

## CHAPTER 3

# PYROTECHNICS

### LEARNING OBJECTIVES

Upon completing this chapter, you should be able to do the following:

1. Discuss the common pyrotechnic devices currently in use on modern Navy surface ships.
2. Describe the procedures for handling and stowing pyrotechnics safely.

### INTRODUCTION

*Pyrotechnic* is the Greek word for fireworks. The Navy uses fireworks not for celebration, but for illumination, marking, and signaling. An example is the illuminating projectile, or star shell, used to illuminate targets for gunfire. The star shell is a pyrotechnic device encased in a projectile body of standard external shape and fired from a standard rifled gun.

In this chapter, we will discuss the common pyrotechnic devices currently in use on modern Navy surface ships. For further information on these and other pyrotechnic devices used by the Navy, refer to *Pyrotechnic Screening, Marking, and Countermeasure Devices*, NAVSEA SW050-AB-MMA-010. All the pyrotechnics we study here are intended for signaling and marking. The devices we will discuss are:

- marine location markers,
- marine illumination signals and the pyrotechnic pistols and projectiles used in firing them, and
- distress and hand signals.

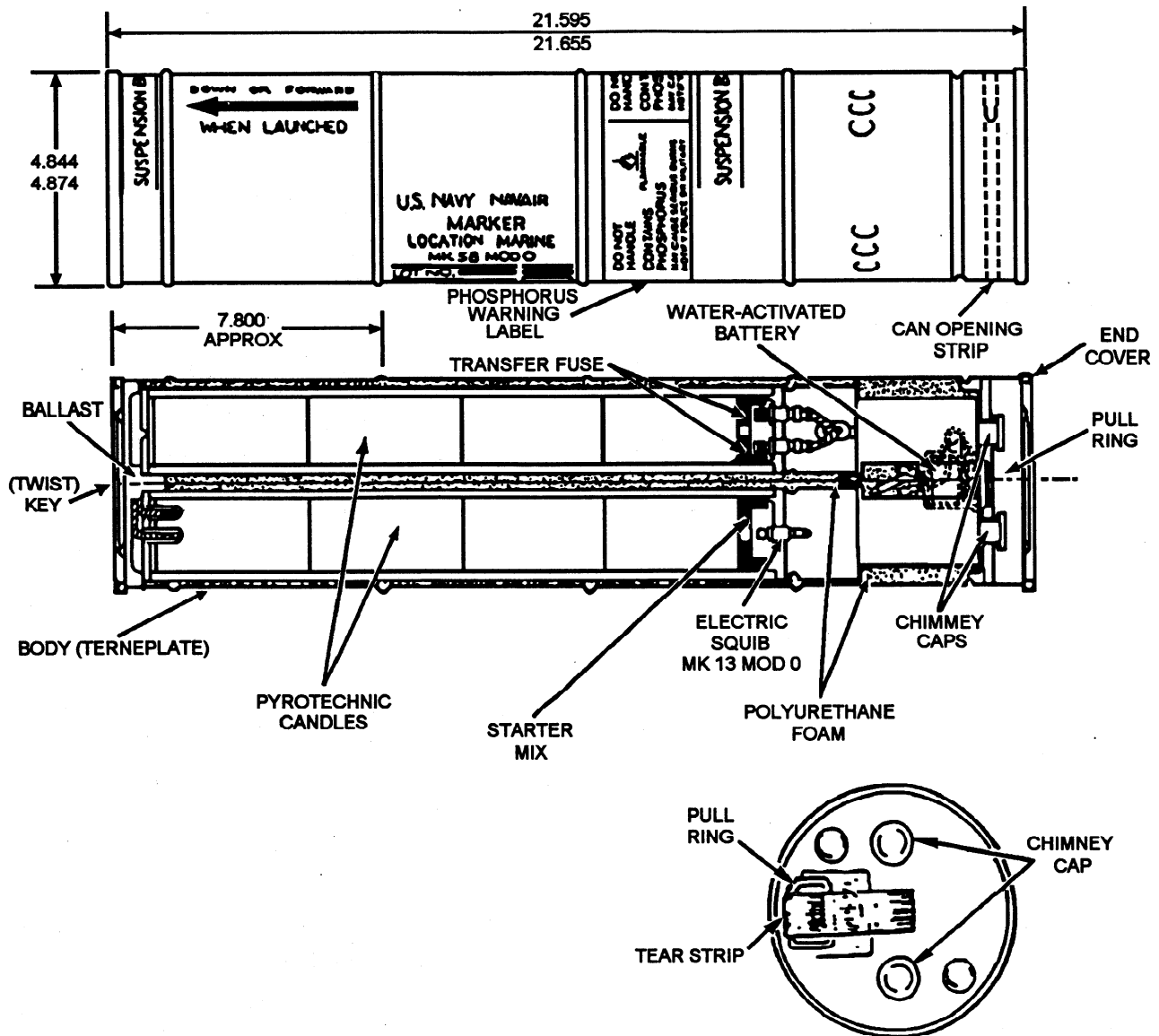
Also, at the end of this chapter, we will provide some basic information on the proper handling and stowage of these devices.

### MARINE LOCATION MARKERS

Marine location markers are used as night or day long-burning reference markings on the surface of the ocean. They are dropped over the side from surface ships for man-overboard marking, navigation drills, and other similar operations. These markers may also be dropped from aircraft for search and rescue operations. The two marine location markers currently in use are the Mk 58 and the Mk 6.

#### MK 58 MARINE LOCATION MARKER

The Mk 58 marine location marker is the primary marine location marker found aboard surface vessels. It is approximately 21 1/2 inches long and weighs about 12 3/4 pounds. It contains a battery squib, some starter mix, two pyrotechnic candles, and a transfer fuse between the two candles. Before the marker is launched (thrown overboard), the tear tape over the water port must be removed so that seawater can enter the marker and activate the battery. Battery current energizes the electric squib, which ignites the starter mix, which, in turn, lights the pyrotechnic candle. As the first candle burns out (in 20 to 30 minutes), the second candle is started by the transfer fuse, for a total burning time of approximately 40 to 60 minutes. The Mk 58 currently is available in two versions, the Mod 0 and the Mod 1.



MNV70085

Figure 3-1.—The Mk 58 Mod 0 marine location marker.

The Mod 0 (fig. 3-1) is a hermetically sealed can whose end cover can be removed with a twist key, much like the lid on a canned ham. Notice on the figure that the opening key is attached to the bottom of the can. If you open one of these devices, be careful. The rim left by the can opening strip is very sharp and can cause serious cuts to your hands as you attempt to remove the tear strip, located under end cover. Figure 3-1 shows the tear strip and its attached pull ring. The chimney caps cover the holes through which the flames and smoke pour when the device is activated.

To correct the safety problem created by removing the end cover with a key, the Mod 1 (fig. 3-2) has a smooth rim at its top and is capped with a replaceable

polyethylene cover. Notice on figure 3-2 the slight difference in the tear strip. Also notice that the chimney caps have been replaced by adhesive foil disks.

### MK 6 MARINE LOCATION MARKER

The Mk 6 smoke and illumination signal (fig. 3-3) is a pyrotechnic device that is launched only from surface craft, to produce a day or night floating reference point. One of its principal uses is as a man-overboard marker. It was previously approved for launching from low-performance aircraft as a long-burning marker but has been replaced for this purpose by the Mk 58 marine location marker.

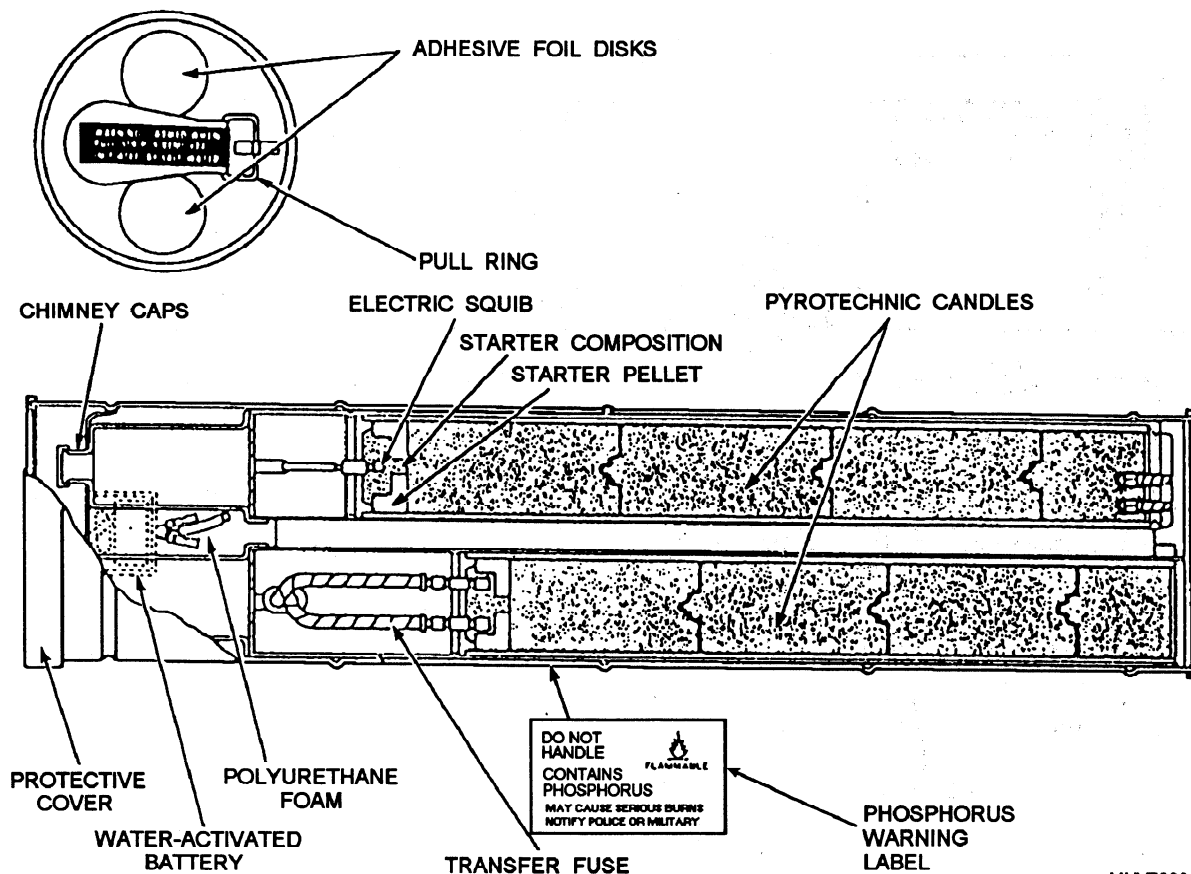


Figure 3-2.—The Mk 58 Mod 1 marine location marker.

The Mk 6 signal consists of a wooden body with a flat, die-cast metal plate fixed to its bottom end to protect it from water impact damage and to maintain it in the correct floating attitude. There are four flame and smoke emission holes in the opposite end, each capped and sealed with tape. The pull-wire ring, also at the emission end, is also covered with tape.

The Mk 6 signal has a direct-firing ignition system. Ignition results from pulling the pull ring. The pull ring is pulled by hand, and the device is thrown into the water immediately. The pull wire ignites a 90-second delay fuse that ignites the quick match at the top of the first of four candles. The quick match ignites the first candle starting mix, which, in turn, initiates burning of that candle. Expanding gases of combustion force the cap and tape from the emission hole, allowing smoke and flame to be emitted. When the first candle is nearly burned out, a transfer fuse carries the ignition to the quick match of the next candle in series. This process continues until all four candles have burned. A yellow flame and gray-white smoke are produced for a minimum of 40 minutes.

After the device has been removed from its shipping container, the following rules apply:

1. Do not disturb the tape over the pull ring until immediately before you launch the device. This tape not only prevents an accidental pull on the pull ring but also protects the igniter assembly from moisture, which might render the signal useless.

### WARNING

This signal is initiated by the physical movement of a friction wire through ignition compound. Take extreme care to prevent tension on the pull ring during all handling operations.

2. If you prepare this device for launching and do not launch it, securely retape the pull ring into position at the top of the signal without exerting any pulling force on the pull-wire igniter.

3. Under no circumstances should these signals be stowed or restowed with their pull rings exposed or with

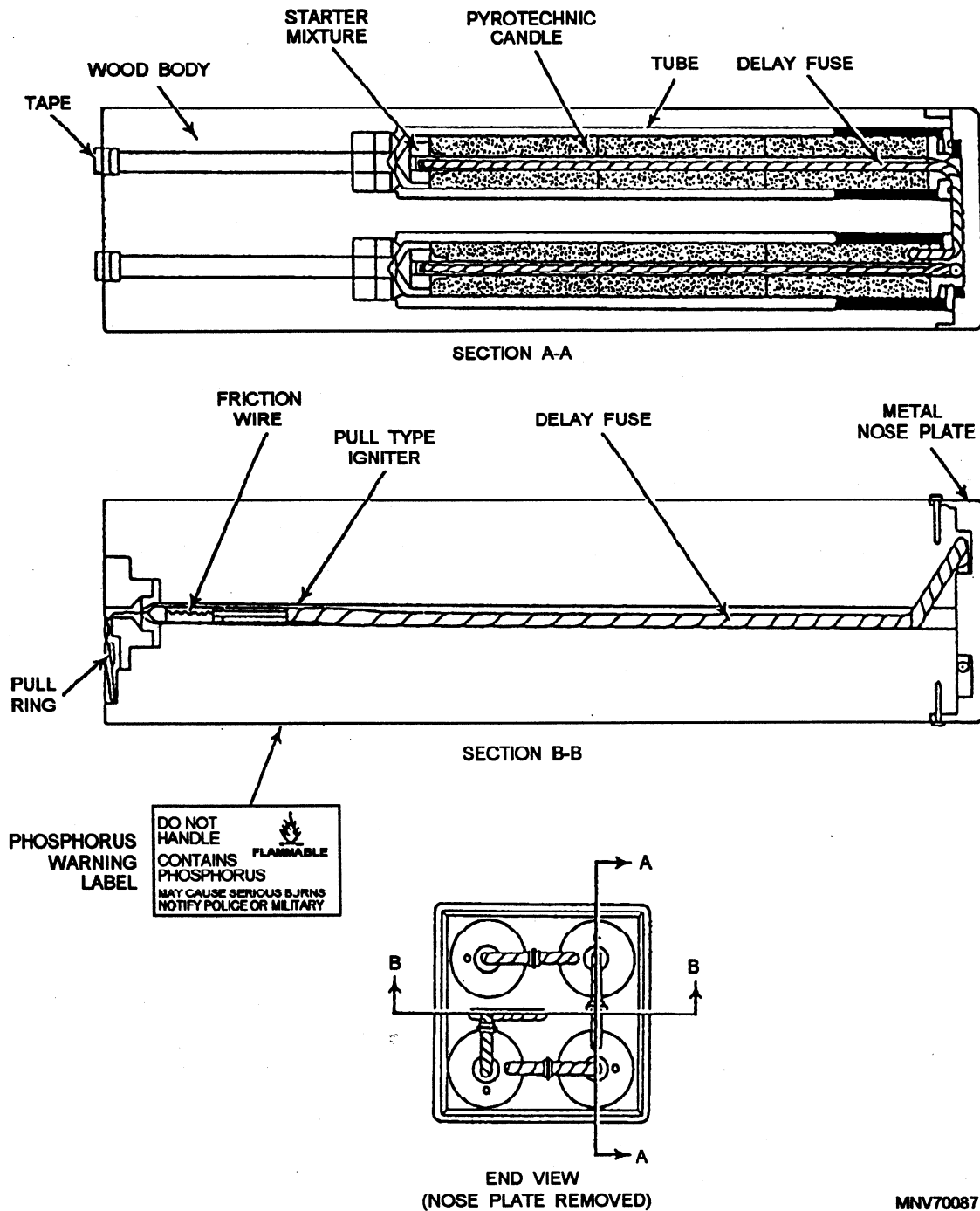


Figure 3-3.—The Mk 6 Mod 3 marine location marker.

any wires, strings, or other material of any kind joined to their pull rings.

All safety precautions pertaining to this signal must be observed. In addition, the following specific, rules apply:

1. Do not remove the tape over the pull ring until immediately before you launch the device.

2. Throw the Mk 6 signal over the side immediately after you pull the pull ring. This device has a maximum 90-second delay between initiation and candle ignition.

3. In all handling situations, take extreme care to avoid pulling on the pull ring. The slightest movement of the friction igniter may start the ignition train.

The Mk 6 marine location marker is being replaced by the Mk 58. There are, however, remaining serviceable stocks of the Mk 6 available. If you have any of these markers in your inventory, use them first. Man-overboard and navigation drills are good instances where these stocks can be efficiently expended.

### MARINE ILLUMINATION AND SMOKE SIGNALS

Marine illumination signals are similar in appearance to a standard shotgun cartridge. When one of these signals is fired from the proper pistol or projector, a burning star (somewhat like a star from a Roman candle) shoots high into the air. In this section, we will describe the marine illumination and smoke signals and pyrotechnic pistols currently in use. These include the

- Mk 2 marine illumination signal,
- Mk 5 pyrotechnic pistol,
- AN-M37A2 through AN-M39A2 series, double-star illumination signal,
- Mk 1 marine illumination signal, and
- AN-M8 pyrotechnic pistol.

#### MK 2 MARINE ILLUMINATION SIGNAL

The Mk 2 marine illumination signal is a six-second signal that is available in three colors: red, green, and

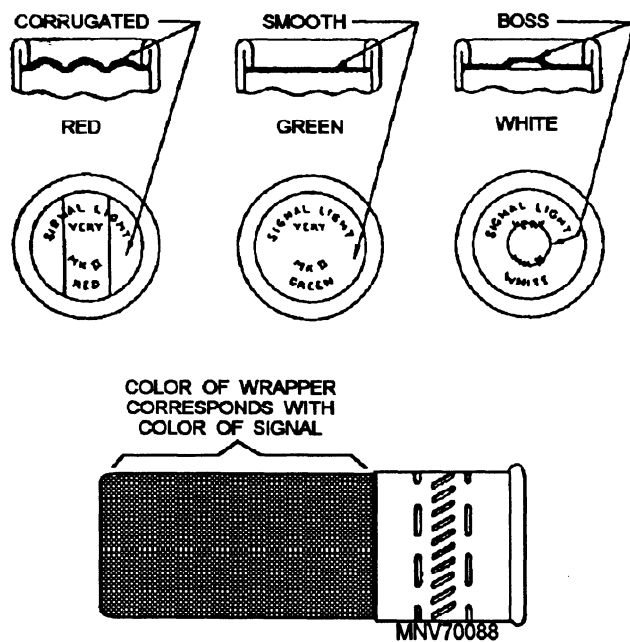


Figure 3-4.—The Mk 2 marine illumination signal.

white. Each cartridge has a percussion primer and a propelling or expelling charge of ten grains of black powder, which projects the burning star to a height of about 200 feet. The star charge is a tightly-packed cylinder wrapped with a quick match (a fast-burning fuse) that ignites when the signal is fired. The star charge is separated from the expelling charge by a shock-absorbing wad of hard felt. The cartridge is closed by a wad whose end is shaped so that color of the star can be determined at night by feel, as shown in figure 3-4.

The red star has a corrugated closing wad, the green star has a smooth closing wad, and the white star has a small conical boss on its closing wad. Each of the signals may also be identified by the corresponding color of the paper on its cartridge.

The illumination signals are available in ten-round metal or cardboard containers. The containers are packaged in wooden boxes that hold 40, 45, or 100 containers.

#### MK 5 Pyrotechnic Pistol

Mk 2 marine illumination signals are fired from the Mk 5 pyrotechnic pistol. This pistol is a breech-loaded, double-action, single-shot device, 11 inches long. Metal parts are mounted on a plastic frame. The operating instructions for the Mk 5 pistol are as follows:

1. To load the pistol, depress the latch button below the barrel. At the same time, pull the barrel downward, as shown in figure 3-5, view A. Insert the signal shell (view B). Bush the barrel upward until it latches in the closed position. The pistol is now ready to fire.

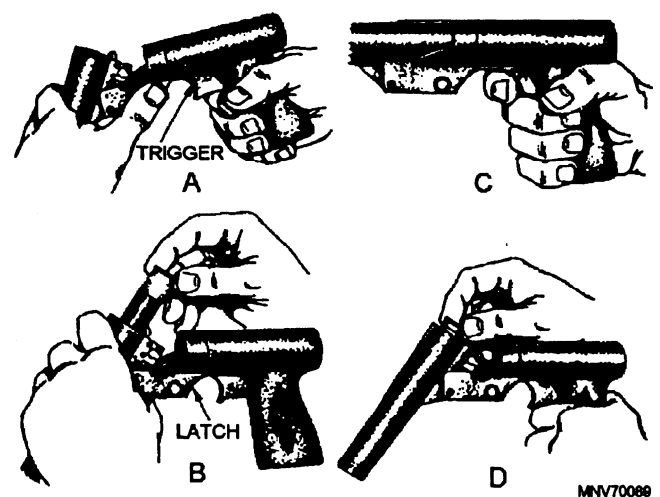


Figure 3-5.—Operation of the Mk 5 pyrotechnic pistol.

2. To fire the pistol, aim it upward at the desired angle, normally 60 degrees, but clear of other ships or personnel. Pull the trigger, as shown in figure 3-5, view C. Keep your elbow slightly bent when firing to absorb the shock of recoil and to prevent the pistol from knocking itself out of your hand.

3. To extract the expended shell, break the pistol open again (view A) and pull the shell out of the chamber (view D).

**WARNING**

The pyrotechnic pistol is cocked at all times when the breech is closed; it has no positive safety mechanism. **DO NOT** load an illumination signal into the pistol until just before you are ready to use it. **DO NOT** leave unfired signals in the pistol.

The Mk 5 pistol must be kept in serviceable condition at all times. Clean it thoroughly after each use according to the procedure prescribed on the appropriate 3-M System maintenance requirement card (MRC).

When you load or fire a pyrotechnic pistol, **NEVER** point it in the direction of other personnel or vessels.

**NEVER** use the Mk 5 pistol with ammunition other than that authorized for use with it. Conversely, never fire illumination signals from shotguns or from projectors other than those authorized

**AN-M37A2 THROUGH AN-M39A2 SERIES,  
DOUBLE-STAR AIRCRAFT  
ILLUMINATION SIGNAL**

The AN-M37A2 through AN-M39A2 series illumination signals (fig. 3-6) are fired from the AN-M8 pyrotechnic pistol for either day or night identification or signaling. Each signal projects two stars of the same color, which burn from 7 to 13 seconds, to an altitude of approximately 250 feet above the point of launch. The 25,000-candlepower stars are visible from 2 to 3 miles in daylight and 5 miles at night in clear weather. The display colors are indicated by 1/4-inch bands around the circumference of the signal and by colors on the closing wad. No provision is made for identification by touch as with the Mk 2 marine illumination signal. These signals ignite upon firing since they have no delay fuse.

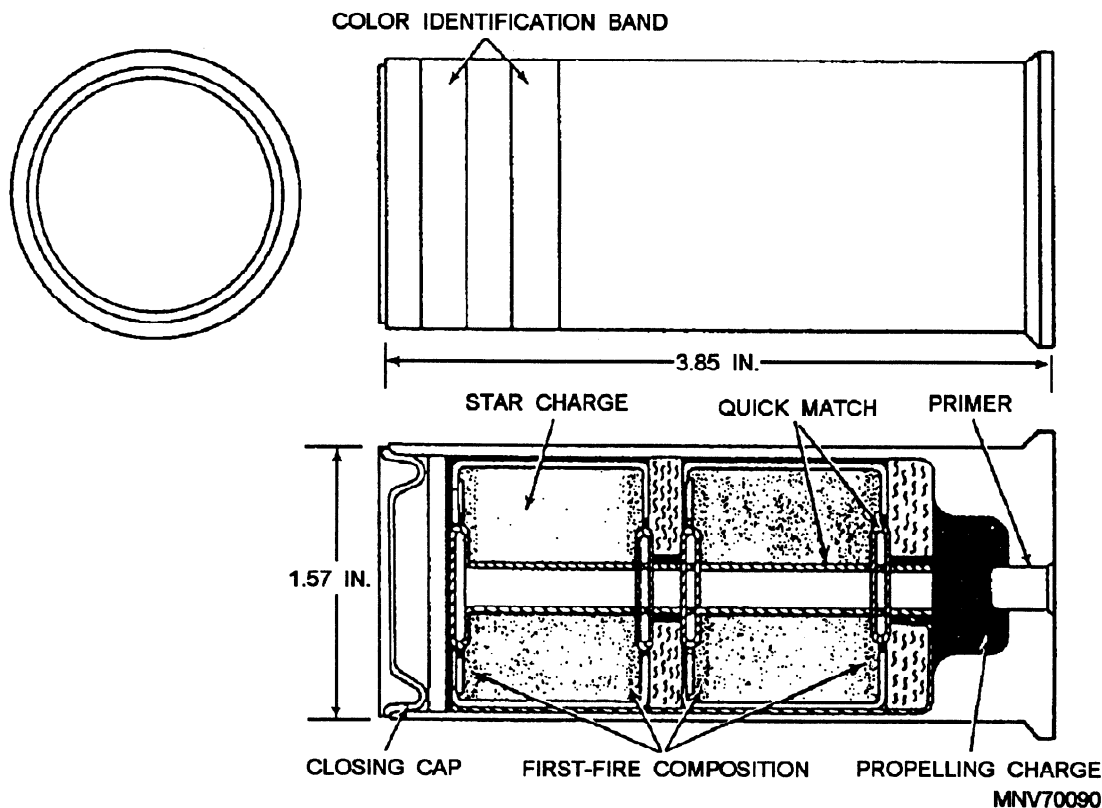


Figure 3-6.—The AN-M37A2 through AN-M39A2 aircraft illumination signals.

## MK 1 MARINE ILLUMINATION SIGNAL

The Mk 1 marine illumination signal (fig. 3-7) is a general-purpose signal fired from the AN-M8 pyrotechnic pistol. The Mk 1 signal is available in two versions: the Mod 0 and the Mod 1. The Mod 0 produces a red, green, or yellow 7- to 11-second star that falls free and leaves a trail of white light, similar to a comet. The Mod 1 produces a 20- to 30-second parachute-suspended red star. Both rounds are expelled from the pyrotechnic pistol by an auxiliary explosive to an approximate altitude of 30 feet. A rocket motor then ignites to propel the signal to a minimum height of 500 feet. It is stabilized in flight by folded fins that spring out once the signal is fired. At the end of its burn, the rocket propellant ignites an expelling charge and the pyrotechnic composition

## MK 2 MARINE SMOKE SIGNAL

The Mk 2 marine smoke signal (fig. 3-8) is intended primarily for signaling between ships and aircraft. It consists of a parachute-suspended red smoke display that persists for 20 to 30 seconds at a minimum height of 500 feet. The Mk 2 smoke signal is fired from the AN-M8 pyrotechnic pistol and functions much the same as the Mk 1 marine illumination signal.

### AN-M8 Pyrotechnic Pistol

The AN-M8 pyrotechnic pistol (fig. 3-9) is similar to the Mk 5 pyrotechnic pistol. It can be used with a number of shotgun-shell-shaped signals. The AN-M8 pyrotechnic pistol is loaded and fired in much the same fashion as the Mk 5. To open the breech for loading and unloading, raise the breechblock and pivot the hinged barrel down. The same safety and maintenance procedures also apply.

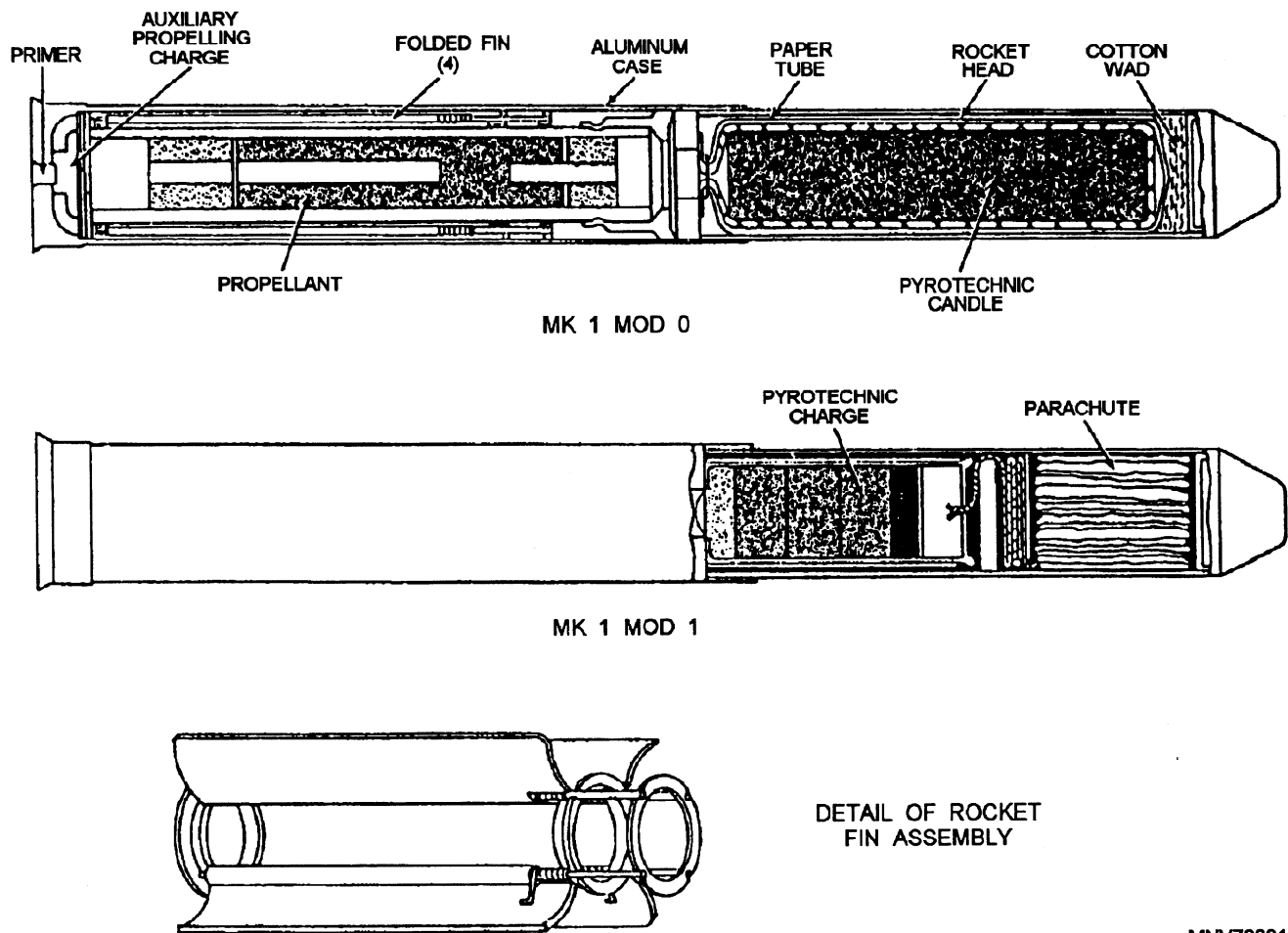
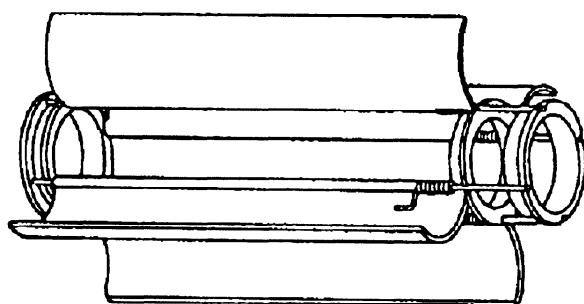
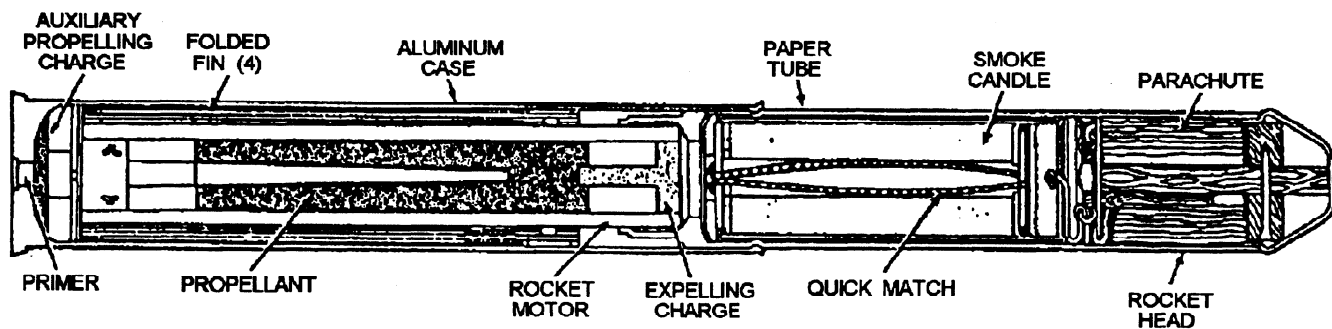


Figure 3-7.—The Mk 1 marine illumination signal.

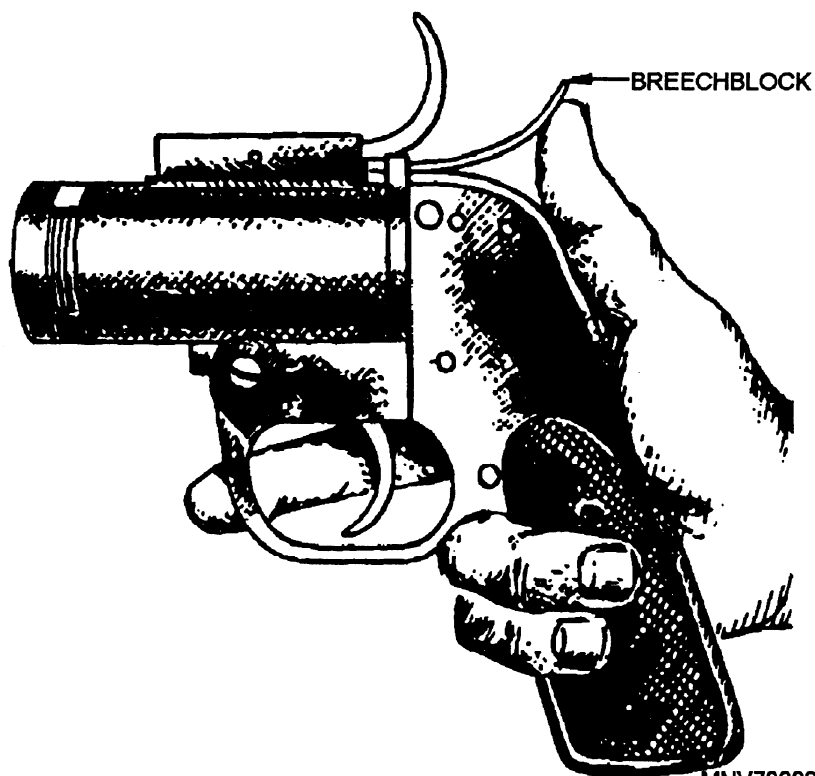
MNV70091



DETAIL OF ROCKET  
FIN ASSEMBLY

MNV70092

Figure 3-8.—The Mk 2 marine smoke signal.



MNV70093

Figure 3-9.—The AN-M8 pyrotechnic pistol.



## PERSONNEL DISTRESS SIGNALS

Three types of personnel distress pyrotechnic devices are currently found aboard surface ships. The Mk 13 smoke and illumination signal and the Mk 1 Navy light are hand-held signaling devices. The Mk 79 personnel distress signal kit contains compact light signal rounds that are shot into the air.

### Mk 13 MARINE SMOKE AND ILLUMINATION SIGNAL

The Mk 13 marine smoke and illumination signal (fig. 3-10) is a metal cylinder about 5 1/8 inches long and 1 5/8 inches in diameter. It weighs between 6 and 7 ounces. One end contains a canister that, when ignited, produces orange smoke for about 20 seconds. The other end contains a pyrotechnic flame pellet that will burn for approximately 20 seconds.

Each end of the metal tube is enclosed by a plastic cap. Under each cap is a pull ring. When you pull the ring, a friction wire moves through a cap coated with a composition that ignites (by friction), setting off either the flare or the smoke canister (depending on which ring you pull).

The signal body carries illustrated instructions for use. The flame end plastic cap has three prominent protrusions (beads) across its face to identify it as the end to use at night. When you use the signal, point it away from your face and hold it at arm's length at a 45-degree angle after it ignites. After the end of the signal that you ignited burns out, douse the signal to cool its metal parts. Keep the signal so that, if necessary, you can use the other end. Each end is separately insulated and waterproofed. NEVER try to use both ends at once. When you use the smoke signal, keep it to leeward.

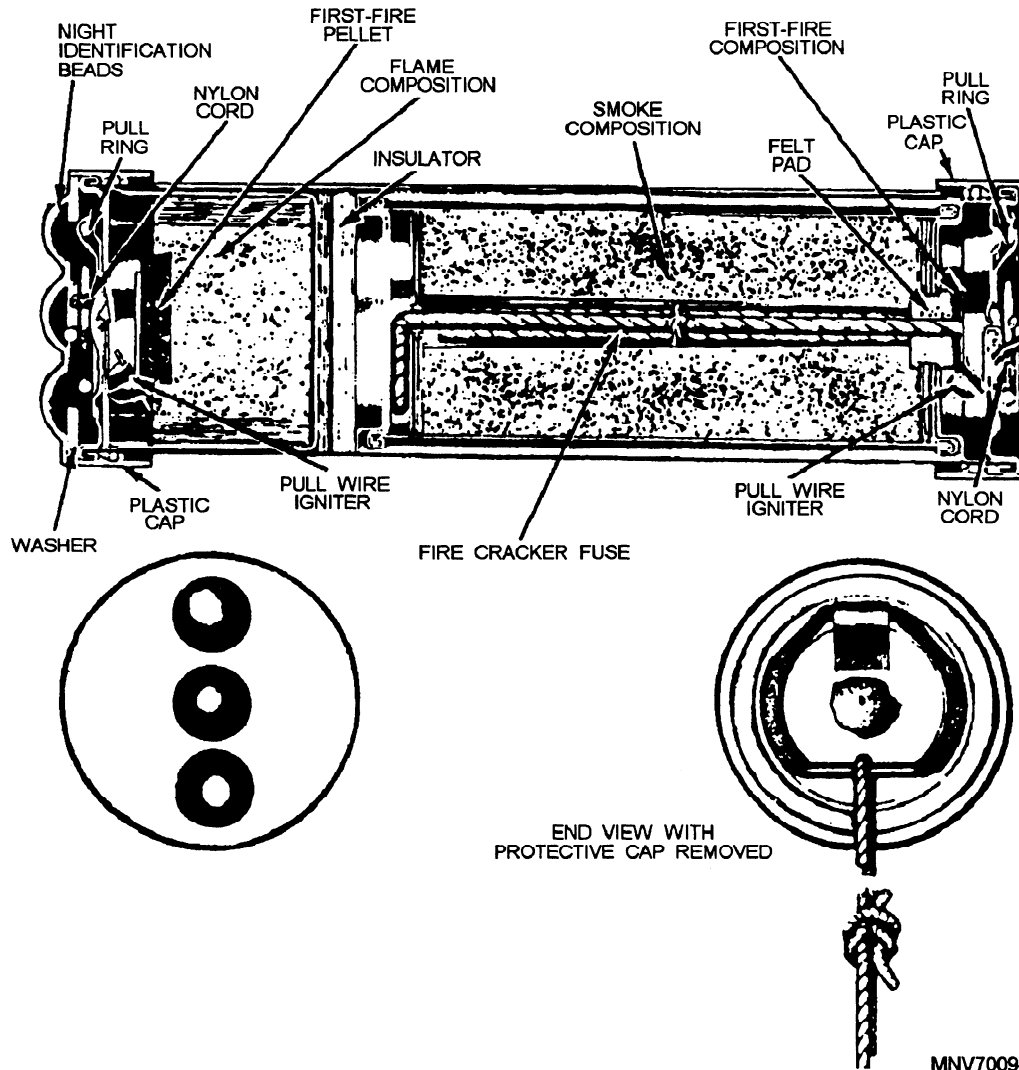


Figure 3-10.—The Mk 13 marine smoke and illumination signal.

These signals are packaged 12 per aluminum container (Mk 3), with 9 containers (108 signals) per wooden box. They may also be packaged 18 signals per aluminum container (M2A1).

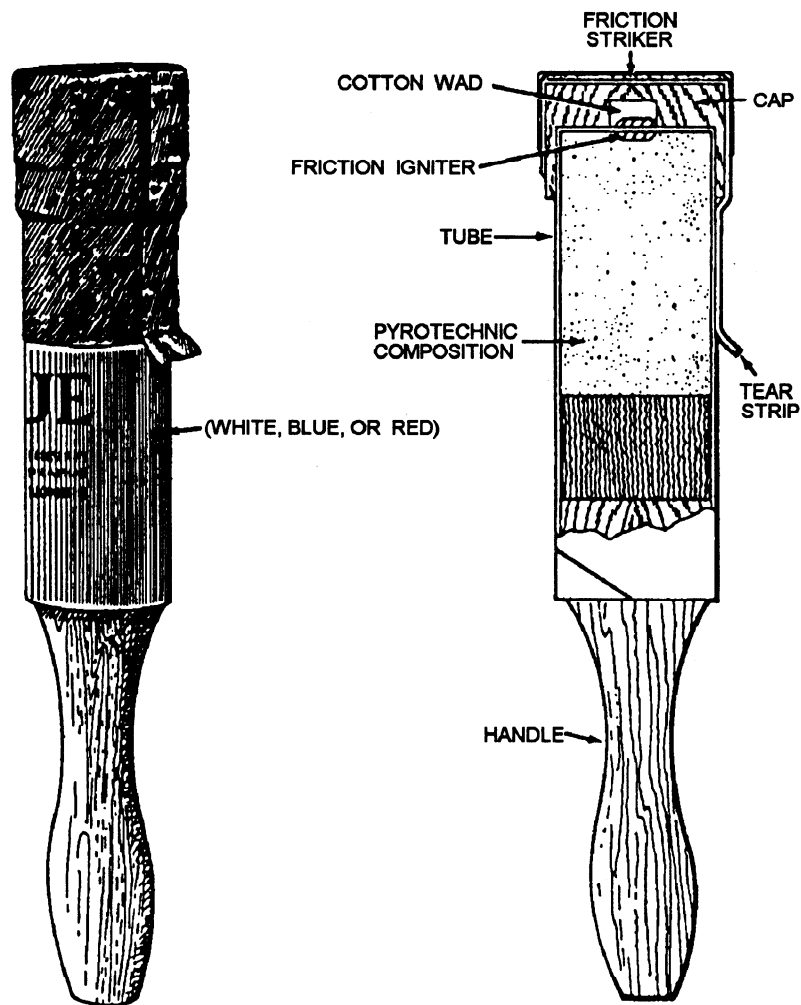
### MK 1 NAVY LIGHTS

Navy lights are hand torches that burn with a brilliant light visible up to 3 miles at night. They come in two colors, blue and red. The blue lights (Mk 1 Mod 1) burn for 75 seconds; the red lights (Mk 1 Mod 0) burn for 135 seconds. The two lights are similar in appearance and construction (fig. 3-11).

Navy lights consist of a paper tube that contains the pyrotechnic substance, with a wooden handle at one end and a cover with an exterior coating of abrasive, like that on the scratching side of a safety matchbox, at the other end. A tear strip protects the exterior of the cover. The upper end of the paper tube, beneath the cover, is capped by a fabric impregnated with igniting compound similar to that on the head of a safety match.

To ignite the Navy light, tear off the protective strip, remove the cover, and scrape the inverted cover across the top of the paper tube. As you strike the light, hold it pointing away from you at an angle of about 45 degrees to avoid contact with hot particles falling off the pyrotechnic candle. Hold the light at that angle while it burns.

Navy lights are shipped in metal containers, each containing 6 to 12 lights. The metal containers are packed into cardboard cartons that hold 12 metal containers. Since these lights deteriorate when exposed to moisture, they should not be removed from their containers until they are needed for use. For the same reason, keep them away from water or moisture. Lights that have been left in open containers for more than 6 months should be turned in to the nearest ammunition depot at the earliest opportunity. Lights that have become chemically encrusted or give off an acetic acid (vinegar) odor should be disposed of immediately. Put them in a weighted sack and dump them overboard.



MNV70095

Figure 3-11.—The Mk 1 Navy light.

**MK 79 MOD 0 AND MOD 2 PERSONNEL  
DISTRESS SIGNAL KIT**

This kit (fig. 3-12) is designed to be used by downed aircrew personnel or personnel in life rafts as a distress signaling device. It is small and lightweight so that it can be carried in pockets of flight suits or on life rafts. Each signal contains a red pyrotechnic star that will burn for a minimum of 4 1/2 seconds. On activation, this star is propelled upward to a minimum height of 250 feet.

The Mk 79 Mod 0 kit consists of one Mk 31 Mod 0 surface signal projector, a plastic bandoleer holding seven Mk 80 hand-fired signals, and an instruction

sheet. The Mk 79 Mod 2 kit contains Mk 80 Mod 2 signals.

The projector consists of a steel cylinder slightly more than 5 inches long and approximately 1/2 inch in diameter. The base (or handle) is knurled to provide a more positive gripping surface. The firing end of the projector has internal threads that match the external threads of the signal. Near this end is a firing slot through which the trigger screw moves when it is released from the safety slot. The trigger screw is attached to the firing pin that is forced against the signal primer by a helical spring within the knurled portion of the cylindrical body.

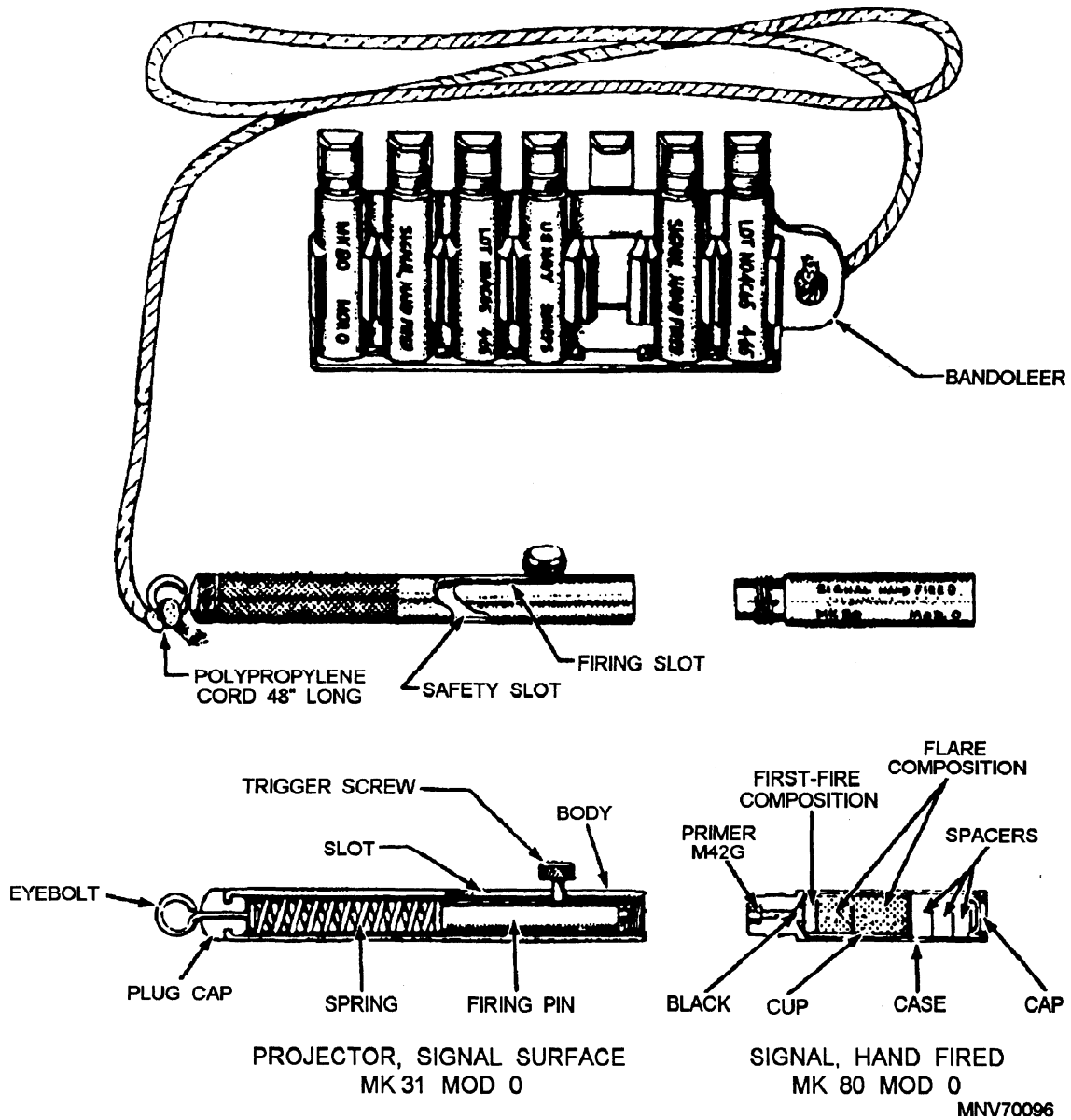


Figure 3-12.—The Mk 79 Mod 0 illumination signal kit.

A plastic bandoleer designed to hold seven signals is attached to the base of the projector by a 48-inch polypropylene cord.

### **Operating Instructions**

The Mk 31 Mod 0 projector is a simple signaling device. Operate it as follows:

1. Cock the firing pin of the projector by moving the trigger screw to the bottom of the vertical slot and slipping it to the right so that it moves to the upper end of the angular (safety) slot.

2. Break the protective plastic tab away from the signal you plan to attach to the projector.

### **WARNING**

The plastic tabs over the signals in the bandoleer protect the percussion primers from being struck accidentally. Do not remove a signal's tab until just before you load the signal into the projector.

3. Mate the projector with the signal and rotate the projector clockwise until it is seated on the signal. Pull the signal from the bandoleer.

4. Hold the projector over your head with your arm fully extended. Be sure the projector is pointed at a slight angle away from your body.

5. While firmly gripping the projector, fire the signal by slipping the trigger screw to the left out of the safety slot and into the firing slot.

### **NOTE**

This action should be one continuous movement so that your thumb does not interfere with the forward motion of the firing pin.

6. If the signal fails to fire, pull the trigger screw back to the bottom of the firing slot against the force of the spring, and release it quickly.

### **WARNING**

Whenever you remove a misfired cartridge, be sure to keep it pointed in a safe direction and do NOT place any part of your hand over the discharge end of the cartridge.

7. Unscrew the spent signal case or signal that has failed to fire and discard it by throwing it over the side.

8. Place the trigger screw in the safety slot and reload, as in step 4, if you need to fire another signal.

### **Safety Precautions**

The following special safety precautions apply to the use of the Mk 79 kit:

1. Signals in this kit are ignited by percussion primers, which should be protected against being struck. Protruding tabs of the bandoleer, which extend over the signal bases, prevent accidental striking of the primers. Do not tear them off or bend them back except when you load a signal into the projector.

2. Do not load the projector until just before you are ready to fire the signal. If you load a signal into the projector but do not fire it immediately, return it to the bandoleer.

### **WARNING**

Do NOT use dented or damaged signals. Dents or other imperfections may cause violent actions if you fire such a signal.

3. Inspect the signals periodically to ensure that they are not dented or otherwise damaged.

4. Keep the signals away from fire and other heat sources.

5. Check the projector trigger screw frequently to ensure that it is tight. A loose trigger can release the firing pin prematurely and cause injury, or it might fall out and be lost during emergency loading, thereby rendering the projector useless.

6. Keep the trigger screw in the safety slot while you load a signal.

7. When you fire the projector, be sure to raise your arm well above your head and hold the projector in a vertical position. NEVER point a loaded projector toward other personnel or toward your body.

### **PYROTECHNIC SAFETY, HANDLING, AND STOWAGE**

The following general information is taken directly from chapter 1 of *Pyrotechnic Screening, Marking, and Countermeasure Devices*, NAVSEA SW050-AB-MMA-010.

## **PYROTECHNIC SAFETY**

All pyrotechnic and screening devices, while designed and tested to be safe under normal conditions, can be subject to accidental ignition because of a wide variety of circumstances. The general rule to follow is: Be constantly aware that pyrotechnics contain chemical components that are intended to burn with intense heat, and act accordingly.

### **Toxic Hazards of Pyrotechnics**

Many chemicals used in pyrotechnics, screening equipment, and dye-marking devices are poisonous if taken internally. This also applies to the residue of burned pyrotechnics. From the inhalation standpoint, the products of pyrotechnic devices and smoke generators often present a serious problem. Many of the smokes and fumes given off by pyrotechnics and screening devices are considered nontoxic and are only mildly irritating to the eyes and nasal passages when encountered in relatively light concentrations out-of-doors. Heavy concentrations in closely confined spaces, however, are dangerous and may be lethal because they reduce the amount of oxygen in the air. Avoid anything more than a brief exposure to the gases of combustion or to screening smokes. If you must, spend more than a brief time in the gases or smokes, protect yourself by using an appropriate breathing apparatus.

## **PYROTECHNIC HANDLING AND STOWAGE**

All pyrotechnics and smoke-screening devices are designed to withstand normal handling. However, they should still be handled as little as possible, to lessen the chances of damage, which might cause accidental ignition or leakage. Many devices contain dangerous materials and are therefore designed with built-in safety features, which should be maintained in good operating condition. Dents, deformations, or cracks in the outer body may interfere with the proper functioning of these

safety features or might cause ignition during handling or stowage. Because of the potential dangers associated with these devices, take great care to prevent damage both to the devices and to their containers.

### **Effect of Moisture on Pyrotechnics**

The proper functioning of pyrotechnic, dye-marking, and screening devices is frequently affected by moisture. Some compositions become more sensitive and dangerous when exposed to moisture, while others tend to become difficult to ignite and less dependable in operation. When you handle or stow these devices, exercise care to prevent damaging their seals because some of them are activated when their chemical contents react with moisture in the air. Also, bear in mind that some marine location markers, such as the Mk 58, are saltwater-activated. In emergency situations, markers with damaged seals could be activated by exposure to fire-fighting water or runoff.

### **Effect of Temperature on Pyrotechnics**

Pyrotechnics and some screening devices may become adversely affected by excessively high or variable temperatures. These devices should never be stored where direct rays of the sun could generate excessively high temperature. Stowage should be in dry, well-ventilated places that provide the greatest possible protection from such conditions. All Navy pyrotechnics have been designed to withstand temperatures from -65°F to 160°F, so they should be safe from deterioration or damage within that range. However, every reasonable effort should be made to maintain stowage temperature at not more than 100°F. Specific ammunition stowage temperature requirements for all types of ammunition are addressed in NAVSEA OP 4.

