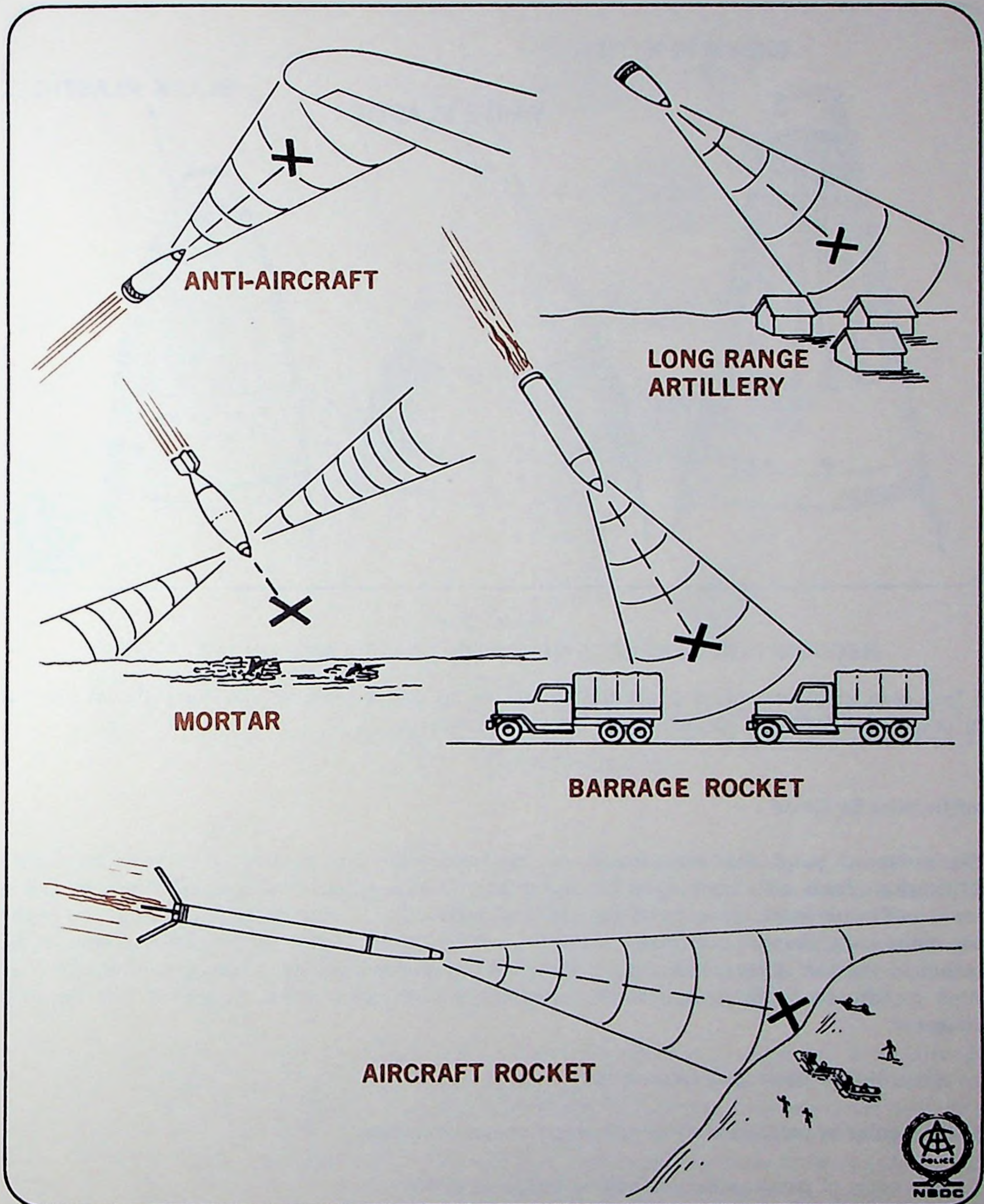


Figure 302
TYPICAL FUNCTIONING OF PROXIMITY ACTION FUZES EMPLOYED IN ARTILLERY, MORTAR, AND ROCKET PROJECTILES

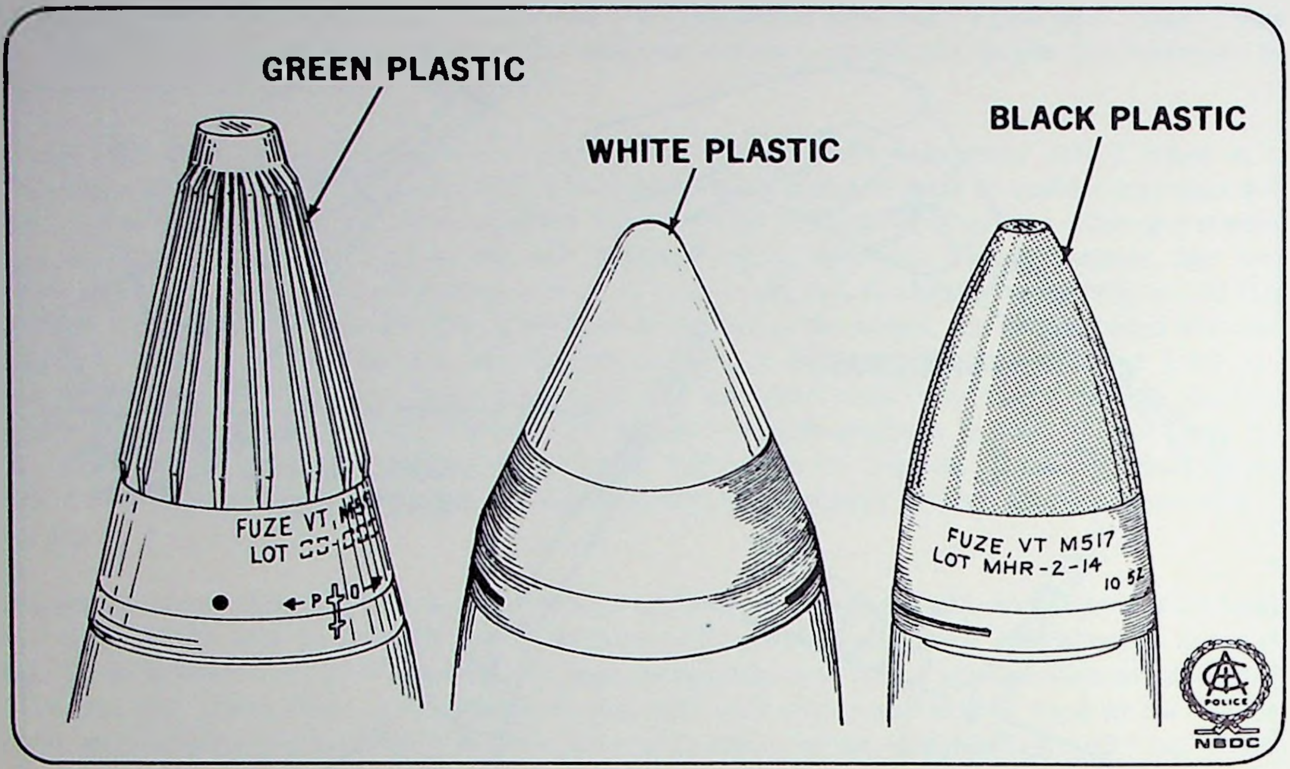


Figure 303
RECOGNITION FEATURES OF U.S. PROXIMITY ACTION (VT) FUZES

The first step in identifying a projectile should be to closely observe and correctly interpret the color coding and markings applied at the time of manufacture.

Identification By Color

The color of paint markings found on the projectile can frequently be used to assist in identification. Each color employed by the military has a specific meaning or meanings and can often identify the projectile as to its general type or function. Unfortunately, there have been three major color code changes and many deletions and additions to the military color coding of U.S. ordnance in the last thirty years. As a result, it is sometimes difficult to correctly interpret what is painted on the projectile body. Three distinct types of color markings are of interest to the investigator:

- The color of paint used to cover the entire projectile.
- The color of paint used to stencil on letters and numbers.
- The color of paint used to stencil on bands or patterns.

If, for instance, an unidentified projectile has olive drab paint covering the body and letters stenciled in yellow paint, the investigator could initially determine by consulting the color coding

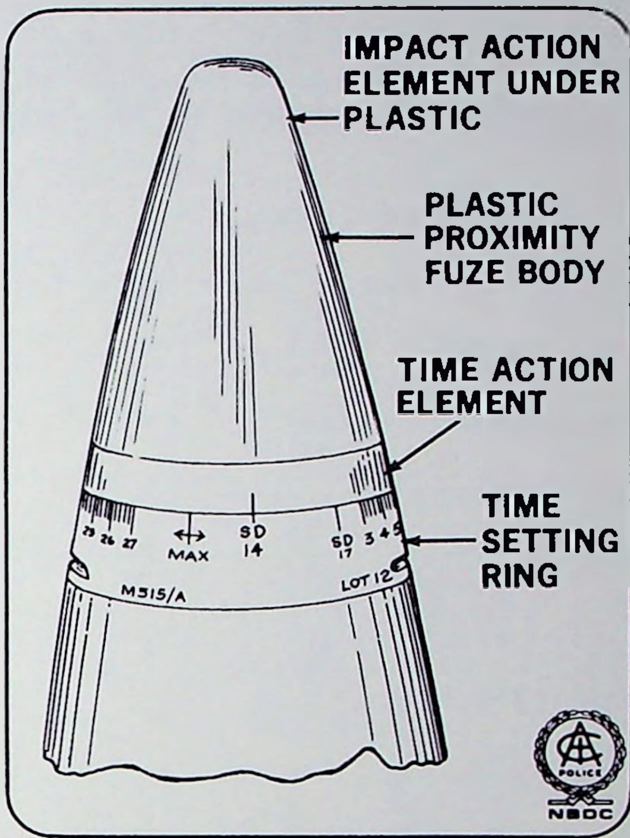


Figure 304
RECOGNITION FEATURES OF PROXIMITY ACTION FUZES WITH ADDITIONAL TIME ACTION ELEMENT, IMPACT ACTION ACTION ELEMENT, AND SELF-DESTRUCT ELEMENT INCORPORATED

identification chart (Figures 305 and 306) that the item is *probably* an early or recent manufacture high explosive (HE) projectile, or an early or recent manufacture high explosive anti-tank (HEAT) projectile, or an early manufacture high explosive plastic (HEP) projectile. The use of the color code chart in this instance has narrowed the field of search from 22 types of projectiles and fillers down to three types. There is no *guarantee* that the initial identification through the use of color code is correct, but very few projectiles are deliberately mismarked or improperly color coded.

The actual colors employed in military color coding will be found inside the front cover of this manual. As an extra check, it is always wise to scrape away a portion of the paint down to bare metal to determine if the projectile has been overpainted. In scraping away the outer layer of paint, or in using paint remover, care should be taken *not* to chip away the paint but to lightly scrape it away. Most *steel* body projectiles will have a coat of primer paint which is brown to almost maroon in color applied over the body and under the exterior paint to prevent rust.

Special care should be taken to identify the color of any bands stenciled around the body or the color and shape of any figures, such as diamonds or stars, found on the projectile.

Identification By Markings

If a projectile has letters or numbers stenciled on the body, they will certainly assist in making the proper identification if the investigator knows how to interpret them correctly. Markings placed on military projectiles generally indicate:

- The size of the projectile (in millimeters or inches)
- The type of weapon which it is used with (artillery, mortar, rocket)
- The filler or functioning of the filler
- The specific model of the projectile

Also often marked on the projectile are:

- The ammunition lot number
- Date of manufacture
- Code designation of place of manufacture
- Other special instructions

For example, if a projectile had the following numbers and letters *stenciled on the body* (disregard metal stampings), specific identification may be obtained by referring to two charts that have been prepared to assist the investigator in the interpretation of U.S. military artillery, mortar, and rocket letter and number markings stenciled on the body of the projectiles:

75G
TNT
SHELL M48

Figure 307 provides a chart of standard U.S. military *letter abbreviations* that may be found stenciled on the projectiles.

Figures 308 and 309 are charts of all the commonly employed numbers and associated letters used to designate U.S. military caliber or size of artillery, mortar, and rocket projectiles, as well as the type of weapons systems which employ them. *In addition, this chart provides measurement conversions from millimeters to decimal inches and fraction inches to assist the investigator in converting actual measurements taken of the projectile to the correct caliber designation.*

TYPE OF PROJECTILE	EARLY COLOR CODE			RECENT COLOR CODE		
	PROJECTILE BODY COLOR	LETTERING COLOR	BAND COLOR	PROJECTILE BODY COLOR	LETTERING COLOR	BAND COLOR
HE	Olive Drab	Yellow		Olive Drab	Yellow	
HEAT	Olive Drab	Yellow		Black	Yellow	
HEP	Olive Drab	Yellow		Olive Drab or Black	Yellow Yellow	Black
Smoke (except PWP or WP)	Grey	Yellow	One-Yellow	Light Green	Black	
Smoke (PWP or WP)	Grey	Yellow	One-Yellow	Light Green	Light Red	One-Yellow
Illuminating	Grey	White	One-White	White	Black	
Illuminating (Separate Loading)	Grey	White	One-White	Olive Drab	White	White ☆ star or One-white
Practice without explosive filler	Blue or Black	White		Blue	White	
Practice with high explosives	Blue or Black	White		Blue	White	One-Yellow
Practice with low explosives	Blue or Black	White		Blue	White	One-Brown
AP-HVAP and HVAP-DS (without filler)	Black	White		Black	White	
APHE	Black	Yellow		Black	Yellow	
APERS (fletchettes)				Olive Drab	White	One-Yellow One-w/white diamonds
APERS (fletchettes)				Olive Drab	White	One-Brown one-w/white diamonds
Canister (slugs)	Black	White		Olive Drab	White	
Canister (fletchettes)				Olive Drab	White	White Diamonds

Figure 305
U.S. MILITARY COLOR CODES FOR ARTILLERY, MORTAR, AND ROCKET PROJECTILES

TYPE OF PROJECTILE	EARLY COLOR CODE			RECENT COLOR CODE		
	PROJECTILE BODY COLOR	LETTERING COLOR	BAND COLOR	PROJECTILE BODY COLOR	LETTERING COLOR	BAND COLOR
Chemical Persistent Toxic Agent	Grey	Green	Two-Green	Grey	Green	Two-Green One Yellow w/explosive burster
Non-Persistent Toxic Agent	Grey	Green	One-Green	Grey	Green	One-Green One Yellow w/explosive burster
Persistent Irritant	Grey	Red	Two-Red	Grey	Red	Two-Red One Yellow w/explosive burster
Non-Persistent Irritant	Grey	Red	One-Red	Grey	Red	One-Red One Yellow w/explosive burster
"G" Series Agents	Grey	Green	One-Green	Grey	Green	Three-Green One Yellow w/explosive burster
"V" Series Agents	Grey	Green	Two-Green	Grey	Green	Three-Green One Yellow w/explosive burster
Dummy	Black or Blue	White		Bronze	White	
Chaff	Aluminum	Black		Blue	White	

This chart is for use in identifying only *artillery*, *mortar* and *rocket* projectiles through the use of color coding applied at the time of manufacture. The body paint color should be identified first, followed by the color of paint used to stencil on letters and numbers and lastly by the color of paint used in marking bands or designs on the projectile body.

Figure 305
U.S. MILITARY COLOR CODES FOR ARTILLERY, MORTAR, AND ROCKET PROJECTILES
(Continued)

BANDS OR FIGURES	EARLY MEANING	RECENT MEANING
Green	Toxic War Gas Non-Persistent	Toxic War Gas Non-Persistent
Green Green	Persistent	Persistent
Green Green Green		All Nerve Gases Now Marked with 3 Bands
Red	Irritant War Gas Non-Persistent	Irritant Gas (Riot Control) Non-Persistent
Red Red	Persistent	Persistent
Yellow	Smoke WP	High Explosive (Bursting Charge)
Brown		Low Explosive (Propellant)
White	Illuminating	
☆ White Star	Illuminating (Navy)	Illuminating (Navy)
☆☆	Illuminating (Navy)	
◇◇◇ ◇◇◇ White Diamonds		APERS (Anti-Personnel Fletchettes)

Figure 306
U.S. COLOR CODES FOR ARTILLERY, MORTAR, AND ROCKET PROJECTILES

BANDS OR FIGURES		EARLY MEANING	RECENT MEANING
CCC	In Colored Paint		Color of paint indicates color of signaling stars or smoke produced

This chart is for use in identifying only *artillery*, *mortar*, and *rocket* projectiles through through the use of color coding applied at the time of manufacture. The body paint color should be identified first, followed by the color of paint used to stencil on letters and numbers and lastly by the color of paint used in marking bands or designs on the projectile body.

Figure 306
U.S. COLOR CODES FOR ARTILLERY, MORTAR, AND ROCKET PROJECTILES (Continued)

ABBREVIATION	MEANING
A	Anti-Aircraft
AA	Anti-Aircraft
AACom	Anti-Aircraft Common
AC	Aircraft Cannon
AN-	Model Number Standardized by Army and Navy
AP	Armor-Piercing
APC	Armor-Piercing, Capped
APC BC	Armor-Piercing, Capped/Ballistic Cap
APC BC HE	Armor-Piercing, Capped/Ballistic Cap/High Explosive
APERS	Anti-Personnel (Fletchettes)
AP HE	Armor-Piercing/High Explosive
AP-I	Armor-Piercing-Incendiary
AP-T	Armor-Piercing-Tracer
APT-DI	Armor-Piercing, Tracer (Dark Ignition)
AR	Aircraft Rocket
AT	Anti-Tank
BALL	Solid projectile in 20mm cannon ammunition (Old Marking)
BC	Ballistic Cap
B C	Bursting Charge
BDU	Bomb Dummy Unit (Practice)

Figure 307
IDENTIFICATION FEATURES STENCILLED ON ARTILLERY, MORTAR, AND ROCKET PROJECTILE BODIES

ABBREVIATION	MEANING
BE	Base Ejection
BLU	Bomblet. Live Unit
BL & P	Blind Loaded and Plugged (Inert Loaded Cavity)
BL & T	Blind Loaded with Tracer (Inert Loaded Cavity)
BLK PDR	Black Powder
BP	Black Powder
BUR CHG	Bursting Charge
CAL	Caliber
CART	Cartridge identifies the item as an artillery or mortar projectile – not a rocket
CBU	Container Unit. Bomblet
CCC	Color indication – letters will be painted the color of the signal smoke or star
CG GAS	Phosgene (Choking Gas) War Gas
CHAFF	Chaff (Radar Defeating Foil)
CK GAS	Cyanogen Chloride (Blood Agent) War Gas
CNS GAS	Chloropicrin (Tear Gas)
COMP A	Composition A (Explosive)
COMP A-3	Composition A-3 (Explosive)
COMP B	Composition B (Explosive)
CSTR	Canister
CTG	Cartridge
D DR	Dummy Drill
DUMMY	Inert
EXP D	Explosive D (Explosive)
FFAR	Folding Fin Aerial Rocket
G	Gun
GB GAS	Sarin (Nerve Gas) War Gas
H	Howitzer
HC	High Capacity
HC BE	HC (Smoke) Base Ejection
HC SMOKE	Hexachlorethane (Burning)
HD GAS	Distilled Mustard (Blister Gas) War Gas
HE	High Explosive
HE APAM	High Explosive, Anti-Personnel/Anti-Material
HE APERS	High Explosive, Anti-Personnel (Sub-Projectiles)
HEAT	High Explosive, Anti-Tank
HEAT-T	High Explosive, Anti-Tank with Tracer
HE-I or HEI	High Explosive-Incendiary

Figure 307
IDENTIFICATION FEATURES STENCILLED ON ARTILLERY, MORTAR, AND ROCKET PROJECTILE BODIES (Continued)

ABBREVIATION	MEANING
HE-I-T	High Explosive-Incendiary-Tracer
HE-I-T (DI)	High Explosive-Incendiary-Tracer (Dark Ignition)
HE-I-T-NSD	High Explosive-Incendiary-Tracer-Non-Self-Destroying
HE-I-T-SD	High Explosive-Incendiary-Tracer-Self-Destroying
HE MARKER	High Explosive Containing dye to produce a colored cloud upon detonation
HEP	High Explosive, Plastic (Explosive)
HEP-T	High Explosive, Plastic (Explosive) with Tracer
HERA or HE RA	High Explosive, Rocket Assisted
HET or HE-T	High Explosive, Tracer
HET-DI	High Explosive, (Dark Ignition) Tracer
HET-SD	High Explosive, Tracer-Self-Destroying
H GAS	Mustard (Blister Gas) War Gas
HPT	High Pressure Test (For Testing Weapons)
HT GAS	Mustard/Sulfur/Chlorine mix (Blister Gas)
HVAP	Hypervelocity, Armor-Piercing
HVAP-DS	Hypervelocity, Armor-Piercing-Discarding Sabot
HVAP-DS-FS	Hypervelocity, Armor-Piercing-Discarding Sabot-Fin-Stabilized
HVAP-T	Hypervelocity, Armor-Piercing-Tracer
HVHE-DS-FS	Hypervelocity, High Explosive-Discarding Sabot-Fin Stabilized
-I	Incendiary
I	Illuminating
ILL	Illuminating
ILLM	Illuminating
ILLUM	Illuminating
IN	Inch
IN	Inert
INCEN or INCEND	Incendiary
LEAF	Propaganda Leaflets
LEAFLET	Propaganda Leaflets
LOT	Group of manufacture, usually followed by letters and numbers (Lot PA-116-55)
M	Mortar
M (and number)	Model (specific identification of the item by model number)
MLU	Mine (bomblet) Live Unit
MOD	U.S. Navy designation for modification
MP	Multi-Purpose (high explosive and some other effect)

Figure 307
IDENTIFICATION FEATURES STENCILLED ON ARTILLERY, MORTAR, AND ROCKET PROJECTILE BODIES (Continued)

ABBREVIATION	MEANING
OCTOL	Octol (Explosive)
PRAC	Practice
PROJ	Projectile
PROPAGANDA	Propaganda Leaflets
PWP SMOKE	Plasticized White Phosphorus (Bursting)
SS	Illuminating (Star Shell)
SSR	Spin-Stabilized Rocket
SUB CAL	Subcaliber, used in firing training
SUB CALIBER	Subcaliber, used in firing training
SUP CH	Supplementary Charge (Explosive)
SUPPL CHG	Supplementary Charge (Explosive)
T (followed by numbers)	Test model number, such as T13 (item is under development)
-T	Tracer
TTT	Tracer
TACTICAL CS	Chlorobenzylmalnonitrile (Tear Gas)
TAC CS	Chlorobenzylmalnonitrile (Tear Gas)
TNG	Training
TNT	TNT-Trinitrotoluene (Explosive)
TNT-CT	Cast TNT
TP	Target Practice
TRA	Tracer
VX GAS	(Nerve Gas) War Gas
W	Window (Radar Defeating Chaff, Navy)
W/	With/
WP	White Phosphorus
WP SMOKE	White Phosphorus (Bursting)
W/O	Without
W/T	With Tracer
XM	Non-standardized Model (item is in use but not fully accepted-under development)
☆	Illuminating (Navy)
◇◇◇◇◇◇	Anti-Personnel Fletchettes

This chart is for use in identifying the meanings of letter and number abbreviations found stenciled on the body of artillery, mortar, and rocket projectiles.

Figure 307
IDENTIFICATION FEATURES STENCILLED ON ARTILLERY, MORTAR, AND ROCKET PROJECTILE BODIES (Continued)

By checking the letters and numbers found on the projectile against those listed in Figures 307, 308, and 309, the majority of the markings may be correctly interpreted as indicated below:

75G	=	75 (mm) (caliber) Gun (weapon)
TNT	=	TNT (explosive filler)
SHELL M48	=	Shell (not a rocket) M48 (specific model number)

STENCIL MARKINGS ON PROJECTILE	MEANING	SIZE IN MM EQUALS SIZE IN INCHES		
		MILLI-METERS	DECIMAL INCHES	FRACTION INCHES
20G	20mm Gun, Aircraft or Ground Fired	20	.79	25/32
20MM	20mm Gun, Aircraft or Ground Fired	20	.79	25/32
37G	37mm Gun	37	1.46	1 15/32
40G	40mm Gun	40	1.57	1 9/16
57G	57mm Gun	57	2.24	1 1/4
57R	57mm Recoilless Rifle	57	2.24	1 1/4
60M	60mm Mortar	60	2.36	2 3/8
2.36 Inch	2.36-Inch Rocket (Original Bazooka)	60	2.36	2 3/8
66MM	66mm Rocket (LAW)	66	2.60	2 19/32
2.75 Inch	2.75-Inch FFAR Rocket	70	2.75	2 3/4
75G	75mm Gun	75	2.95	2 15/16
75H	75mm Howitzer	75	2.95	2 15/16
76G	76mm Gun	76	2.99	3
81M	81mm Mortar	81	3.19	3 3/16
3.5 Inch	3.5-Inch Rocket (Bazooka)	88.90	3.50	3 1/2
90G	90mm Gun	90	3.54	3 17/32
90R	90mm Recoilless Rifle	90	3.54	3 17/32
105G	105mm Gun	105	4.13	4 1/8

Figure 308
U.S. MILITARY ARTILLERY, MORTAR, AND ROCKET PROJECTILE MARKINGS

STENCIL MARKINGS ON PROJECTILE	MEANING	SIZE IN MM EQUALS SIZE IN INCHES		
		MILLI-METERS	DECIMAL INCHES	FRACTION INCHES
105H	105mm Howitzer	105	4.13	4 1/8
105R	105mm Recoilless Rifle	105	4.13	4 1/8
106R	106mm Recoilless Rifle	106	4.17	4 5/32
4.2 Inch	4.2-Inch Mortar	106.68	4.20	4 3/16
4.2 In CM	4.2-Inch Chemical Mortar	106.68	4.20	4 3/16
4.5 Inch	4.5-Inch Rocket	114.30	4.50	4 1/2
120G	120mm Gun	120	4.72	4 23/32
5 Inch	5-Inch Spin-Stabilized Rocket or 5-Inch Zuni Aircraft Rocket	127	5.00	5
152G	152mm Gun	152		
155G	155mm Gun	155	6.10	6 3/32
155GH	155mm Gun Howitzer	155	6.10	6 3/32
155H	155mm Howitzer	155	6.10	6 3/32
155MM	155mm Rocket, Chemical	155	6.10	6 3/32
165G	165mm Gun (Engineers)	165	6.50	6 1/2
175G	175mm Gun	175	6.89	6 7/8
7.2 Inch	7.2-Inch Rocket or Projector Charge	182.88	7.20	7 3/16
8G	8-Inch Gun	203	8.00	8
8H	8-Inch Howitzer	203	8.00	8
240H	240mm Howitzer	240	9.45	9 7/16
280G	280mm Gun	280	11.02	11 1/32

This chart is for use in identifying the size of artillery, mortar, and rocket projectiles and lists the projectile measurement, in millimeters, decimal inches and fraction inches as well as the common stenciled size identification and weapon designation employed by the U.S. military. All size measurements must be taken at a projectile bourrelet surface by employing outside calipers.

Figure 308

U.S. MILITARY ARTILLERY, MORTAR, AND ROCKET PROJECTILE MARKINGS (Continued)

STENCIL MARKINGS ON PROJECTILE	MEANING	MILLI-METERS	DECIMAL INCHES	FRACTIONS
20MM	Anti-Aircraft Gun	20	.79	25/32
20MM	Aircraft Gun	20	.79	25/32
1.10/75	Anti-Aircraft Gun	27.94	1.10	1 3/32
40MM	Anti-Aircraft Gun	40	1.57	1 9/16
3"/23	Anti-Aircraft Or Surface Fire Gun	76.20	3.00	3
3"/50	Anti-Aircraft Or Surface Fire Gun	76.20	3.00	3
4"/50	Surface Fire Gun	101.60	4.00	4
5"/25	Anti-Aircraft Or Surface Fire Gun	127.00	5.00	5
5"/38	Anti-Aircraft Or Surface Fire Gun	127.00	5.00	5
5"/50	Surface Fire Gun	127.00	5.00	5
5"/51	Surface Fire Gun	127.00	5.00	5
5"/54	Anti-Aircraft Or Surface Fire Gun	127.00	5.00	5
6"/47	Surface Fire Gun	152.40	6.00	6
6"/50	Surface Fire Gun	152.40	6.00	6
6"/53	Surface Fire Gun	152.40	6.00	6
7"/45	Surface Fire Coast Artillery	177.80	7.00	7
8"/55	Surface Fire Gun	203.20	8.00	8
12"/50	Surface Fire Gun	304.80	12.00	12
14"/45	Surface Fire Gun	355.60	14.00	14
14"/50	Surface Fire Gun	355.60	14.00	14
16"/45	Surface Fire Gun	406.40	16.00	16
16"/50	Surface Fire Gun	406.40	16.00	16

This chart is for use in identifying the size of artillery, mortar, and rocket projectiles and lists the projectile measurement, in millimeters, decimal inches and fraction inches as well as the common stenciled size identification and weapon designation employed by the U.S. military. All size measurements must be taken at a projectile bourrelet surface by using outside calipers.

Figure 309
U.S. NAVY ARTILLERY PROJECTILE MARKINGS

The item found may, therefore, be correctly identified as a 75mm high explosive-filled artillery projectile, specifically the Model 48 used in the 75mm gun.

The use of the charts contained in Figures 307, 308, and 309 will not provide 100 percent identification in all cases, but they do represent the first collection of technical data in usable chart form to be made available to members of the law enforcement community. The availability of these charts eliminates, for the most part, the endless shuffling through numerous military publications in search of some identifying feature which may be applied to the item in question.

Military marking systems are not standard from one type of ordnance to another and the position of the identifying marks varies somewhat on the projectile body. Figure 310 illustrates typical markings for various types of military projectiles. The charts in Figures 307, 308, and 309 should be employed in "reading" these markings to build up a familiarity with military projectile markings and their meanings.

Military fuzes are also frequently marked by stenciling, metal stamping, or engraving a series of words, numbers, and letters on the fuze body. These markings, if present, will usually provide some

20G INCENDIARY SHELL M-96	CS TAC 105H CTG XM629	40G TNT MK- W/T MK-11	37G CTG APC-T M-63 MOD 1
75G COMP B CARTRIDGE M-352 W/SUPPL CHG	3"/50 A.A. BUR CHG TNT	WP SMOKE 76G CARTRIDGE M-36	90G HVAP-T M332A1
152G CTG-CSTR XM-625 ◊ ◊ ◊ ◊ ◊ ◊ ◊ ◊ ◊ ◊ ◊ ◊ ◊ ◊ ◊	155G TNT PROJ M-107 W/SUPPL CHG	105H APERS-T CTG XM-546 ◊ ◊ ◊ ◊ ◊ ◊ ◊ ◊ ◊ ◊ ◊	H GAS 155H LOT 7571 PROJECTILE M110
5"/38 HC BUR CHG TNT	60MM COMP B CTG M-49	TTT COMP B 76G HEAT-T CTG M-496	M-329A1 TNT 4.2 IN M W/SUPPL CHG
ROCKET 66MM HEAT OCTOL M-18	3.5 IN COMP B ROCKET HEAT M-35	2.75 IN COMP B ROCKET M-1	ILLUM 81M CARTRIDGE M301A2

Figure 310
TYPICAL MARKINGS APPEARING ON ARTILLERY, MORTAR, AND ROCKET PROJECTILE BODIES

indication of the type of fuze encountered. Figure 311 provides a list of common abbreviation markings normally found on fuze bodies along with information as to their meaning to assist the investigator in fuze identification.

Figure 312 illustrates typical metal stamped, engraved, and stenciled markings which may be found on fuze bodies. Although the letters and numbers appear in some cases to be rather confusing, it is possible in each case to determine the function action of the fuze.

ABBREVIATION	MEANING
ADF	Auxiliary Detonating Fuze
AUX DET	Auxiliary Detonating Fuze
BD	Base Detonating (Delay)
BDF	Base Detonating Fuze (Delay)
CP	Concrete Piercing (Impact)
D	Delay
M	Model of Fuze
MECH	Mechanical (Time)
MK	Model of Fuze (Navy)
MOD	Modification
MT	Mechanical Time
MTF	Mechanical Time Fuze (Time)
MTSQ	Mechanical Time/Super Quick (Time and Impact)
PD	Point Detonating (Impact)
PDF	Point Detonating Fuze (Impact)
PDSD	Point Detonating/Self-Destroying (Impact/Self-Destroying)
PDSQ	Point Detonating/Super Quick (Impact)
PI	Point Initiating (Impact)
PIBD	Point Initiating/Base Detonating (Impact)
PTTF	Powder Train Time Fuze
SD	Self-Destroying
SQ	Super Quick (Impact)
T	Test Number – Not Standardized Model
TIME	Time
TSQ	Time Super Quick (Impact/Time)
VT	Proximity Fuze
VT PD	Proximity/Point Detonating (Impact)
VT SQ	Proximity/Super Quick (Impact)
VT SQ SD	Proximity/Super Quick/Self-Destroying
XM	Non-Standardized Model

Figure 311
PROJECTILE FUZE IDENTIFICATION MARKINGS

FUZE MARKINGS

LOT PA 1-89-12-55 PD M52A2
FUZE PD M503A2
FUZE PD M508
PD FUZE MK176
FUZE PD XM593
NOSE PI MK406
FUZE PDSD T234E2
LOT PA 1-89-3-67 PD XM717
BD FUZE M404A1
MECH TIME FUZE M61A2 LOT 144-0
BDF MK48 MOD 1
FUZE MT M562
FUZE MT XM711
BDF MK64
FUZE MTSQ M500A1 LOT PA 1-3217
FUZE M506, MTSQ PA-2-55
TIME FUZE M65A1
TIME FUZE M84
TIME AND SUPER QUICK, M55A3
FUZE BD M66A2
BD FUZE M91A1
FUZE VT M517
FUZE VT M532
PD MK181

Figure 312
TYPICAL MARKINGS FOUND ON ARTILLERY, MORTAR, AND ROCKET FUZES

In attempting to relate a type of fuze and fuze action to a type of projectile, it is convenient to know where they are *not* employed so that certain types of fuze/projectile combinations may be eliminated initially. This type of negative identification is not at all uncommon when dealing with military projectiles. Figure 313 provides this information.

Identification By Function

Not *all* types of projectiles are employed by each artillery, mortar, and rocket weapons system. If an item can be identified simply as an artillery, mortar, or rocket projectile, certain types of

FUZE ACTION	NOT EMPLOYED IN
Impact Action Fuzes (Nose)	Piercing action projectiles
Delay Action Fuzes (Base)	Mortar projectiles Fin-stabilized rockets–except 3.5-inch HEAT Bazooka Spin-stabilized rockets Artillery projectiles – except APHE, HEAT, HEP and Navy HE
Time Action Fuzes (Nose)	Piercing action projectiles Fin-stabilized rockets – except 5-inch Zuni flare aircraft rocket Spin-stabilized rockets Fin-stabilized artillery projectiles
Proximity Action Fuzes (Nose)	Piercing-action projectiles Ejection projectiles

Figure 313
FUZES NOT EMPLOYED IN VARIOUS TYPES OF PROJECTILES

projectiles are automatically eliminated because they are not used in that particular type of weapons system. When the encountered projectile has no paint color code or markings, Figure 314 may be employed to assist in an initial and general identification by function and type of the projectile. Figure 314 may also be referred to as a check system to insure that a tentative identification of the type and functioning of a projectile is compatible with the proper weapons system.

Identification By Fin Assembly

Fifteen years ago, U.S. mortar fins had a fairly standard appearance, while rocket fins displayed much more variety and artillery projectiles *did not* have fins. Modern artillery, mortar, and rocket fin-stabilized projectiles now present a confusing array of fin styles and construction, which often makes it quite difficult to clearly identify the type of weapon which launches the projectile. Since a determination of the type of weapons system is one of the primary steps in recognition, a review of some basic and differentiating identification features may assist the investigator.

Fin-Stabilized Rocket Projectiles. The majority of fins used with ground-fired and aircraft-fired rockets are of the folding or swing out type. Only *one* artillery projectile (106mm HEAT projectile, 106mm recoilless rifle) has folding fins and *no* mortar projectiles employ folding fins. Therefore, a projectile with folding fins is probably a rocket projectile. Positive identification can easily be made by inspecting the rear of the rocket motor tube for the presence of a venturi or nozzle assembly.

FUNCTION	TYPE OF PROJECTILE	EMPLOYED BY		
		ARTILLERY	MORTAR	ROCKET
Bursting	High Explosive (HE)	X	X	X
	Smoke (WP)	X	X	X
	HEAT	X	–	X
	HEP	X	–	–
	APHE	X	–	–
	War Gas	X	X	X
Ejection	Illuminating	X	X	X
	Leaflet	X	X	–
	Chaff	–	–	X
	War Gas	X	X	X
	Tear Gas	X	X	X
	Shrapnel	X	–	–
	APERS	X	X	X
	Burning Smoke (HC)	X	X	–
	HE APERS (Bomblets)	X	X	X[1]
Piercing	Armor Piercing (AP)	X	–	–
	APC	X	–	–
	APC BC	X	–	–
	HVAP	X	–	–
	HVAP-DS	X	–	–
Other	Canister	X	–	–
	Rocket Assisted	X	–	–
	HEHV-DS-FS (Gunfighter)	X	–	–

[1] Large caliber rockets only (unguided missiles, "Little John" and "Honest John")

Figure 314
U.S. MILITARY PROJECTILES IN VARIOUS WEAPONS SYSTEMS IN CURRENT STANDARD USE (1972)

The presence of a tapered or cone-shaped opening (or openings) in the rear is proof of rocket identification. Fin-stabilized mortar and artillery projectiles *do not* employ venturi or nozzles.

Fin-Stabilized Mortar Projectiles. U.S. mortar fin assemblies employ five basic construction shapes, as illustrated in Figure 315. U.S. mortar fins have either 6 or 12 individual fin blades which comprise the fin assembly. Located in the rear center of the fin assembly is the primer unit which resembles the end of a shotgun shell. This primer unit will also be found on some fin-stabilized artillery projectiles. Mortar projectiles are equipped with removable propellant increments for zone firing and, because these increments are removable, the mortar fin assembly has an increment

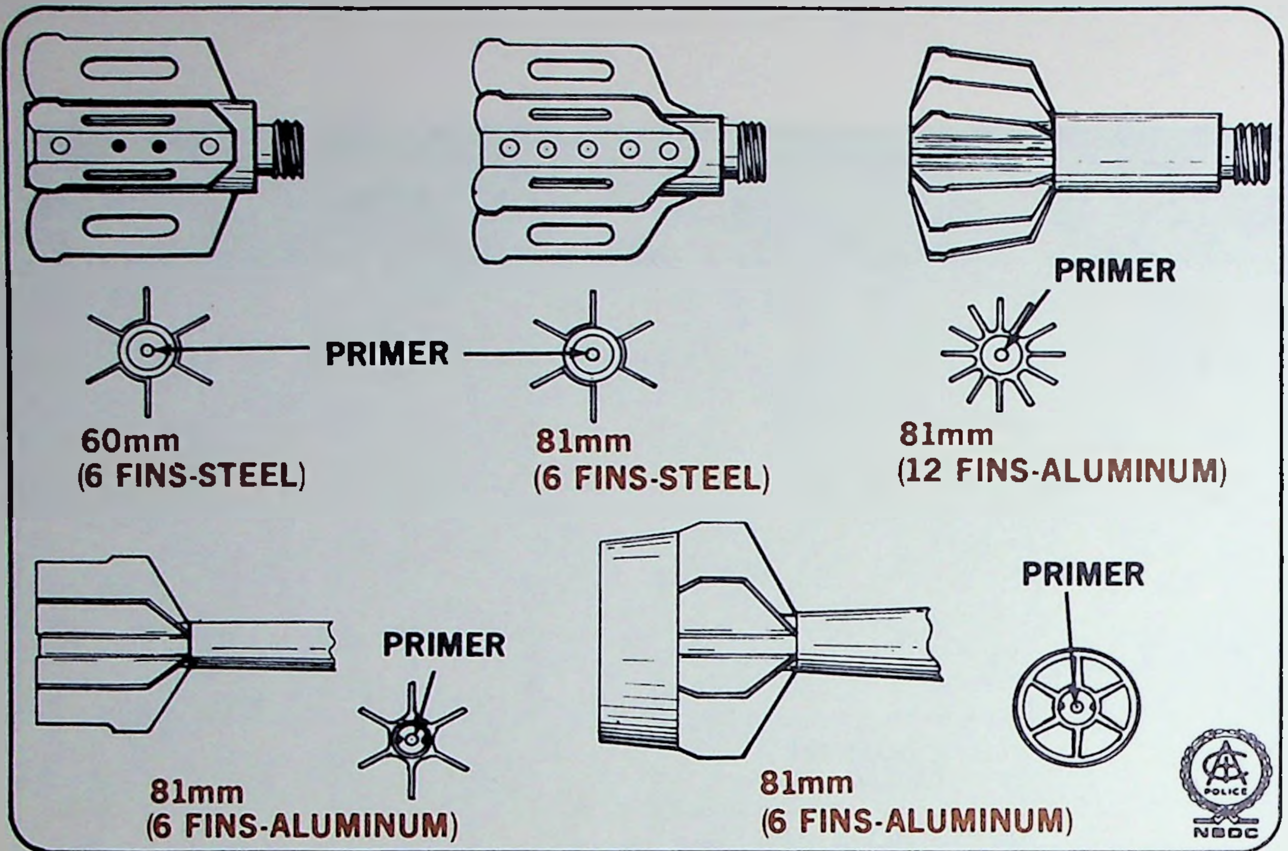


Figure 315
RECOGNITION FEATURES OF U.S. MILITARY 60MM AND 81MM MORTAR FIN ASSEMBLIES

holding device permanently affixed to it. These increment holders are constructed of spring wire or have a protruding "T" shape, as illustrated in Figure 316. The fin assembly should always be inspected closely for increment holders because they are common *only* to mortar projectiles and are not found on fin-stabilized artillery projectiles.

When attempting to identify a projectile as a fin-stabilized mortar or artillery projectile, it should also be kept in mind that *only* mortar projectiles employ gas check bands (5) or an obturator groove (1) at the point of major diameter. While this alone is not sufficient to allow identification since some fin-stabilized artillery projectiles also have cuts and assembly grooves in their bodies, when considered with the other features common to mortars, a positive identification becomes possible.

Fin-Stabilized Artillery Projectiles. In attempting to identify any fin-stabilized projectile, it should be first subjected to the rocket and mortar identification tests since these are more conclusive than those which may be applied for fin-stabilized artillery projectiles. Eliminating rocket and mortar identification features is in itself the first step in identifying a fin-stabilized artillery projectile. The only artillery projectiles which are fin-stabilized are HEAT projectiles and one high explosive projectile. Figure 317 lists these projectiles.

Of the fin-stabilized projectiles listed in Figure 317, it should be noted that the three latest models employ a spike nose configuration. The other projectiles with long, tapered ogives and long fin booms are of an older design and will in all probability be phased out when existing supplies of

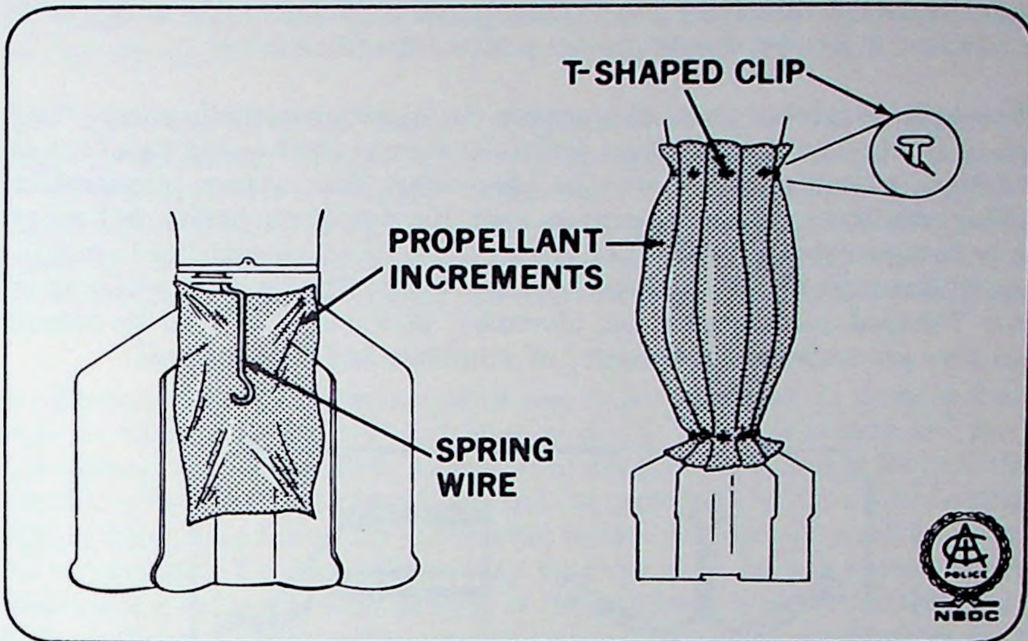


Figure 316
PROPELLANT INCREMENT HOLDERS ON U.S. 81MM MORTARS

WEAPON*	IDENTIFICATION	BRIEF DESCRIPTION
90G	HEAT (M348A1)	Long fin boom, long tapered ogive, approximate total length 32 inches.
90G	HEAT-T (M431)	Spike nose, approximate total length 21 inches.
90R	HE (XM591)	Long fin boom, large fuze with protruding plunger, approximate total length 26 inches, projectile diameter 81mm (employs sabot)
90R	HEAT (M371A1)	Spike nose, approximate total length 28 inches.
105R	HEAT (M341)	Long fin boom, long tapered ogive approximate total length 41 inches.
106	HEAT (M344A1)	Long tapered ogive, 6 folding fins, projectile length 18 1/2 inches.
120G	HEAT-T (M469)	Spike nose, approximate total length 29 inches.

*Arrow projectiles are not included because of readily identified shape.

Figure 317
U.S. FIN-STABILIZED ARTILLERY PROJECTILE IDENTIFICATION FEATURES

the projectiles are expended. The spike nose configuration is common *only* to fin-stabilized HEAT artillery projectiles and, if present, should provide positive identification.

All HEAT fin-stabilized artillery projectiles employ electrical impact action fuzes ("Lucky" fuzes). The only means of identifying "Lucky" fuzes is their location at the forward tip of the spike nose or long ogive and their resemblance to a cap or plug rather than a fuze. Fin-stabilized artillery projectiles employ plastic or rubber obturators near the rear of the bodies, or have pre-engraved rotating bands *or* have no rotating bands or obturator at all. Newer fin-stabilized artillery projectiles employ a slighly different fin shape than those used previously. The fin blade radiating out from the fin boom has a T-shaped configuration, as illustrated in Figure 318. The fin assemblies of all fin-stabilized artillery projectiles are constructed of aluminum and are unpainted.

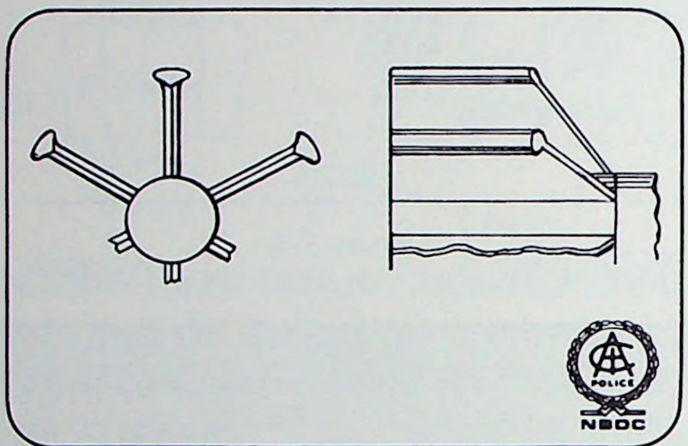


Figure 318
T-SHAPED FIN BLADE ON NEWER FIN-STABILIZED HEAT ARTILLERY PROJECTILES

Identification By Measurement

If the artillery, mortar, or rocket projectile is rust-covered or if no paint markings are present, correct identification of the projectile can be made *only* by a painstaking and careful analysis of its overall construction features and specific component parts. It would be impossible to provide enough detailed information on every size and type of projectile manufactured for the military since World War II in less than several hundred pages, and such a volume would probably be of doubtful value to law enforcement officers. The identification system proposed for use when no paint or color markings are available on the projectile consists of the following steps:

- Take accurate measurements of the projectile to determine its size and weight.
- Determine what type of projectile it is – artillery, mortar, or rocket and attempt to determine if the projectile bursts, ejects, or penetrates.
- Attempt to identify the type of fuze(s) (by functioning action) the projectile employs and check to see that the type of fuze is compatible with the type of projectile.

If careful work is done and hasty judgments are avoided, a reasonably accurate general identification should result.

When color codes and paint markings are not available to assist the investigator, the next most valuable identification feature becomes the projectile measurements. Accurate measurement of the *diameter* of the projectile, when compared to the chart which identifies projectile size and weapons system (Figures 309 and 310), can quickly narrow the field of search and tell the investigator if the item is an artillery, mortar, or rocket projectile of a specific size. Further identification efforts may then be concentrated on types of projectiles common to that particular weapons system.

Bourrelet Measurement. All projectiles must rest or be supported on some surface prior to and during launch or firing; the artillery or mortar projectile in the gun tube and the rocket in its launcher, rest against the side of their surrounding weapon. To decrease friction drag upon firing and to center the projectile in its tube or launcher, all projectiles have a slightly enlarged portion or portions of their body designed to act as a bearing surface and contact point between the projectile and its tube or launcher. This area (there may be more than one) is known as a *bourrelet*. The bourrelet, because it is the largest *steel* portion of the projectile, is where the diameter measurement *must* be obtained. Figure 319 illustrates a typical artillery projectile and identifies the bourrelet area where the measurement should be taken.

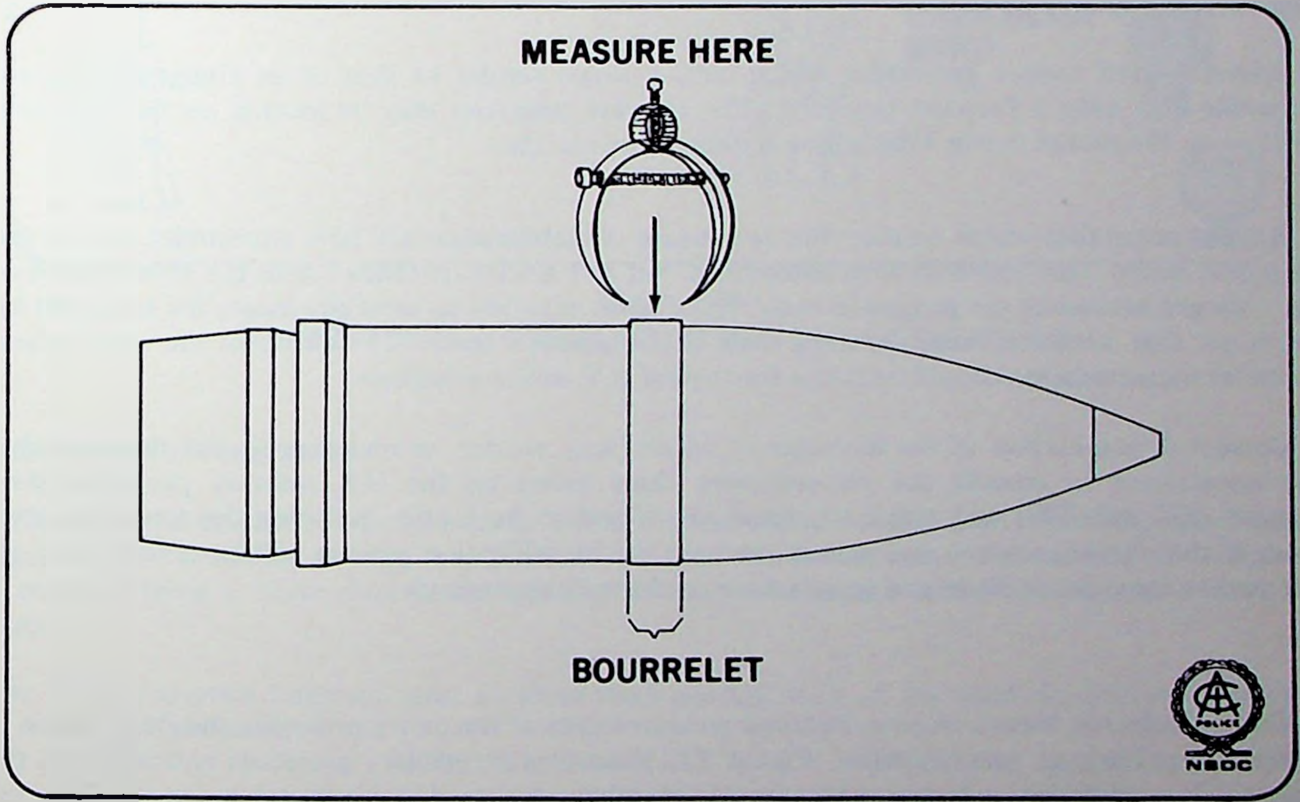


Figure 319
DIAMETER MEASUREMENT OF ARTILLERY PROJECTILES

It should be noted that, *prior to firing*, the rotating band is actually the largest diameter portion of the projectile. The rotating band is normally made of *copper* (sometimes sintered iron or plastic) which is cut or engraved by the weapon's rifling when it is fired and *should not* be used to determine projectile diameter because of its oversize construction. When the projectile is fired, the rotating band, as it is cut by the rifling, supports and centers the rear half of the projectile while the bourrelet supports the forward half. *All* artillery projectiles will have a bourrelet, although in some cases they may be difficult to visually identify. Remember that the *bourrelet* is the bearing surface for the *forward half* of the projectile and by sliding the hands along the projectile body it is possible to locate the bourrelet area by "feel," even though it may be difficult to see. Diameter measurements of artillery projectiles *must be taken at the bourrelet or they will not be accurate enough to identify the caliber of the projectile.*

Mortar projectiles employ two basic body shapes, that of a teardrop and an elongated or projectile shape. Those mortar projectiles which have an elongated body will also have a bourrelet on the forward half of the projectile and it is here that the diameter measurement should be taken, as was the case with artillery projectiles. Those mortar projectiles which have a teardrop or very streamlined shape have, as their forward bearing surface, a machined area known as the gas check band or obturator. (The rear bearing surface of these mortars is the fin area.) The gas check band consists of from 1 to 5 alternately raised and grooved portions of the body set closely together at the maximum diameter point of the projectile body. The gas check band area is usually unpainted. Diameter measurements should be taken across any one of the *raised portions* of the gas check band. Figure 320 illustrates typical U.S. mortar projectiles and indicates the points where measurements should be taken.

Spin-stabilized rocket projectiles which have a shape similar to that of an elongated artillery projectile also have a forward bourrelet. The forward bourrelet may be located on the projectile itself or on the rocket motor tube where it joins the projectile.

Rocket projectiles which employ fins as a means of stabilization will have a bourrelet area on the projectile body. This bourrelet area sometimes, but not always, extends across the entire length of the enlarged section of the projectile body. Once again, it is best to carefully locate the bourrelet by touch so that accurate measurements may be obtained. Figure 321 illustrates the areas where diameter measurements should be taken for typical U.S. military rockets.

Correct determination of the diameter of an artillery, mortar, or rocket projectile should enable the investigator to consult the measurement chart listing all the U.S. military projectile sizes (Figures 308 and 309) and make an initial identification by simply matching the measurements. Even if the identification is not precise, at least the identification process will have eliminated all but two or three possibilities and greatly narrowed the field of search.

Other Projectile Measurements. Detailed measurements of the entire projectile should be taken in order to establish an identification. Figure 322 illustrates an artillery projectile and indicates the points where detailed measurements should be taken. Figure 323 illustrates a sample form for recording this detailed information. Comparable measurements should be taken for mortar and rocket projectiles.

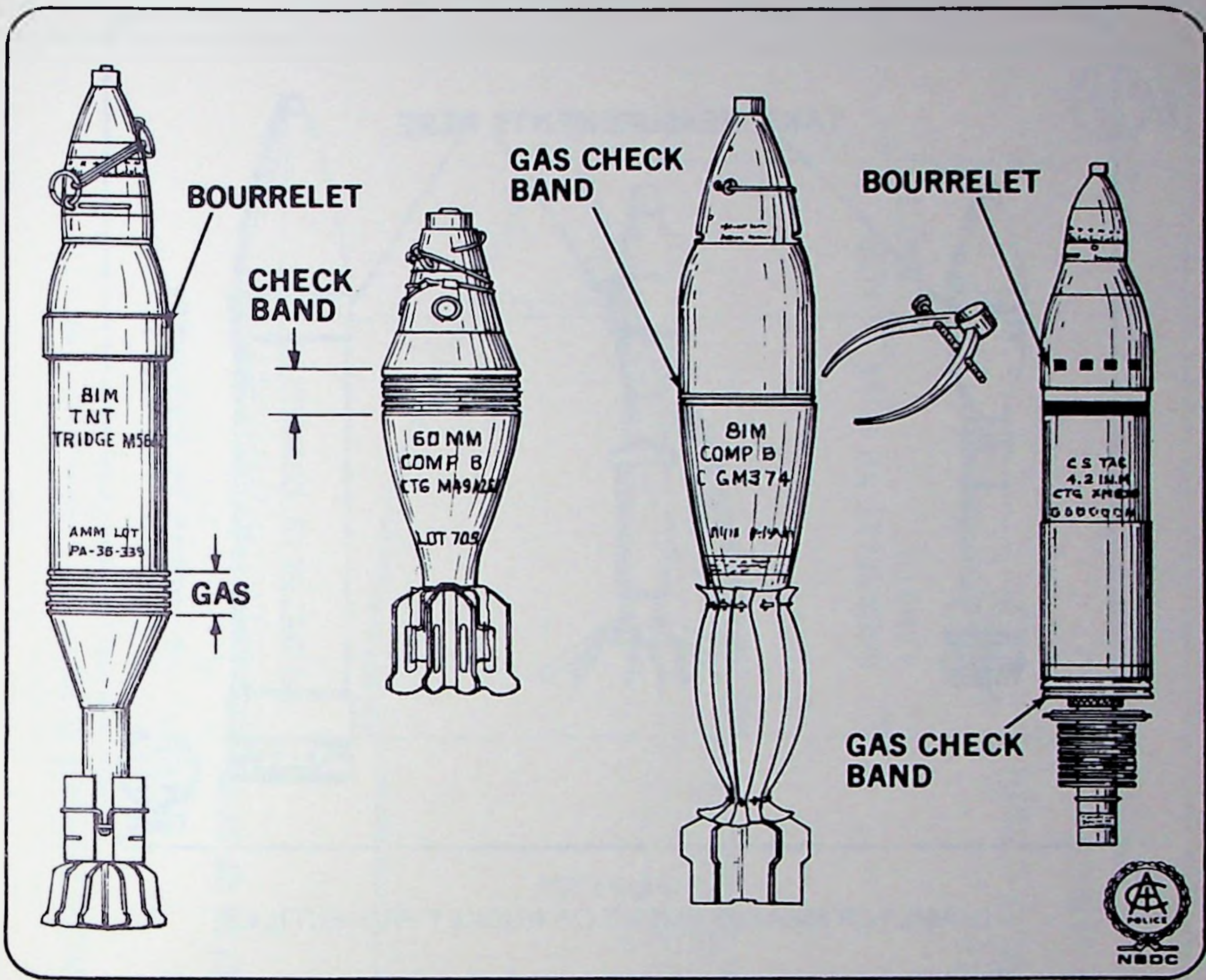


Figure 320
DIAMETER MEASUREMENT OF MORTAR PROJECTILES

Identification of Fragments

To aid in the determination of original artillery projectile size based upon recovered crime scene fragments, the following method is suggested. This approach is based on the geometric construction of circumscribing a circle about a triangle. For accurate results, the following conditions must be present:

- The recovered fragment must be more than one-half inch of the total circumference of the artillery projectile.
- The fragment must be from that portion of the shell between the rotating band and the bourrelet, preferably including a small portion of the keying marks normally associated with the rotating band, as illustrated in Figure 324.

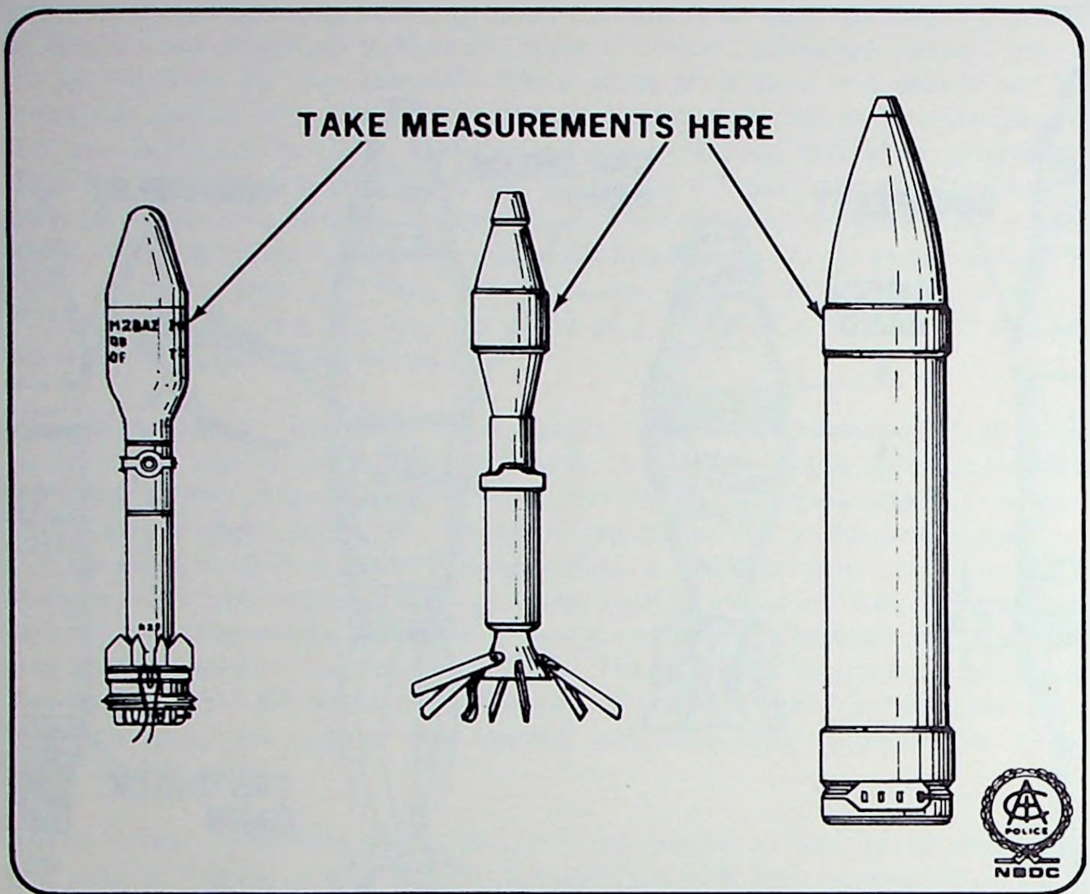


Figure 321
DIAMETER MEASUREMENT OF ROCKET PROJECTILES

- The fragment should not have been distorted by the detonation of the projectile. If slight distortion is present, the results will be approximate but will still give an indication of the projectile size.

Having recovered a suitable fragment which meets these conditions, proceed as follows:

- **Step 1.** Select two points (Points "A" and "B", Figure 324) as far apart as possible. The two points should be on the circumference of the original shell.

- **Step 2.** Measure the distance between the two points with dividers or any other suitable instrument and plot this measurement on paper (Figure 325).

- **Step 3.** Select a third point (Point "C", Figure 324) on the arc fixed by the two points "A" and "B" and measure the distance from Point "A" to Point "C". Using this distance as the radius swing an arc about Point "A" on the paper (Figure 325).

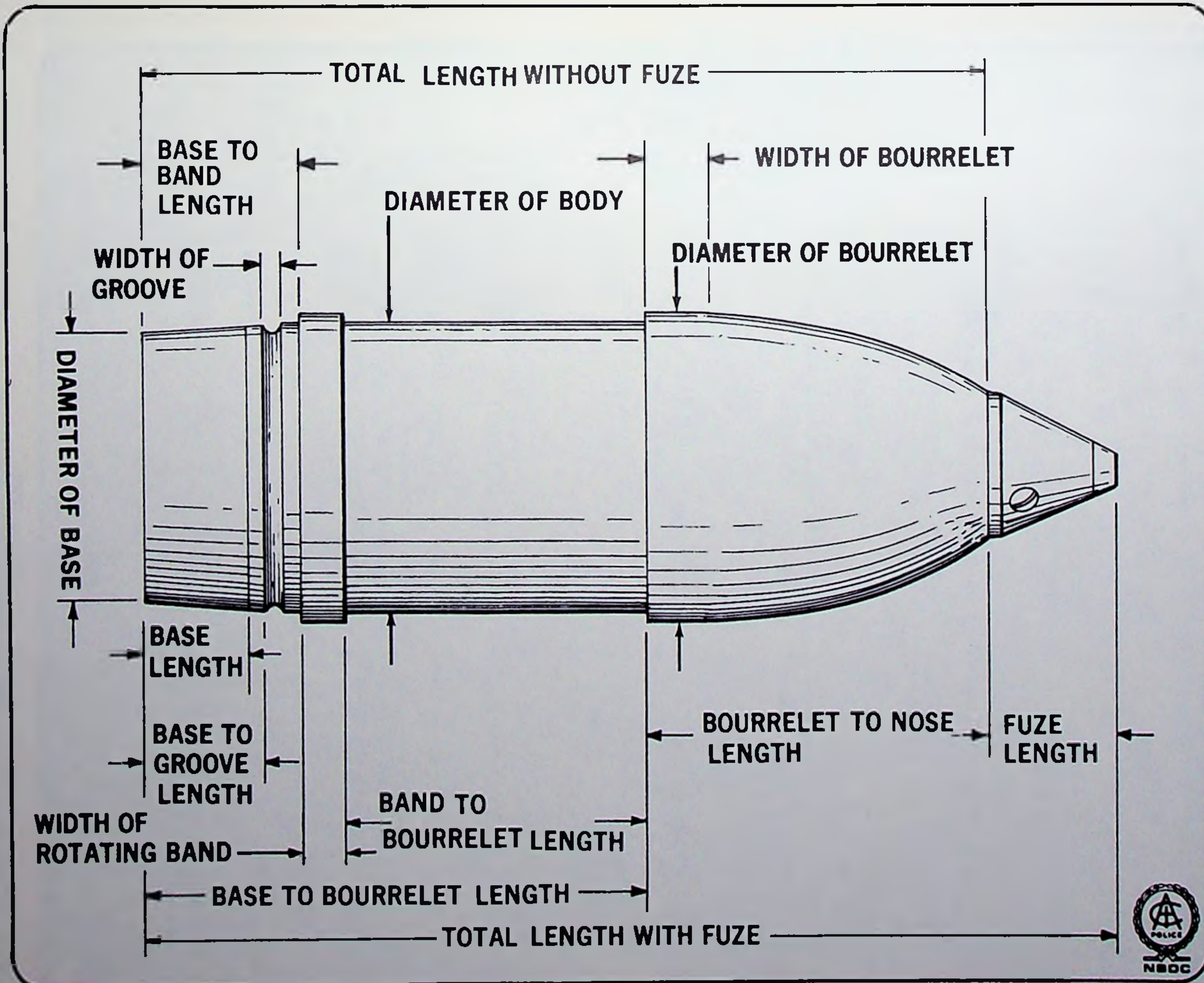


Figure 322

POINTS OF MEASUREMENT FOR IDENTIFICATION OF AN ARTILLERY MORTAR PROJECTILE

IDENTIFICATION INFORMATION RECORDING FORM

Projectile

Color of Body Paint ______________________

Color of Paint Used for Letters and Numbers ______________________

Color of Paint Used for Bands or Figures ______________________
*(Record all letters, numbers, bands and markings on separate sheet)

Color of Paint Undercoat ______________________

Bourrelet Measurement ______________________

Length with Fuze ______________ Length without Fuze ______________
*(Record all fuze markings on separate sheet)

Length, Bourrelet to Nose ______________ Width of Bourrelet ______________

Length, Bourrelet to Base ______________ Rotating Band Material ______________

Length, Bourrelet to Rotating Band ______________ Width of Rotating Band ______________

Number of Grooves in Rotating Band (if fired) ______________________

Number of Grooves in Rotating Band if Unfired (cannalures) ______________
*(Record all markings on rotating band on separate sheet)

Length, Base to Rotating Band ______________ Length, Base to Groove ______________

Width of Groove ______________ Diameter of Base ______________
*(Record all markings stamped or engraved on the body on a separate sheet)

Fins

Number of Fins ______________ Diameter Across Fins ______________

Fin Material ______________ Length of Fins ______________

Length, Fins to Projectile ______________ Length, Fin Boom ______________

Diameter of Fin Boom ______________ Number, Holes in Fin Boom (side) ______________

Figure 323
SAMPLE FORM FOR RECORDING IDENTIFICATION INFORMATION

Hole in Center Rear of Fins, Diameter ________ Primer in Place ________

Inside of Hole is: Threaded ________ Tapered ________ Straight Sides ____

Length of Rocket Motor Tube ________ Diameter ________
*(Record all markings on motor tube or fin boom on separate sheet)

Length of Base Fuze ________ Diameter ________ Material ________
*(Record all markings on base fuze on separate sheet)

Tracer Diameter ________ Length ________

Weight of Entire Projectile ________ lbs. ________ oz.

*Sketch Entire Projectile and Indicate Measurements on Sketch

*Photograph Entire Projectile from Various Angles (8 x 10 prints) (1:1 if possible)

X-ray Projectile (if possible)

Figure 323
SAMPLE FORM FOR RECORDING IDENTIFICATION INFORMATION (Continued)

- Step 4. Measure the distance from Point "B" to Point "C"(Figure 324). Using this distance as the radius swing an arc about Point "B" on the paper (Figure 325).

- Step 5. Mark the intersection of the two arcs. This is the plot of Point "C".

- Step 6. Draw the triangle thus formed using Points "A", "B", and "C" as the vertices. Erect perpendicular bisectors to the two longest sides of the triangle (Figure 326). To construct a perpendicular bisector of a line, with dividers, set off a radius greater than one-half the length of the line, swing arcs, one on each side of the line, from each end of the line. The line connecting the two points of intersection of the arcs is the perpendicular bisector. (See Figure 327).

- **Step** 7. Measure the distance from the point of intersection of the two perpendicular bisectors to any one of the vertices of the triangle. Multiply this distance by two and the result is the diameter of the artillery projectile from which the fragment came. (See Figure 328).

Identification Assistance

The Research Division of the International Association of Chiefs of Police maintains extensive identification files for all types of U.S. military and foreign ordnance dating back to the late 1920s

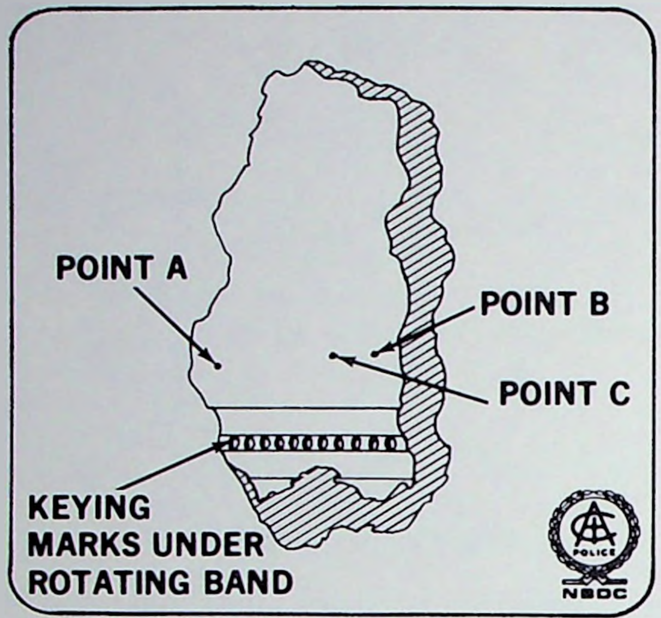


Figure 324
STEPS 1, 3 & 4 OF THE METHOD FOR DETERMINING THE SIZE OF A PROJECTILE FROM RECOVERED FRAGMENTS

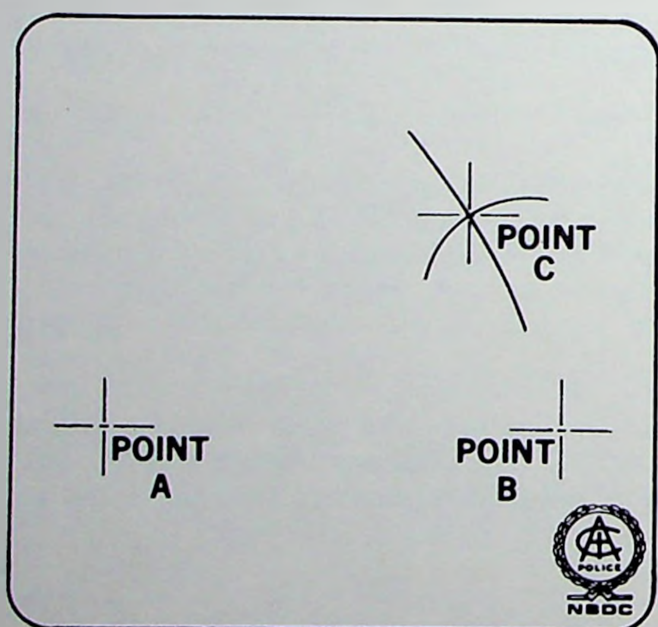


Figure 325
STEPS 2, 3, & 4 OF THE METHOD FOR DETERMINING THE SIZE OF A PROJECTILE FROM RECOVERED FRAGMENTS

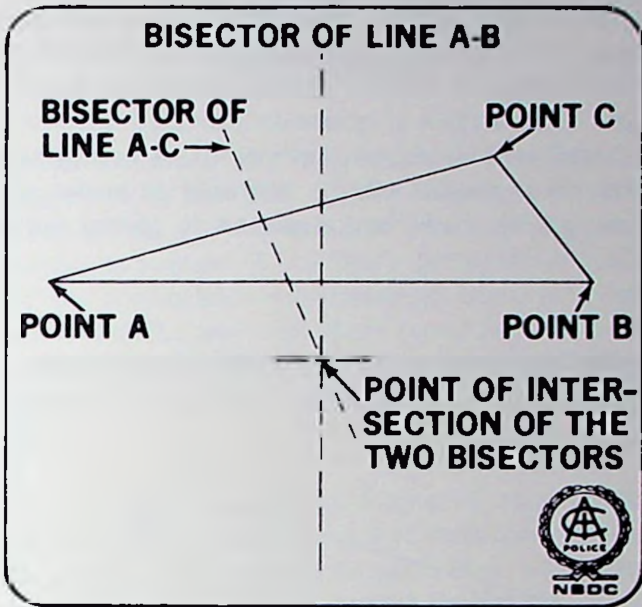


Figure 326
STEP 6 OF METHOD FOR DETERMINING THE SIZE OF A PROJECTILE FROM
RECOVERED FRAGMENTS

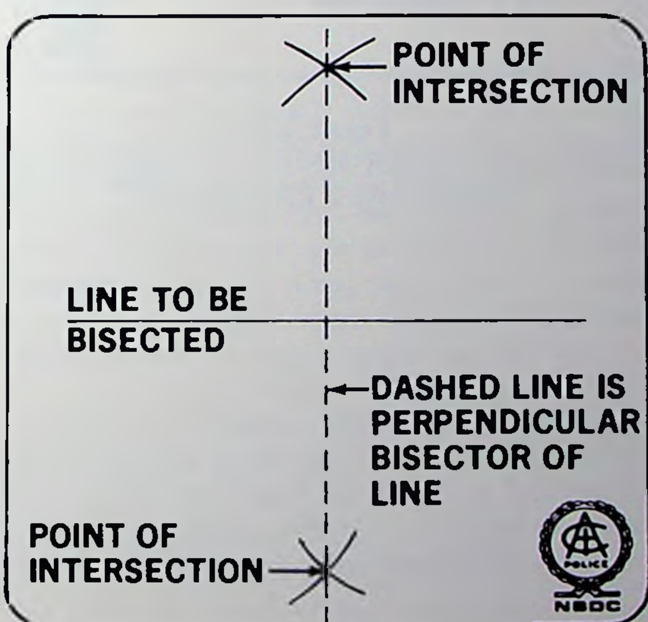


Figure 327
STEP 6 OF THE METHOD FOR DETERMINING THE SIZE OF A PROJECTILE
FROM RECOVERED FRAGMENTS

and, in some instances, prior to this period. Assistance in identification of military ordnance involved in *criminal cases* may be obtained by contacting the Director of the Research Division, International Association of Chiefs of Police, Eleven Firstfield Road, Gaithersburg, Maryland 20760, by letter or telephone. This service is normally provided without cost to law enforcement officials within the limits of time and workload restrictions. A completed identification recording form, a sketch, and several photographs will be required in order to render assistance. It is recommended that initial contact be made by telephone to insure mutual understanding of the information to be submitted.

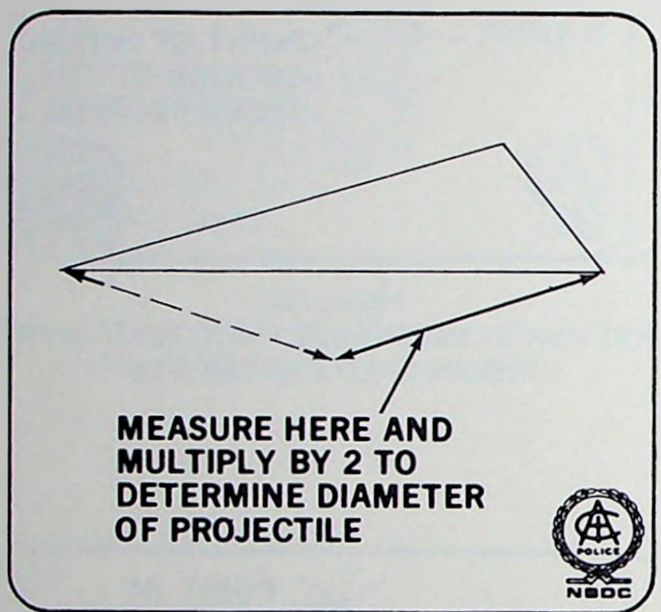


Figure 328
STEP 7 OF THE METHOD FOR DETERMINING THE SIZE OF A PROJECTILE FROM RECOVERED FRAGMENTS

SECTION THREE
BOMBLETS

Military artillery projectiles, rockets, guided missiles, and aircraft bombs as well as special aircraft dispensers are currently employed by the U.S. Armed Forces to dispense small explosive bomblets or sub-projectiles over a battlefield area. There is a decided tactical advantage to be gained by employing this type of munitions system. An artillery projectile, for example, can only strike and explode in one portion of the battlefield, whereas small bomblets ejected by the same projectile high above the combat area will strike and explode in many areas, producing more casualties. These small bomblets have been recovered in the past by law enforcement officers from persons who have stolen them from arms plants and military installations or who have brought them back to the United States as war souvenirs.

While it is not possible to present a complete listing of each bomblet in existence due to the classified nature of some military items, the majority of bomblet configurations currently in use are illustrated in the following section, which should be more than adequate as a recognition guide. The military identification for the majority of these small bomblets is BLU- followed by an identifying number and letter designation. The BLU identification stands for *Bomb Live Unit.*

Unfortunately, not all bomblets are designated as BLU's. In some cases, a bomblet has been developed for more than one tactical use, and it is referred to by a different name, even though it is identical to another bomblet with a BLU designation. The text and illustrations in this section will indicate those bomblets which have the same recognition features but different name designations, and group them together into recognition families. The other designations used for BLU's are *grenade* and *mine.*

Practice versions of live or explosive loaded BLU bombs are identified as *BDU*'s *(Bomb Dummy Unit). BDU*'s are *not always* inert but frequently contain *spotting charges of black powder* intended to produce a smoke puff upon impact with the target. These spotting charges are sometimes capable of causing the bomb body to rupture and produce fragmentation and *BDU*'s should, therefore, be handled with caution. *BDU*'s are frequently, but not always, painted a torch red color (very bright red) or a bright orange color to aid in their identification and location on military bombing and gunnery ranges. When spotting charges are employed in *BDU*'s, a 1/2- to 3/4-inch-wide band of brown paint is supposed to be placed on the bomb body to indicate that it contains a low explosive charge. Experience has indicated that this band is not always present.

BDU bodies which are *inert* (containing no spotting charge) have been painted light blue in the past and may be encountered painted in this manner. Live BLU bombs are normally painted bright yellow, olive drab or black, or may be found unpainted. In general, it is *unwise* to rely upon color coding of BLU or *BDU* items as a primary method of identification, the overall configuration of the found item generally provides the best method of positive identification because of the distinctive shapes employed.

BLU-3/B Fragmentation Anti-Personnel and Anti-Material Bomb

The BLU-3/B is a small, fragmentation anti-personnel *and* anti-material bomb that measures 3 3/4 inches in length by 2 3/4 inches in diameter and weighs approximately 1 3/4 pounds. The bomb, normally painted bright yellow, is used against targets such as personnel, trucks, parked aircraft, ammunition dumps, fuel tanks, and radar equipment. When the bomb is ejected, air pressure lifts off the wind tab, releasing the retaining band which holds the fins together. The fins spring outward, stabilizing the bomb in its fall and arming the fuze. Upon impact, detonation projects small steel balls at high velocity in a radial pattern. Figure 329 illustrates the BLU-3/B bomb.

Practice bombs almost identical in physical size and shape to the BLU-3/B are identified as: *BDU-27/B, BDU-28/B,* and *BDU-40/B.* The *BDU-27/B* has a solid aluminum body and contains approximately 38 grains of a *black powder spotting charge.* The *BDU-28/B* has a hollow cast aluminum body and *does not* contain a spotting charge. The BLU-40/B has a plastic body which contains a *shotgun shell spotting charge.* Figure 330 illustrates these practice bombs which are normally painted bright red or orange. Those practice bombs containing a spotting charge should have a 1/2- to 3/4-inch brown paint band around the body.

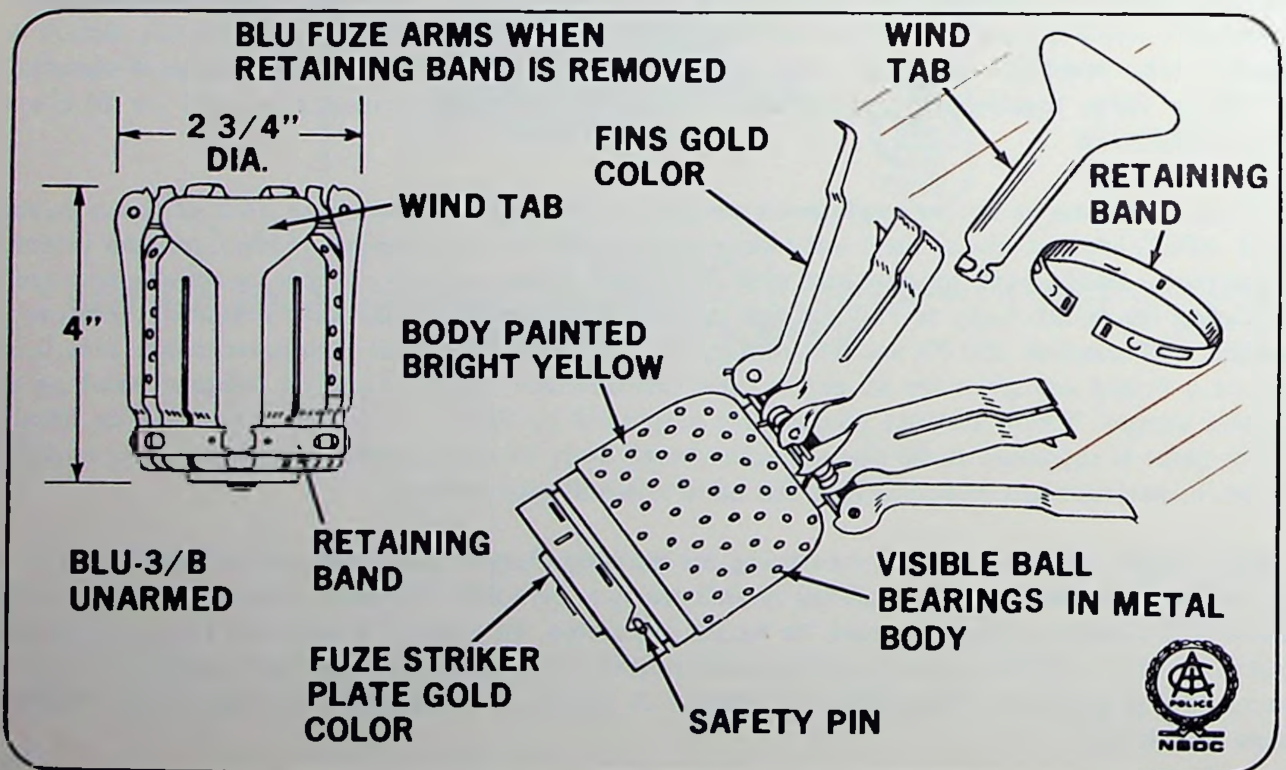


Figure 329
BLU-3/B FRAGMENTATION ANTI-PERSONNEL BOMB

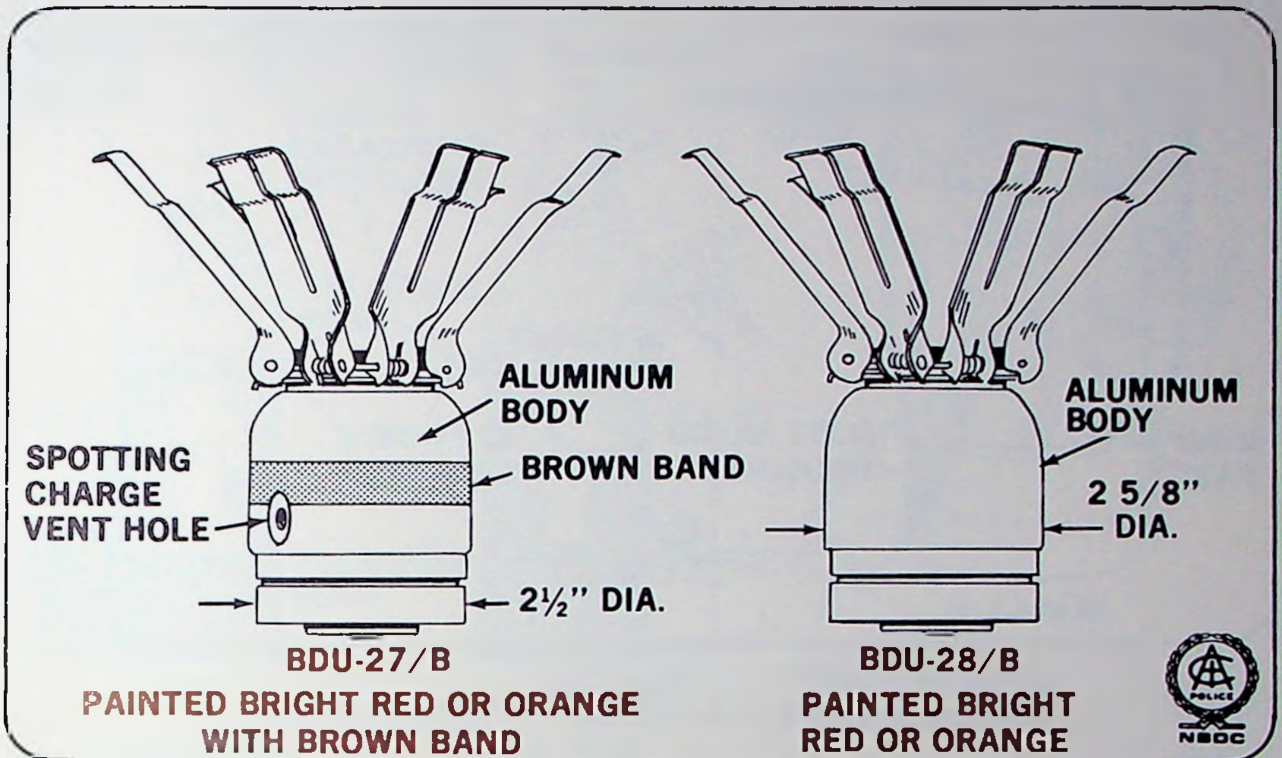


Figure 330
BLU-27/B AND BDU-28/B PRACTICE BOMBS

BLU-4A/B Fragmentation Anti-Personnel Bomb

The BLU-4A/B is a small, fragmentation anti-personnel bomb. This bomb has a maximum diameter of 2 3/4 inches (with the fins closed) and is approximately 5 inches in length. The bomb weighs 1 1/4 pounds. When it is ejected from the aircraft or other dispenser, air pressure lifts off the wind tab which in turn releases the fin retaining band holding the fins (also known as *drag vanes*) together. The spring steel fins spring outward, stabilizing the bomb in its fall and arming the fuze and the ejection portion of the bomb. Upon impact, a fragmentation hemisphere is ejected from the bomb body and a lanyard, fastened to both the fragmentation hemisphere and the bomb body, unreels. When the lanyard reaches its full 10-foot length, it detonates the high explosive charge in the fragmentation hemisphere. No practice bomb has been identified for the BLU-4A/B. Figure 331 illustrates the BLU-4A/B bomb.

BLU-7/B and BLU-7A/B Anti-Tank Shaped Charge Bomb

The BLU-7/B and BLU-7A/B are anti-tank shaped charge bombs employed against targets such as tanks, armored vehicles, and parked aircraft. The BLU-7/B bomb is 7 7/8 inches in length by 2 3/4 inches in diameter, and weighs 1 1/2 pounds. The BLU-7A/B is 8 1/4 inches in length and 2 3/4 inches in diameter. These bombs are parachute-armed and stabilized. When the bombs are ejected, the air stream lifts off the wind tab, permitting the retaining band and plastic parachute protector

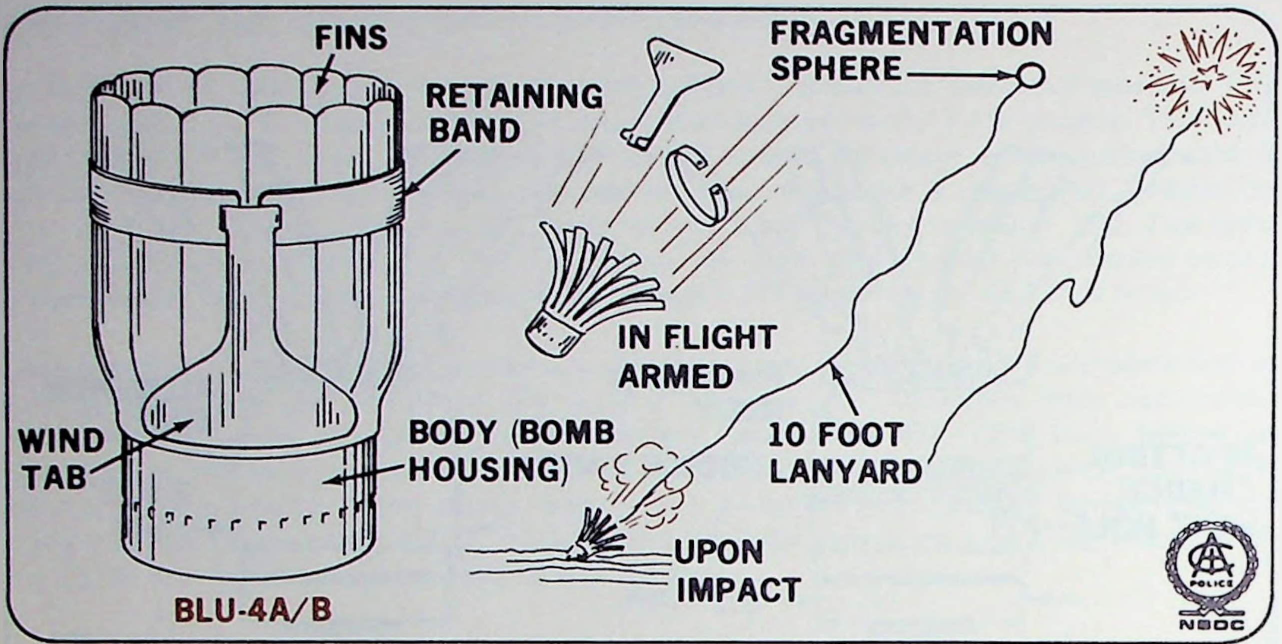


Figure 331
BLU-4A/B FRAGMENTATION ANTI-PERSONNEL BOMBLET

to fall away and allow a ribbon parachute to open and arm the fuze. Upon impact with a solid object such as a tank, the fuze striker drives into the detonator which initiates the explosive train and detonates the bomb. Detonation of the explosive forms a shaped charge jet to perforate the tank's armor. Figure 332 illustrates the BLU-7/B and BLU-7A/B bombs.

The two practice bombs for the BLU-7 bombs are identified as the *BDU-37/B* and the *BDU-25/B*. The practice bomb *BDU-37/B* is identical in size and shape to the *BLU-7A/B* bomb and does *not* contain a spotting charge. The practice bomb *BDU-37/B* usually has a light blue, anodized aluminum body.

The *BDU-25/B* practice bomb is a partly hollow steel cylinder with a parachute packed inside. The body is painted bright red. Raised letters on the bottom of the *BDU-25/B* identify it as "Bomb, Practice, *BDU-25/B*." This *BDU* contains *no explosive*. Figure 333 illustrates the *BDU-37/B* and the *BDU-25/B*.

BLU-16/B Burning White Smoke (HC) Bomb

The BLU-16/B is a small cylindrical, beer can-size burning white smoke bomb, similar in appearance to the M8 smoke hand grenade. The body is 2 3/4 inches in diameter and 4 3/4 inches in length. The weight of the bomb is approximately 2 1/4 pounds. A M201A1 striker release hand grenade fuze installed in the top of the bomb body ignites the burning smoke mixture. Four tape-covered smoke vent holes are located in the top of the metal body surrounding the fuze. When the bomb is ejected, the wind tab is lifted off by air pressure, releasing the retaining band and

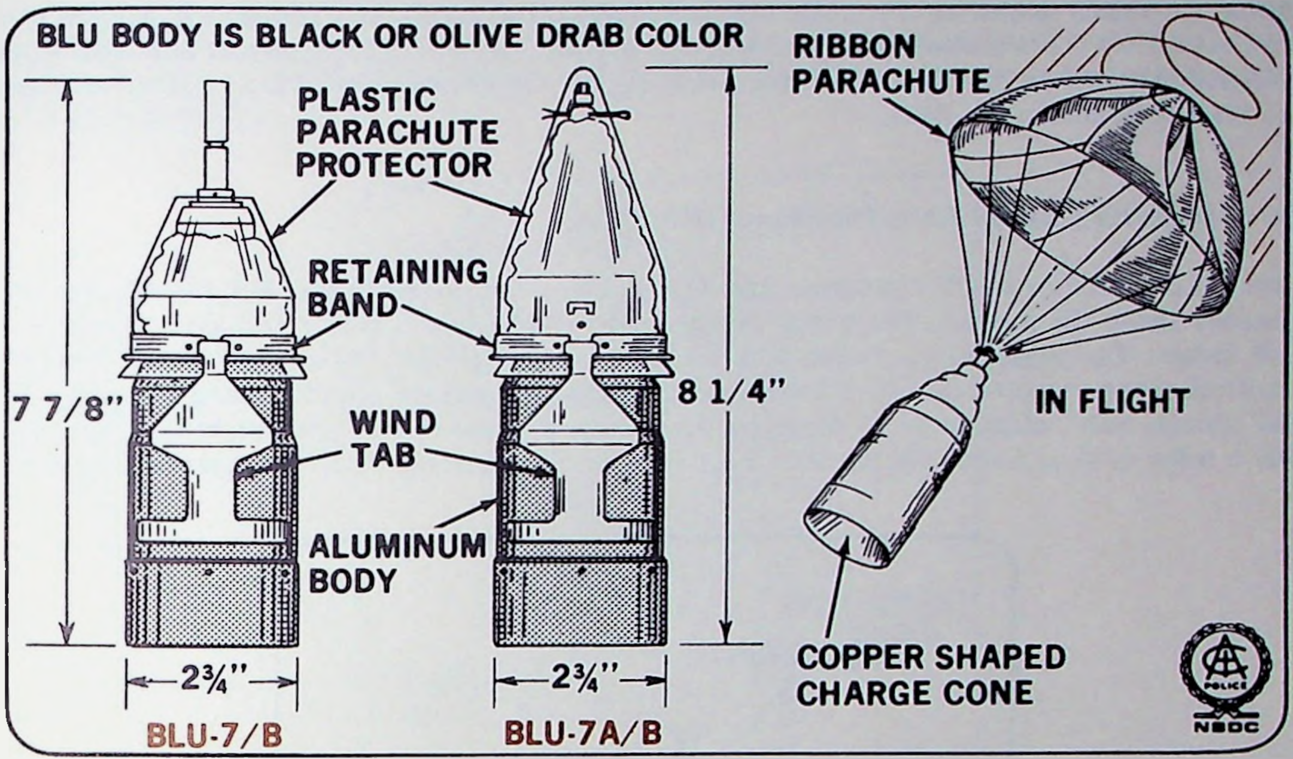


Figure 332
BLU-7B AND BLU-7A/B ANTI-TANK SHAPED CHARGE BOMBS

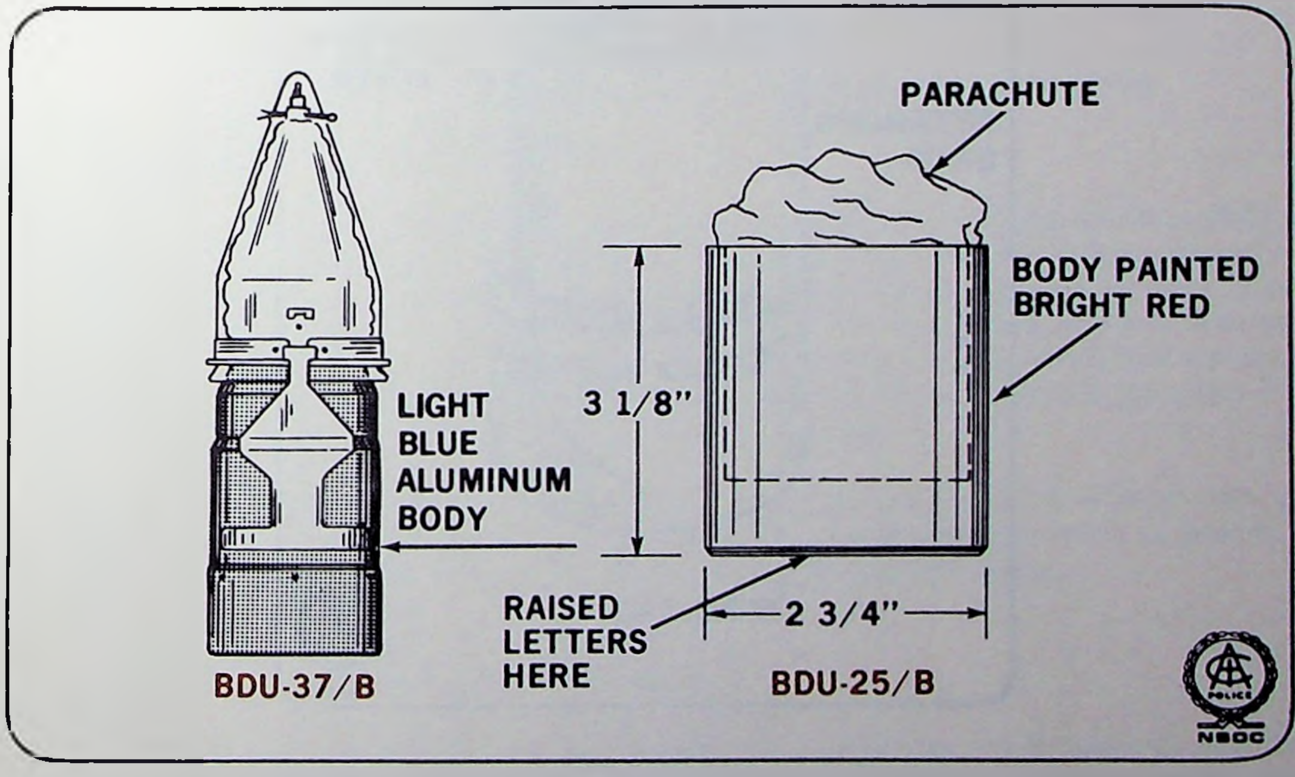


Figure 333
BDU-37/B AND BDU-25/B PRACTICE BOMBS

allowing the striker release hand grenade fuze to function. The bomb body is normally painted light green, except for the top which is painted white to indicate the color of the smoke. Bomb markings are stenciled on the body in white or black paint. Figure 334 illustrates the BLU-16/B bomb. There is no practice bomb for this BLU.

BLU-17/B Bursting Smoke White Phosphorus (WP) Bomb

The BLU-17/B is a small, cylindrical bursting smoke, white phosphorus (WP)-filled bomb that detonates above the ground. The bomb with fuze is 5 3/4 inches in height and has a diameter of 2 3/4 inches. The weight of the bomb with the fuze is 2 1/4 pounds. When it is ejected from the aircraft dispenser, air pressure lifts off the wind tab which releases the retaining band and allows the hand grenade fuze safety lever to move outward, releasing the striker and functioning the fuze. After a delay of 4 to 5 seconds, the fuze functions, detonating the burster and rupturing the bomb

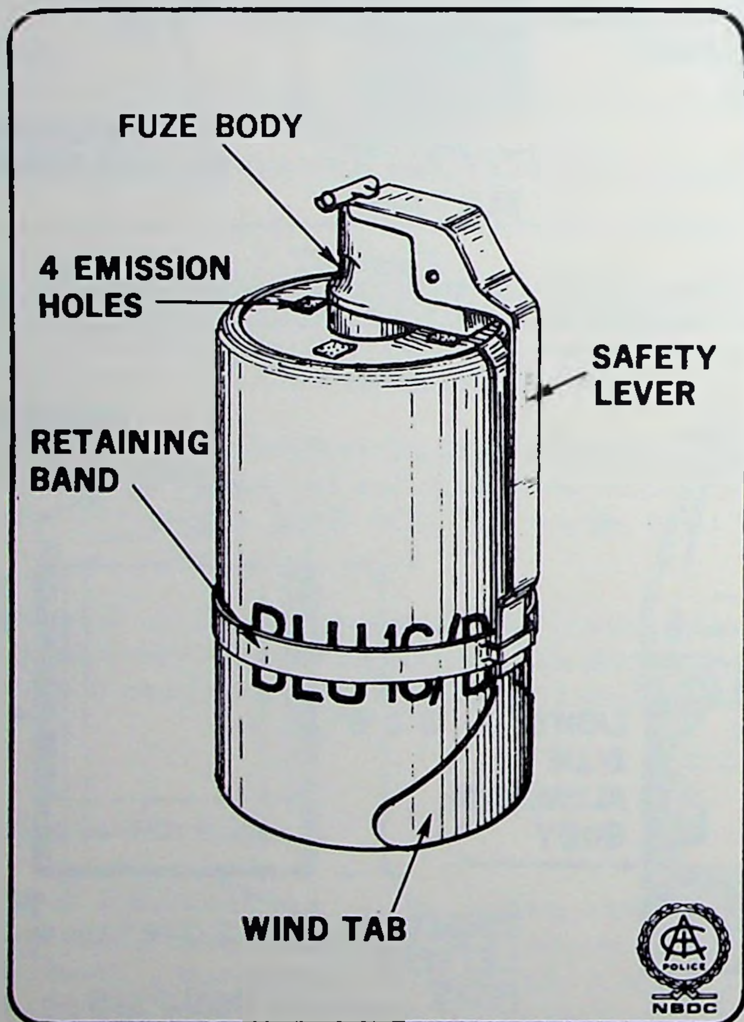


Figure 334
BLU-16/B BURNING WHITE SMOKE (HC) BOMB

body. Particles of steel and burning white phosphorus as well as dense smoke are scattered over a 35-yard radius. The bomb body is normally painted light green with markings stenciled in red on the side or bottom of the body. Figure 335 illustrates the BLU-17/B bomb. There is no practice bomb for this BLU.

Figure 335
BLU-17/B BURSTING SMOKE WHITE PHOSPHOROUS (WP) BOMB

BLU-18/B Fragmentation Anti-Personnel Bomb

The BLU-18/B is a small, anti-personnel, fragmentation bomb which is fin-stabilized in flight. The aluminum body of the bomb is triangular in shape with a 2-inch base, and is 2 inches wide and 1 1/2 inches high. The triangular aluminum body is normally unpainted and the fins are black in color. The bomb has a weight of 1/2 pound. When it is ejected, the bomb fins open and fuze arming occurs. Upon impact with the target, the fuze striker is driven into a primer, which fires a propellant charge, projecting a fragmentation sphere into the air. The fragmentation sphere detonates 4 to 6 feet above the ground. Figure 336 illustrates the BLU-18/B bomb.

The practice bomb for the BLU-18/B bomb is identified as the *BDU-34/B*. This practice bomb has a *solid aluminum body* and contains no explosive. No fragmentation sphere is present. The BDU-34/B body is unpainted, but the fins are sometimes painted bright orange.

BLU-19/B23 Bursting Chemical War Gas (GB) Bomb

The BLU-19/B23 is a cylindrical bomb, 9 7/16 inches in length by 4 5/8 inches in diameter. It weighs 9 1/2 pounds and is employed as an anti-personnel, chemical war gas munition. It contains

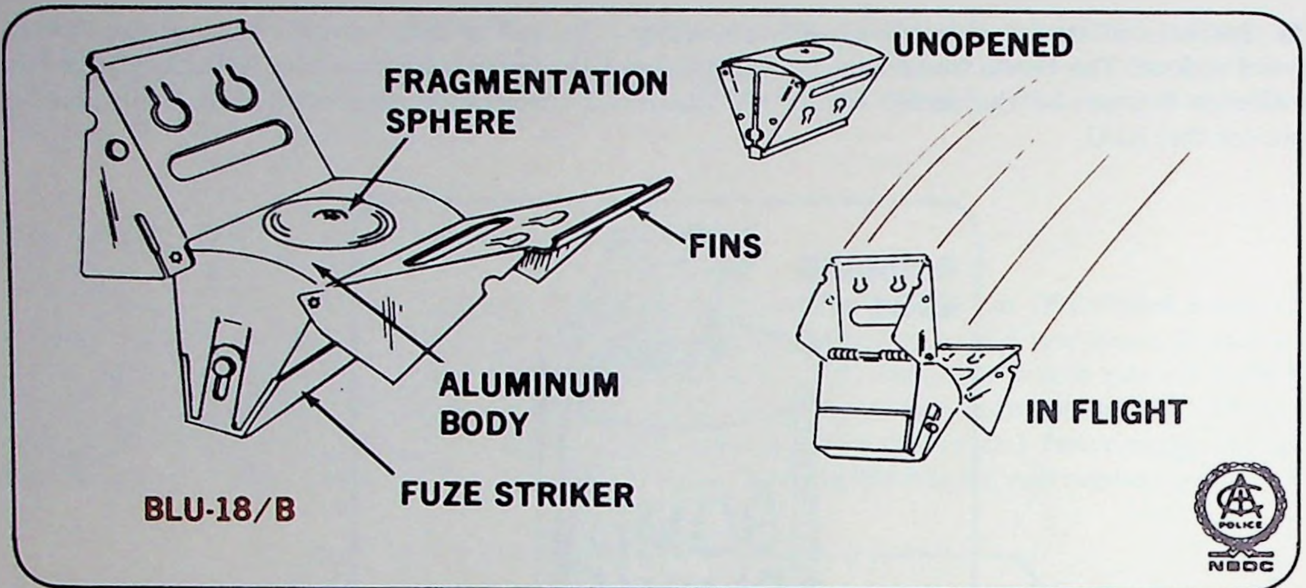


Figure 336
BLU-18/B FRAGMENTATION ANTI-PERSONNEL BOMB

an RDX central burster and a chemical war gas agent known as GB. The bomb is armed 1 1/2 seconds after it leaves the dispenser tube. Upon impact the *all-ways action impact fuze* detonates the explosive in the central burster tube and the lethal chemical agent is dispersed. Figure 337 illustrates the BLU-19/B23 bomb. No practice bomb for this BLU has been identified.

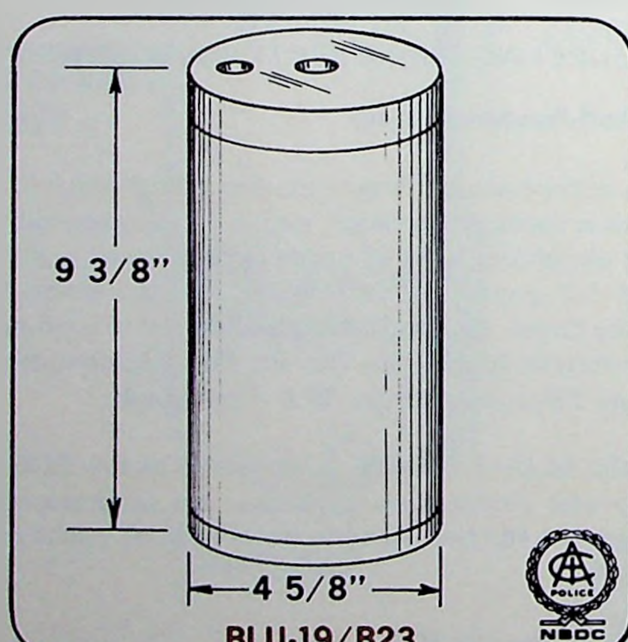


Figure 337
BLU-19/B BURSTING CHEMICAL BOMB

BLU-24/B, BLU-24B/B, BLU-24C/B, BLU-66A/B, and BLU-66B/B Fragmentation Anti-Personnel Bombs (Jungle Bomb)

The BLU-24/B is an anti-personnel fragmentation bomb designed to penetrate jungle foliage before detonation. The bomb is 3 11/16 inches in length by 2 7/8 inches in diameter, with a total weight of 1 5/8 pounds. A plastic vane (rotating fin assembly) provides the necessary spin force for arming the bomb as it falls. When the bomb impacts and penetrates jungle foliage, the spin force declines and the bomb detonates, producing fragmentation. The BLU's are delivered to the target area by an aircraft dispenser and may in the future be delivered by a 2.75-inch FFAR rocket projectile. The bomb bodies are normally painted bright yellow.

The practice bomb for the BLU-24 and BLU-66 family of bombs has the same construction as the live bombs but contains no explosive. The BDU-42/B is normally painted bright red. Figure 338 illustrates this family of bombs.

BLU-26/B, BLU-36/B, BLU-59/B, and BLU-63/B Fragmentation Anti-Personnel Bombs

These bombs are round, free-fall fragmentation bombs intended for tactical use against light material and personnel targets. The bomb is similar in size to a baseball, having a diameter of 2 3/4 inches and weighing approximately 1 pound. It has four protruding wind vanes molded into the metal body to impart spin to the bomb as it falls, causing the fuze to arm. Upon detonation, the bomb produces a large number of small, high velocity fragments. Figure 339 illustrates this family of bombs.

The only difference between these bombs is in the type of fuze employed. The BLU-26/B and BLU-63/B have an *impact fuze* which detonates the bomb on contact with the ground. The BLU-36/B and BLU-59/B both employ a *variable time delay fuze* which will detonate the bomb at some time after impact with the ground. These bomb bodies may be painted olive drab with a 1/4-inch-diameter dot of yellow paint at some point on the body. Identification markings, if present, should be stenciled in yellow.

SPECIAL NOTE

BLU bombs which are ball-shaped and fitted with wind vanes have fuzes which are armed by centrifugal force and require approximately *2,400 revolutions per minute* (rpm) in order to cause arming. Rolling the bomb along the ground or throwing it through the air *does not normally* provide sufficient centrifugal force to cause the bomb fuze to arm. Hence, their employment as hand thrown grenades is not generally practical.

XM38, M38, and M40 Fragmentation Anti-Personnel Grenades

These anti-personnel grenades are dispensed from an aircraft bomb, but are nonetheless identified as grenades. The grenades are the general shape and size of a large ping pong ball and measure 1 11/16 inches in diameter. Several rows of protruding wind flutes are molded into the metal body. When released from the aircraft, the wind flutes impart a high rate of spin to the grenade and arm its internal fuze. Impact with the water, mud, soft earth, or any hard surface causes the *M40*

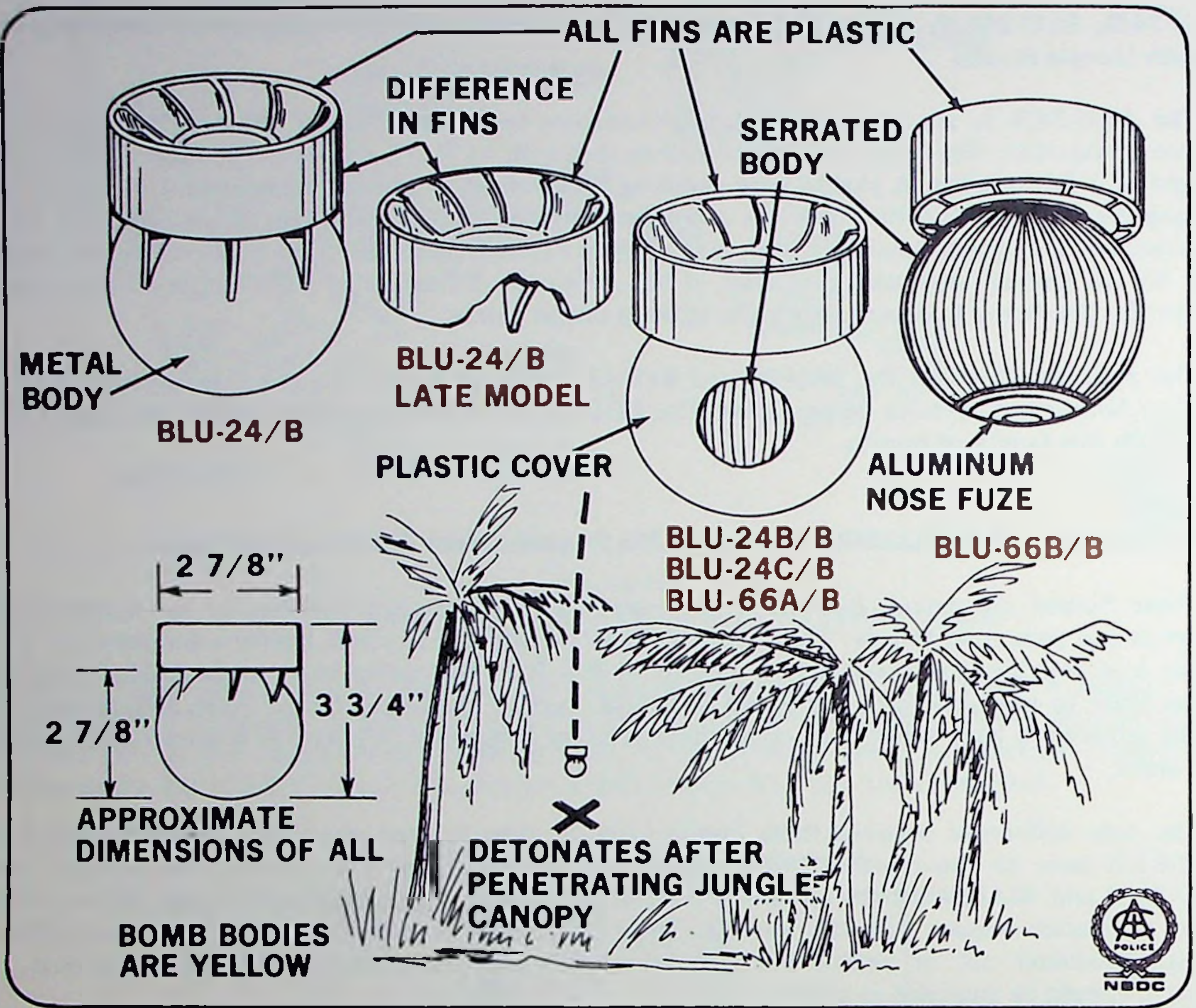


Figure 338
BLU-24/B, BLU-24B/B, BLU-24 C/3, BLU-66 C/B AND BLU-66 B/B FRAGMENTATION ANTI-PERSONNEL BOMBS (JUNGLE BOMB)

grenade to detonate, propelling fragments in all directions. The *XM38* and *M38* grenades *do not* detonate upon impact. The XM38 and M38 grenades are equipped with internal *random time delay fuzes* and detonate after the expiration of a preset time. *No visible distinction can be made between the three grenades.* The grenade bodies are normally painted olive drab and have no markings. Figure 340 illustrates this family of grenades.

SPECIAL NOTE

BLU bombs which are ball-shaped and fitted with wind vanes have fuzes which are armed by centrifugal force and require approximately *2,400 revolutions per minute* (rpm) in order to cause arming. Rolling the bomb along the ground or throwing it through the air *does not normally* provide sufficient centrifugal force to cause the bomb fuze to arm. Hence, their employment as hand thrown grenades is not generally practical.

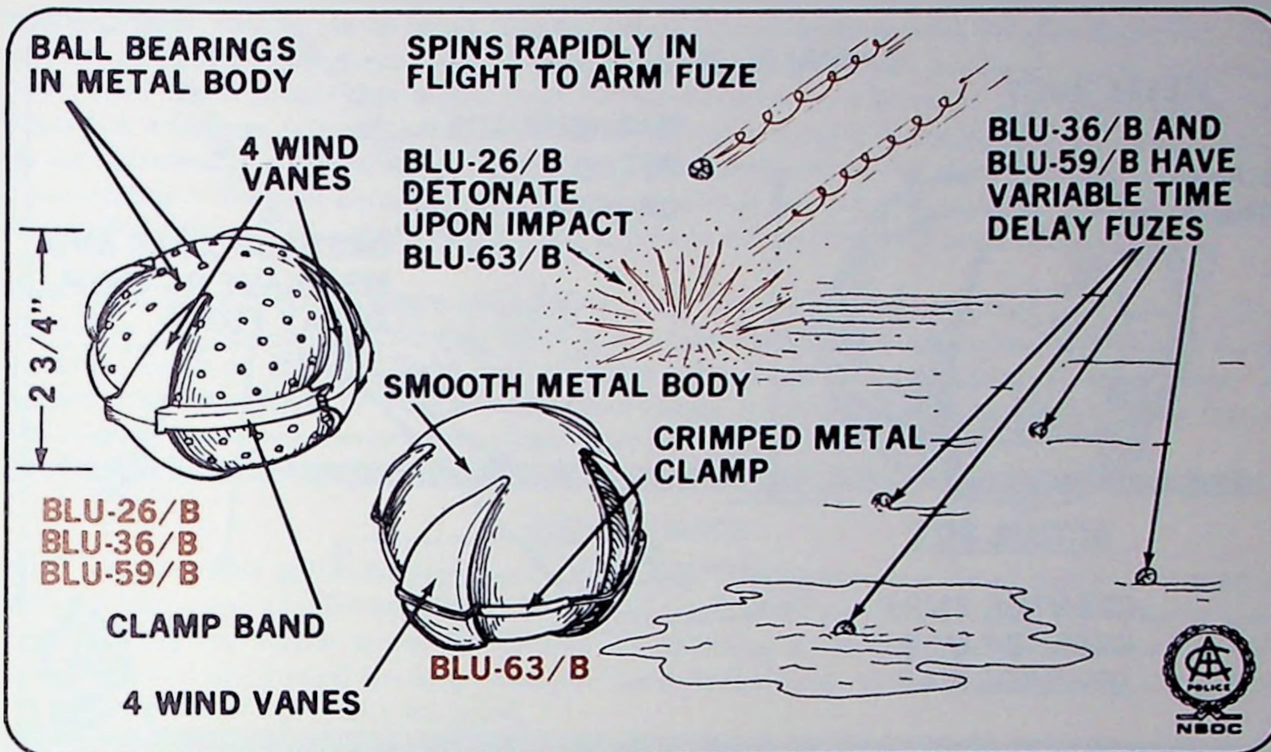


Figure 339
BLU-26/B, BLU-36/B, AND BLU-59/B FRAGMENTATION ANTI-PERSONNEL BOMBS

BLU-39/B Burning CS Bomb (Skitter Bomb)

The BLU-39/B is a small, cylindrical CS (tear gas)-filled bomb. The bomb measures 2 1/2 inches in length by 1 1/4 inches in diameter and weighs approximately 2 ounces. Its primary use is to disrupt enemy operations by causing eye and respiratory irritations. When the bombs are ejected, the match head igniters of each bomb are activated by a flash from the ejection charge. A length of safety fuse in each bomb burns for approximately 6 seconds. At the end of the delay time, the safety fuse ignites the burning CS filler. Because of the off-center vent hole in the upper bomb body, the burning of the CS filler propels the bomb along the ground in an erratic path as it burns. Hence, its name of "skitter bomb." The BLU-39/B has a 1/2-inch-wide circumferential red band painted around the midsection of the body. Figure 341 illustrates the BLU-39/B bomb. No practice bomb has been identified for the BLU-39/B.

BLU-42/B, BLU-42A/B and BLU-54/B Fragmentation Anti-Personnel (SADA or WAAPM) Mines

These three BLU bombs are designated as *mines.* The mines are similar in size and shape to a baseball and have a diameter of 2 3/8 inches, excluding wind vanes. The four protruding wind vanes molded into the sintered iron body impart spin to the mine as it falls through the air. Steel cross-shaped tabs are positioned at the top and bottom of the ball-shaped body, covering and

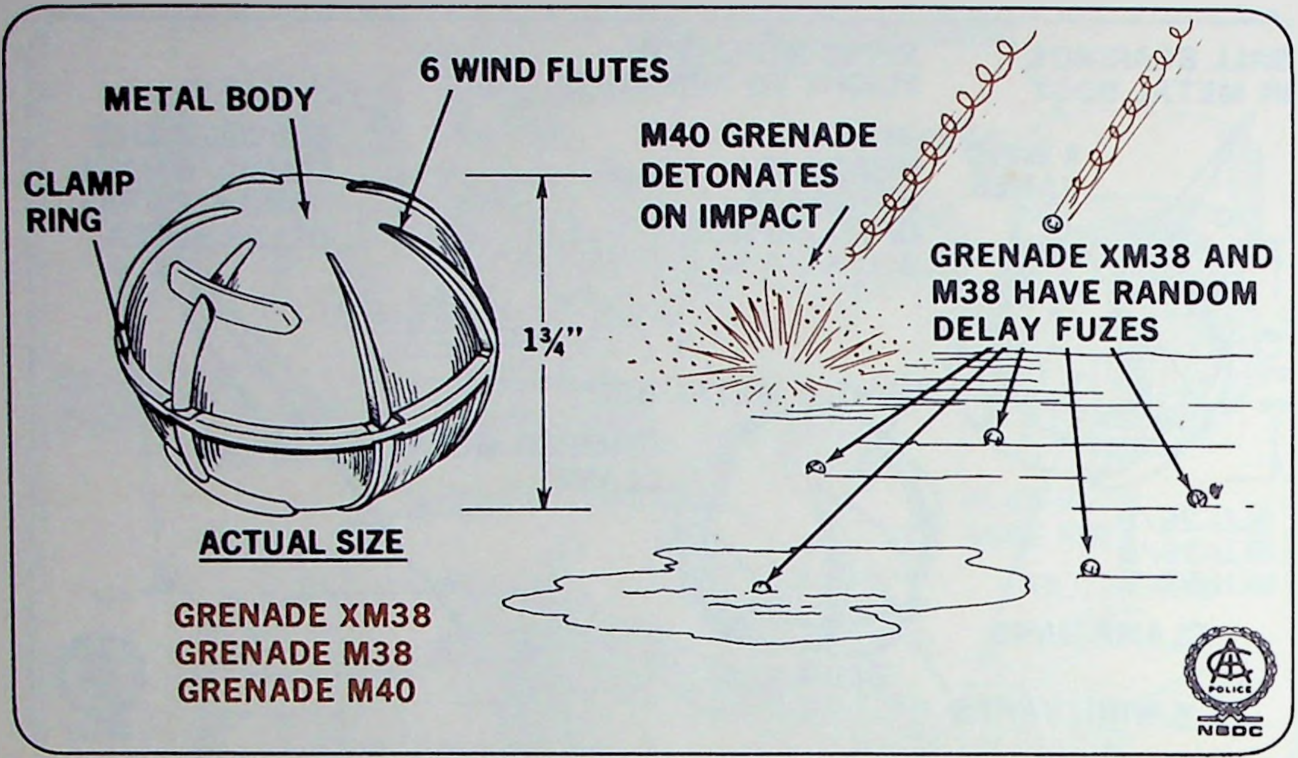


Figure 340
XM38, M38, AND M40 FRAGMENTATION ANTI-PERSONNEL GRENADES

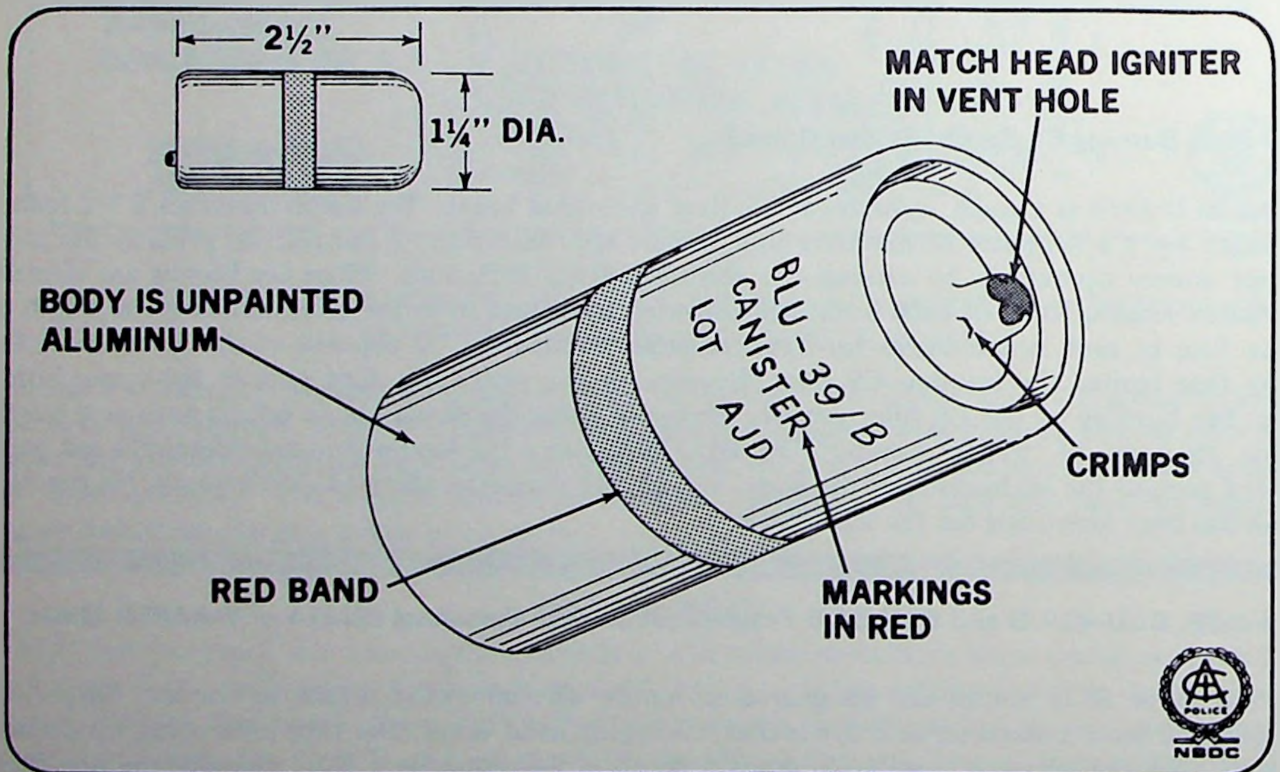


Figure 341
BLU-39/B BURNING (CS) BOMB (SKITTER BOMB)

restraining eight circular metal plugs. The live mines are normally painted an olive drab color. These mines are delivered to the target area by aircraft or artillery projectile. As the mine falls, air pressure on the wind vanes causes spin which arms an internal *electro-mechanical fuze.* Upon impact with the ground, trip lines (strings) are ejected outward from the eight round plugs in the body. The trip lines are attached to a disturbance ring in the fuze assembly. A pull of several ounces on any one of the trip strings will cause detonation of the mine. If undisturbed, the mine will self-destruct after a predetermined delay. Detonation of the mine produces a fragmentation anti-personnel effect.

This mine is *extremely dangerous* once the trip lines have been ejected and should not be disturbed in any manner. Should this item be encountered, contact the nearest U.S. Armed Forces Explosive Ordnance Disposal team for assistance. The three mines, identical in size, shape, and appearance are illustrated in Figure 342. The practice mine is identical in appearance to the live mines except that it is normally painted light blue and contains no explosive.

SPECIAL NOTE

BLU bombs which are ball-shaped and fitted with wind vanes have fuzes which are armed by centrifugal force and require approximately *2,400 revolutions per minute* (rpm) in order to cause arming. Rolling the bomb along the ground or throwing it through the air *does not normally* provide sufficient centrifugal force to cause the bomb fuze to arm. Hence their employment as hand thrown grenades is not generally practical.

BLU-45/B Anti-Material Mine

The BLU-45/B mine has a rectangular bullet shape, measuring 14 1/4 inches in length and 4 inches in width. It has a heavy cast steel nose and weighs approximately 20 pounds, containing some 5 pounds of explosive. When the mine is released from the aircraft, four folding umbrella fins open to stabilize it in flight. The mine fuze and its functioning are classified by the military. Figure 343 illustrates this mine. No practice mine for this BLU has been identified.

BLU-49/B Fragmentation Anti-Material Anti-Personnel Bomb (Ringtail)

The BLU-49/B consists of a fragmentation body 10 inches in length by 4 5/8 inches in diameter, with a total weight of 13 pounds. When this anti-material, anti-personnel bomb is ejected from the aircraft, a conical spring extends the telescoping fin assembly and permits fuze arming to begin. The bomb will explode upon impact with the ground, fragmenting the serrated body. The bomb body is manufactured of cast steel and the fin assembly is of plastic. The BLU-49/B body is normally painted bright yellow with markings in black. The practice bomb is normally painted bright red and may contain a large spotting charge. Figure 344 illustrates this bomb.

BLU-61/B Fragmentation and Incendiary Anti-Personnel and Anti-Material Bomb

The BLU-61/B bomb is the shape and size of a large softball measuring 3 7/8 inches in diameter and weighing approximately 2 1/2 pounds. The bomb has four protruding wind vanes molded into its steel body. When the bomb is released, the wind vanes impart spin to the bomb and arm the

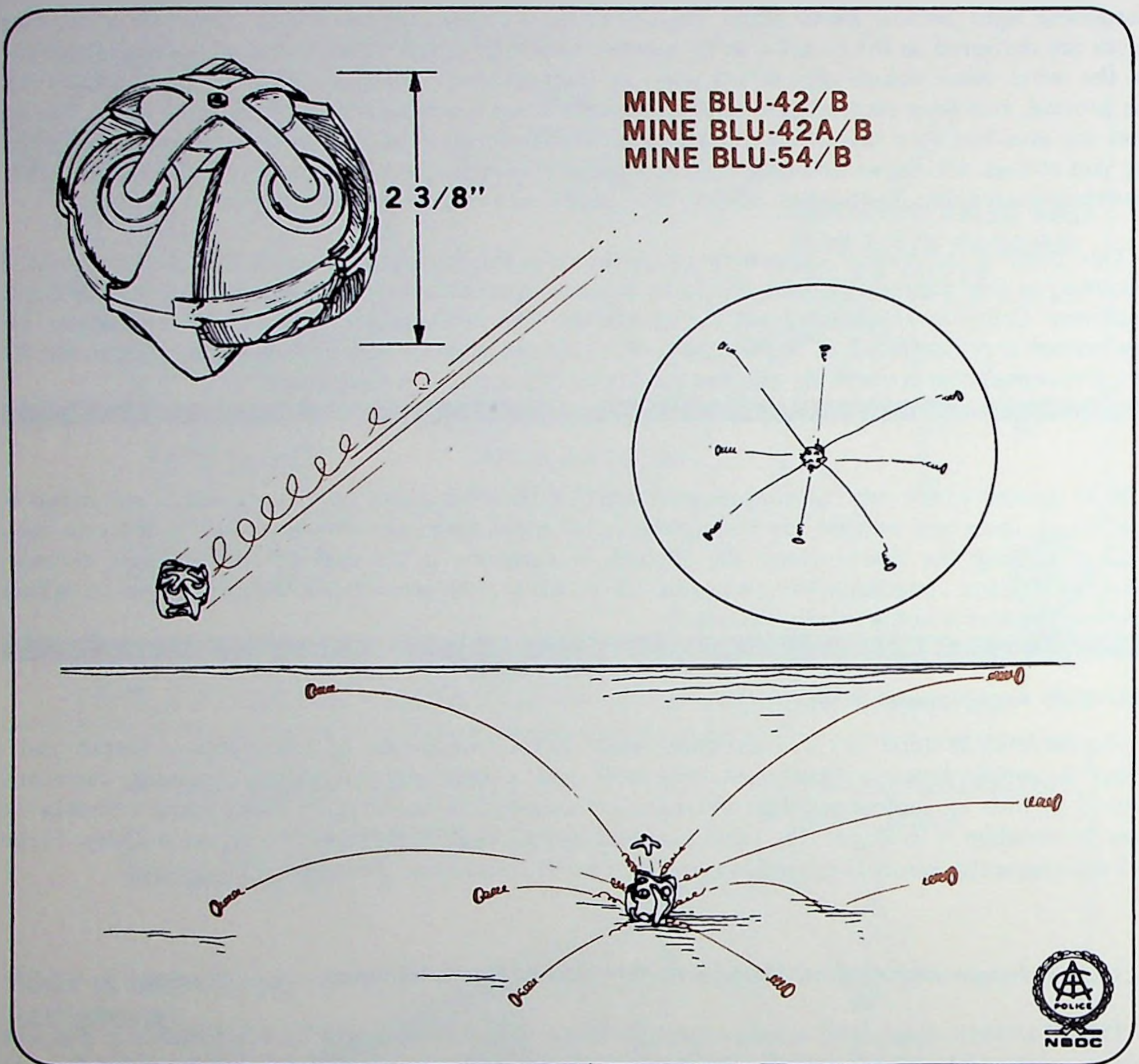


Figure 342
BLU-42/B, BLU-42A/B, AND BLU-54/B FRAGMENTATION ANTI-PERSONNEL MINES
(SADA OR WAAPM MINE)

internal fuze. Upon impact, the bomb detonates, producing a large number of high velocity fragments which may also produce an incendiary effect upon striking a material target. The bomb is normally painted olive drab with a 1/4-inch-diameter yellow paint dot and a 1/4-inch red paint dot on each half of the bomb. The bomb identification markings are normally stenciled on the body in black paint. No practice bomb has been identified for this BLU. Figure 345 illustrates the BLU-61/B bomb.

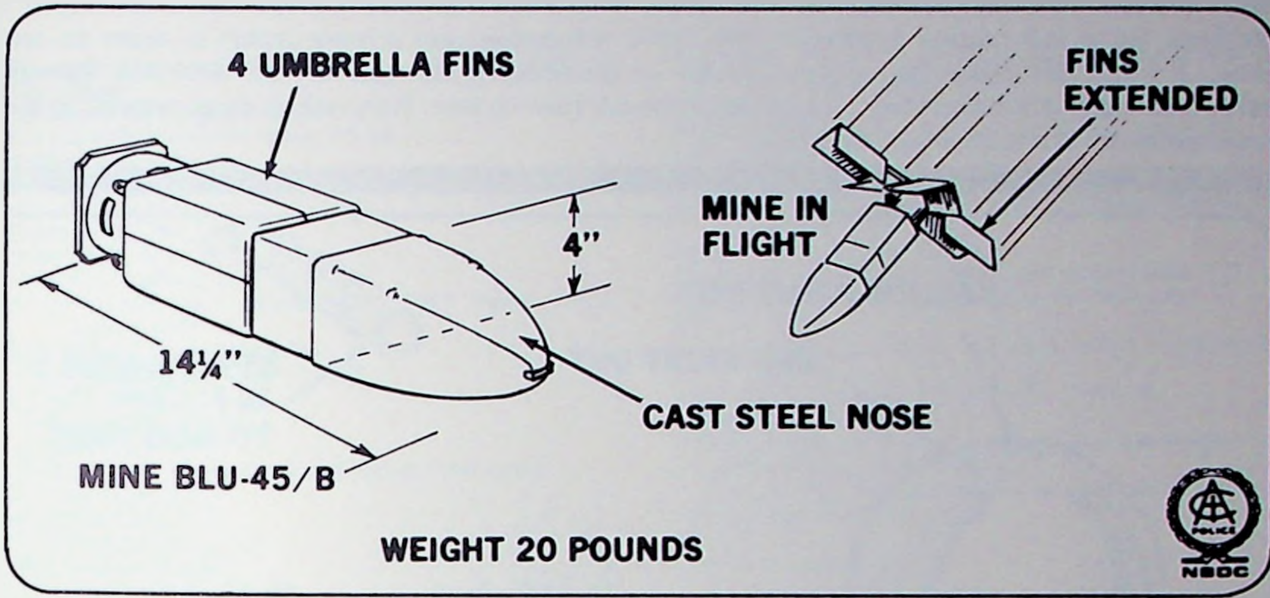


Figure 343
BLU-45/B ANTI-MATERIAL MINE

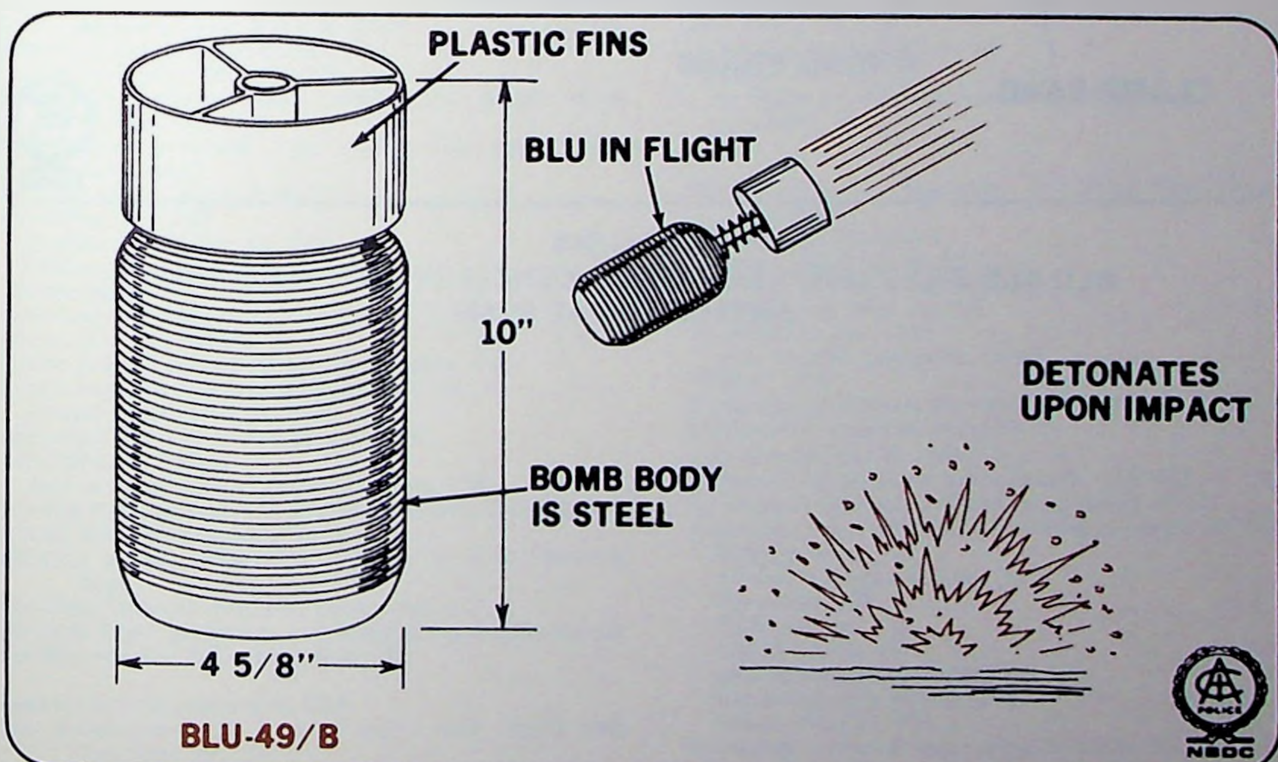


Figure 344
BLU-49/B FRAGMENTATION ANTI-MATERIAL ANTI-PERSONNEL BOMB
(RINGTAIL)

SPECIAL NOTE

BLU bombs which are ball-shaped and fitted with wind vanes have fuzes which are armed by centrifugal force and require approximately *2,400 revolutions per minute* (rpm) in order to cause arming. Rolling the bomb along the ground or throwing it through the air *does not normally* provide sufficient centrifugal force to cause the bomb fuze to arm. Hence their employment as hand thrown grenades is not generally practical.

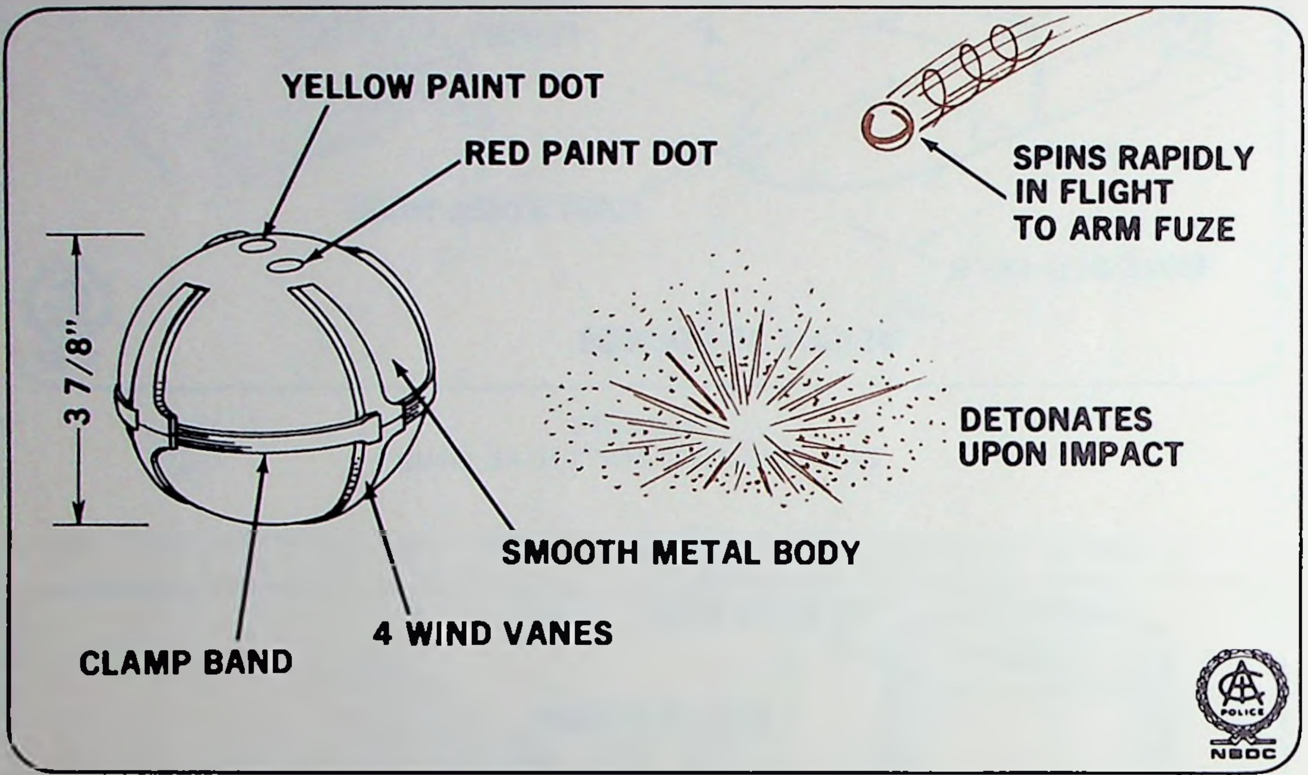


Figure 345
BLU-61/B FRAGMENTATION AND INCENDIARY ANTI-PERSONNEL ANTI-MATERIAL BOMB

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