UNITED STATES MARINE CORPS
THE BASIC SCHOOL
MARINE CORPS TRAINING COMMAND
CAMP BARRETT, VIRGINIA 22134-5019

ENGINEERING FIELD FIRING EXERCISE B3L4258 STUDENT HANDOUT

Military Explosives

Introduction

Understanding and properly employing demolitions can mean the difference between mission accomplishment or failure. Using explosives requires much knowledge and responsibility, extensive and thorough planning, and, in some circumstances, patience.

Importance

The importance of a working knowledge of military explosives is demonstrated in the following synopsis from the book, The Bridge at Dong Ha.

On Easter Sunday, 1972, two North Vietnamese infantry divisions, more than 200 T-54 tanks, and supporting units attempted to cross the Cua Viet River over the bridge near the village of Dong Ha, eight miles south of the DMZ. The Easter Offensive was to be the push to ultimately capture Saigon. With his knowledge of military explosives, Captain John W. Ripley, 0302/USMC, serving as an advisor to the 3rd Battalion Vietnamese Marine Corps, halted the North Vietnamese offensive. Captain Ripley successfully placed and detonated over 300 pounds of TNT and C-4 to destroy a section of the steel and timber bridge at Dong Ha. The North Vietnamese were unable to launch another large offensive to capture Saigon for another three years.

In This Lesson

You will learn the various types of explosives, their intended usage, and how to safely and effectively prepare them for use.

This lesson covers the following topics:

Learning Objectives

Terminal Learning Objectives

Given an M18A1 Claymore mine and sector of fire, while wearing a fighting load, describe how to emplace an M18A1

Claymore mine to ensure the sector of fire is covered without endangering friendly personnel or equipment. (0300-DEMO-1003)

Given a unit, an assault or engineer unit, demolitions, a mission, and a commander's intent, employ demolitions to achieve desired effects of the demolitions in support of the ground scheme of maneuver. (0302-OFF-1206)

Given a unit, a barrier plan, and material needed to emplace obstacles, direct obstacle emplacement to achieve the effect desired by the commander. (MCCS-DEF-2203)

Enabling Learning Objectives

Given a unit, a mission, a mental estimate of the situation, supporting engineer assets, and a commander's intent, employ engineers in support of defensive operations to accomplish the mission. (0302-DEF-1301e)

Without the aid of references, describe engineer capabilities that support offensive operations to support mission accomplishment. (0302-OFF-1201g)
Without the aid of references, describe the four functional areas of combat engineering without error. (0302-OFF-1201h)

Without the aid of reference, identify demolition capabilities/limitations without error. (0302-OFF-1206b)
Without the aid of reference, identify obstacle types without error. (MCCS-DEF-2203a)

Given a mission, a commander's intent, obstacle materials, and while leading a rifle squad or platoon, plan obstacles to support the defensive scheme of maneuver. (MCCS-DEF-2203b)

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Military Explosives

Explosives. Explosives are substances that, through chemical reaction, violently change to a gaseous form. In doing so, they release pressure and heat equally in all directions. The table below describes the two major categories of explosives.

Category	Description
Low explosives	• Change from solid to gaseous state slowly over a sustained period (1300 feet/second) • Are ideal when a *pushing* or *shoving* effect is required
High explosives	• Change from solid to gaseous state almost instantaneously (3280 to 28,880 feet/second) • Produce a *shattering* effect on the target

Military Explosives. To be suitable in military operations, explosives must:

- Be:
  - Produced from readily available raw materials
  - Inexpensive to manufacture
  - Suitable for use under water or in a damp climate
  - Conveniently sized and shaped for packaging, storing, distribution, handling, and emplacing by troops
  - Assigned a relative effectiveness factor (a ratio that compares the effectiveness of any given military explosive to the effectiveness of TNT)
- Have:
  - Relative insensitivity to shock or friction, yet able to be positively detonated by easily prepared initiators
  - A shattering effect (Brisance) and potential energy adequate for the purpose
  - The stability adequate to retain usefulness for a reasonable time when stored in any climate at temperatures between –80 degrees Fahrenheit (F) and 165 degrees F
  - High density (weight per unit of volume)
  - Minimum toxicity (poisonous effect) when stored, handled, and detonated
  - A high energy output per unit of volume

CAUTION: Since explosives contain their own oxidizer, burning explosives cannot be extinguished by smothering. Whenever explosives burn, possible detonation poses a hazard. Personnel should not attempt to extinguish burning explosives without competent supervision and the advice and assistance of explosive ordnance disposal (EOD) personnel.

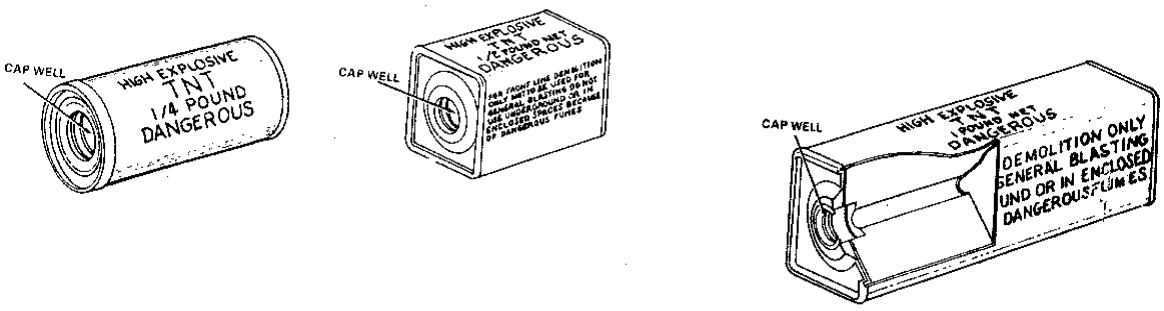
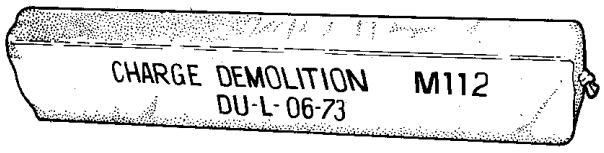
Military Explosives (Continued)

Characteristics of US Explosives. The table below lists the characteristics and principal uses of US explosives.

Explosive	Principal Uses	Velocity of Detonation		Relative Effectiveness as a Breaching Charge (TNT – 100)	Intensity of Poisonous Fumes	Water Resistance
		(m/sec)	(ft/sec)			
Black powder	Time blasting fuse	400	1,300	0.55	Dangerous	Poor
Ammonium nitrate	Demolition charge (cratering)	2,700	8,900	0.42	Dangerous	Poor
Amatol 80/20	Bursting charge	4,900	16,000	1.17	Dangerous	Poor
Military dynamite, M1	Demolition charge (quarrying, stumping, and ditching)	6,100	20,000	0.92	Dangerous	Fair
Detonating cord	Priming	6,100 to 7,300	20,000 to 24,000			Excellent
TNT	• Demolition charge (breaching) • Composition explosives	6,900	22,600		Dangerous	Excellent
Tetrytol 75/25	Demolition charge (breaching)	7,000	1.2		Dangerous	Excellent
Tetryl	• Booster charge • Composition explosives	7,100	1.2		Dangerous	Excellent
Sheet explosive M118 and M186	Demolition charge (cutting)	7,300	2,400	1.14	Dangerous	Excellent
Pentolite 50/50	• Booster charge • Bursting charge	7,450	24,400		Dangerous	Excellent
Nitroglycerine	Commercial dynamites	7,700	25,200	1.5	Dangerous	Good
Bangalore torpedo, M1A2	Demolition charge (wire and minefield breaching)	7,800	25,600	1.17	Dangerous	Excellent
Shaped charges M2A3, M2A4, and M3A1	Demolition charge (cutting holes)	7,800	25,600	1.17	Dangerous	Excellent
Composition B	Bursting charge	7,800	25,600	1.35	Dangerous	Excellent
Composition C4 and M112	Demolition charge (cut and breach)	8,040	26,400	1.34	Slight	Excellent
Composition A3	• Booster charge • Bursting charge	8,100	26,500		Dangerous	Good
PETN	• Detonating cord • Blasting caps • Demolition charges	8,300	27,200	1.66	Slight	Excellent
RDX	• Blasting caps • Composition explosives	8,360	27,400	1.6	Dangerous	Excellent

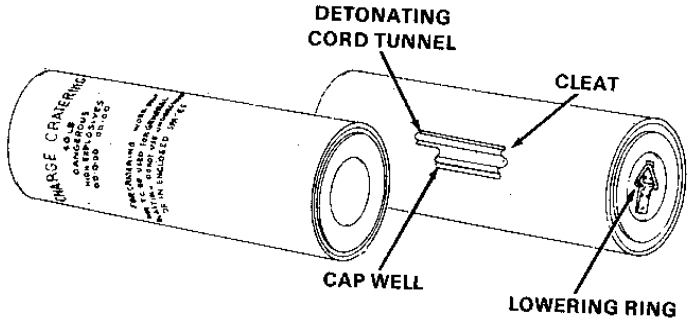
Demolition Charges

Demolition Charges. The table below lists the principle uses, advantages, and limitations as well as a diagram of three demolition charges (refer to the Characteristics of US Explosives table, page 5, for their characteristics).

Charge	Principle Uses	Advantages	Limitations
Trinitrotoluene (TNT)	• Standard demolition charge for all types of demolition work • The ¼-pound charge used primarily for training	• Has a high detonating velocity • Is ○ Stable ○ Relatively insensitive to shock or friction ○ Water resistant ○ Convenient in size, shape, and packaging	• Cannot be molded • Is difficult to use on irregularly shaped targets Not recommended for use in closed spaces (explosion produces poisonous gases)
	 TNT		
M112 Block Demolition Charge (C-4)	• Primarily for ○ Cutting ○ Breaching ○ All types of demolition work • Because of high shattering effect, ideally suited for cutting steel and other hard materials	• Can be cut and molded to fit irregularly shaped targets • Adhesive backing allows charge to be attached to any relatively flat, clean, dry surface above the freezing point • Paper color aids in camouflage	• Odd weight, 1.25 versus 1 pound (calculating charge weight is difficult) • Adhesive backing will not adhere to wet, dirty, rusty, or frozen surfaces
	 M112 Block Demolition Charge		

Demolition Charges (Continued)

Forty Pound Ammonium Nitrate Block Demolition Charge (Cratering)	• Suitable for
	  ○ Cratering operations
	  ○ Ditching operations
	• Has been designed as a standard cratering charge
	• Can also be used in destroying
	  ○ Buildings
	  ○ Fortifications
	  ○ Bridge abutments
		• Size and shape of charge makes it ideal for cratering operations
		• Is inexpensive to produce compared to other explosives
			• Ammonium nitrate absorbs moisture
			• When wet, is impossible to detonate (to ensure detonation use only metal containers showing no evidence of water damage)
			• Detonate all charges placed in wet or damp boreholes as soon as possible



Forty Pound Ammonium Nitrate Block Demolition Charge (Cratering)

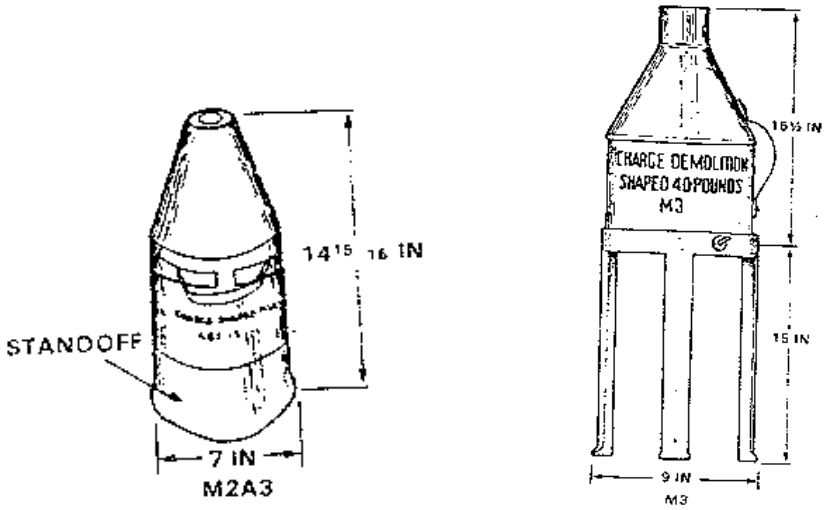
Specialized Demolition Charges and Assemblies

Shaped Charge. The table below lists the principle uses, advantages, and limitations as well as a diagram of the shaped charge (refer to the Characteristics of US Explosives table, page 5, for its characteristics).

Principle Uses	Advantages	Limitations

• Primarily to bore holes in
  ○ Earth
  ○ Metal
  ○ Masonry
  ○ Concrete
  ○ Paved and unpaved roads
• Effectiveness depends largely on
  ○ Target's shape and material (what it is made of)
  ○ Explosive and emplacement
	Strong penetration capabilities	Not effective
		• Under water
		• When foreign objects are present inside the conical cavity (prevents a narrow jet from forming)

Specialized Demolition Charges and Assemblies (Continued)

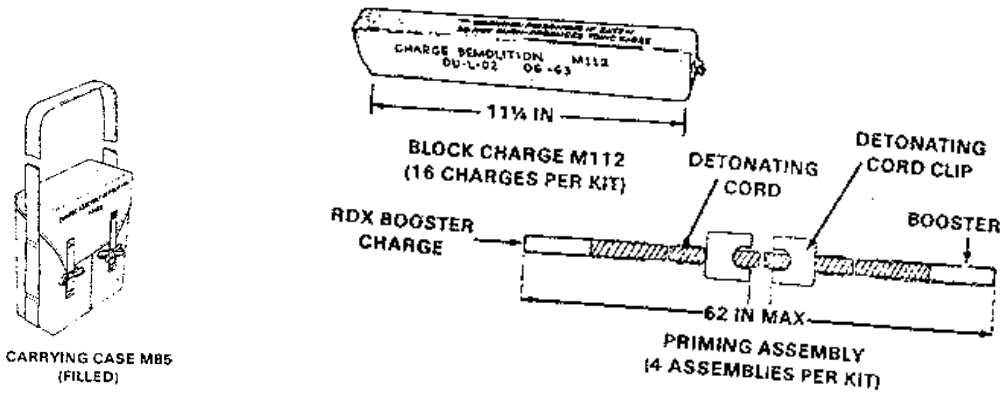


15 and 40 Pound Shape Charge

M183 Demolition Charge Assembly (Satchel Charge). The table below lists the characteristics and principal uses as well as a diagram of the M183 demolition charge assembly (satchel charge).

Characteristics	Principle Uses

• Consists of
  ○ M112 (C-4) demolition blocks – 16 total
  ○ Priming assemblies – 4 total
• Total explosives weight is 20 pounds
• Demolition blocks are packed in two bags of 8 blocks per bag
• Bags are housed in an M85 canvas carrying case
	• Primarily in breaching obstacles
	• Demolition of structures where large demolition charges are required



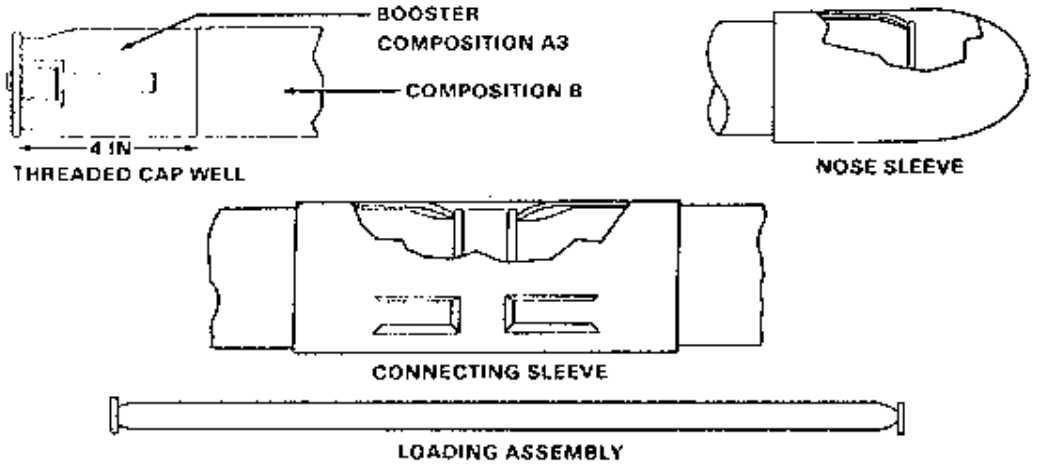
M183 Demolition Charge Assembly

Specialized Demolition Charges and Assemblies (Continued)

Bangalore Torpedo Demolition Kit. The table below lists the characteristics and principal uses as well as a diagram of the Bangalore torpedo demolition kit.

Characteristics	Principle Uses

• Each is
  ○ 5 feet long
  ○ Weighs approximately 15 pounds (total)
• Contains
  ○ 10 pounds Composition B4
  ○ 1 pound Composition A3 as a booster
• Each kit consists of 10 torpedoes (loading assemblies)
	• To clear paths through
	  ○ Wire entanglements
	  ○ Minefields
	  ○ Heavy undergrowth
	  ○ Bamboo
	• Clears a path approximately 3 to 4 meters wide through wire entanglements
	• In minefield breaching, will explode
	  ○ All antipersonnel mines
	  ○ Most of the antitank mines in a narrow footpath approximately 1 meter wide



Bangalore Torpedo Demolition Kit

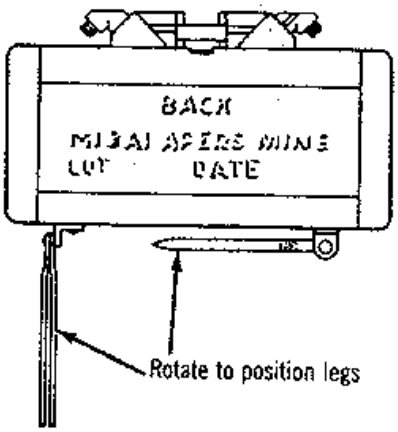
Specialized Demolition Charges and Assemblies (Continued)

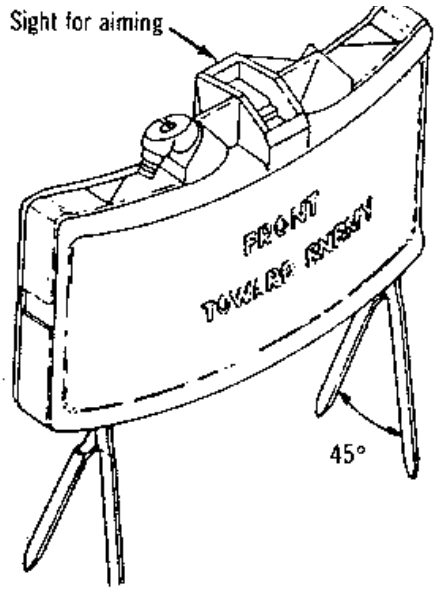
M18A1 Claymore (Directional Fragmentation) Anti-Personnel Mine. The table below lists the characteristics, functioning, and effects of the M18A1 claymore (directional fragmentation) anti-personnel mine (see diagram below).

Characteristics	• Contains
	  ○ 1.5 pounds of C-4 explosive
	  ○ 700 steel pellets encased in plastic
	• Is equipped with 33 meters of firing wire attached to an electric blasting cap and an M57 power source (clacker) (which provides only enough power to detonated at 33 meters)
	• If distance is increased, use an alternate power source, wire, and cap
	• One out of six contains a tester (to ensure the firing wire, electric cap, and M57 clacker are functioning properly)

Functioning	Command detonated using the M57 clacker

Effects	• Designed to deliver
	  ○ Lethal steel ball bearings
	  ○ In a fan-shaped pattern
	  ○ Over a designated target area
	• Effective casualty radius is
	  ○ 50 meters in a 60-degree arc
	  ○ 2 meters high with a forward danger area of 250 meters
	• Minimum back and side blast safety distances are
	  ○ 16 meters in a covered position
	  ○ 100 meters in an uncovered position





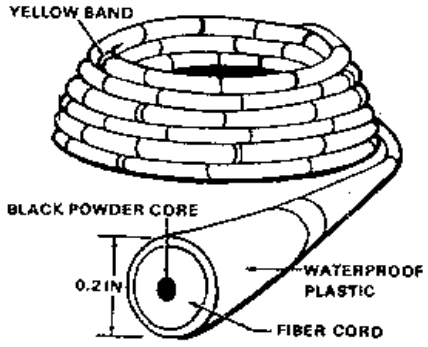
M18A1 Claymore Mine

Demolition Accessories

Demolition Accessories.

Time Fuse. The M700 fuse (see diagram below) is a dark green cord, 0.2 inches in diameter, with a plastic cover. Depending on the time of manufacture, the cover may

- Be smooth
- Have single yellow bands around the outside at 12- or 18-inch intervals and double yellow bands at 60- or 90-inch intervals (bands are provided for easy measuring)



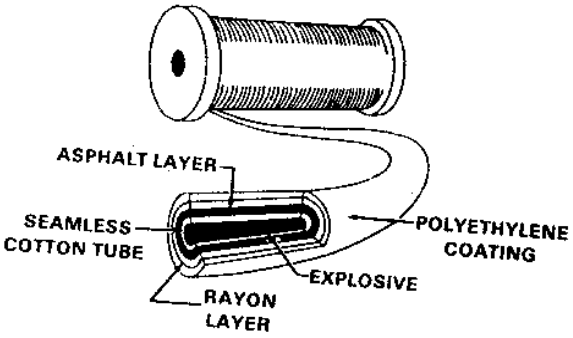
The outside covering becomes brittle and cracks easily in arctic temperatures. The burning rate is approximately 40 seconds per foot.

Detonating Cord. The table below lists the characteristics and principal uses, as well as a diagram of detonating cord.

Characteristics	Principal Uses

• Core of PETN or RDX explosive in a textile tube coated with a thin layer of asphalt
• On top of this layer of asphalt is an outer textile cover finished with a wax gum composition or plastic coating
• Transmits a detonating wave from one point to another at a rate between 20,000 to 24,000 feet per second
• A partially submerged, water soaked detonating cord will detonate if initiated from a dry end
• When exposed to low temperatures
  ○ Does not lose explosive properties
  ○ Covering becomes stiff and cracks when bent
• Use great care when using detonating cord primers in arctic conditions
	• To prime and detonate other explosive charges
	• When its explosive core is detonated by a blasting cap or other explosive device, detonating cord transmits the detonation wave to an unlimited number of explosive charges

Demolition Accessories (Continued)

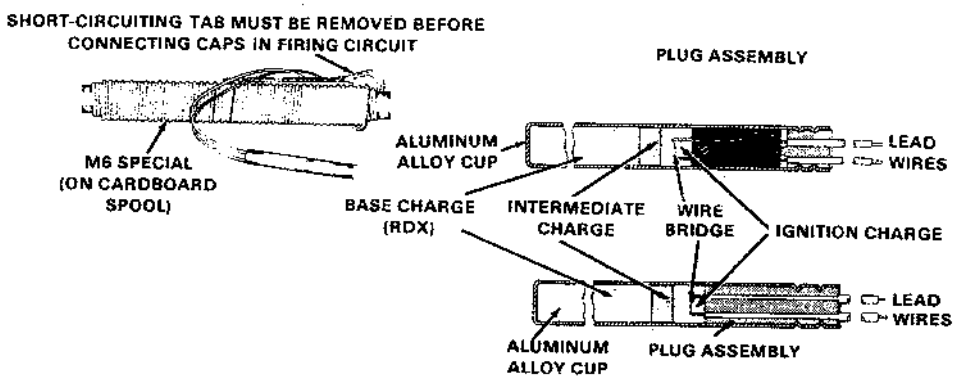


Detonating Cord

Blasting Caps. The table below describes and diagrams:

- Electric blasting caps
- Non-electric blasting caps

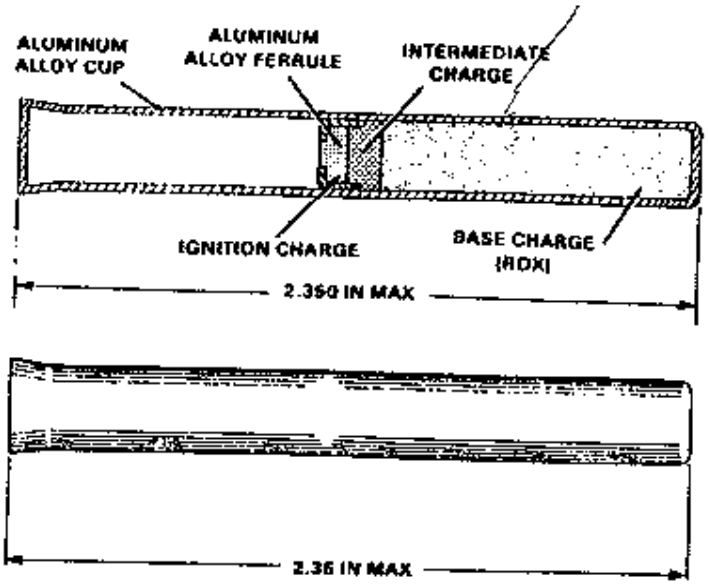
Electric Blasting Caps	• Use when a source of electricity such as a blasting machine or battery, is available • Lead wires are 12 feet long • For ignition, requires 1½ amperes of electricity passing through their wires



Electric Blasting Cap

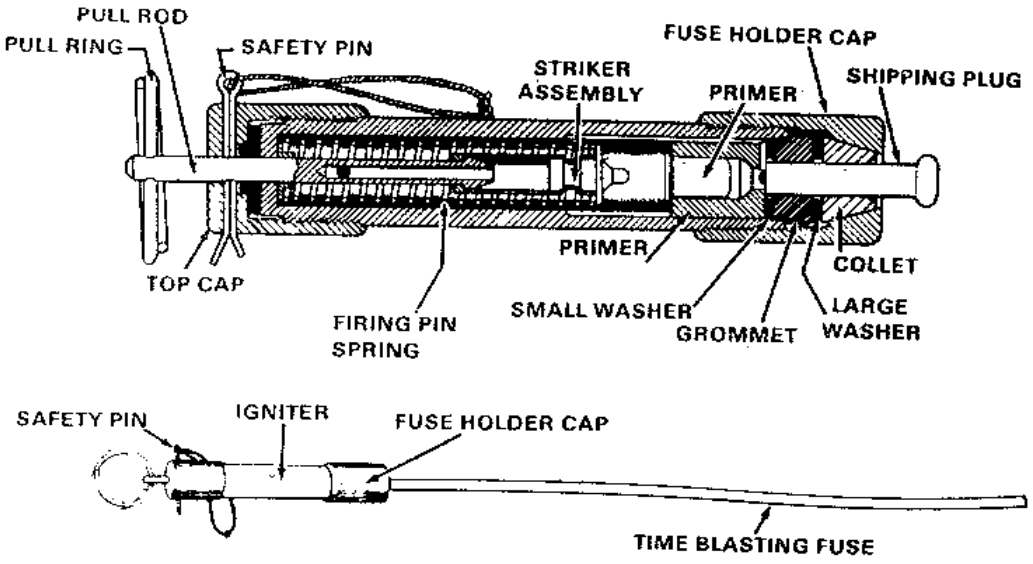
Non-Electric Blasting Caps	• May be initiated by a
	  ○ Time blasting fuse
	  ○ Firing device and detonating cord
	• Because they are difficult to waterproof, when possible, avoid using to prime charges placed
	  ○ Underwater
	  ○ In wet boreholes
	• If necessary, use moisture-proof non-electric blasting caps with a waterproof sealing compound

Demolition Accessories (Continued)



Non-Electric Blasting Cap

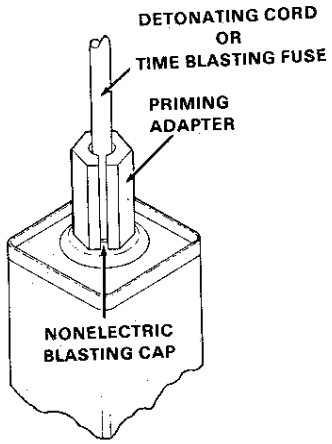
M81 Weatherproof Fuse Igniter. The M81 weatherproof fuse igniter (see diagram below) is designed to ignite a time blasting fuse in all sorts of weather conditions, even underwater if properly waterproofed. The fuse is inserted through a sealing rubber grommet and into a split collet, which secures the fuse when the end cap on the igniter is tightened. A pull on the pull ring releases the striker assembly, allowing the firing pin to drive against the primer, which ignites the fuse.



M81 Fuse Igniter

Demolition Accessories (Continued)

M1A4 Priming Adapter. The M1A4 priming adapter (see diagram below) is a plastic, hexagonal shaped device threaded to fit threaded cap wells. A shoulder inside the threaded end is large enough for a time blasting fuse and detonating cord, but too small for a military blasting cap. The adapter is slotted lengthwise to permit easy, quick insertion of the electric cap lead wires.

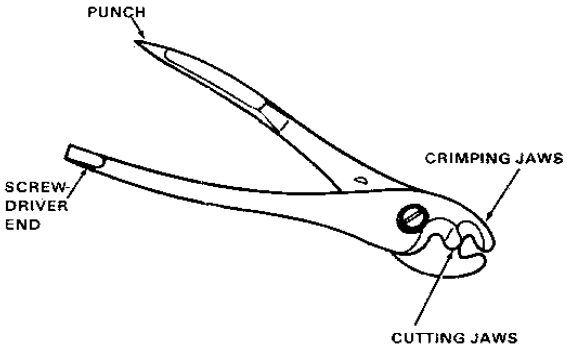


Priming Adapter

M2 Cap Crimpers. The M2 cap crimper (see diagram below) is used to squeeze the shell of a non-electric blasting cap around a

- Time fuse
- Standard base
- Detonating cord

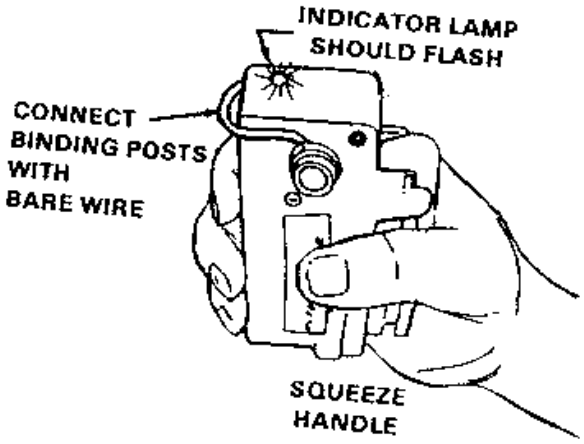
securely enough to keep it from being pulled off, but not tight enough to interfere with the burning of the powder train in the fuse of the detonating cord. One leg of the handles is pointed to use in punching cap wells in explosive material for easy insertion of the blasting cap. The other leg is a screwdriver end. Use the cutting jaw for cutting fuse and detonating cord only.



M2 Cap Crimpers

Demolition Accessories (Continued)

M51 Test Set. Use an OHM meter (see diagram below) to test the continuity of an electrical circuit.

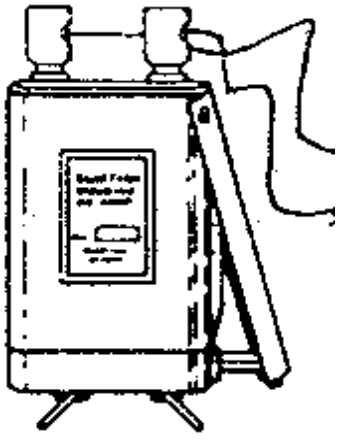


M51 Test Set

Blasting Machine. Use the blasting machine (see diagram below) to provide the electric impulse needed in electric blasting operations. The two types of blasting machine are the:

- M32 blasting machine, capable of producing enough electricity to set off up to 10 blasting caps
- M34 blasting machine, capable of setting off up to 50 blasting caps

Both blasting machines are small, lightweight, and impact resistant.



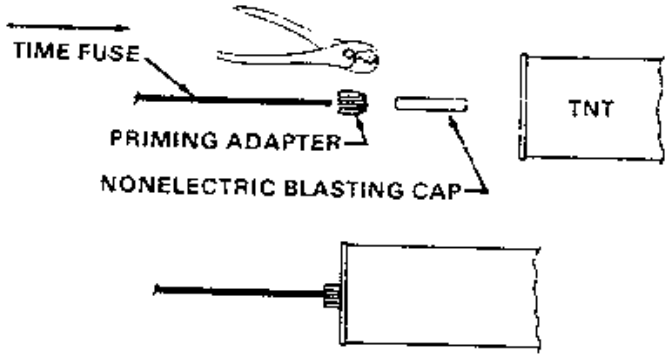
Blasting Machine

Firing Systems

Firing Systems.

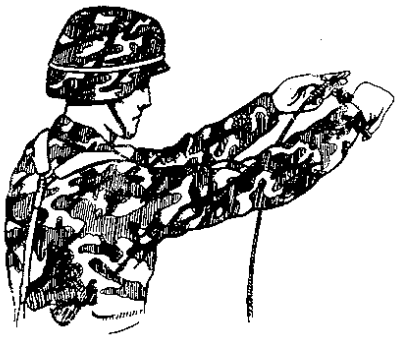
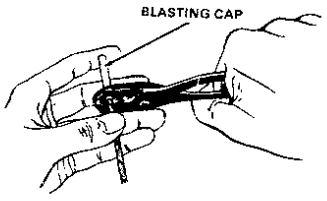
Non-Electric Firing System. A non-electric system (see diagram below) is one in which an explosive charge is prepared for detonation by means of a non-electric blasting cap. The basic priming materials consist of

- A non-electric blasting cap, which provides the shock adequate to detonate the explosive
- A time fuse, which transmits the flame that fires the blasting cap
- A fuse igniter, which initiates the firing system



Non-Electric Firing System

The table below lists the steps to prepare a non-electric firing system.

Step	Action
1	Test burn time fuse.
2	Prepare time fuse to necessary length.
3	Attach fuse igniter.
4	Crimp blasting cap to time fuse (see diagram below).   Crimping
5	Insert blasting cap into explosive.
6	Light time fuse.

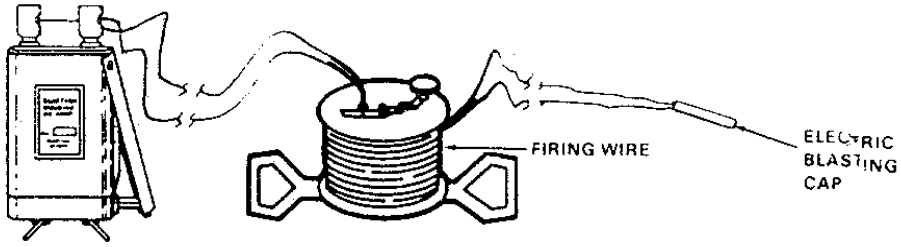
Firing Systems (Continued)

For non-electric misfires,

- Delay investigation for at least 30 minutes.
- If the misfire charge is:
    - Not tamped, do not move or disturb it. Lay a primed one-pound charge on the misfired charge and fire.
    - Tamped:
        - One foot or less, place a two-pound charge on top
        - More than one foot, *carefully* remove tamping material. Lay a primed one-pound charge on the misfired charge and fire

Electric Firing System. An electric firing system (see diagram below) is one in which electricity is used to fire the primary initiating element. An electric impulse supplied from a power source, usually an electric blasting machine, travels through the firing wire and cap lead wires to fire an electric blasting cap. The chief components of the system are the:

- Electric blasting cap
- Firing wire
- Blasting machine or battery or alternate power source



Electric Firing System

The table below lists the steps to prepare an electric firing system.

Step	Action
1	Lay out and test firing wire.
2	Test blasting caps.
3	Connect caps to circuit.
4	Insert caps into charges.
5	Test entire circuit.
6	Test blasting machine.
7	Connect blasting machine to circuit.
8	Fire.

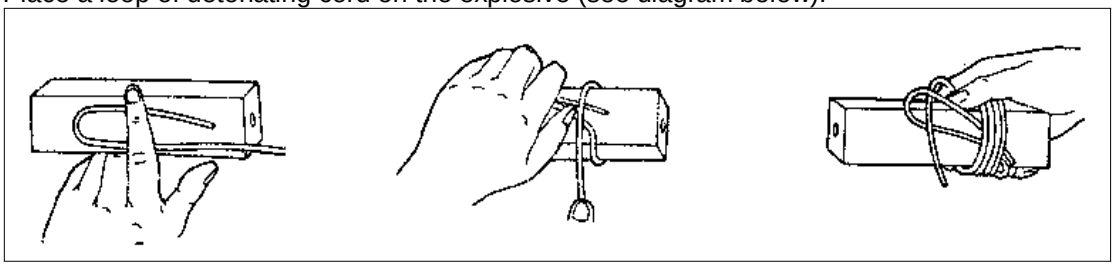
Firing Systems (Continued)

For electric misfires:

- Take corrective action immediately
- Check the firing wire connection to power source to be sure the contacts were good
- Try two or three more times to fire
- Use another power source
- When employing:
    - Only one electrical blasting cap:
        - Disconnect the blasting machine
        - Shunt wires (twist wires together)
        - Investigate immediately
    - More than one electrical blasting cap, wait 30 minutes before inspecting.
- Check entire circuit
- Replace shot wire/cap
- Initiate detonation

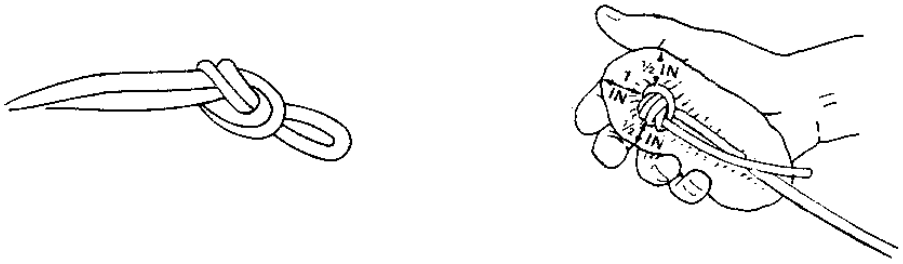
Detonating Cord Priming.

Alternate Tie #2. The table below lists the steps for Alternate Tie #2 (TNT only).

Step	Action
1	Place a loop of detonating cord on the explosive (see diagram below).  Alternate Method #2
2	Wrap the cord four to six times around the explosive. Be sure the first wrap goes immediately over the short leg of the loop, wrapping towards the loop.
3	Insert the running end through the eye of the loop.
4	Tighten the knot by pulling on the short leg.

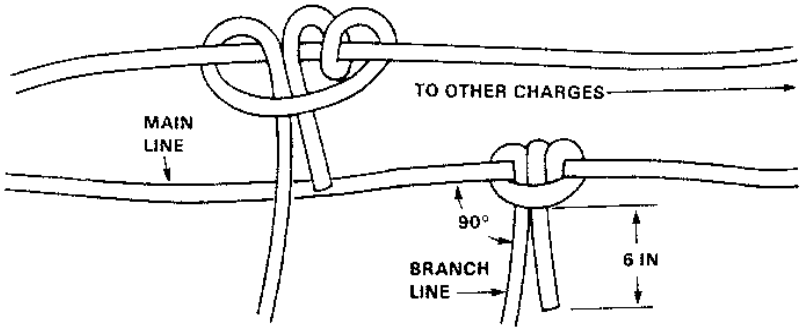
Firing Systems (Continued)

Overhand Knot (C-4). Insert the knot into the explosive or molded piece of explosive. Be sure at least ½-inch of explosive is on all sides of the knot (see diagram below).



Overhand Knot

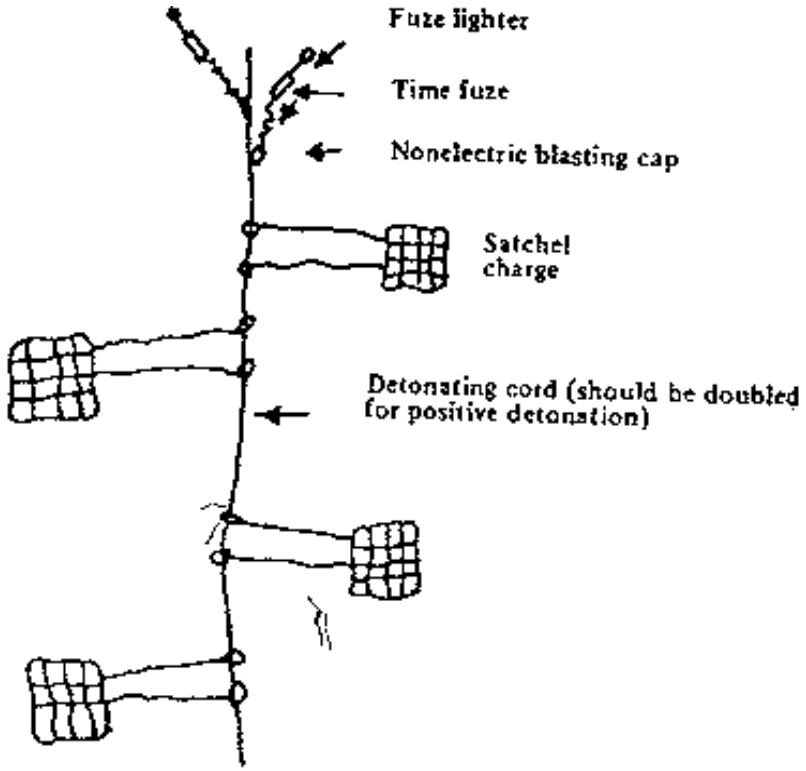
Branch Line Connections. Fasten a branch line to a main line with a girth hitch with one extra turn (see diagram below).



Girth Hitch with Extra Turn

Firing Systems (Continued)

Trunk Line. Place a single strand of detonating cord down the center of charges (see diagram below).



Trunk Line

Ring Main. Make a ring main by:

- Bringing the main line back in the form of a loop
- Attaching the main line to itself with a girth hitch with one extra turn

A ring main will detonate an almost unlimited number of charges. The ring main makes the detonation of all charges more positive because the detonating wave approaches the branch lines from both directions. The charges will be detonated even if there is one break in the ring main.

Safety Precautions

General Safety Precautions for Handling Military Explosives.

- Do not detonate demolitions electrically during any electrical, dust, sand, or snow storm of a severity great enough to produce atmospheric static electrical charges or when such a storm is within three miles.
- Do not work with electric blasting caps while wearing static electricity-producing clothing (nylon, silk).
- Do not ingest any explosive material.
- Do not get in the smoke of burning explosives. The vapors are toxic if inhaled. Additionally, the smoke will penetrate ordinary clothing and may result in severe dermatitis.
- When placing charges underground, do not bury blasting caps (instead use detonating cord).
- Carry blasting caps in approved containers and keep them out of the direct rays of the sun.
- Within 100 feet of an area in which explosives are being handled or used, do not permit:

    - Smoking
    - Matches
    - Other sources of fire or flame

- Never kink a time fuse.
- Before investigating non-electric misfires, wait 30 minutes.
- Before firing any charge, always sound off, “Fire in the hole!” three successive times.
- Use only crimpers to crimp blasting caps.
- Do not store or transport caps with high explosives.
- Before unwinding your electrical reel, always be sure the person in charge has the power source.

Summary

Handling explosives requires responsibility and knowledge. They must be treated with respect and never abused. If an explosive charge is not prepared correctly and an attempt to initiate the explosive fails someone now has to approach the explosive to render it safe for others and/or to accomplish the mission.

References

Reference Number or Author	Reference Title
FM 5-100	Engineers in Combat Operations
FM 5-101	Mobility
FM 5-102	Counter-mobility
FM 5-103	Survivability
FM 5-250	Explosives and Demolitions
FM 5-34 (MCRP 3-17A)	Engineer Field Data
FM 23-23	Antipersonnel Mine M18A1 Claymore
FM 20-32	Mine/Countermine Operations
MCWP 3-31.2	Mine Warfare
MCWP 3-17	MAGTF Engineer Operations
MCWP 3-17.3	MAGTF Breaching Operations

Glossary of Terms and Acronyms

Term or Acronym	Definition or Identification
Explosives	Explosives are substances that, through chemical reaction, violently change to a gaseous form. In doing so, they release pressure and heat equally in all directions.
Low Explosives	Change from solid to gaseous state slowly over a sustained period (1300 feet/second) and are ideal when a *pushing* or *shoving* effect is required
High Explosives	Change from solid to gaseous state almost instantaneously (3280 to 28,880 feet/second) and produce a *shattering* effect on the target
Non-Electric Firing System	A non-electric system is one in which an explosive charge is prepared for detonation by means of a non-electric blasting cap.
Electric Firing System	An electric firing system is one in which electricity is used to fire the primary initiating element. An electric impulse supplied form a power source, usually an electric blasting machine, travels through the firing wire and cap lead wires to fire an electric blasting cap.
EOD	Explosive Ordinance Disposal

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