TECHNICAL MANUAL

DESCRIPTION AND CHARACTERISTICS AIRBORNE BOMB AND ROCKET FUZE MANUAL

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CHAPTER 1

INTRODUCTION

1.1 SCOPE.

The Airborne Bomb and Rocket Fuze Manual is prepared by the Naval Air Warfare Center, Weapons Division, Pt. Mugu, CA and is published by direction of Commander, Naval Air Systems Command, under the authority of Commander, Naval Material Command. This publication provides technical details of fuzes used in Navy air-launched bombs and rockets.

1.2 PURPOSE.

1.2.1 This manual is intended as a reference document for anyone having a need for fuzing information at a more detailed and complex level than that provided by the summary-type information given in NAVAIR 11-5A-17 and NAVAIR 11-75A-92. Information in this manual is intended for instructors, senior ordnance personnel, and other ordnance personnel who wish to better understand the operation of their weapons. It is also intended to provide general design and operational data for engineering and test personnel.

1.2.2 All fuzes currently authorized for Navy use are covered. Data covering new fuzes will be added when those fuzes are released for Fleet use.

1.2.3 This manual is not intended for use in assembling weapons or loading ordnance on aircraft, NAVAIR 11-140-5, NAVAIR 11-140-9, NAVAIR 11-140-10, NAVAIR 11-75A-92, and the appropriate Airborne Weapons/Stores Loading Manuals cover these areas.

CAUTION

This manual does not authorize the fuzing or the carriage of any weapon on any aircraft. Refer to the appropriate NATOPS/Tactical Manual for flight authorization.

1.3 ARRANGEMENT.

1.3.1 This manual is divided into the following chapters: Chapter 1-Introduction; Chapter 2-Airborne Bomb Fuzes; Chapter 3-Airborne Submunition Fuzes; Chapter 4-Airborne Rocket Fuzes.

1.3.2 The material contained in this manual is sectionalized in order to provide a detailed description and illustration of a bomb or a rocket fuze and its associated system. Coverage of individual fuzes is sectionalized as follows:

1.3.3 GENERAL DESCRIPTION. This section is a brief summary of the significant features and characteristics of the fuze. It also serves as an introduction to the following more specific sections. One or more illustrations of the external configuration of the fuze are included.

1.3.4 OPERATIONAL CHARACTERISTICS. This section provides details on the use of the fuze, such as warhead compatibility, general tactical applications, arming and functioning delays, and basic fuze limitations.

1.3.5 EXPLOSIVE COMPONENTS. This section details the explosive components of the fuze and gives the type and weight of each explosive material, where pertinent.

1.3.6 SAFETY FEATURES. This section summarizes design safety features, including handling and inflight environmental safety and visual indication of armed or safe condition of the fuze.

1.3.7 FUNCTIONAL DESCRIPTION. This section covers the method in which the fuze operates. Enabling, arming, and firing sequences are described, as are backup and fail-safe features if applicable. Illustrations may include internal views or exploded views.

1.3.8 INSTALLATION REQUIREMENTS.

Operations to be performed prior to or during fuze installation and fuze removal are covered in this section. Such items as recommended pre-loading checks, critical assembly operations which could affect safety or reliability, and setting of arming and functioning delays are discussed.

1.4 CHANGE TO MANUAL.

Personnel may report technical errors or omissions to this manual. Comments and recommendations concerning this publication should be forwarded in accordance with the Technical Publications Deficiency Report (TPDR) procedures established in OPNAVINST 4790.2 series.

1.5 WARNINGS, CAUTIONS, AND NOTES.

The following definitions apply to “Warnings,” “Cautions,” and “Notes” found throughout the manual:

WARNING

An operating procedure, practice, etc., which if not correctly followed, could result in personal injury or loss of life.

CAUTION

An operating procedure, practice, etc., which if not correctly observed, could result in damage to, or destruction of, equipment.

NOTE

An operating procedure, condition, etc., which is essential to highlight.

1.6 CHANGE SYMBOL.

Revised Text is indicated by a black vertical line in either margin of the page, like the one printed next to this paragraph. The change symbol shows where there has been a change. The change might be to material added, revised, or information restated.

1.7 REQUISITIONING AND AUTOMATIC DISTRIBUTION.

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CHAPTER 2

AIRBORNE BOMB FUZES

2.1 INTRODUCTION.

2.1.1 Airborne bomb fuzes are generally divided into two broad categories: mechanical and electrical. While these two categories appear to be straight-forward, controversy can arise when one begins to define the characteristics of each category. A fuze could, for example, be classified as a mechanical fuze only if it were activated by either a solid or a flexible lanyard. In other words activation would be via the devices normally identified as the mechanical fuze arming solenoids. The operation of the fuze after activation could be mechanical, electrical, chemical, or any combination of the three. The traditional definition of a mechanical fuze, however, is a device in which all major functions are non-electrical in operation. The means of activation is not defined but, traditionally and historically, it is considered to be via an arming wire or lanyard and an arming solenoid. This traditional classification will be the one followed in this manual.

2.1.2 Fuzes of both categories may be further sub-divided according to their mode of functioning (i.e., the action which initiates the explosive train): impact, time, proximity, and hydrostatic. A further subclassification would be a function of the fuze's position in the bomb: nose, tail, or side.

2.1.3 There are certain general characteristics for fuzes in each of the two main categories and the four functioning sub-categories. These are summarized below.

2.2 MECHANICAL FUZES.

2.2.1 All mechanical bomb fuzes are activated by means of an arming wire or lanyard. Pulling this arming wire or lanyard at weapon release frees a vane. Rotation of the vane in the airstream can provide mechanical energy to an internal mechanism to arm the fuze or can unlock a powered mechanism so that arming can occur. When a fuze is armed, the explosive train is aligned so that the main explosive charge in the weapon can be detonated and the mechanism which determines the mode of fuze functioning is free to operate.

2.2.2 The time at which a fuze arms can be fixed or it can be variable. In the former case, the arming time is determined at fuze manufacture. In the latter case, the arming time is preflight selected during the weapon build-up operation or the aircraft loading sequence. The actual arming time to be utilized is a function of the delivery tactic to be employed during weapon delivery.

2.2.3 Impact functioning requires target (ground) contact. Fuze operation could be the result of crushing the fuze. A firing pin is driven into a sensitive explosive element thus initiating the explosive train.

2.2.4 A fuze which functions at target contact or shortly thereafter (up to 0.25 second after impact) is called simply an impact fuze. A fuze which functions minutes, hours, or even days after impact is called a long delay fuze or long delay impact fuze. The short delay in the impact fuze allows a bomb to penetrate the target in order to achieve maximum damage. A long delay impact fuze is employed to deny an area to the enemy or for its nuisance value.

2.2.5 A time fuze operates at a specific time after weapon release. The time is determined by a clock. As with impact fuzes, the time at which a time fuze functions could also be fixed or preflight selectable. At the end of the time interval, a firing pin is released to initiate the explosive train.

2.2.6 In a hydrostatic fuze, water pressure is employed to release the firing pin. Presently there are no hydrostatic fuzes for bombs in the Navy inventory.

2.2.7 Proximity is defined as nearness, so there are no true mechanical proximity fuzes. With the use of fuze extenders or probes, impact fuzes can duplicate the action and the effectiveness of a true low burst height proximity fuze.

2.3 ELECTRICAL FUZES.

2.3.1 Electric fuzes can be activated either by means of a lanyard or by means of electrical energy transferred from aircraft carried equipment to the fuze as the weapon is released from the aircraft. If a fuze is activated by means of a lanyard, its arming time and its function time delay are selected before flight (i.e., at weapon buildup or aircraft loading). If a fuze is electrically activated, the electrical signal in addition to being a source of energy can also contain commands. For the first U.S. electric bomb fuze of this type, the format of the electrical activation signal was that of a DC voltage level with superimposed RF voltages. For current electric bomb fuzes, the electrical signal format is a combination of DC voltage levels and polarities. The command portion of this activation signal can be decoded within the fuze to select either an arming or a functioning time or both. This highlights the advantage of electrical activation. With electrical activation, the fuze arming time and functioning characteristics can be determined inflight to match changing conditions at the target area or conditions at alternate target areas.

2.3.2 All electrical fuzes utilize inertia trigger devices to initiate the fuze explosive train at target (ground) contact. These devices only close electrical firing circuits, and do not (as in mechanical fuzes) of themselves provide the energy to accomplish firing of the explosive train. The inertia of these trigger devices is very small, so over the total target spectrum electric fuzes are quicker to function in the instantaneous option than impact mechanical fuzes, even fuzes of the nose crush type.

2.3.3 Electric fuzes which are lanyard operated are powered by a power source activated by that lanyard. This power source could be a thermal battery or airstream driven generator. This energy must be continually present during the arming time interval. After arming, energy is stored in capacitors. This stored energy powers the impact-firing timing circuitry. In those fuzes in which the power source may be a thermal battery, providing on deck safety can result in circuit complexity. There is no difference, in respect to fuze input, if activation occurs as the result of an intentional release, accidental release, or just the pulling of the lanyard during the aircraft loading cycle. Safety for a fuze with this means of activation usually depends on the operation of impact sensors. A system which depends on the operation of a device to stop an action is not inherently fail safe. The use of an airstream driven generator requires the aircraft to be airborne, and if airstream driven generator will not operate below a threshold velocity, this type of power source can provide on-deck safety.

2.3.4 For electrically activated fuzes, on-deck safety is assured by maintaining absolute control of the fuze activating signal and by transmitting this signal over isolated dedicated aircraft cabling. Isolated cabling (isolation of both wiring and connectors) eliminates the probability of spurious voltages appearing at the fuze input. Control of the fuze activating signal is accomplished by requiring that a number of deliberate events or actions take place. The aircraft signal generating equipment (the Fuze Function Control Set) must be enabled by the pilot, aircraft power must be present, the weight-on-wheel switch must be operated, the pickle must be depressed, and the bomb rack must be unlocked. When the aircraft is airborne (and all the above are intentionally or automatically accomplished) the rack operates, releasing the bomb. Rack operation closes a switch associated with the opening of that rack's hooks. When there is about 6 inches of separation between bomb and bomb rack, the bomb to aircraft interface umbilical (the MK 122 Arming Safety Switch) operates, completing the path from the Fuze Function Control Set to the bomb fuze. Energy is now transferred to the fuze. With the introduction of this energy, the fuze is committed to the arming cycle.

2.3.5 All current Navy electric fuzes are simple impact fuzes. Electric fuzes are usually located in the tail position. While one can be employed in both the nose and tail position, the normal position in a single fuzed bomb is the tail position.

2.3.6 The term "fuze" indicates that the device contains an explosive train capable of initiating the warhead charge. With the exception of the FMU-140 Series Dispenser Proximity Fuze, there are no bomb proximity fuzes in the current Navy inventory. There are proximity sensing elements or target detecting devices. These devices do not contain an explosive train and must be used in combination with an impact fuze. As the bomb approaches the target (ground), the proximity device generates an electric signal. The impact fuze acts as the safety and arming device for the system. If the impact fuze is armed, the electric signal from the proximity device initiates the impact fuze explosive train. If the proximity device malfunctions (no fire signal), the impact fuze will function providing an impact backup or clean up feature.

2.4 SAFETY AND DELIVERY REQUIREMENTS.

2.4.1 Fuzes are designed to be safe while unarmed and as reliable as possible when armed. These requirements are not necessarily exclusive. Improving safety can decrease reliability.

2.4.2 If catastrophic accidents are to be avoided, safety during handling, shipping, aircraft loading, after bomb release (during the arming cycle), and if impact occurs before arming is absolutely necessary. This type of safety is provided in all bomb fuzes and meeting this goal has led to complexity in fuze design. In addition to providing safety, a fuze is required to withstand extremes of environmental conditions and rough handling without degradation of the fuze's normal operating characteristics.

2.4.3 The first explosive in an explosive train (the fuze primer or detonator) is the most sensitive. The last (the fuze booster and the warhead explosive) is the least sensitive. All bomb fuzes developed since 1950 employ a barrier or out-of-line feature to separate or isolate the two types of explosives. A fuze is defined as being armed when the barrier is removed or when the out-of-line feature is placed in-line. The time from launch to fuze arming is called the arming time or safe separation time. If bomb detonation were to occur at the end of this time, the probability of the delivery aircraft receiving a fragment hit should be an acceptable value. The value currently accepted by the Navy is 0.10. A computer program utilizing aircraft flight path, bomb trajectory, bomb fragmentation pattern, expected limits of bomb pitch, and the acceptable hit probability value is employed to determine the magnitude of the fuze arming time.

2.4.4 The overall hazard to the delivery aircraft at any point is defined by the following relationship:

$$P_{H/D} = P_D \bullet P_H$$

where

P_H is the probability of the aircraft receiving a hit if detonation occurs at a specific fuze event or time after bomb release

P_D is the probability of detonation occurring at that fuze event

$P_{H/D}$ is the overall hazard probability for that event.

2.4.5 The overall hazard probability for any event currently considered acceptable by the Navy is 0.0001. The same computer program used to determine the fuze arming time can also be employed to determine the minimum release altitude. P_D for a live release is 1.00 (at impact the fuze is armed and will function). From the above relationship, P_H must be 0.0001 for this ground detonation event. The value 0.0001 can be considered to be equivalent to zero without changing the results significantly. For a P_H equal to zero means that the aircraft is outside the fragment envelope. The computer program provides a time for a P_H in question. It is an arming time for a P_H of 0.10 and a time-of-fall for a P_H of 0.0001. This time-of-fall is in turn translated into minimum release altitude. Normal fuze arming time plus the maximum timing tolerance on this arming time should be less or at maximum, equal to this minimum time-of-fall, so that the fuze does not impose any restriction on the minimum delivery altitude.

2.4.6 The minimum arming time or minimum release altitude is determined for some minimum conditions (for high performance aircraft; for a straight and level release, 400 KIAS minimum; for a dive delivery, 400 KIAS minimum, 1 second stick length and bombs are released prior to a pull-out maneuver). Exceeding these minimum conditions (for straight and level, higher speed; for a dive, higher speed and/or shorter stick length and/or release during pull-out) will decrease the magnitude of the hit probability and therefore reduce the overall hazard probability.

2.4.7 The above hazard relationship can also be used to define another fuze characteristic, early burst rate. Early burst is defined as fuze functioning at arming or after arming, but before intended operation. This characteristic is more pronounced in fuzes which are inertia triggered than fuzes that operate due to deformation or crushing. The maximum value accepted for P_H at the end of the arming time is 0.10 and the value accepted for $P_{H/D}$ is 0.0001; then P_D (the rate of fuze functioning at the end of the arming time, i.e., the early burst rate) that would be acceptable is 0.001.

2.4.8 The above early burst rate is the rate inherent to the fuze (determined during single weapon releases). In the field, a slightly higher early function rate can be experienced. There is always the danger of fuze functioning occurring due to bomb-to-bomb collisions. These collisions are a function of the bomb free flight stability and the rate at which bombs are being released (ripple interval). The number of collisions increases as the ripple interval decreases or if bombs are released in salvo. Fortunately, the rate of occurrence of bomb-to-bomb collisions drop off rapidly with time. By the end of fuze arming time, the collision rate has decreased greatly but is still a factor that must be considered.

2.4.9 A single arming time does not meet the safe separation requirements for all launch conditions for air delivered bombs fuzed with impact fuzes. First, bombs vary in size and so does the fragment pattern for each, the launch platform is moving and following a path nearly parallel to the bomb; and bombs may be released in various patterns of salvo and ripple. For long linear targets, the total interval during which releases may be occurring can be very long (i.e., seconds). To simplify the fuze from both the design consideration and from the user's standpoint, a minimum arming time has been established for the free-fall delivery of general purpose bombs in either the level or the dive delivery maneuver and for delivery of bombs in the high drag weapon configuration. These are the three times incorporated into fuzes featuring in-flight selection of arming times. The arming time recommended to be used with this type fuze is the longer arming time nearest to the minimum arming time established for each of the three delivery maneuvers.

2.4.10 Impact fuzes are designed to withstand hard target impact at high velocities (greater than 900 feet per second) in the unarmed state without functioning. It must be pointed out that when bombs impact very hard targets (lava or thick reinforced concrete) they may themselves be the source of an explosive reaction. This reaction would be independent of the safe or armed state of the fuze. The warhead's explosive reaction under these conditions cannot be controlled or forecasted and can vary from low order to high order. An unarmed fuze is not an assurance that a bomb will not function at impact.

2.5 FUZE, MECHANICAL TIME, MK 339 MOD 0 AND MOD 1.

2.5.1 GENERAL DESCRIPTION. The Fuze, Mechanical Time, MK 339 MOD 0 and MOD 1 (figures 2-1 and 2-2) was designed to be a universal fuze for canister or cluster-type weapons which are to be delivered from high performance aircraft. It is presently employed on the Bomb, Cluster, Anti-Tank, MK 20, CBU-99/B and CBU-100/B (ROCKEYE II); and in other weapons which dispense a payload or submunitions. The nose-mounted MK 339 fuze provides two accurate preflight settable times, either one can be selected in-flight. Explosive leads and bursters to open the canister are not a part of the fuze but are to be provided as a part of the canister case. General characteristics of the MK 339 fuze are listed in table 2-1.

2.5.2 OPERATIONAL CHARACTERISTICS. The MK 339 fuze is a precision time fuze featuring two preflight set functioning time intervals. Inflight, the pilot may select either one of these two time intervals. The functioning time for either of the two settings can, for the MOD 0, range from 1.2 to 50.0 seconds and, for the MOD 1 range, from 1.2 to 100.0 seconds. The two inner dials for each MOD are marked in 0.1-second increments. The timing accuracy is within 0.100 second for settings from 1.2 to 10.0 seconds and within 1% for settings greater than 10 seconds.

2.5.2.1 The altitude at which the fuze opens a canister is a function of the fuze operating time set and selected and the weapon release altitude. For a given fuze function time, the dispersal and flight characteristics of the payload will determine how accurately release conditions must be held to provide a required payload density and area coverage in the target area.

2.5.2.2 The MK 339 will arm and function at delivery speeds in excess of 180 KIAS at zero angle of attack. Arming at delivery speeds between 140 and 180 KIAS is uncertain and the fuze will not arm at delivery speeds below 140 KIAS. As the weapon angle of attack increases the all-arm speed increases. At a 20-degree angle of attack, the all-arm speed is 200 KIAS. Since current cluster weapons do pitch shortly after release, the minimum recommended release velocity is 200 KIAS. This minimum is for the MK 339 fuze only. The submunitions may require a higher minimum release speed. The requirement for the submunitions would then be the controlling factor. The fuze may be employed in weapons that are released at dive angles up to 70 degrees and at release altitudes from 200 to 40,000 feet. Wind tunnel tests have demonstrated that the MK 339 fuze will function reliably at speeds as high as Mach 5.0. Field tests have demonstrated that the fuze will function reliably when released at speeds up to Mach 2.0.

2.5.2.3 The MK 339 provides the pilot with the in-flight option to select either one of the two functioning times set into the fuze. This is accomplished by withdrawal of one or both arming wires at weapon release. Two functioning times are normally pre-set into the fuze at fuze manufacture and are not changed at fuze weapon marriage. These times may be changed prior to aircraft launch to accommodate delivery conditions required by the mission. The two pre-set times, corresponding to current delivery scenarios, are 1.2 seconds as a primary time and 4.0 seconds as an option time. Some early MK 339 fuzes were pre-selected so that only the 4.0-second option time could be utilized. These fuzes were assembled in single function MK 20 MOD 2 (ROCKEYE II) weapons. The option time may be reset. The primary mechanism is inoperative and should be left on the 1.2-second setting.

2.5.2.4 Two independent operations are necessary to accomplish arming: vane rotation and timer operation. These two operations are independent in that they do not have to occur in any set sequence. Vane rotation however must occur before the pre-set time has elapsed for the fuze to function. If the release velocity is 200 KIAS or greater and the timer has started and is operational, the fuze will be enabled and arming will occur 1.1 seconds after arming wire withdrawal. Fuze functioning will occur after the selected pre-set time has elapsed.

2.5.2.5 Since the two events controlling arming are independent, the MK 339 fuze will, theoretically, function properly when a weapon in which it is mounted is launched at zero forward velocity. The only restriction is that the weapon must be airdropped from an altitude which permits the vane to reach a rotation velocity of 5400 rpm or greater before the fuze function time selected has elapsed.

2.5.3 EXPLOSIVE COMPONENTS. The MK 339 contains Detonator Stab MK 43 MOD 1 or MOD 2 which will initiate the weapon's explosive devices. This detonator contains approximately 250 milligrams of various explosives.

2.5.4 SAFETY FEATURES. The MK 339 fuze incorporates an air-velocity discriminating feature (an arming-vane-driven centrifugal clutch) which prevents arming at delivery speeds below 140 KIAS. The air velocity discriminating feature will provide an all-arm capability for delivery speeds above 200 KIAS.

2.5.4.1 The fuze contains a safe-set feature which provides a minimum function time delay of 1.2 seconds for safe separation of the weapon from the aircraft. Safe separation here, since warhead functioning is not an event, refers only to providing sufficient separation between the weapon and the aircraft so that there is little or no possibility of canister case parts hitting the delivery aircraft. Submunitions have their own fuzes and individual arming times. For settings

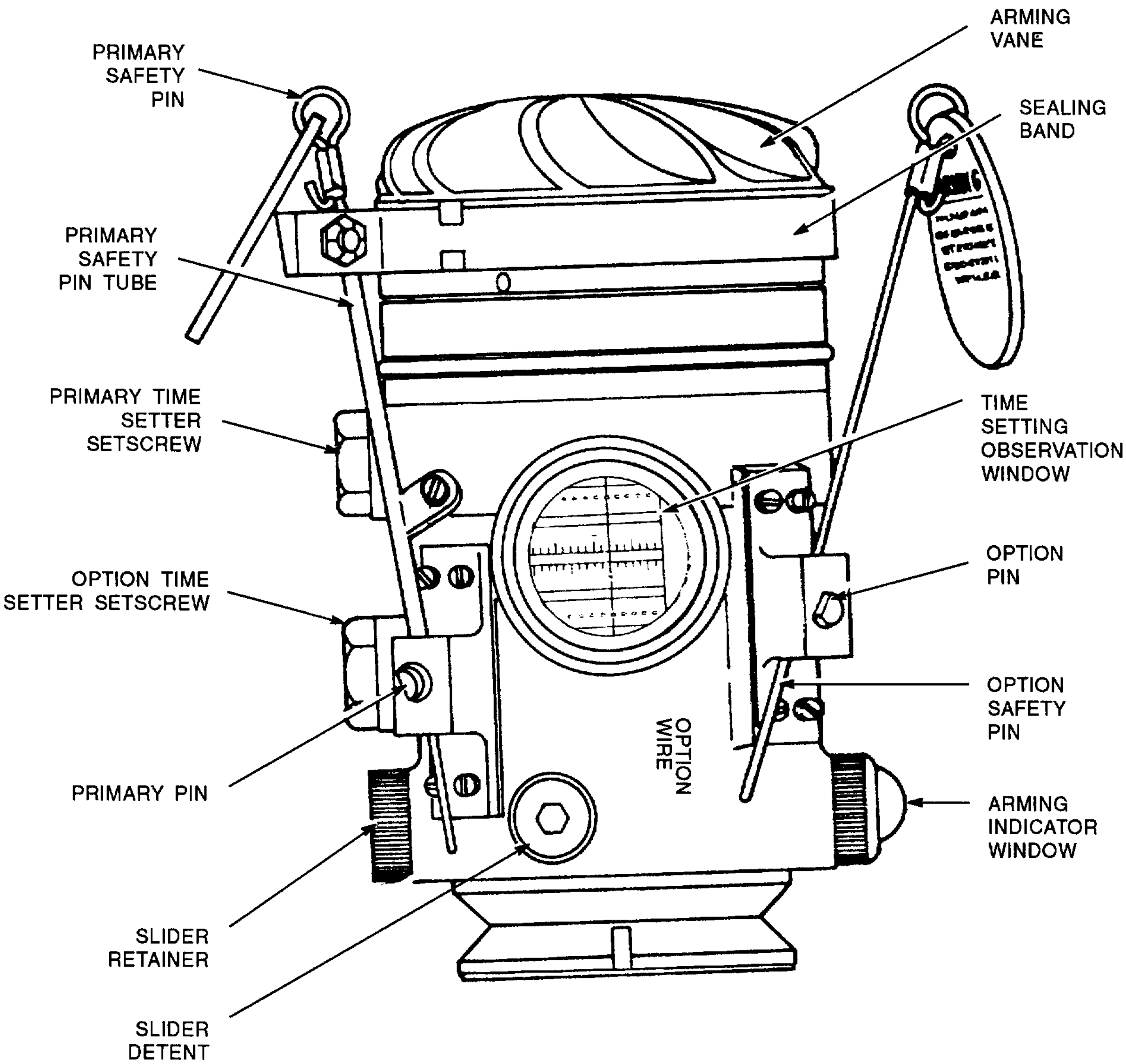

Figure 2-1. Fuze, Mechanical Time, MK 339 MOD 0 - External View

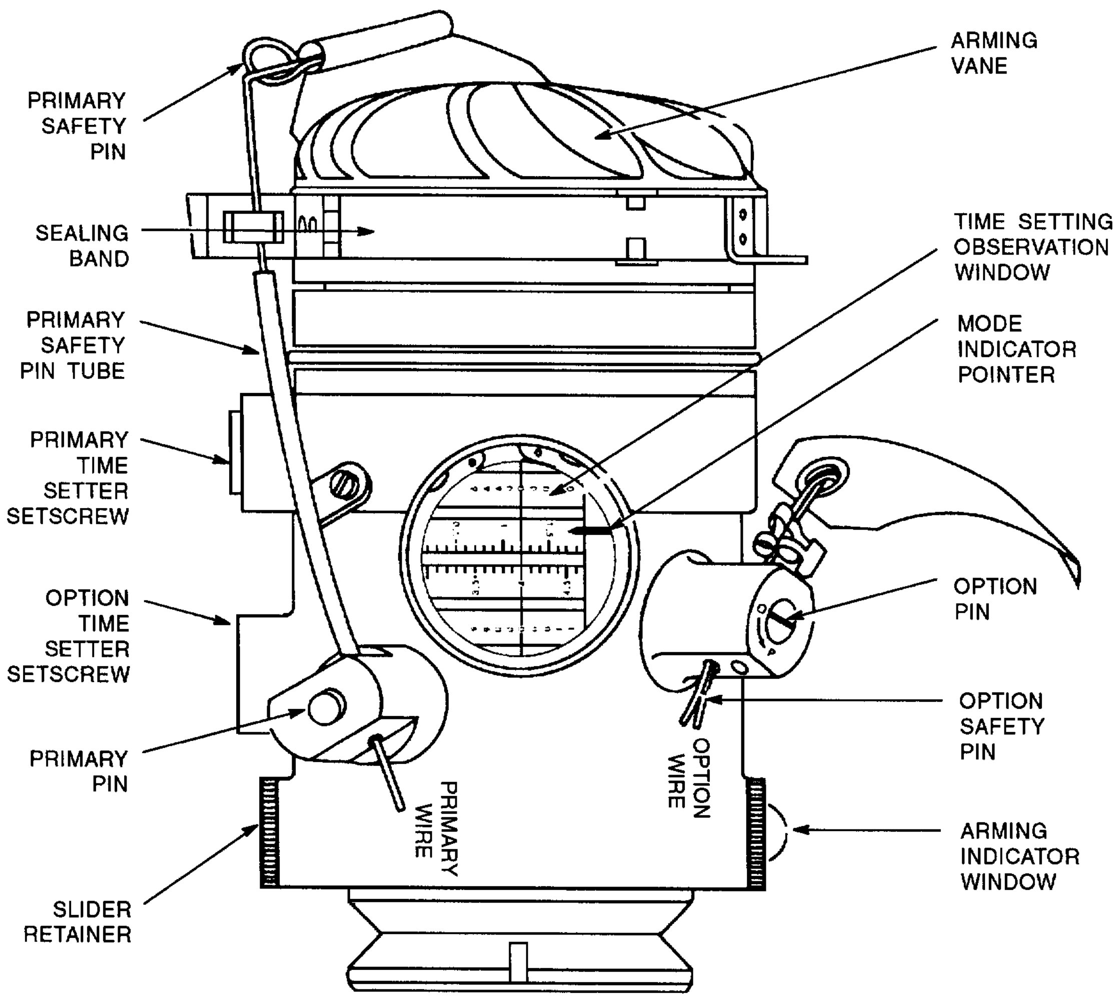

Figure 2-2. Fuze, Mechanical Time, MK 339 MOD 1 - External View

Table 2-1. General Characteristics of the MK 339 Fuze

Model	MOD 0	MOD 1
Drawing #	LD 549439	DL 479AS100
Type		Mechanical
Firing Action		Time
Position		Nose
Function Delay	1.2 to 50 sec. in 0.1 sec. increments	1.2 to 100 sec. in 0.1 sec. increments
Arming:		
Type		Vane rotation (velocity discrimination) and time
Rev. to enable		0.6 at vane rotation of 5400 rpm or greater
Air velocity to enable		200 KIAS min. (see text)
Time to enable		0.32 second at 200 KIAS
Time to arm		1.1 seconds
Physical Characteristics:		
Overall Length (in.)		6.75
Widest Body Diameter (in.)		4.5
Intrusion into Weapon (in.)		0.75
Total Weight (lbs)		3.75
Thread Size		N/A
Explosive Weights:	Detonator, Stab, MK 43 MOD 1	Detonator, Stab, MK 43 MOD 2
	63 mg NOL #130 priming mix	63 mg NOL #130 priming mix
	100 mg lead azide	100 mg lead azide
	93 mg tetryl	93 mg tetryl
Shelf Life:	Indefinite	Indefinite
Service Life:	Indefinite	Indefinite

from 1.0 to 1.2 seconds, the fuze will function at 1.2 seconds and not before. For fuze settings less than 9 second, the fuze will function at the maximum time (50 seconds for the MOD 0 fuze and 100 seconds for the MOD 1 fuze) plus the set time. This safe-set feature also allows the time setting mechanism to be rotated in either direction through zero without triggering the firing pin release mechanism.

2.5.4.2 The MK 339 fuze has a clear plastic bubble-type indicator window via which the SAFE or ARMED condition of the fuze can be determined. If the tip of the slider protrudes beyond the fuze housing into the clear plastic bubble, the fuze is considered armed. To enhance indication and to provide a safe/arm indicator that would not be subject to question, this area has undergone several design iterations. The latest design features a green foil which is pierced by a red tipped slider.

2.5.5 FUNCTIONAL DESCRIPTION. The MK 339 fuze utilizes two arming wires: a primary wire and an option wire. These two wires replace the primary and the option cotter pins which are removed during weapon/fuze marriage. Removal of either the primary arming wire or both the primary and option arming wires initiates two independent events, arming vane rotation and timer operation. The enabling, arming and functioning sequence is as follows (figures 2-3 through 2-6):

a. When the primary arming wire is withdrawn, it releases the sealing band and the primary pin. The sealing band flies off and the vane is free to rotate in the airstream. When vane rotation reaches 5400 revolutions per minute, centrifugal force causes the spring-mass clutch mechanism (figure 2-4) to move outward against the catch. This catch then unlocks the knurl, permitting the spring-mass clutch mechanism to engage and turn the knurl. As the knurl turns, it drives a worm gear, which turns the sector gear. The half-round shaft of the sector gear rotates so that it moves out of engagement with the enable pin. When released, the spring-loaded enable pin moves forward and its lower end clears the slider, thus removing a lock on the slider. This first event in the arming cycle takes from 30 milliseconds at 450 KIAS to 0.32 second at 200 KIAS to complete. After removal of this first lock on the slider, the fuze is considered enabled.

b. Simultaneous to release of the sealing band, the primary pin is released upon removal of the primary arming wire from the primary starting bracket. A spring propels the primary pin outward thus releasing a spring-loaded latch which starts the timer (figure 2-5). The timing disc rotates to a position where the notched arming pin is allowed to move up to a step on the timing disc. This disengages the lower end of the arming pin from the slider. This event will occur at 1.1 seconds after arming wire removal. The fuze is considered armed when this second lock is removed from the slider. In the MOD 0 fuze, the slider moves to the arm position and is locked in the armed position by a slider detent. The MOD 1 fuze does not have this slider lock.

c. If the fuze arming vane is not exposed to an air speed sufficient to rotate the vane in excess of 5400 rpm, the spring-mass clutch will not have released the enable pin. Because the fuze cannot arm or function if it has not enabled, such a fuze will be a dud.

d. At 1.2 seconds after the primary arming wire removal, the timing disc will have rotated sufficiently to allow the arming pin to move up, free of the timing disc (figure 2-6). The upward movement of the arming pin places the firing mechanism dropleaf into the firing mode. That is, the torsion of the dropleaf spring rotates the dropleaf to a position where it rides on the two primary timing dials. The timing disc and timing dials continue to rotate until the notches on the timing dials coincide with the dropleaf. This will occur at the end of the pre-set primary time. As the dropleaf moves into the timing dial notches, the shaft of the dropleaf rotates sufficiently to allow the trip assembly to disengage from the outer end of the firing mechanism lever. The spring-loaded firing pin collar bears against a half-round shaft which, in turn, bears against the opposite end of the firing mechanism lever (the end nearest fuze centerline). When the trip assembly is disengaged, the firing mechanism lever is free to rotate away from the half-round shaft. The half-round shaft is then forced to rotate by the spring-loaded firing pin, thus freeing the firing pin. The firing pin stabs the detonator and the explosive sequence begins.

e. If both primary arming and option wires are moved, the enabling, arming, and functioning cycles of the option mode are identical to those of the primary mode. As described above, if the primary arming wire only is removed, the dropleaf is held in place over the primary timing dials by the option pin. If the option wire is also removed, the option pin is propelled outward by its spring and the compression of the dropleaf spring forces the dropleaf to a position over the two option timing dials. Subsequent functioning is identical to the primary mode; however, the fuze will function at the end of the pre-set option time.

2.5.6 INSTALLATION REQUIREMENTS. Currently the MK 339 fuze is shipped to the Fleet only as part of an all-up round. Installation of the fuze will be done at the depot level.

2.5.6.1 The primary and option delay times are preset at the factory. Should tactical requirements necessitate changing the times, resetting is accomplished by inserting a screwdriver in the time setter setscrew, pressing the

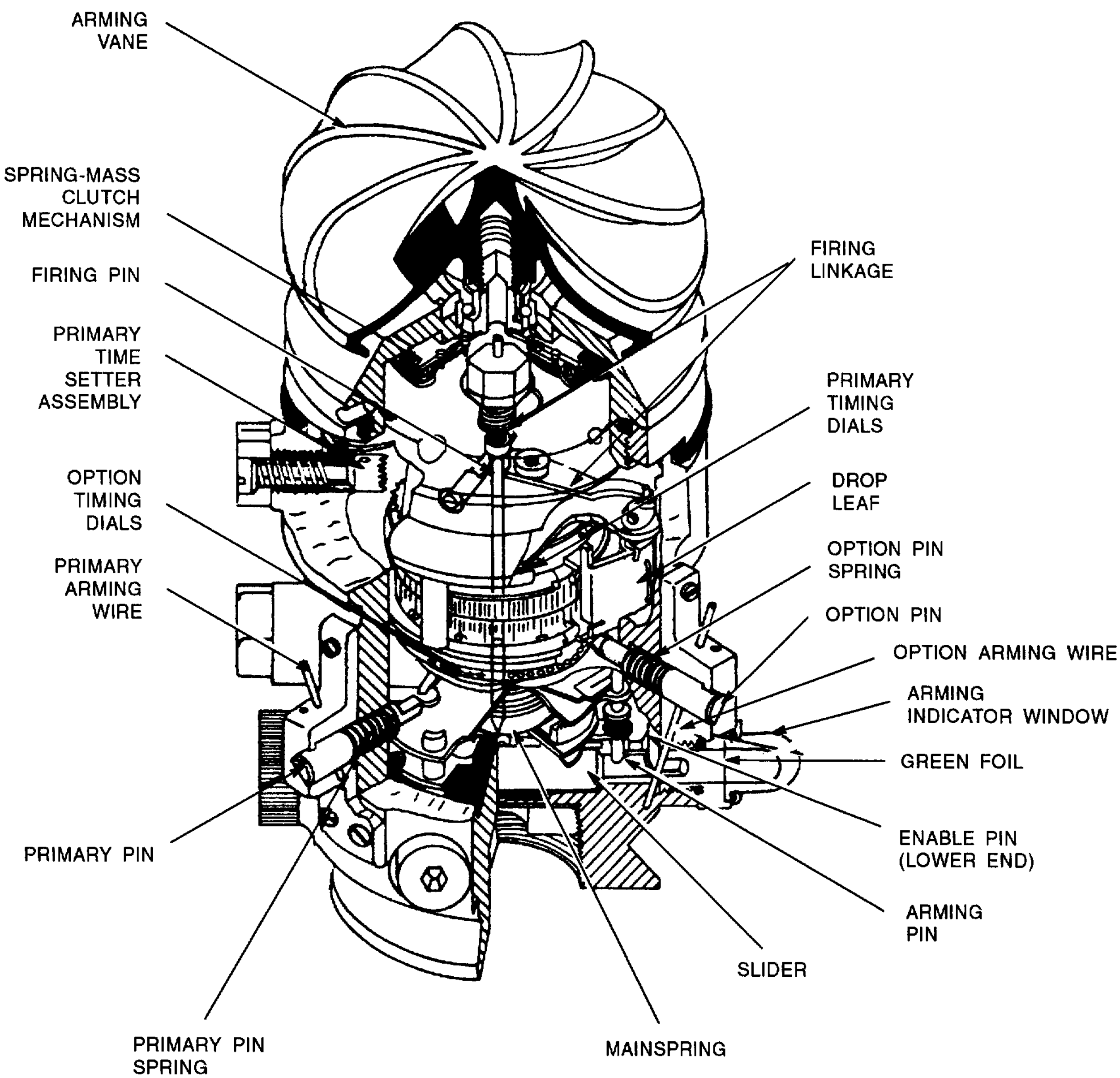

Figure 2-3. MK 339 MOD 0 Fuze - Internal View

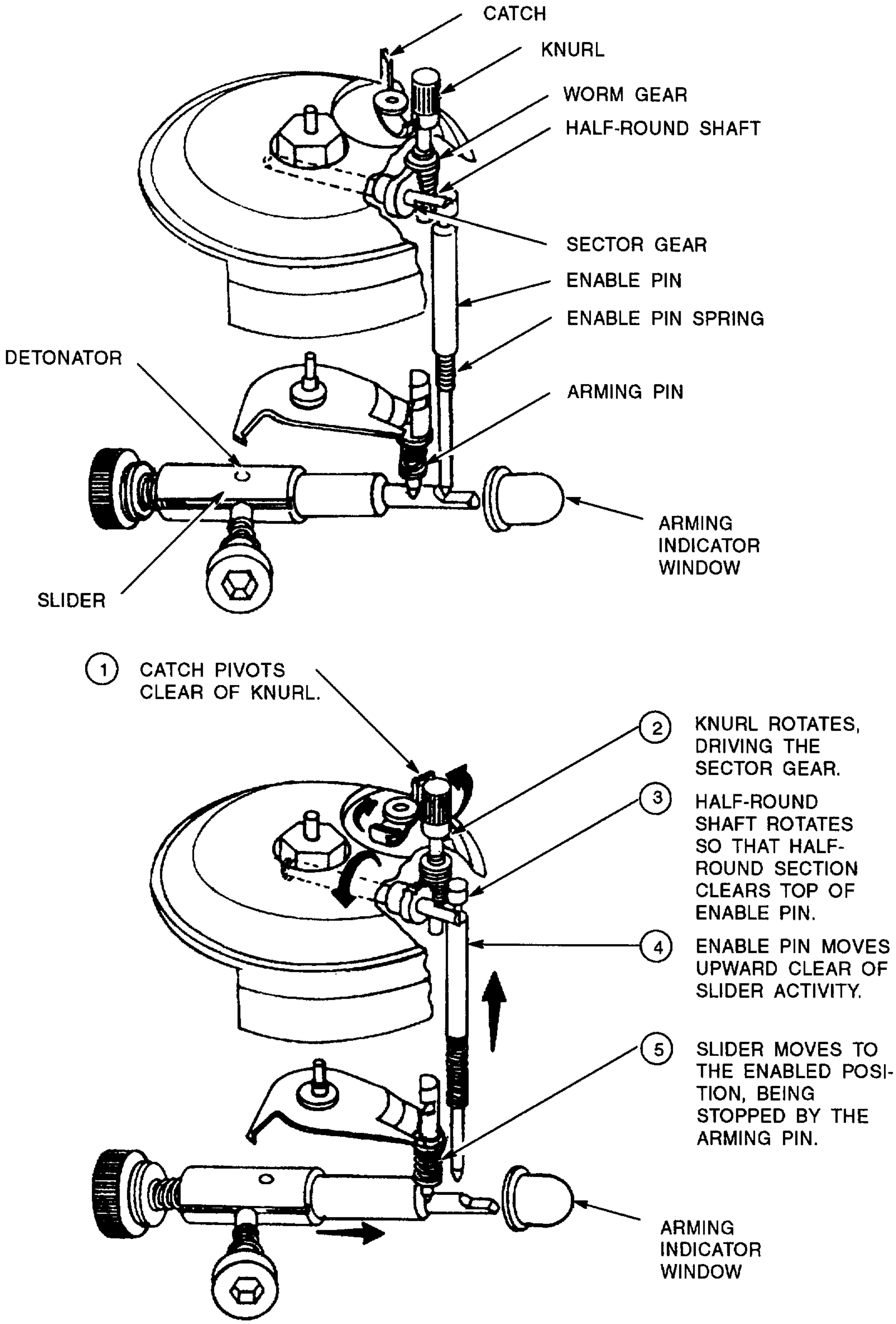

Figure 2-4. MK 339 MOD 0 Fuze - Enabling

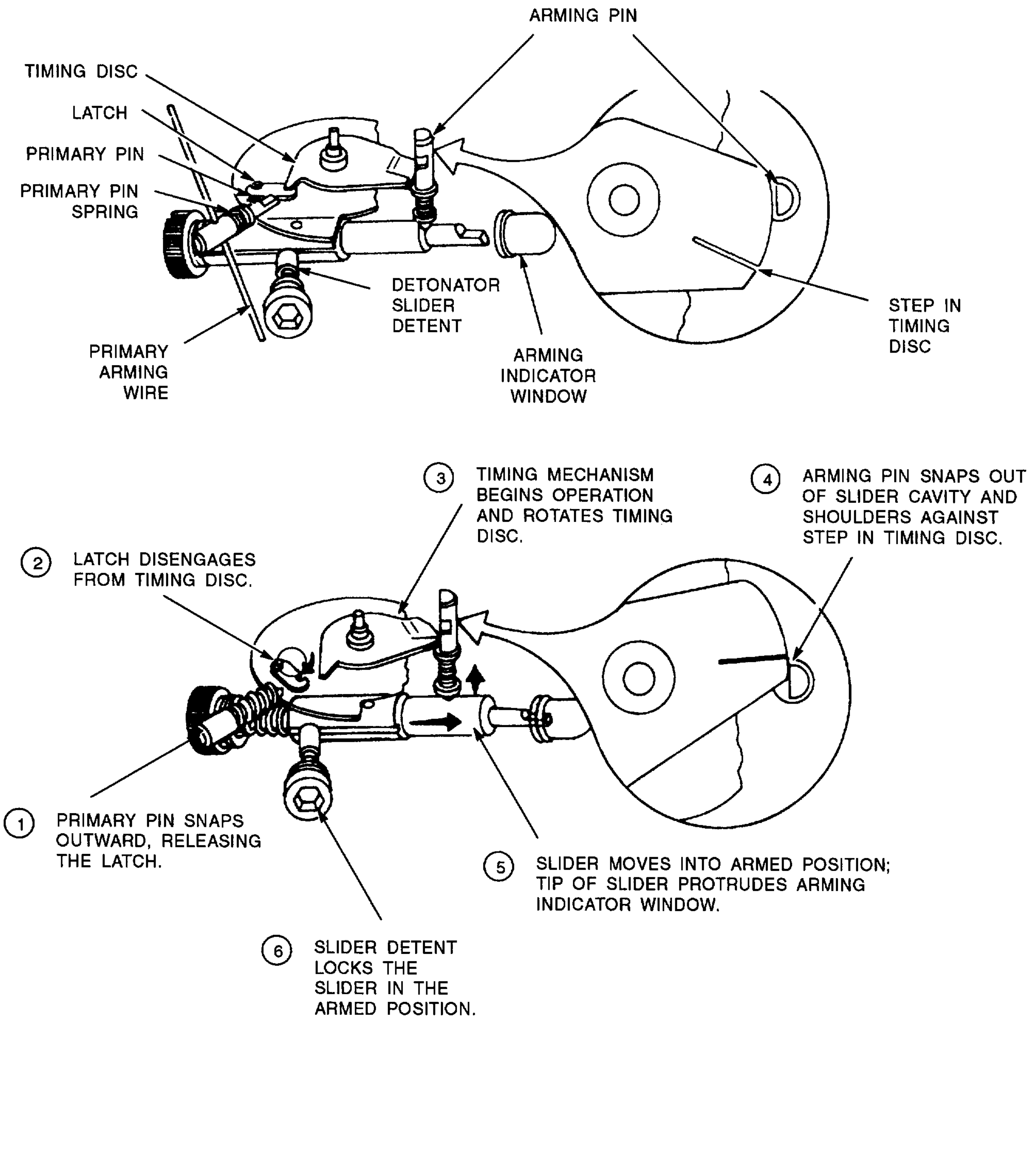

Figure 2-5. MK 339 MOD 0 Fuze - Arming

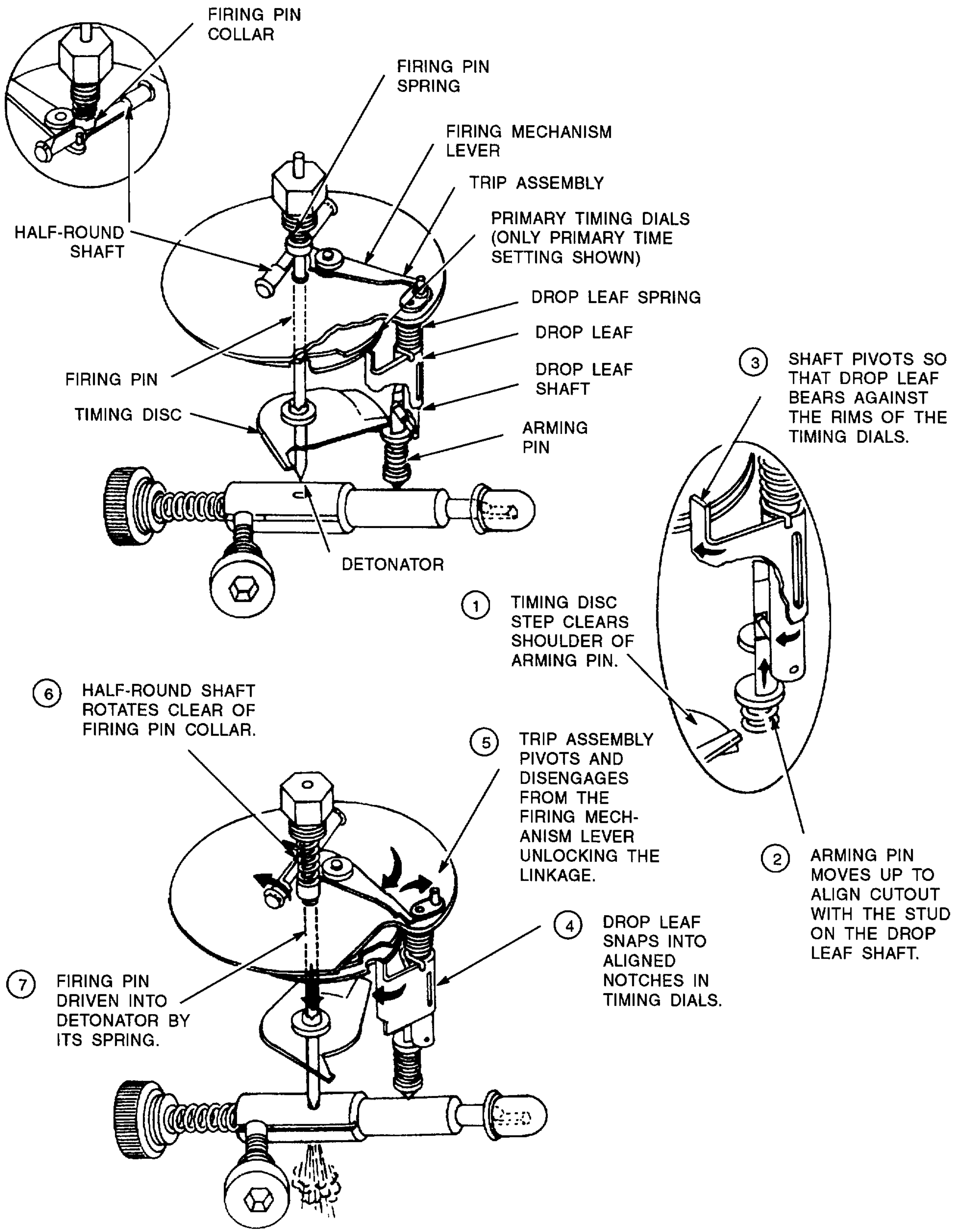

Figure 2-6. MK 339 MOD 0 Fuze - Functioning

setscrew inwards then turning the setscrew. The setscrew engages the time setter assembly of the two timing dials and the time set appears in the time setting observation window (under the index line, as in figure 2-7). The setter may be turned in either direction and rotated through zero if necessary.

NOTE

If the MK 339 MOD 0 has been committed to the option mode by the accidental removal of the option arming wire, the fuze cannot be reset for the primary mode. No attempt should be made to reset by pushing in the option pin.

2.5.6.2 The MK 339 MOD 1 Fuze has a white mode indicator pointer in the time setting observation window, which when it points to the primary (black) dial (also identified with a white “P” at the pointer end of the window) indicates that the fuze can operate (depending on the number of arming wires pulled) in either the primary or option mode. If the fuze is committed to the option mode, the pointer points to the white dial (also identified with a white “O” at the same end of the window).

2.5.6.3 If during weapon buildup or during aircraft loading, the option wire has been accidentally pulled on the MOD 1, the fuze has been committed to the option mode and will function in this mode even if only the primary wire is removed at weapon release. This MOD of the fuze can however be reset for the primary mode. This is accomplished by inserting a screwdriver blade in the slot on the option timing pin. Turning it 90 degrees counter-clockwise and reinserting the option arming wire. This action engages the drop leaf and removes it from its position over the option dials. The drop leaf is now returned to a position where it is positioned over the primary timing dials. (Note position of mode indicator pointer.) The fuze will now function in the primary mode if only the primary wire is removed.

2.5.6.4 Before being committed to a weapon, the MK 339 fuze will be stockpiled in M548 Metal Containers; each container contains nine fuzes which are individually packaged in sealed bags. As packaged, these fuzes may be stockpiled and transported overseas.

2.6 DELETED.

2.6.1 DELETED.

2.6.2 DELETED.

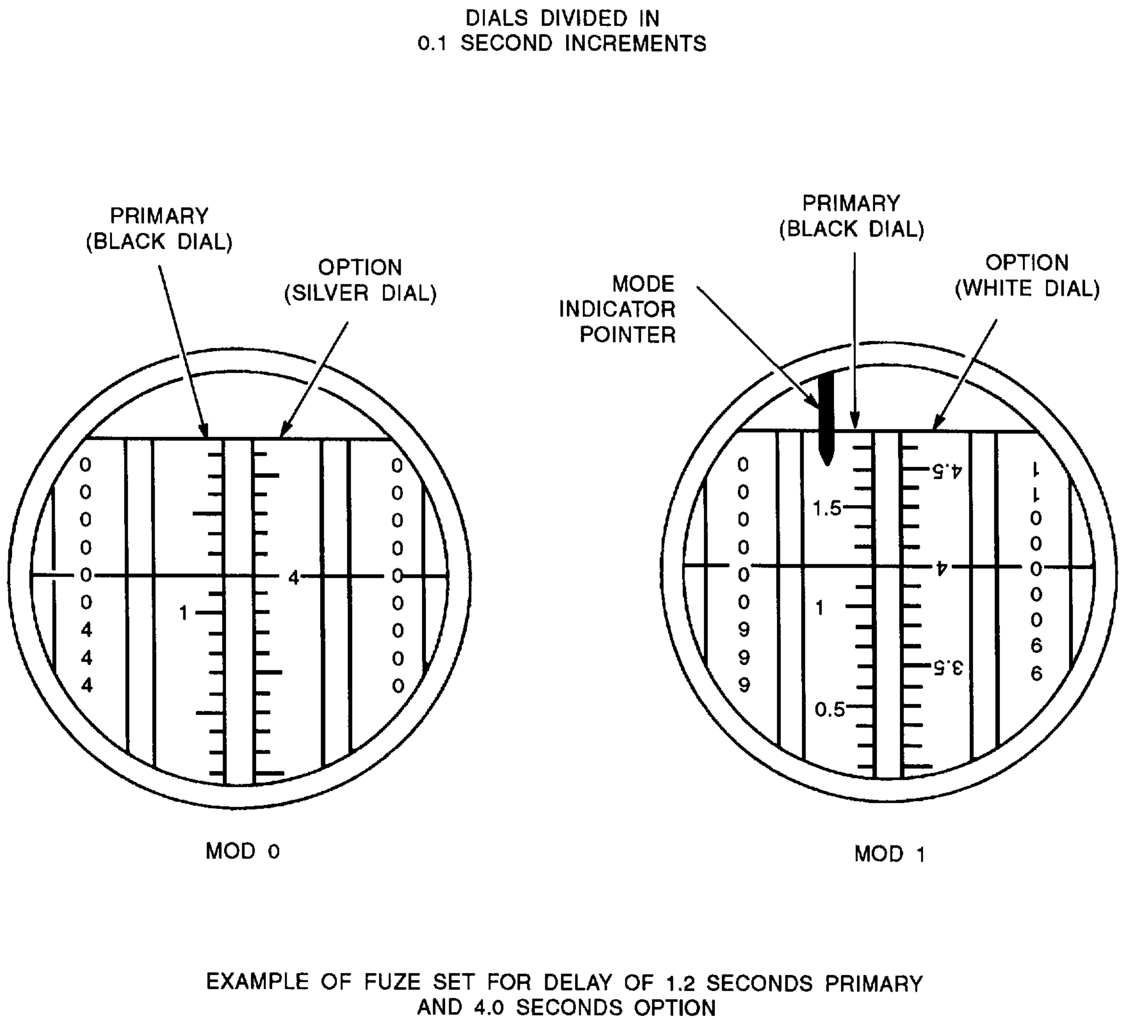

Figure 2-7. MK 339 MOD 0 and MOD 1 Fuze - Time Setting Window

Figure 2-8. Deleted

Table 2-2. Deleted

2.6.3 DELETED.

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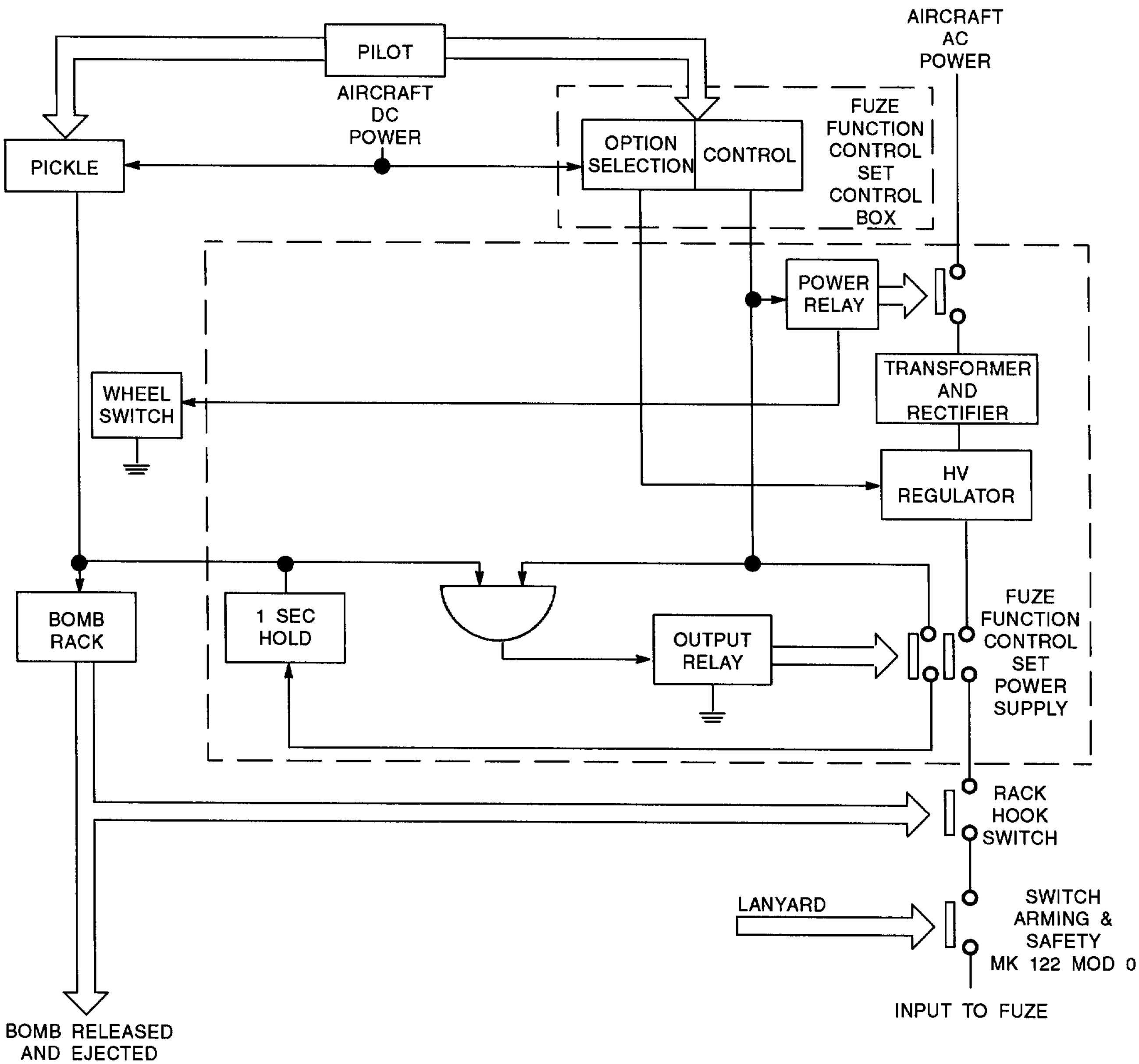

Figure 2-9. Fuze Function Control Set - Block Diagram

2.6.5 DELETED.

Figure 2-10. Deleted

Figure 2-11. Deleted

Figure 2-12. Deleted

Figure 2-13. Deleted

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2.7 FUZE, BOMB, MECHANICAL NOSE, M904E4.

2.7.1 GENERAL DESCRIPTION. The Fuze, Bomb, Mechanical Nose, M904E4 (figure 2-14) are impact fuzes and were designed to be employed in he MK 10 series BLU-111/BLU-110/BLU-117 GP bombs. The fuze is mounted in the bomb nose fuze well and may be employed in both the low drag or the high drag (retarded) bomb configurations. These fuzes may be used by themselves or in combination with any of the bomb tail fuzes to increase delivery flexibility or to increase reliability. The M904 fuzes require the use of an Adapter-Booster M148 or the Adapter-Booster, Thermal Protected M148E1. The M904E4 fuze is mechanically an M904E3 fuze modified to improve its cook-off characteristics. The M904E1, M904E2 and M904E3 have been declared obsolete. General characteristics of the M904 fuze are listed in tables 2-3 and 2-4.

2.7.1.1 Only one operation is necessary to accomplish arming: vane rotation. A clutch-type governor provides a relatively constant output shaft rotational speed and therefore a constant arming time at release speeds above 175 KIAS. The fuze can be preflight-set to an arming time from 2 to 18 seconds in 2-second increments. The function options are provided by individual plug-in pyrotechnic elements. The six interchangeable M9 elements available provide for the preflight selection of a function option of non-delay (0.00), and of delay (0.01, 0.025, 0.05, 0.1, or 0.25 second).

2.7.2 OPERATIONAL CHARACTERISTICS. The M904 fuzes are recommended for weapon releases at aircraft speeds between 175 KIAS and 525 KIAS. However, these fuzes will arm at speeds outside this range. These fuzes are preflight set for an arming time in the 2- to 18-second range. The settings are divided into 2-second increments. Provided the release is above 175 knots, the accuracy of arming times is ± 10 percent for all arming delays except the 2-second delay which will range from 1.8 to 2.4 seconds. The 2- and 4-second arming times are recommended for use only with bombs to be delivered in the high drag configuration. Depending on the delay element utilized, the fuze functioning delay may be 0.00 (instantaneous), 0.01, 0.025, 0.05, 0.1, or 0.25 seconds after impact. The fuze contains a centrifugally operated governor which provides a relatively constant rate of arming independent of the vane's rotational speed for air speeds above 175 KIAS. The governor's rotational output is 1800 ± 100 rpm.

2.7.2.1 The M904E4 fuze can be used against land and water targets. This fuze is protected by a sleeve of a molded rubber compound which is placed over the forward end of the fuze. All metal parts of the fuze with the exception of the arming vane, hub, and the arming delay setting knob and plate are thus protected from direct contact with flame. The minimum cook-off time for a thermally protected M904E4 fuze is approximately 12 minutes.

2.7.2.2 Additionally, a thermally protected adapter booster has been designed for use with the M904E4 nose fuze (the Adapter Booster, Thermal Protected M148El). When used in conjunction with the MK 80 series thermally protected GP bombs, the entire system provides superior cook-off characteristics. In representative tests, thermally protected bombs, fuzes, and adapter boosters have survived fires for 10 minutes as opposed to an average of 3.5 minutes for non-protected bombs fuzes, and adapter boosters. Although these figures have been produced through testing programs, it should be remembered that the results are dependent upon a number of factors, the heat of the fire, the velocity of winds proximity to other hot objects, etc., and should not be taken as an absolute value.

2.7.2.3 Mixing of thermally protected M904E4 fuze with non-thermally protected adapter booster M148 is authorized for shore-based use only.

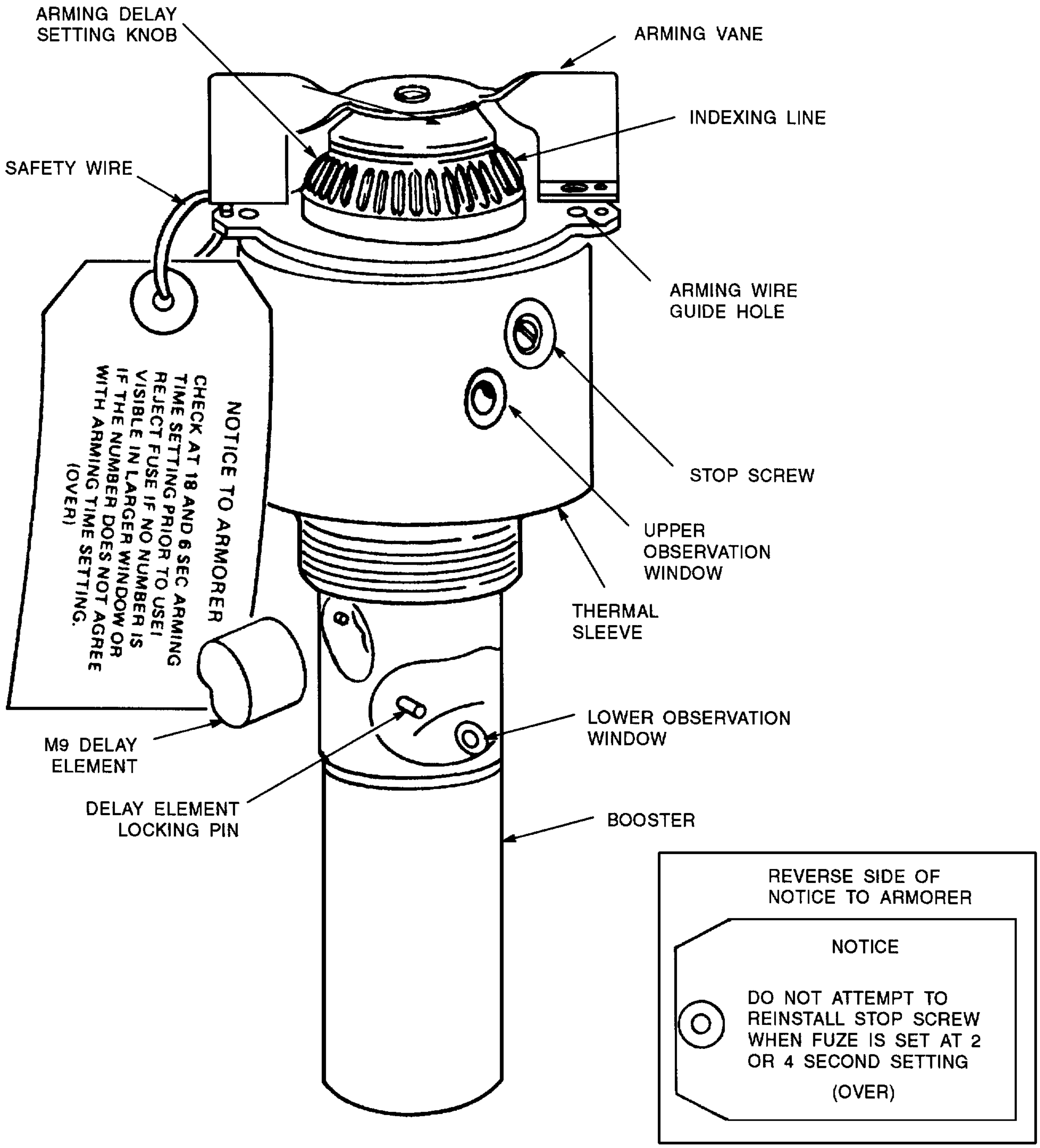


Figure 2-14. Fuze, Bomb, Mechanical Nose, M904E4

Table 2-3. Indications for Determining the Safe or Armed Condition of the M904E4 Fuze

Condition	Timing Setting	Upper Window	Lower Window
SAFE	6 seconds	Green background with white number 6. Green background with white number 18.	Vacant or dark in color.
PARTIALLY	18 seconds.	Green background with no numbers visible. If numbers appear at other than 6- or 18-sec. setting or if numbers do not match setting, fuze is partially armed.	Vacant or dark in color.
FULLY ARMED	Any setting.	Black letters "A" against red background. Some green may show at top of window.	Black letter "A" on red background.

Table 2-4. General Characteristics of the M904E4 Fuze

Model	E4
Drawing #	PL 333AS102
Type	Mechanical
Firing Action	Impact
Position	Nose
Function Delay	0.00, 0.01, 0.025, 0.05, 0.1, or 0.25
Arming:	
Type	Vane Rotation (governed)
Rev. to enable	30 revolutions for each second of arming time
Arm velocity to arm	Will arm at any speed, will arm at set time with a ±10% accuracy at speed above 175 KIAS
Time to arm	2 to 18 seconds in 2 second increments
Physical Characteristics:	
Overall Length (in.)	9.32
Widest Body Diameter (in.)	3.7
Intrusion into Weapon (in.)	5.1
Total Weight (lbs)	2.11
Thread Size	2-12UNS-1

Table 2-4. General Characteristics of the M904E4 Fuze - Continued

Explosive Weights:		
	M9 Element Primer, Percussion, M42 23 mg PA101 primer mix Non-Delay Element Percussion Primer and Element Relay Only Delay Element 0.01 sec; 37 mg F33B delay mix 0.025 sec; 22 mg Z2A delay mix 0.05 sec; 43 mg Z2A delay mix 0.1 sec; 27 mg Z2B delay mix 0.25 sec; 75 mg Z2B delay mix Element Relay 66 mg lead azide XM9 Relay 135 mg lead azide Detonator, Flash, M35 266 mg lead azide 200 mg tetyl Lead 100 mg tetryl Booster 72.5 gms tetryl	
	M904 Fuze	M9 Delay
Shelf Life[1]:	35 Years	Indefinite
Service Life:	180 Days	Indefinite

[1] If shelf life has expired, do not use. Request disposition from Item Manager.

2.7.3 EXPLOSIVE COMPONENTS. M904E4 fuze contains an M9 element, an XM9 relay, an M35 detonator, and a tetryl lead and a tetryl booster. The booster in turn initiates the explosive charge in the Adapter Booster M148. The M35 detonator and XM9 relay contain a total of 600 milligrams of explosive material. The booster contains 72.5 grains of tetryl. The M9 elements contain a percussion primer and a relay of 66 milligrams of lead azide. The delay elements in addition contain a delay composition, the type and the amount of which varies according to the functioning delay the element is to provide. The fuze contains a total of approximately 73.3 grams of various explosives and pyrotechnic mixes.

2.7.4 SAFETY FEATURES. The 2- and 4-second arming time settings for M904E4 fuze is "locked-out", so that a conscious effort is required to select either of these settings. The fuze stop screw must be removed. The stop screw is only removed to obtain these two time settings and must not be replaced after selecting either of these two times. A fuze dud will result if dropped with stop screw installed at 2- and 4-second settings.

2.7.4.1 The M904 fuzes require that an M9 element be installed. If the delay element is not installed, the fuze will dud. If the delay element is not in place, the element locking pin protrudes, making it difficult if not impossible to install the fuze properly in the adapter booster.

2.7.4.2 M904 fuzes have two observation windows for visual determination if the fuze is in the SAFE or ARMED condition. To determine the safe/arm condition of an uninstalled M904 fuze, the fuze must be viewed through the upper and lower windows at both the 6- and 18-second settings. Table 2-3 summarizes the markings and indicated condition for the M904E4 fuze.

2.7.4.3 The governor allows the fuze mechanism to provide an accurate arming time at delivery speeds above 175 KIAS. The M904 fuzes may be, however, partially or fully armed by manually spinning the arming vane at any speed (allowing the vane to windmill on the deck will also partially or fully arm an M904-type fuze). The fuze will not become fully armed unless it experiences a force equal to a wind velocity of 40 KIAS or greater because of the internal shear pin. A higher torque is required to shear this pin and complete the arming cycle. If an M904 fuze has partially or fully armed, it must be turned over to the EOD personnel or other proper authority for disposal.

2.7.5 FUNCTIONAL DESCRIPTION. When the bomb is released, the arming wire is withdrawn from the arming vane. The arming and functioning cycles for the M904E4 fuze is as follows (figure 2-15).

a. When the arming wire is withdrawn, the arming vane rotates in the airstream turning the governor. The governor output is a relatively constant rotational speed. This rotation is transferred through the reduction gears to the arming stop, which is rotated at a rate of approximately 11 degrees per second. Two driving pins protruding from the lower side of the arming stop lock into the striker body so that the striker body rotates along with the arming stop. Rotation of the striker body also causes rotation of the firing pin and firing pin guide because the firing pin is keyed to the striker body. A shear wire secures the firing pin to the firing pin guide. When the preselected arming delay has elapsed, a notch in the striker body is aligned with the index stop, the striker body spring forces the striker body to move upward and bear against the bottom of the arming stop. (The firing pin does not move upward.) As the striker moves upward, a spring-loaded steel ball moves into the space formed between the striker body and upper end of the firing pin.

NOTE

> A shoulder on the fuze body prevents the striker body from bearing against the upper end of the firing pin before arming. Only after the steel ball moves into the space between the striker body and firing pin resulting from the upward movement of the striker body, can the striker body bear on the firing pin.

b. A shear pin in the tip of the rotor release rod rides in a slot on the bottom of the firing pin guide. Just before the notch in the striker body aligns with the index stop the shear pin contacts the end of the firing-pin-guide slot. Additional movement of the firing pin guide shears this pin. After the pin is sheared off, the firing pin guide can rotate an additional increment and the rotor release rod stem is now free to move upward through the cut-out section in the firing pin guide. As the spring forces the rotor release rod upward, the lower end of the rotor release rod clears the detonator rotor. The spring-loaded detonator rotor pivots and moves the detonator in-line with the firing pin and the rest of the explosive train. A rotor latch locks the detonator rotor in the armed position. The fuze is now fully armed.

c. Upon impact the arming delay setting knob is driven aft shearing the three shear lugs, driving the nose assembly into the fuze body against the arming stop, forcing the striker body against the steel ball and the steel ball against the firing pin, breaking the shear wire. The firing pin moves, initiating the delay element. After the proper functioning option, the explosive output is transferred via the relay to the detonator, to the lead and finally to the booster, which transfers the energy to the explosive charge of the weapon.

2.7.6 INSTALLATION REQUIREMENTS. M904 fuzes arming time delay time must be set before installation in the bomb by depressing the setting index locking pin and rotating the arming delay setting knob to the desired setting. The white index line is aligned with the desired setting (2, 4, 6, 8, 10, 12, 14, 16, or 18 seconds) stamped on the nose retaining ring. Setting the fuze for 2 or 4 seconds requires removal of the stop screw adjacent to the setting index locking pin. This screw should not be replaced as long as the fuze is in the 2- or 4-second setting. If after setting the fuze to the 2- or the 4-second arming time setting the stop screw is replaced, the screw may interfere with striker body rotation and could result in an erratic arming time interval or a dud. If the fuze is set to 6 seconds or longer, the screw should be replaced.

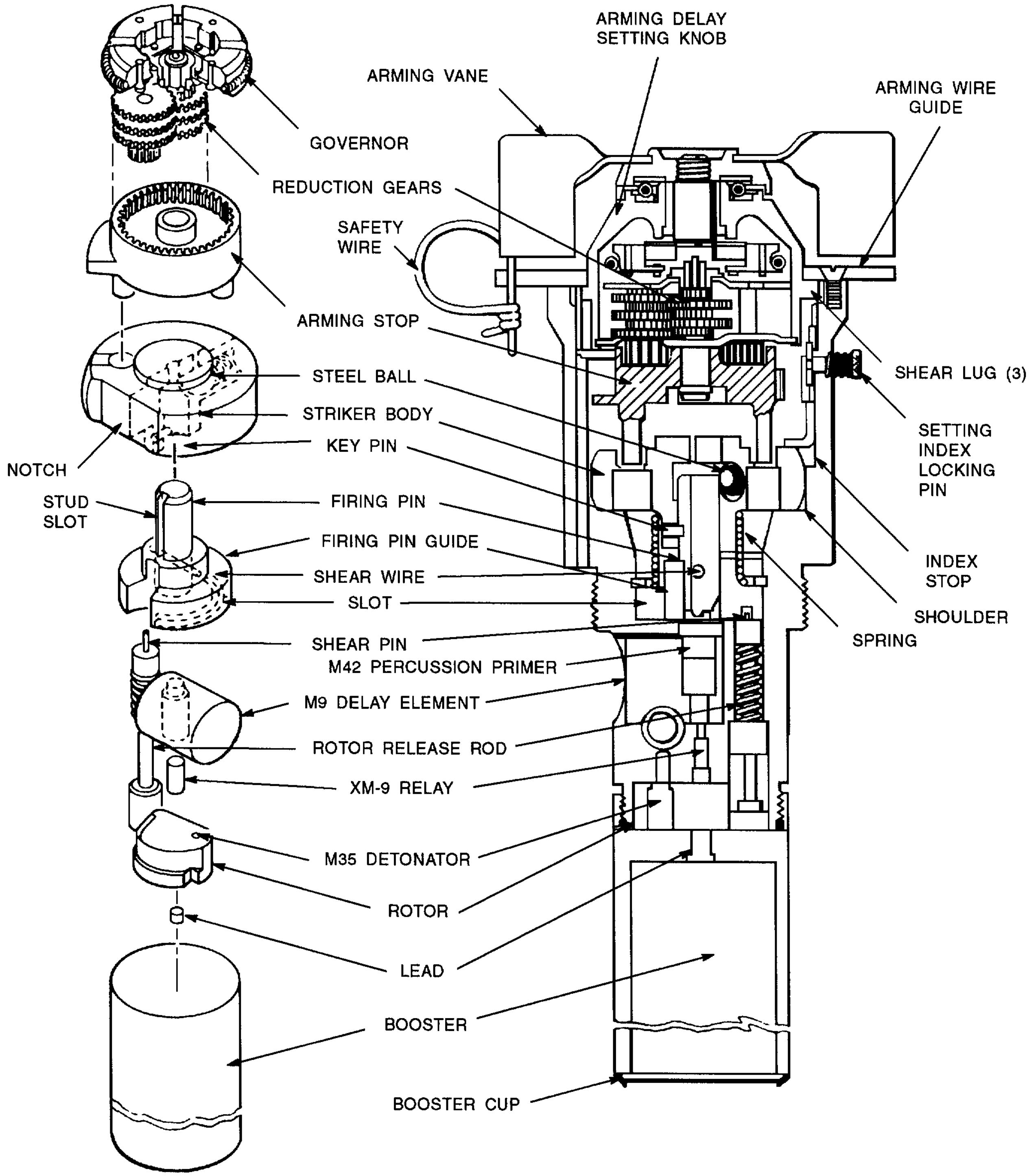


Figure 2-15. M904E4 Fuze - Internal View

2.7.6.1 After setting the fuze to a desired arming time, the indication in both observation windows should be checked. If the fuze is not armed (safe), the arming time may be set or reset to any other arming time. If the fuze is partially armed, resetting the fuze to another time may fully arm the fuze.

2.7.6.2 The M904 fuze, as received from Navy stock, has either the 0.00-second M9 non-delay element or the 0.025-second M9 delay element installed (fuzes from Air Force stocks are received without M9 elements). If the 0.00- or the 0.025-second delay is not satisfactory for the planned target, the proper element must be ordered and installed in the fuze. The delay element is removed by depressing the delay element locking pin, tipping the fuze allowing the element to drop out into one's hand. The proper M9 element is installed by depressing the element locking pin, locating the slot in the element with the pin in the fuze body, and pressing the element in place. The element locking pin should lock the delay element in place.

2.7.6.3 The M904 fuze is hand-screwed in the nose well of the bomb into a previously installed adapter-booster. An arming wire is threaded through the vane and arming wire guide. After the arming wire is installed, the safety wire and tag may be removed.

2.8 INITIATOR, FIREBOMB, MK 13 MOD 0.

2.8.1 GENERAL DESCRIPTION. The Initiator, Firebomb, MK 13 MOD 0 (figure 2-16) consists of two major subassemblies, the Fuze, Bomb, MK 343 MOD 0 (figure 2-17) and the Igniter, Bomb, MK 273 MOD 1 (figure 2-18). These two subassemblies are assembled, shipped, stored, and issued as a unit, the Initiator, Firebomb, MK 13 MOD 0. The MK 13 initiator is designed to be used only with the MK 77 MOD 5 firebomb. A MK 13 initiator is installed in each of the two filler holes of the MK 77 MOD 5 firebombs and with its O-ring seals the filler holes. General characteristics of the MK 343 Fuze are listed in table 2-5. General characteristics of the MK 13 Initiator and the MK 273 MOD 1 Igniter are listed in table 2-6.

2.8.1.1 The Fuze, Bomb, MK 343 MOD 0 is an impact fuze designed for use only with the Igniter, Bomb, MK 273 MOD 1. It is not compatible with any other igniter including the MK 273 MOD 0. The fuze can provide two functioning delays, instantaneous or delay. The delay selected depends on the type of gel used as a weapon filler. Avgas, non-diesel vehicle fuels, or JP-4 based gels against land targets require the use of the function delay in order to result in maximum weapon effectiveness. A JP-5 based gel against land targets or all gels against water targets require the use of the instantaneous function delay. NAVAIR 19-1-112 details the loading and handling characteristics of these gels.

2.8.1.2 The Igniter, Bomb, MK 273 MOD 1 is designed to reliably ignite all current jelled fuels. These may be either Avgas, vehicle fuel, JP-4, JP-5 or JP-8 based gels, and the target area can be either ground or water.

NOTE

> MK 13 MOD 0 initiators for use with the MK 77 MOD 5 Firebomb set in the delay mode has a high probability of initiating in an instantaneous mode. Operationally, setting the initiator in the delay mode should be avoided. Recommend MK 13 MOD 0 initiator be set to instantaneous with the MK 77 MOD 5 firebomb filled with JP-5/JP-8 fuels. When utilizing JP-8 fuels in MK 77 MOD 5 firebombs, the weapon effectiveness may be reduced due to lack of fuel dispersal prior to detonation.

2.8.2 OPERATIONAL CHARACTERISTICS. The MK 343 fuze is an "all-ways" action impact fuze featuring two preflight set functioning delay times; instantaneous and delay. The delay interval is 0.270 + 0.120 second.

2.8.2.1 Two operations are necessary to accomplish arming: vane rotation and time. These two operations are interdependent in that they must occur in a given sequence and in a given time relationship. Both the vane and the timer are started at weapon release. The timer interval is 1 ± 0.2 second. The vane must complete its function (latch pin unlock) before the end of this time interval for the fuze to reliably arm. If the vane were released in an 80 KIAS across the deck wind, latch pin unlock would occur no sooner than 1.2 seconds. Since the latch pin unlock event occurs for this wind condition at the maximum end of the timer interval, the fuze will dud for all across the deck wind velocities below 80 KIAS. If the latch pin unlock event occurs at 0.8 second, the fuze will arm. If latch pin unlock occurs between 0.8 and 1.2 seconds after timer start (weapon release), the fuze may or may not arm.

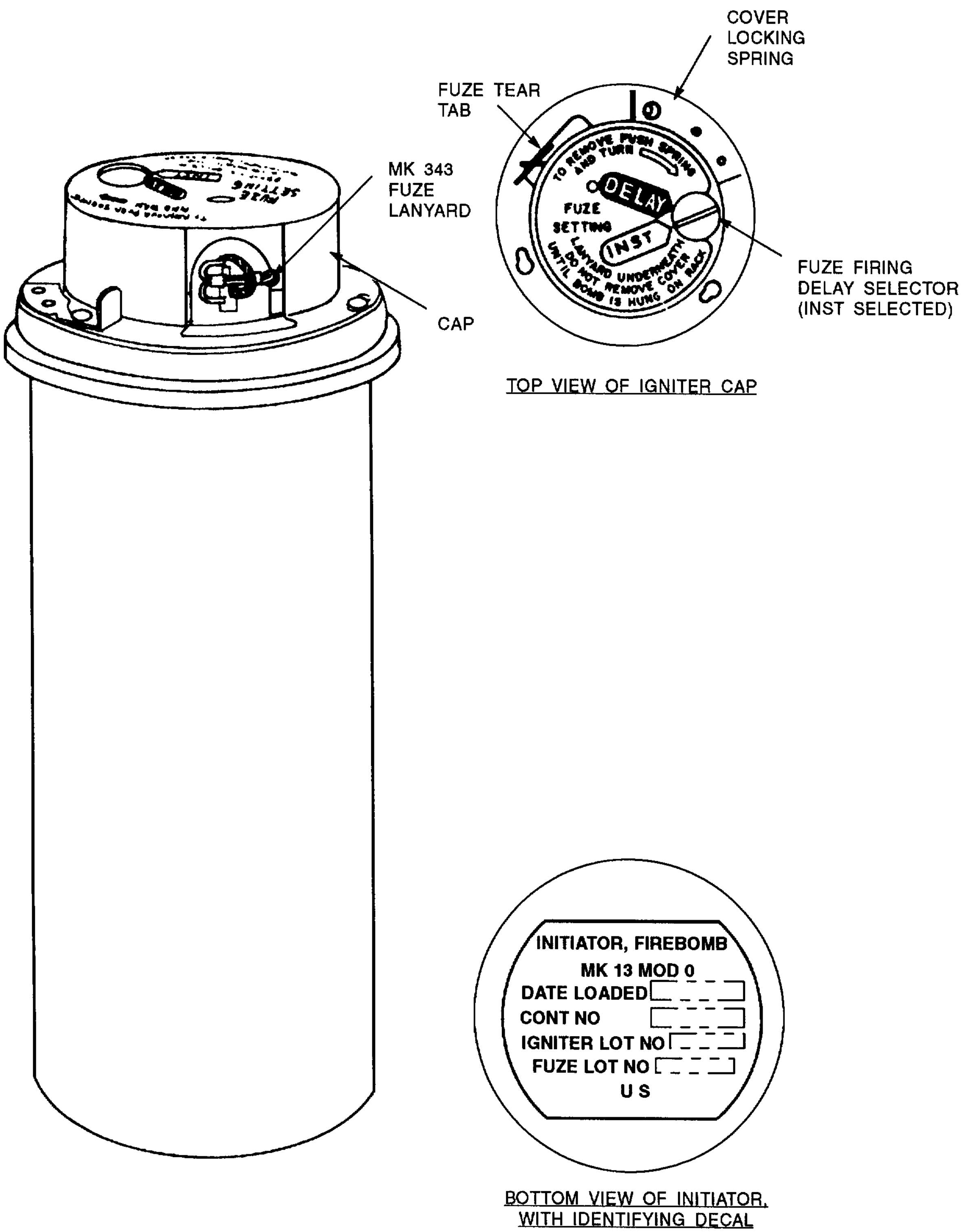


Figure 2-16. Initiator, Fire Bomb, MK 13 MOD 0 - External View

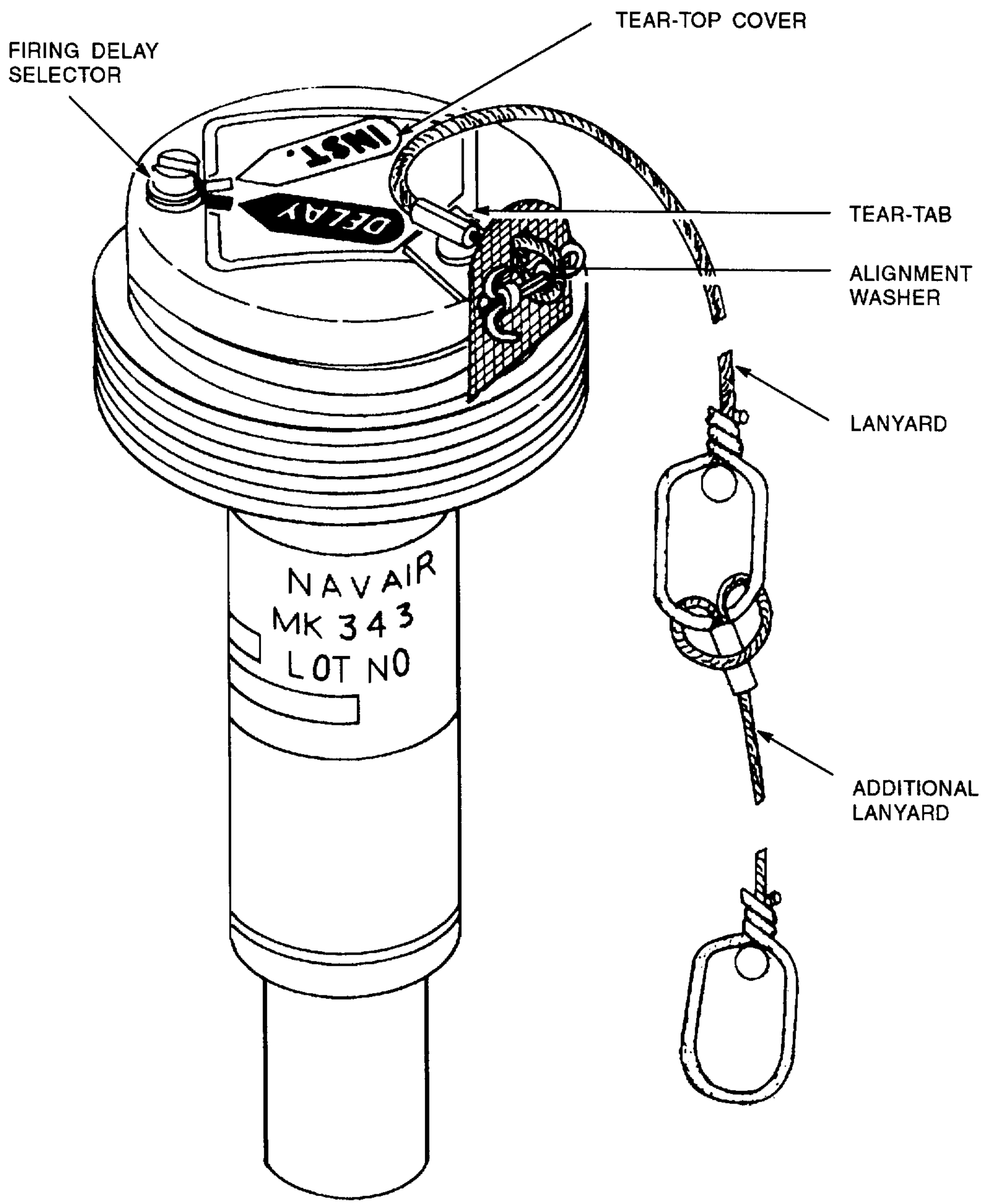


Figure 2-17. MK 343 MOD 0 Fuze - External View

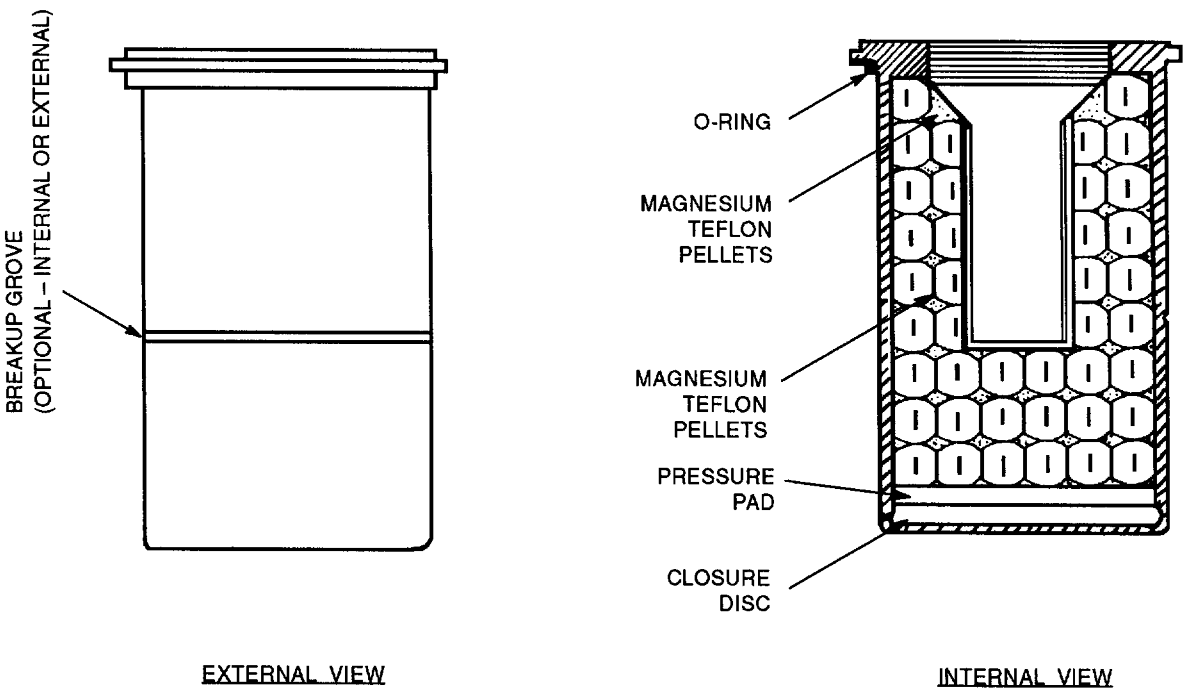


Figure 2-18. Igniter, Bomb, MK 273 MOD 1 - External and Internal Views

Table 2-5. General Characteristics of the MK 343 Fuze

Drawing #	LD 549668
Type	Mechanical
Firing Action	Impact
Position	Side
Function Delay	0.00 or 0.27 second
Arming:	
Type	Vane rotation and time (velocity discrimination)
Rev. to enable	22
Air velocity to enable	300 KIAS min (see text)
Time to enable	0.8 second at 300 KIAS (see text)
Time to arm	0.8 to 1.2 seconds at 300 KIAS and above
Physical Characteristics:	
Overall Length (in.)	5.7
Widest Body Diameter (in.)	2.75
Intrusion into Weapon (in.)	N/A-Assembled into MK 273 MOD 1 igniter
Total Weight (lbs)	1.5
Thread Size	2.3/4-16UN-2B
Explosive Weights:	
	Primer, Stab, MK 158 MOD 0 110 mg NOL #130 priming mix 150 mg lead azide
	Detonator, MK 104 MOD 0 80 mg lead azide
	Detonator, MK 105 MOD 0 203 mg lead azide 60 mg RDX
	Detonator, Delay, MK 106 MOD 0 100 mg lead azide 240 mg powder, ignition, gasless 155 mg manganese delay 62 mg RDX
	Lead (2) (each) 400 mg tetryl
	Booster 5.6 mg tetryl

Table 2-6. General Characteristics of the MK 13 Initiator and the MK 273 MOD 1 Igniter

	MK 13 Initiator	MK 273 Igniter
Drawing #	2601820	156241
Type	See MK 343 Fuze	N/A
Firing Action	See MK 343 Fuze	N/A
Position	Side	Side
Function Delay	See MK 343 Fuze	N/A
Arming:	See MK 343 Fuze	N/A
Overall Length (in.)	8.25	7.25
Widest Body Diameter (in.)	3.75	3.75
Intrusion into Weapon (in.)	6.75	See MK 13 Initiator
Total Weight (lbs)	4.9	3.4
Thread Size	N/A	N/A
Explosive Weights:		
	See MK 343 Fuze and MK 273 igniter	1.9 lbs magnesium teflon powder and pellets
Shelf Life:	Indefinite	
Service Life:	180 Days	

2.8.2.2 Firebombs are not stabilized and tumble in flight. The wind flow across the fuze vane is, therefore, complex. Tests show that the firebomb must be released at speeds of 300 KIAS or greater for the fuze to reliably arm.

2.8.3 EXPLOSIVE COMPONENTS. The MK 343 fuze contains a Primer, Stab, MK 158, a Detonator, MK 104, a Detonator, MK 105, and a Detonator, Delay, MK 106 in addition to a lead and a booster. The fuze contains a total of approximately 6.6 grams of various explosives and pyrotechnic mixes.

2.8.3.1 The MK 273 MOD 1 igniter contains 1.9 pounds of a pyrotechnic material (magnesium-teflon powder and pellets).

2.8.4 SAFETY FEATURES. The MK 343 fuze features a tear-top cover which prevents the vane from being exposed during shipping and storage. Should the tear-top be lifted or torn by any amount, the timing mechanism may start and run-down without concurrent arming vane rotation. This will result in a dud fuze. If the tear-top cover has been pulled off far enough so that the vane is popped up, the fuze should be considered to be armed and EOD personnel must be called to dispose of the fuze.

2.8.4.1 The MK 343 fuze can be armed only if the required number of revolutions of the vane occurs within a given period of time after the start of the timing mechanism. Hand rotation of the vane will not result in an armed fuze since it is very difficult if not impossible to rotate the vane sufficiently rapid to enable (latch pin unlock) in less than 1.2 seconds. If the required number of vane revolutions are not accomplished in this 1.2-second interval, the result will be a dud fuze.

2.8.4.2 The explosive train has been designed to prevent the assembly of an armed rotor into a fuze. The design will not allow assembly of the outer fuze housing onto the upper fuze housing if the rotor is in the armed position.

2.8.5 FUNCTIONAL DESCRIPTION. The MK 343 fuze arming cycle is started at release of the weapon from the aircraft bomb rack. As the weapon separates, a lanyard connected to the bomb rack solenoid tears the prescored tear-top cover (beer can style) from the top of the fuze. Removal of the tear-top cover initiates two separate actions: (1) a four-bladed, anemometer-type arming vane pops up through the opening left by the tear-top and rotates in the airstream; and (2) the timing mechanism is started. The arming vane must complete 22 revolutions before the timing mechanism times out 0.8 second or the fuze will dud. Operation of arming and functioning cycles are as follows (figures 2-19 through 2-22):

a. As the vane rotates it turns and withdraws the arming pin. Withdrawal of the arming pin releases the locking balls, thus freeing the "all-ways" action firing mechanism and also causes the latch pin to be unlocked. The latch pin must be unlocked prior to 0.8 second (the minimum timer operation) after weapon release or the fuze will dud.

b. The timer consists of a power spring, a timing gear, and an escapement assembly. This timer is held in the cocked position by a lever which is in turn prevented from moving by a pin on the cover. At first movement of the tear-top, the timer begins operation. The timing gear rotates so that the release hole will align with the rotor release rod in 1.0 $\pm$0.2 second. If the vane system has enabled, the rotor release rod will pop up through the release hole in the timing gear when alignment occurs. Conversely, if the vane system has not enabled, the rotor release rod will move a short distance and then be restrained by the latch pin. The timing gear will continue to rotate until the slotted hole binds on the small diameter tip of the rotor release rod, thus preventing any further movement of the rotor release rod even if the vane system is subsequently enabled. This time dependent sequence provides environmental safing, requiring an on the deck wind velocity of greater than 80 knots to result in fuze arming.

c. The firing pin of the "all-ways" mechanism is prevented from striking the primer by the locking action of the locking balls and the arming pin. Withdrawal of the arming pin releases the locking balls and enables the all-ways firing mechanism. Subsequent impact of sufficient force from any angle will cause the striker to move within the sleeve, resulting in the firing pin striking the primer. When the primer fires, it, in turn, initiates the MK 104 transfer detonator.

d. When the vane and timer systems work in proper time sequence, either the rotor or both the rotor and the selector rotor together is released by the movement of the rotor release rod. Rotor rotation moves the instantaneous and delay detonators into line with the leads. Selector rotor rotation blocks the channel from the MK 104 detonator to the MK 106 delay detonator and opens a channel from the MK 104 detonator to the MK 105 detonator. For the delay setting, the option selector lever limits the movement of the rotor release rod so that it only releases the rotor. The selector rotor does not rotate. The output from the MK 104 detonator is directed to the MK 106 delay detonator. For the instantaneous setting, the option selector lever does not restrain the movement of the rotor release rod, allowing both the rotor and the selector rotor to rotate 90 degrees. This movement aligns a channel between the MK 104 detonator and the MK 105 (instantaneous) detonator. With initiation of the MK 158 primer, the detonation is transferred to the MK 104 detonator; to either the MK 106 delay detonator or the MK 105 instantaneous detonator; then to the appropriate lead; and finally to the booster.

e. As long as the rotor containing the detonators does not move to the in-line position, the fuze is considered safe. This is true before the arming cycle begins, or when duding has occurred. When the rotor is out of line, detonation of any of the shock sensitive explosive elements will not result in booster detonation or hazardous case breakage.

f. Igniter MK 273 MOD 1 is a flanged cylindrical container filled with magnesium-teflon pellets surrounded by powder of the same material. The igniter has one circumferential groove and eight longitudinal grooves. These may be internal or external depending on manufacturing processes. When the fuze detonates, the igniter bursts along the grooves. At the same time, the flame from the fuze booster causes the magnesium-teflon powder to burn, which in turn ignites the magnesium-teflon pellets. The lighted pellets are propelled out to cover a circular area and ignite the gelled fuel within that area.

2.8.6 INSTALLATION REQUIREMENTS. The initiator is supplied with one lanyard attached to the tear tab and an additional lanyard under the protective cap. One initiator is installed in each of the two filler holes of the firebomb immediately after the bomb has been filled.

NOTE

With the initiator installed, the weapon is safe to handle and transport anywhere, including the hanger bay.

2.8.6.1 The initiator is secured with the retaining ring that previously held the bomb filler cap in place. The fuze is selected for delay or instantaneous, the bomb is hung on the aircraft, the protective cap is removed, and the lanyard attached to the tear-tab is routed and fastened to the nearest bomb-rack solenoid. If due to bomb rack solenoid location, the lanyard attached to the tear-tab is not of sufficient length to reach the solenoids, the additional lanyard can be attached to the first to provide a lanyard of sufficient length.

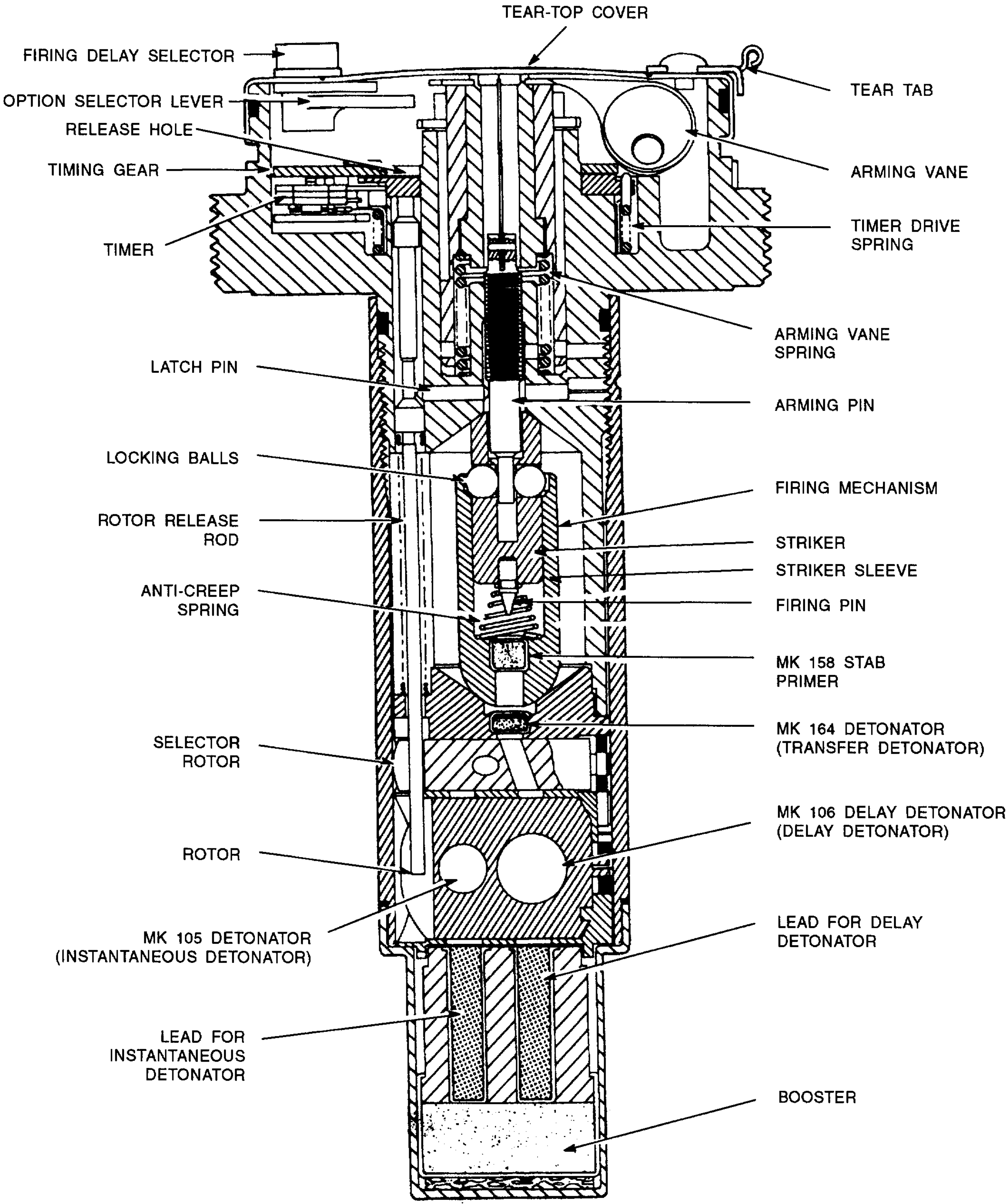


Figure 2-19. MK 343 MOD 0 Fuze - Internal View

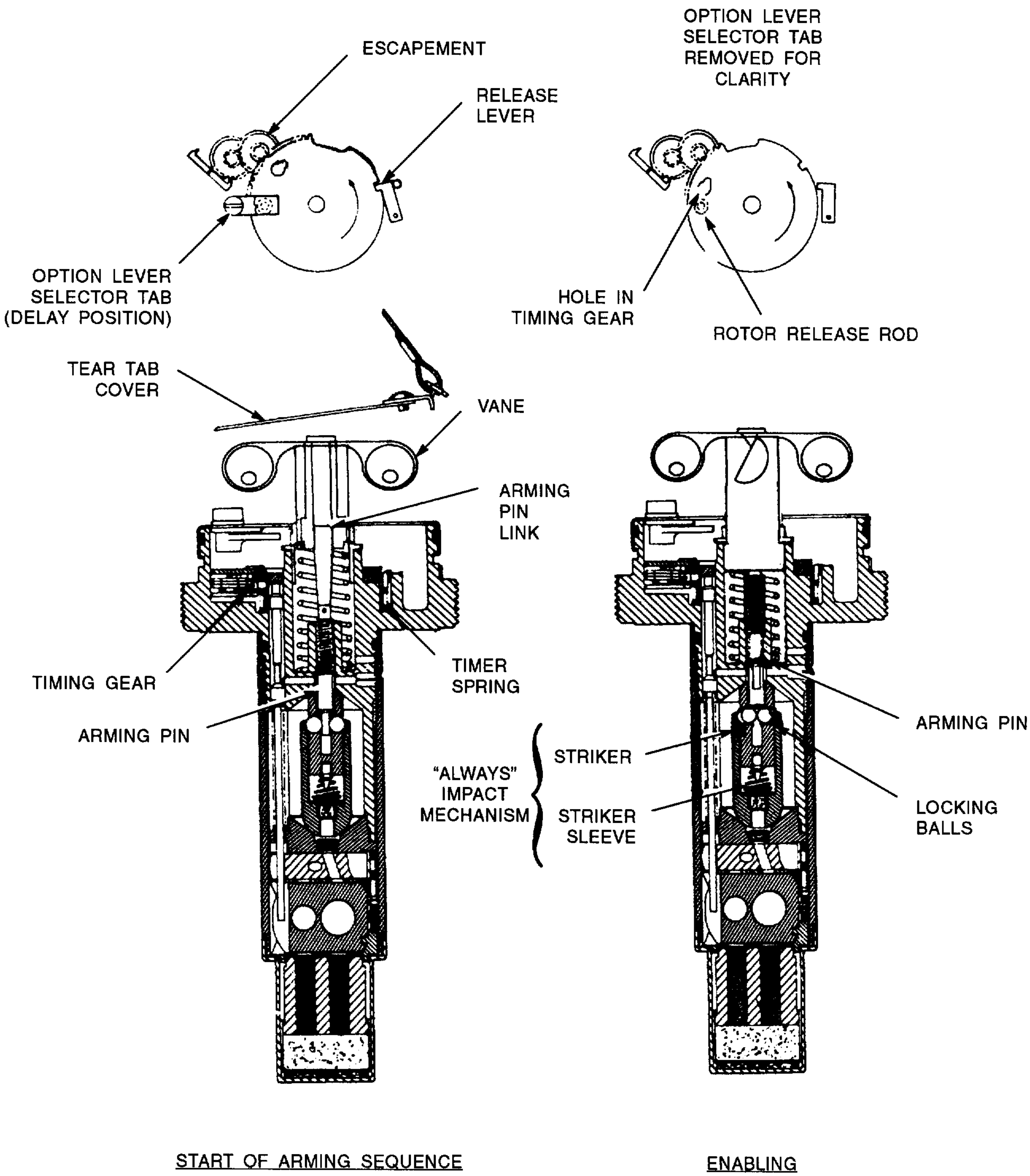


Figure 2-20. MK 343 MOD 0 Fuze - Enabling

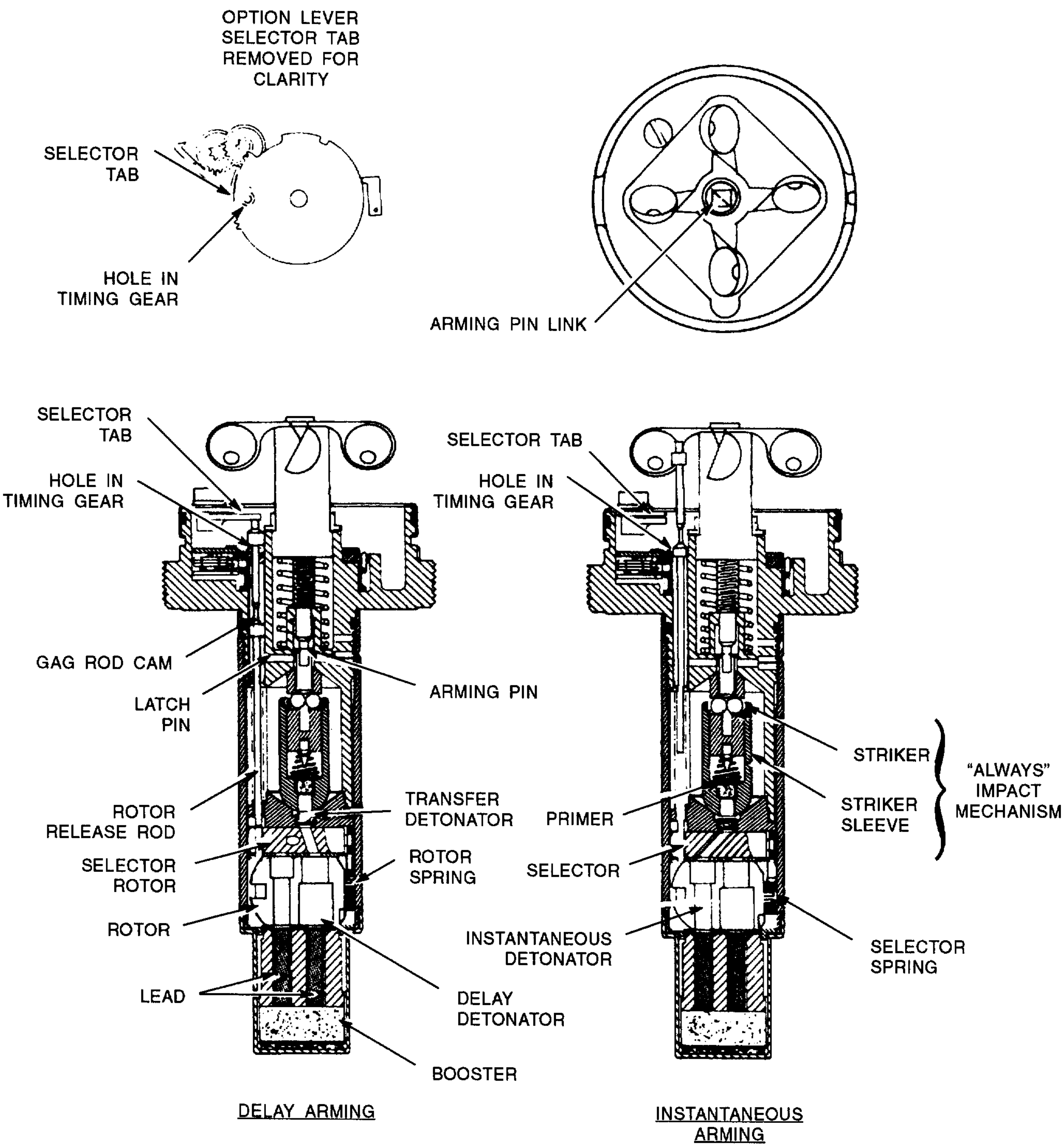


Figure 2-21. MK 343 MOD 0 Fuze - Arming

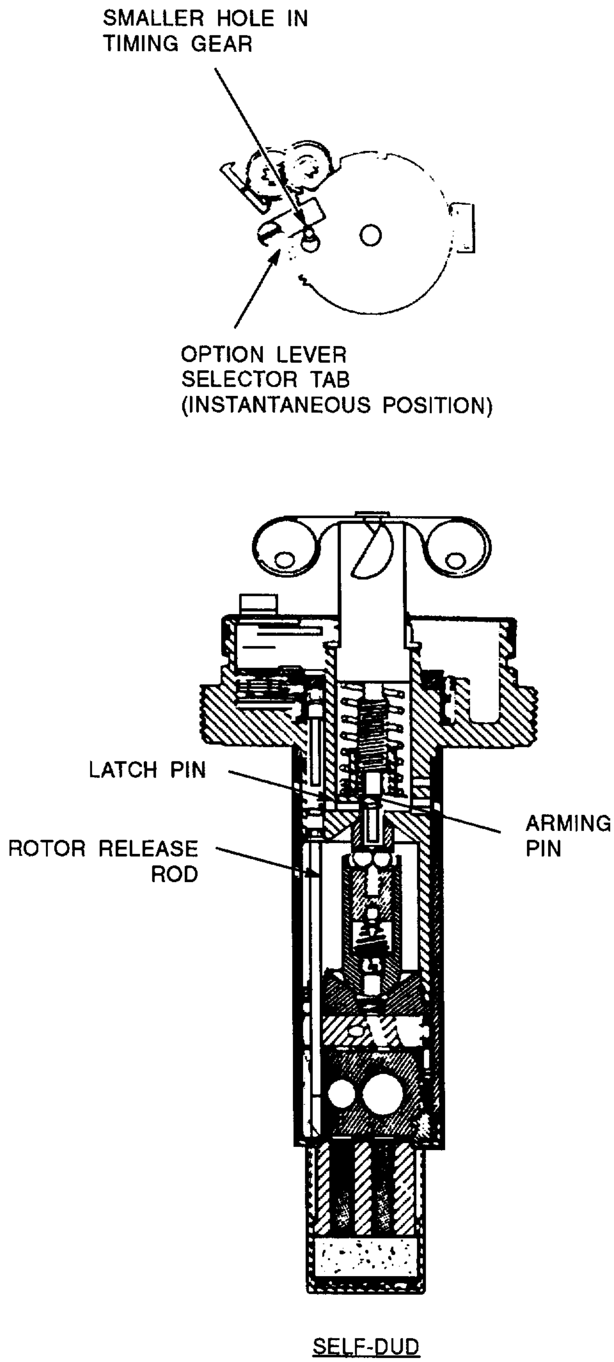


Figure 2-22. MK 343 MOD 0 Fuze - Self Dud

2.9 FMU-139 SERIES ELECTRONIC BOMB FUZE.

2.9.1 GENERAL DESCRIPTION. The FMU-139 Series fuze (see figures 2-23, 2-24, 2-35, 2-26, and 2-27) is an electronic impact/impact delay fusing system. It is a solid state, micro-computer, multi-option tail/nose fuze that is used in MK 80 Series, BLU-110, BLU-111, and BLU-117 general purpose bombs, including guided bomb units, and the BDU-45 practice bomb. The fuzes are joint service (Navy and Air Force), and have multiple settings. The arming times are in-flight selectable and the functioning delay (high drag arm/delay switch) must be set during weapon assembly. Weapons can be delivered in either high drag (retarded) or low drag (unretarded) mode. The FMU-139 Series fuze incorporates three arming times (2.6, 5.5 and 10.0 seconds) and has four functioning delay settings (10, 25 and 60 milliseconds, and instantaneous). The FMU-139 Series fuze consists of FMU-139B/B and FMU-139C/B (figure 2-23) along with dummy fuze FMU-139(D-2) Series (figure 2-24). Dummy fuzes are available for ground training and other inert applications. The FMU-139 Series fuze is authorized only for use as a tail fuze by the Navy. General characteristics are provided in table 2-7. The FMU-139B/B has a PBXN-7 booster and electrostatic discharge protection. The FMU-139C/B is identical to the FMU-139B/B except that it has a 4 minute capacitor vice the 60 second capacitor in the FMU-139B/B. FMU-139 Series fuzes are interchangeable for Navy use and require no special training.

NOTE

Only 2.6/60, 2.6/25, 2.6/10, and 2.6/INST high drag arm/delay switch positions are authorized for Navy/Marine Corps use.

The LOW DRAG ARM TIME rotary switch is positioned at X for shipping, storage, and all Fuze Function Control Set (FFCS) use. When the FMU-139 is utilized with the FZU-48/B initiator vice the MK 122 Safety Switch, the LDAT switch must be set to other than “X” position. If the LDAT switch is set to “X” position when the FZU-48/B is utilized the weapon will dud.

High drag arm time must be less than low drag arm time in order for fuze to function.

The FMU-139 Series fuze differs from other Navy electronic fuzes in that the gag rod and arming wire housing are located in the center of the faceplate (figure 2-25), and the fuze is secured into the fuze well by means of a separate closure ring which is screwed into the fuze well using an enclosure ring wrench.

2.9.2 OPERATIONAL CHARACTERISTICS. The FMU-139 Series fuses are designed for use with the cockpit control FFCS or with FZU-48/B power in GBUs.

2.9.2.1 The FFCS consists of a cockpit control box and a power supply. Airborne, the aircrew operates the FFCS to communicate the desired arming time options to the fuze. The FFCS translates the desired option selection into a voltage signal of discrete polarity and magnitude. Aircraft cabling routes the FFCS signal to the bomb rack interlock switch in each weapon station. The interlock switch interrupts the signal until the weapons station bomb rack hooks open at weapon release. The interlock switch provides an interface and quick-disconnect receptacle for the MK 122 arming safety switch installed into the bomb charging receptacle. The MK 122 provides an electrical radiation hazard shield for the bomb fuze and also interrupts the FFCS voltage signal before weapon release. After the first few inches of bomb travel at weapon release, a lanyard is withdrawn from the MK 122 to allow the FFCS power signal to travel through the bomb cabling to the tail fuze well. The FMU-139 fuze then receives discrete FFCS power and provides the specific arming time.

2.9.2.2 FZU-48/B power consists of removal M70 series cable from bomb body. FZU-48/B initiator (figure 2-28) is a cylindrically shaped metal component which is installed in bomb charging well. It consists of a main housing with two electrical connectors and a cover assembly with lanyard. The two electrical connectors located on bottom of housing are protected during handling and storage by plastic dust caps. Connectors attach to the electrical cabling in bomb. Cover assembly has an arrow to indicate proper orientation when installed in bomb, and has a flexible lanyard with a swivel break link that attaches to bomb rack. The FZU-48/B initiator mounts in bomb charging well and generates power for FMU-139 fuze.

WARNING

Due to an early burst problem, a new power cable was developed with an in-line filter to prevent early burst from occurring. Part Number 9042203 is the only power cable authorized for use with the FMU-139 fuze.

The power cable assembly (figure 2-28) is a coiled electrical cable with electrical connectors at each end. The appropriate power cable is identified by the white backshell just aft of the fuze connector (approximately 2.25 inches long). The power cable assembly routes power from FZU-48/B to FMU-139 series fuzes.

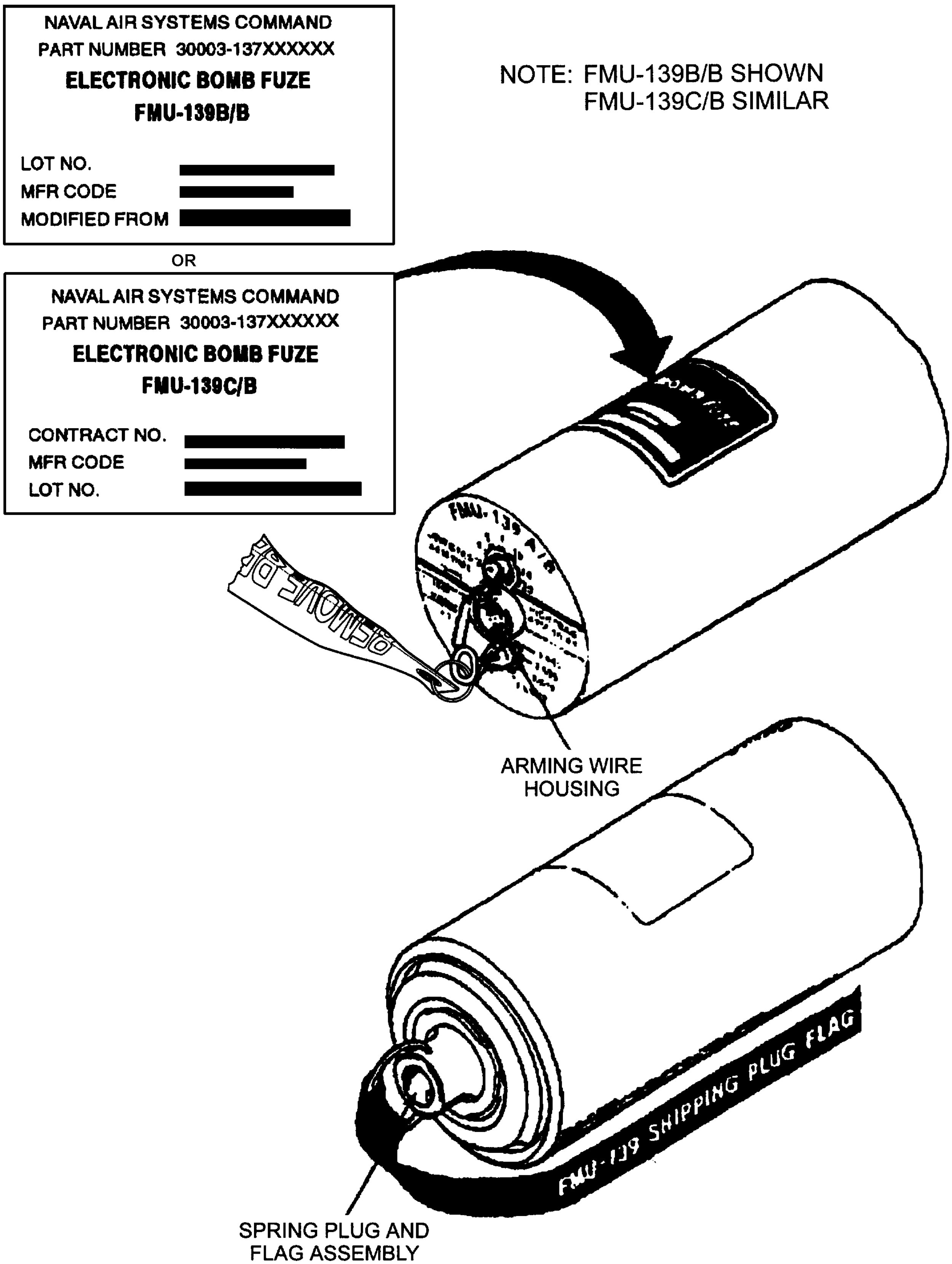
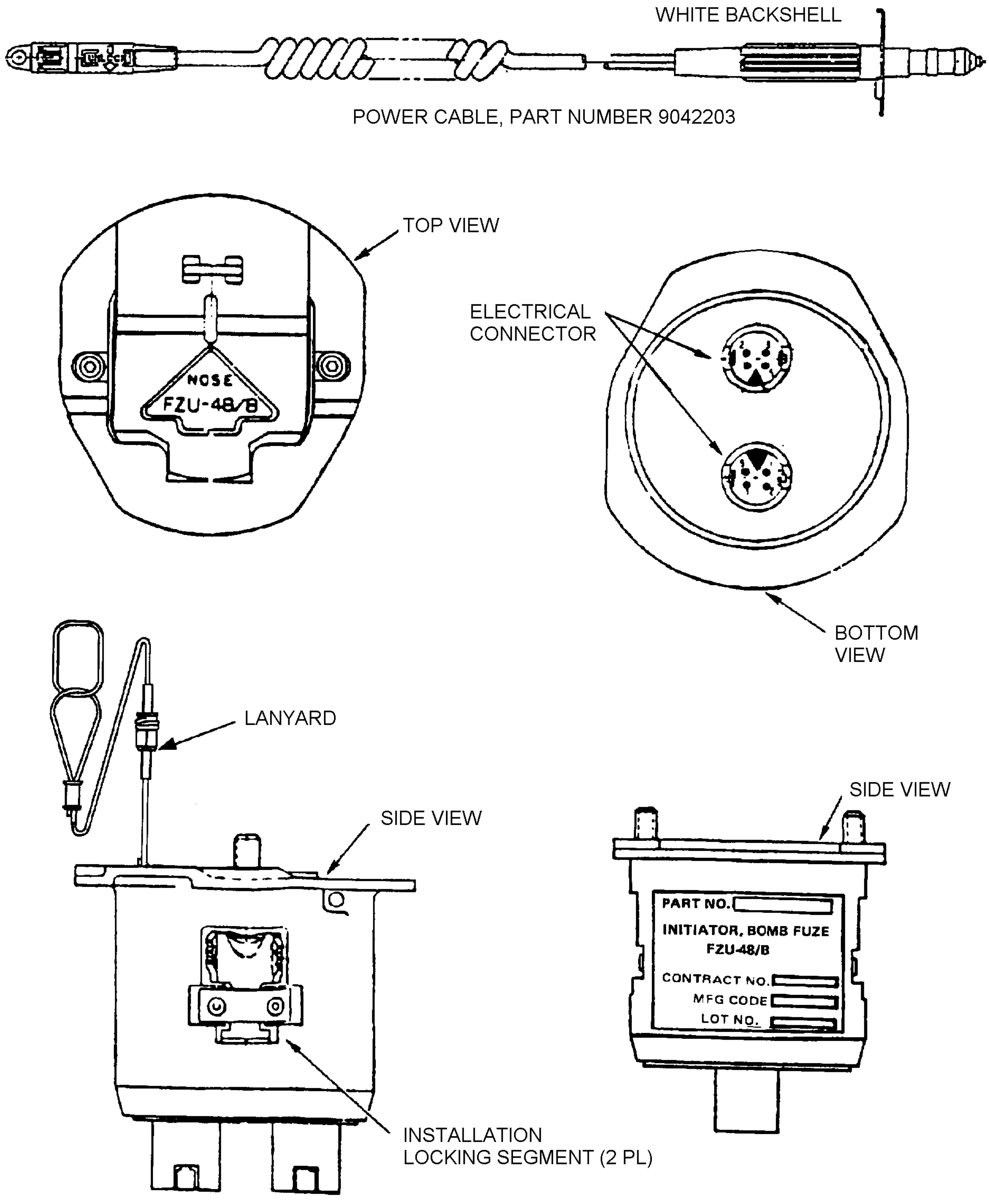


Figure 2-23. Fuze, Electronic Bomb, FMU-139B/B and FMU-139C/B (Sheet 1 of 2)



FZU-48/B

Figure 2-23. Fuze, Electronic Bomb, FMU-139B/B and FMU-139C/B (Sheet 2 of 2)

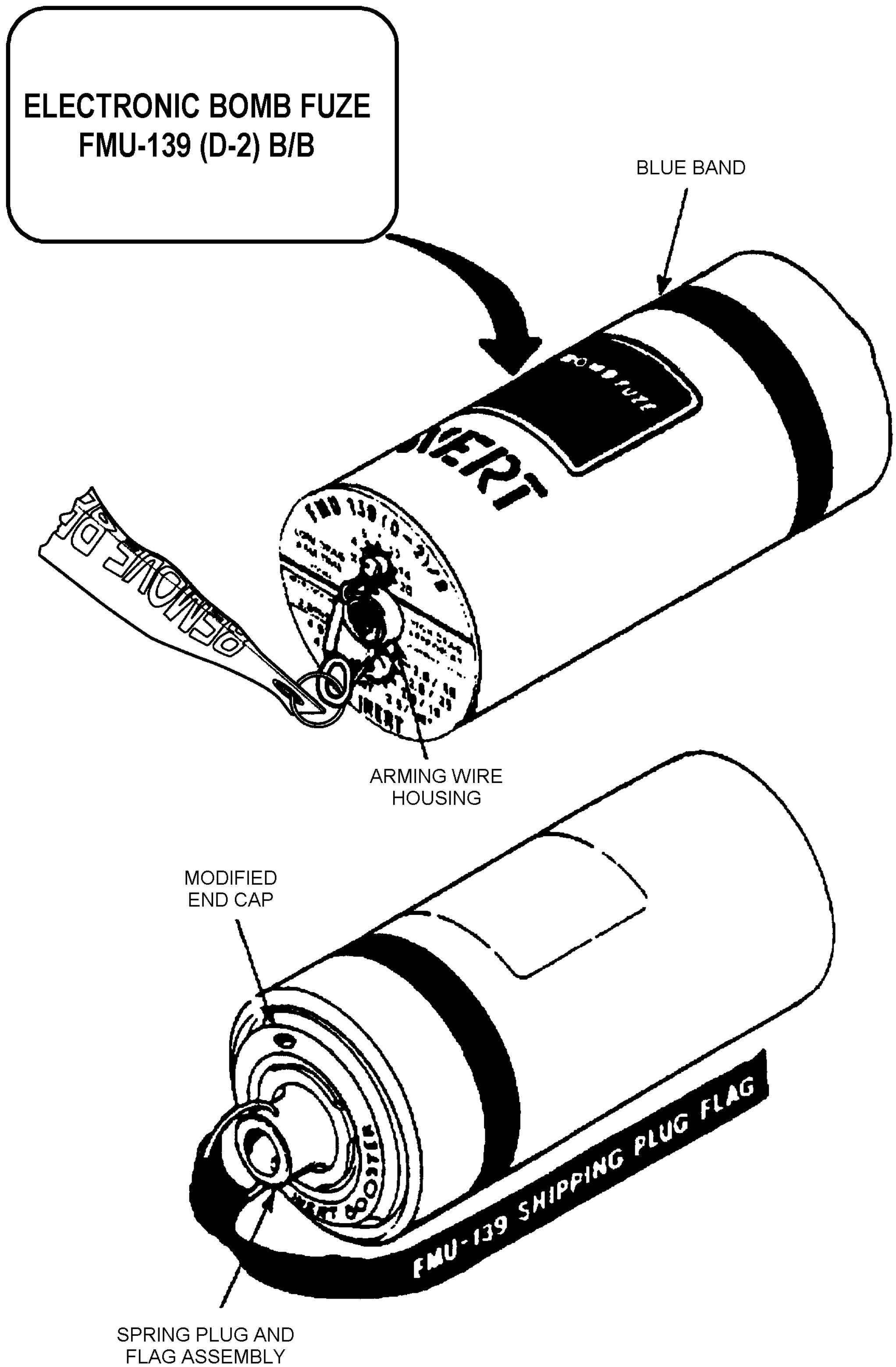


Figure 2-24. Fuze, Electronic Bomb, FMU-139(D-2) Series

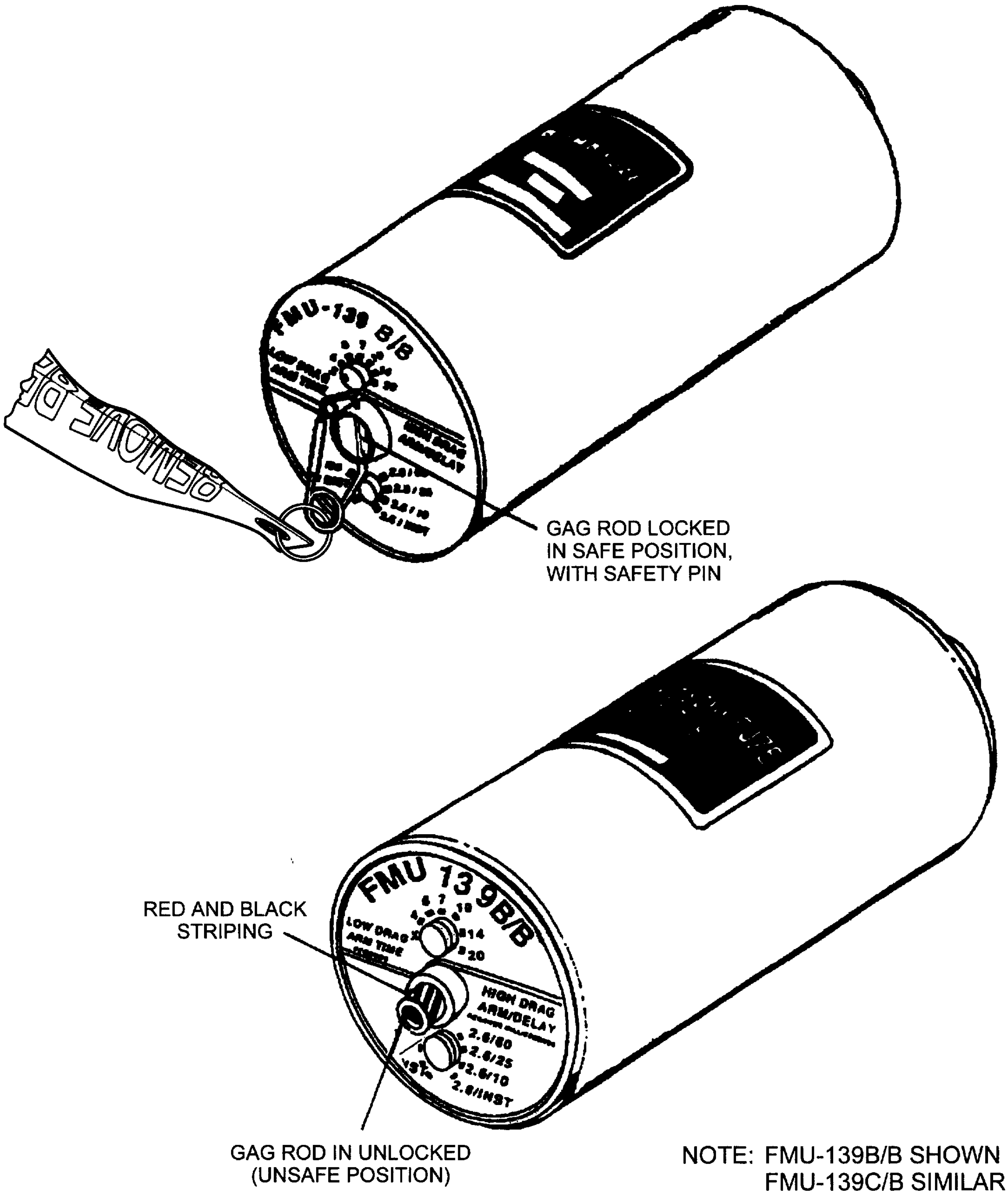


Figure 2-25. FMU-139 Series, Electronic Bomb Fuze with Gag in SAFE and UNSAFE Positions

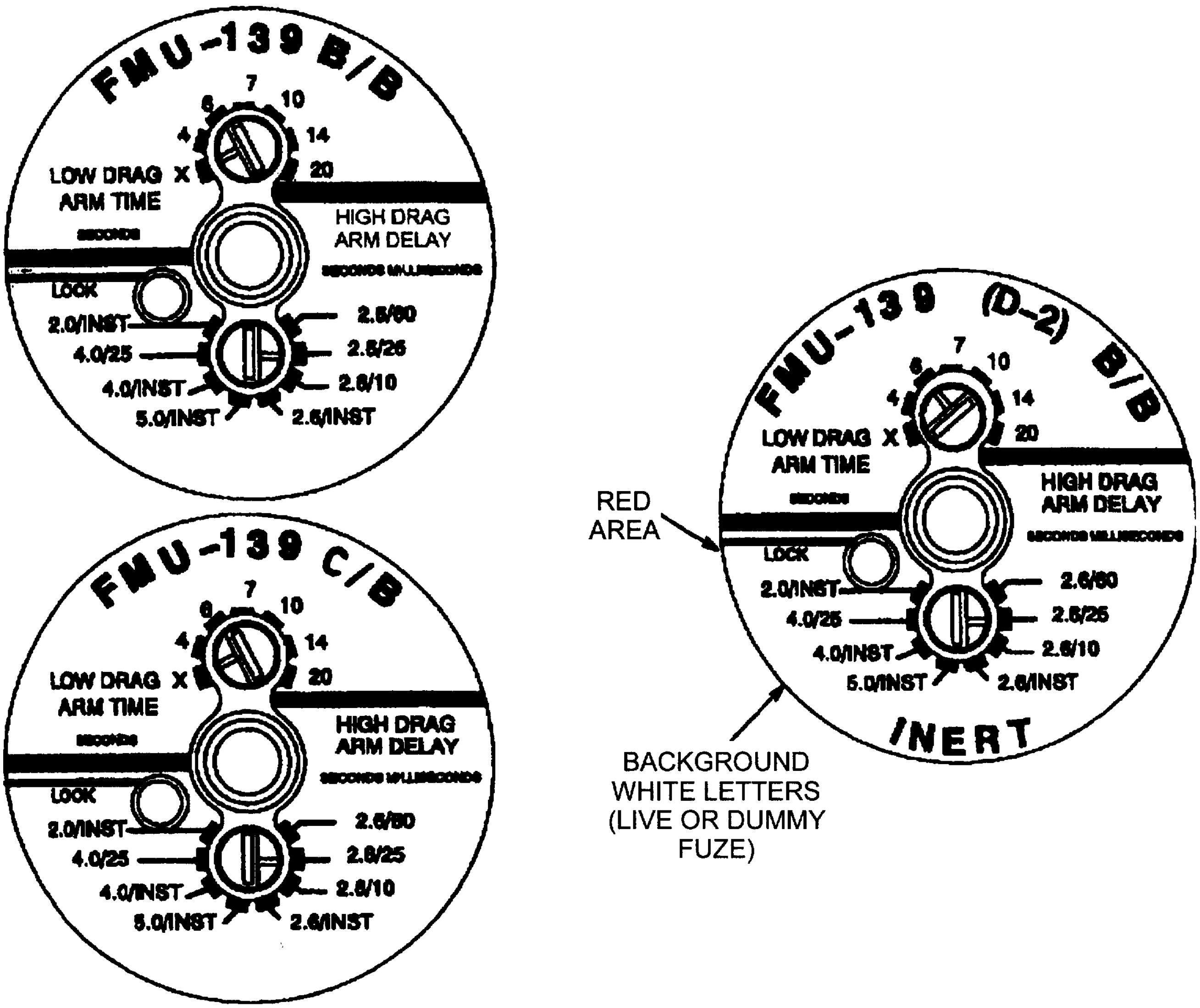


Figure 2-26. FMU-139 Series Faceplates

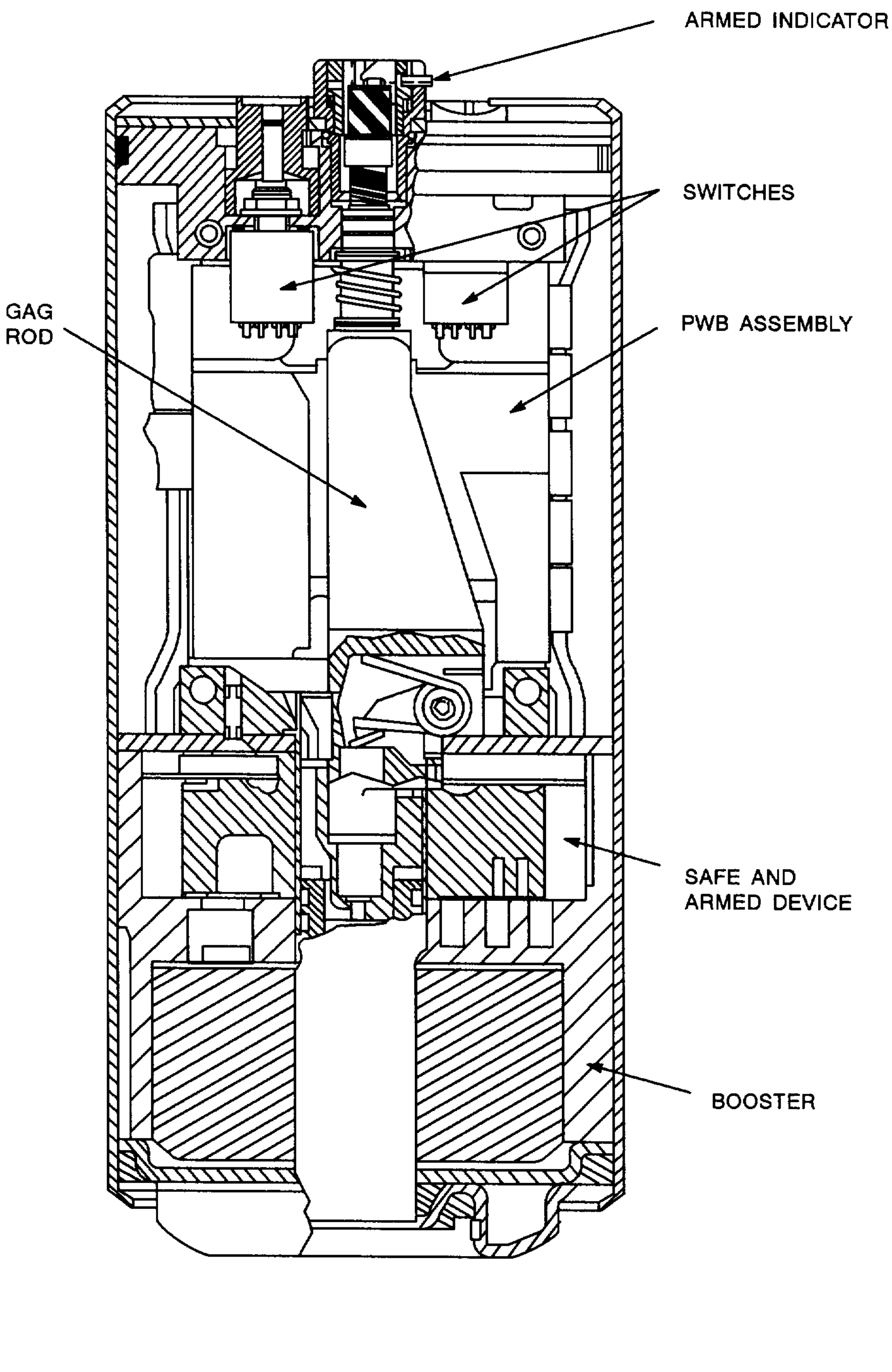


Figure 2-27. Fuze, Electronic Bomb, FMU-139 Series - Internal View

Table 2-7. General Characteristics of the FMU-139 Series Electronic Fuze

Type	Electronic impact/impact delay	
Firing Action	Proximity when used with proximity sensor	
Position	Tail (Navy); Nose/Tail (Air Force)	
Function Delay	Instantaneous; 0.010; 0.025 or 0.060 seconds	
Arming	Electrically initiated, time to arm: Low drag x 4; 6; 7; 10; 14 or 20 seconds High drag 2.0; 2.6; 4.0 or 5.0 seconds	
Physical Characteristics:		
Overall Length	8.50 inches	
Widest Body Diameter	2.87 inches	
Intrusion into Weapon	6.38 inches	
Total Weight	3.5 lbs	
Thread Size	Closure Ring (2 inch dia.)	
Explosive Weights:	Piston Actuator - 9 mg; lead styphnate Explosive Driver - 65 mg; lead styphnate MK 71 MOD 0 Electronic Detonator 21.72 mg, Lead Styphnate; 85mg, Lead Azid; 45 mg, PETN MK 8 MOD 0 Lead - 188 mg CH6 Booster - 140g PBXN-7	
	FMU-139	**FZU-48**
Service Life:	1 year	1 year
Shelf Life[1]:	10 years	Indefinite

[1] If shelf life has expired, do not use. Request disposition from Item Manager.

Table 2-8. Safety Features of the FMU-139 Series Fuze

- Dual independent launch signals
- Two independent arming rotor locks
- Independent arming timer clock checks
- Automatic retard deceleration sampling
- Detonator shorted prior to arming
- Mechanical lock on arming rotor until 100 milliseconds prior to arming
- Internal self-check for arm/safe condition at power up
- Release/arm indication provided by pop-up indicator on arming rotor gag rod

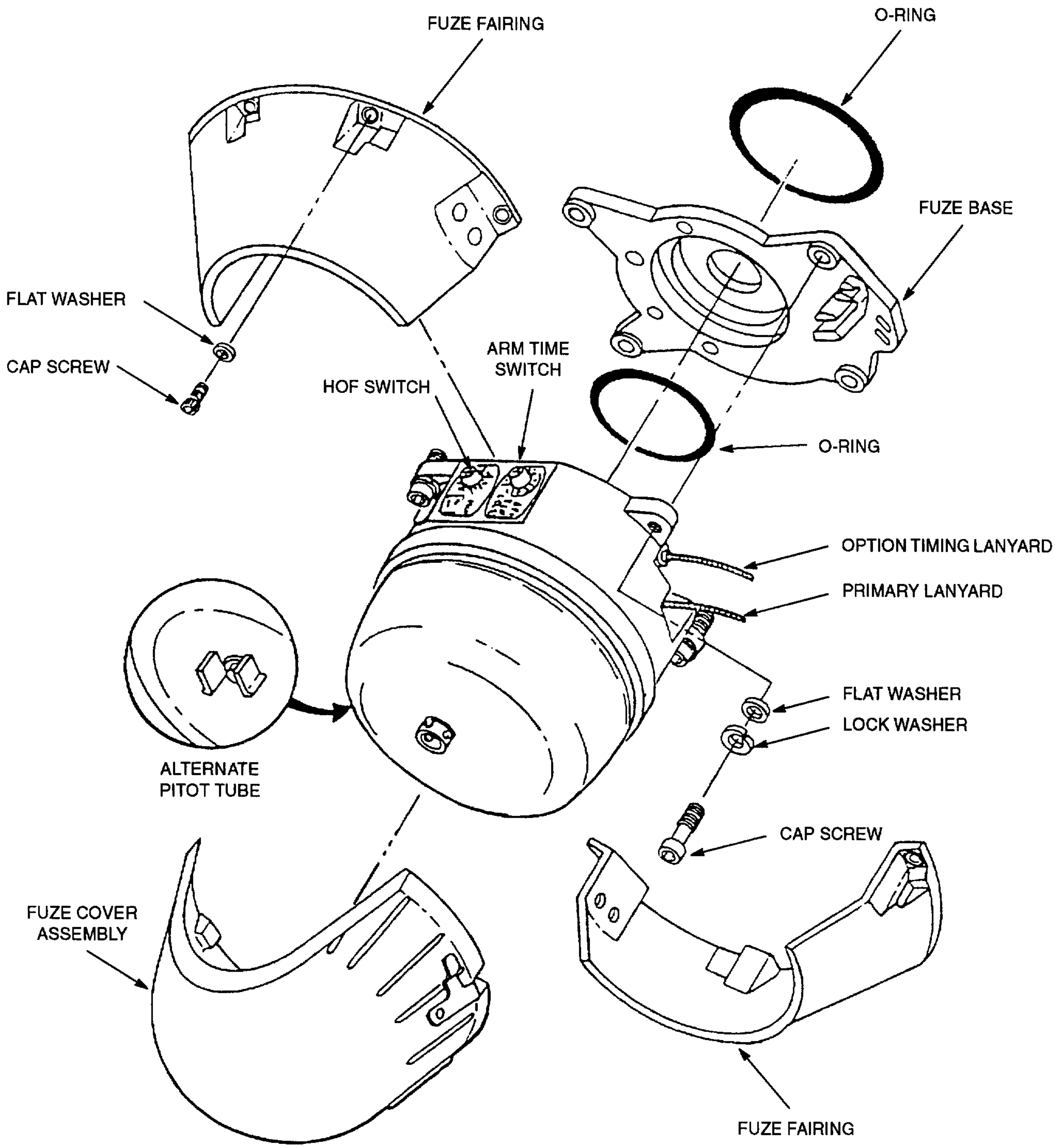


Figure 2-28. Fuze, Dispenser Proximity, FMU-140 Series - Exploded View

2.9.3 EXPLOSIVE COMPONENTS. The FMU-139 Series fuze contains a Piston Actuator, Explosive Driver, MK 71 MOD 0 Electric Detonator, MK 8 MOD 0 Lead, and a Booster. The fuze contains a total of approximately 140.5 grams of various explosives.

2.9.4 SAFETY FEATURES.

2.9.4.1 Safety features of the FMU-139 Series fuze are as follows: Basic safety features are listed in table 2-8.

a. The fuze guillotines a wire on the gag lock assembly when the piston actuator is initiated. The wire provides a redundant gag release indication. This wire is strobed at the beginning of the program to ensure that the piston actuator has not been fired. It is tested again after piston actuation to verify that the piston actuator has cut the gag wire.

b. In the FFCS mode (figure 2-9), the fuze monitors the input power signal from the FFCS via the FFCS release circuitry. If this signal indicates that the FFCS is connected longer than 500 milliseconds, the fuze will dud.

c. In FZU-48/B mode, a pull force of at least 30 pounds on lanyard is required to open initiator cover. If cover is open on initiator, it will not produce electrical power at 100 KCAS or less at sea level. Once opened, cover cannot be pushed back into closed position. If cover is opened 150 seconds before turbine alternator begins generating electrical power, no release signal will be generated, and the fuze will abort and not arm.

d. The fuze begins monitoring the impact signal at Time of Release (To) + 1.8 seconds. If impact is sensed between this time and arming the fuze will dud.

e. If a proximity signal is sensed between To + 1.8 seconds and arm time the fuze will inhibit any further proximity signals and function on impact only.

f. The impact and proximity sensors are inhibited for 80 milliseconds after arming. This prevents the fuze from functioning on any spurious electrical signals generated during arming.

g. The leads on the detonator are shorted together until the fuze has armed.

h. In the FFCS mode, this arming time does not begin until the FFCS release circuit indicates that the weapon has disconnected from the aircraft.

i. The fuze samples the retard switches every 62.5 milliseconds. The fuze will select a retarded mode of operation only after sixteen positive samples of switch closure.

2.9.5 FUNCTIONAL DESCRIPTION. In the FFCS mode, the power is applied to the fuze by the aircraft FFCS. The polarity of this signal determines the arming time while the magnitude selects the functioning delay options. Arming time is further determined by bomb delivery mode: low drag (non-retarded) or high drag (retarded). Sensing an FFCS power source and signal, the fuze ignores any setting of the LOW DRAG ARM TIME rotary switch. If delivery is low drag, the fuze arms in 5.5 or 10 seconds (determined by polarity of the FFCS signal). If the delivery is high-drag, the fuze senses this and arms in 2.6 seconds regardless of any settings of either rotary switch on the fuze faceplate. The fuze functioning time (impact option) will be instantaneous whenever the FFCS power applied is 300 volts (regardless of signal polarity or the fuze HIGH DRAG ARM/DELAY rotary switch setting). With 195 volts of FFCS power, the fuze will function at the time that is preflight selected on the HIGH DRAG ARM/DELAY switch (INST, 10, 25, 60 milliseconds delay options).

2.9.5.1 The FMU-139 Series fuze draws 80 milli-amps from the FFCS. This current charges the primary energy storage capacitor.

2.9.5.2 In the FZU-48/B mode, electrical energy is supplied by FZU-48/B initiator. Initiator is capable of supplying power to FMU-139 fuzes.

a. FZU-48/B sequence of operation follows. When bomb moves away from bomb rack at release, lanyard pulls on cover. Once a force greater than 30 pounds is exerted on cover, a shear wire internal to initiator breaks, allowing cover to pivot upward into airstream. When force on lanyard becomes greater than 130 pounds, a shear wire in swivel breaks, allowing lanyard to stay with cover while ring stays with bomb rack. Once cover is open, alternator begins generating power.

b. Opening of cover releases a spring that slaps a magnetic transducer, creating a small electrical current in release circuit. This current is used to hold release signal circuit on for at least 10 seconds but no more than 150 seconds. If initiator cover is opened while aircraft is on the ground, release signal will not be present when aircraft reaches a speed sufficient to cause alternator to generate power.

c. Once the cover is opened, the initiator cannot be used and will be rejected. This does not arm the fuze. Pushing the cover closed will not reset the spring which generates the release signal. Thus, no release signal will be sent and the fuze will abort. The unserviceable initiator will be replaced prior to the bomb being used.

d. Once cover is open, a minimum of 250 Knots Calibrated Airspeed (KCAS) is required for FZU-48/B turbine alternator to generate sufficient power to arm fuze.

2.9.6 INSTALLATION REQUIREMENTS.

2.9.6.1 The fuze is installed with the safing pin and tag assembly installed and need not be removed to install the closure ring. A special tool is used that engulfs the safing pin and tag assembly. To set the delay knob to the 2.0 second retard position, an interlock button must be depressed simultaneously.

2.9.6.2 The safing pin and tag assembly is capable of being safely reinstalled in the event the safing pin is inadvertently removed and the red and black arm indicator is not extended. If red and black rod is extended, contact EOD for disposition.

2.10 FMU-140 SERIES DISPENSER PROXIMITY FUZE.

2.10.1 GENERAL DESCRIPTION. The FMU-140 Series is a proximity fuze (figure 2-28) with an optional Arm and Fire (timer) mode. It is used with Navy/Marine Corps ROCKEYE II, and GATOR weapons. It is a repackaged version of the Air Force FMU-110/B Dispenser Proximity Fuze (DPF), and contains a mounting bracket, aerodynamic fairings, and a protective cover. General characteristics are provided in table 2-9.

2.10.2 OPERATIONAL CHARACTERISTICS. The FMU-140 Series is a self-powered doppler radar device acting as a radar altimeter. Arming times and functioning altitudes are variable and are selected during preflight on the fuze faceplate, located on the side of the fuze (figure 2-28). When in the proximity mode, if the preselected altitude is reached before the fuze has had time to arm, or the dispenser is released below the pre-selected altitude, then the fuze will have the potential to function at any time after arming. If the FMU-140/B fuze has not functioned by the time it reaches an altitude of 300 $\pm$25 feet, it will function at that time, due to its 300 foot alternateive Height of Function (HOF). The FMU-140A/B has no alternative HOF.

2.10.3 EXPLOSIVE COMPONENTS. The FMU-140 Series fuze contains five explosive components (see table 2-10). The piston actuator, bellows assembly and MK 71 MOD 1 detonator are electrically-initiated. The MK 16 explosive lead charge is initiated by the detonator. The thermal battery is initiated by the battery firing device.

2.10.4 SAFETY FEATURES. The FMU-140 Series fuze has five safety interlocks.

a. Arm time rotary switch in “SAFE” position.

b. Battery firing device (BFD) which has keys engaged in slots in the hub of the Safe and Arm (S&A) rotor, thus preventing the rotor from turning.

c. Thermal battery which does not provide power until the preliminary lanyard is pulled to activate it.

d. Pitot tube base (a pin mechanically locking the rotor) is also locked into the S&A rotor.

e. Pressure switch which is open until an air stream is detected by the pitot tube.

These interlocks are used to prevent inadvertent movement of the S&A mechanism. The sequence of removal of these five safety interlocks takes place in four events.

Event #1. Switching of the arm time rotary switch (figure 2-33) to a position other than “SAFE”. This action removes the first (electrical) safety interlock.

Event #2. Activation of BFD. This action removes the second and third (mechanical) safety interlocks, and is achieved when the arming lanyard is pulled. At this time the keys on the BFD are disengaged from slots in the hub of the S&A rotor, thereby removing the second safety interlock. At the same time, the thermal battery is activated, removing the third safety interlock.

Event #3. Initiation of piston actuator. This action causes the simultaneous protrusion of the pitot tube base (a pin which mechanically locks the rotor). Extrusion of the pitot tube base removes the fourth safety interlock. The locking rod is a mechanical interlock. Protrusion of the pitot tube is not, in and of itself, a safety interlock. It does, however, put the pitot tube into the air stream so that Event #4 can take place.

Event #4. Pressure switch closure. The pressure switch is an electrical switch which is closed when adequate air stream pressure is sensed, thereby removing the fifth safety interlock (electrical).

Table 2-9. General Characteristics of the FMU-140 Series Dispenser Proximity Fuze

	FMU-140/B	FMU-140A/B
Drawing #	1472AS200	1472AS295
Type	Electromechanical	Electromechanical
Firing Action	Proximity	Proximity
Position	Nose	Nose
Function Delay	N/A	N/A
Arming:	Air Pressure	Air Pressure
Physical Characteristics:		
Overall Length	7 inches	7 inches
Widest Body Dimension	8 inches	8 inches
Intrusion into Weapon	N/A	N/A
Total Weight	7 lbs	7 lbs
Thread Size	N/A	N/A
Explosive Weights:	608.33 mg max. - 578.33 mg min.	608.33 mg max. - 578.33 mg min.
Shelf Life[1]:	15 years	15 years
Service Life:	15 years	15 years

[1] If shelf life has expired, do not use. Request disposition from Item Manager.

2.10.4.1 A rotor is the heart of the S&A mechanism. The rotor carries the electric detonator, and it is driven by an electrically-initiated pyrotechnical bellows motor. In the safe condition, the electric detonator is 90 degrees out of line from the firing (explosive lead) position, and is electrically grounded; the detonator is aligned with the explosive lead when the fuze is in the armed condition. Arm time switch selection is normally the first event in the safety interlock removal sequence.

a. Arm Time Switch. If, at thermal battery initiation, the arm time switch (one of two control switches on the exterior of the fuze) is in the safe position, battery output to the fuze timing circuitry and the S&A components is shunted to ground. This is the first interlock. Arm time selection is implemented by hand upon weapon loading to the aircraft or prior to launching the aircraft. This is the first event in the safety removal sequence.

b. Battery Firing Device. This is the second event in the safety removal sequence. The BFD is installed along the axis of the S&A rotor and is actuated at weapon release when a longitudinal pull force extracts the primary lanyard (this is an internal extraction, the primary arming lanyard is not pulled out of the fuze itself). The longitudinal force required to extract this lanyard is specified to be 45-75 lb. Prior to actuation, mating keys on the BFD engage slots in the hub of the S&A rotor. This is the second safety interlock. BFD actuation consists of a two part cock and fire action. The first part of this action compresses the firing pin spring (cocking action). At lanyard extraction, the two interlocking shafts disconnect, allowing the firing pin

Table 2-10. FMU-140 Series Explosive Components

PISTON ACTUATOR P/N 1472AS326	
Lead Styphnate	**0.33 mg**
Hercules SD 149	**1.95 mg**
Total	**2.28 mg**
MK 20 BELLOWS ASSEMBLY P/N 1379AS781	
Lead Styphnate	**2 - 6 mg**
Lead Nononitroresorcinate (LMNR) and black powder mix	**65 ± 3 mg**
Total	**64 - 74 mg**
MK 71 MOD 1 DETONATOR P/N 3024245	
Lead Styphnate (Ignition Charge)	**2 mg**
Lead Styphnate (Flash Charge)	**19.72 mg**
Lead Azide (Charge 1)	**40 - 45 mg**
Lead Azide (Charge 2)	**40 - 45 mg**
PETN	**40 - 45 mg**
Total	**141.72 - 151.72 mg**
MK 16 MOD 0 EXPLOSIVE LEAD P/N 2226843	
CH6	**352 ± 5 mg**
THERMAL BATTERY P/N 1472AS387	
Lead Styphnate and Tetracene mix	**23.33 mg**
TOTAL MAXIMUM WEIGHT =	**608.33 mg**
TOTAL MINIMUM WEIGHT =	**578.33 mg**

to drive forward (firing action). During the second part of the action, the spring holds the firing pin against the face of the thermal battery and keeps the keys on the BFD disengaged from the slots in the hub of the S&A rotor. This removes the second safety interlock. The thermal battery is then initiated (by the firing pin striking the primer on the end of the battery) and removes a lock on the S&A rotor. Activation of the BFD is normally the second event in the safety interlock removal sequence, and it removes the second and third safety interlocks. The BFD extractor assembly is designed to have the ring and swivel separate at a tensile load of 155-180 pounds to the extractor assembly.

c. Locking Rod. At arm time minus one-half second, a piston actuator is electrically initiated. This piston actuator is located in the base of the pitot tube; it drives the rod in a linear manner. Initiation of the piston actuator, which is normally the third event in the safety interlock removal sequence, causes the following actions to occur:

(1) Protrusion of the pitot tube through the radome, providing visual indication of pitot tube base removal and exposure of a pressure port. The exposed end of the indicator is color coded red.

(2) Extraction of the locking rod (a pin at the base of the pitot tube, mechanically locking the rotor) from the periphery of the rotor removes the fourth safety interlock.

NOTE

If the red end of the indicator is visible, the fuze should be considered armed.

d. Pressure Switch. A pressure switch is provided as an electrical interlock. The pressure switch is normally the fourth and final event in the safety interlock removal sequence. Exposure of the pitot pressure port located on the end of the pitot indicator rod allows dynamic air pressure, derived from the air stream, to reach (and close) the pressure switch. This action closes an electrical circuit to the bellows motor that drives the rotor. This removes the fifth safety interlock. The pressure switch is factory set to respond as follows:

(1) Must remain open if airspeed is less than 160 knots.

(2) Must close if airspeed is greater than 225 knots.

NOTE

Pressure switch closure is normally the fourth and final event in the safety interlock removal sequence.

2.10.5 FUNCTIONAL DESCRIPTION. The FMU-140 Series DPF uses three separate firing circuits incorporating firing capacitors to fire it's explosive components (see paragraph 2.10.3). In addition to the proximity mode, an optional 1.2 second fuze arm and function time is also available. Additionally, the fuze incorporates electronic warfare countermeasure features in the form of frequency agility.

2.10.5.1 The DPF offers a choice of two operational sequences, a proximity mode primarily used for loft and dive deliveries, and an arm and fire mode primarily used for laydown maneuvers. The fuze has five arm times from 1.2 to 10 seconds and 10 heights of function from 300 to 3000 feet.

a. Proximity Mode. During weapon preflight, arm time and height of function must be selected on the fuze faceplate. When the arm time knob is switched to a position other than the SAFE position, the battery output to the fuze timing circuitry and S&A components are no longer shunted to ground. This is normally the first event in the safety interlock removal sequence. Prior to weapon release, the pilot energizes the ejector rack solenoid containing the fuze arming lanyard extractor. Upon weapon release, the lanyard activates the BFD. This results in disengaging the keys on the BFD from the slots in the hub of the S&A rotor; this is the first S&A rotor mechanical safety interlock. Removal of this interlock is normally the third "event" in the safety interlock removal process. This process also initiates the thermal battery (by the firing pin striking the primer on the end of the battery). This thermal battery is the only power source required for the fuze. One-half of a second prior to the arm time selected during pre-flight, the piston actuator is initiated and pitot tube is protruded. This action removes the second S&A rotor mechanical safety interlock which is normally the fourth "event" in the overall safety interlock removal sequence. Sufficient dynamic air pressure across the pitot system closes a pressure switch and removes an electrical safety interlock. This pressure switch will not close at airspeeds of less than 160 knots but must close at speeds greater than 225 knots. At the ground-selected arm time (if sufficient air speed is sensed), the safe and arm (S&A) mechanism aligns the explosive detonator with explosive lead. When the proximity sensor senses the preselected function altitude, the fuze electronics initiate the fuze and weapon explosive train.

b. Arm and Fire Mode. Prior to weapon release, the pilot energizes the ejector rack solenoid containing both the primary lanyard and the option lanyard extractors. Upon weapon release, both lanyards are internally extracted, the option lanyard activation closes an electrical switch within the fuze. After lanyard extraction, the sequence proceeds as described for proximity mode, except that the arm time is 1.2 seconds rather than a ground selected value, and the fuze electronics initiate the fuze and weapon explosive train twenty milliseconds after explosive train alignment, regardless of altitude.

2.10.6 INSTALLATION REQUIREMENTS. The FMU-140 Series fuze is shipped to the fleet only as part of an all-up-round installation of the fuze will be done at the Weapons Station/Depot level.

2.11 FMU-143 SERIES ELECTRONIC BOMB FUZE SYSTEM.

2.11.1 GENERAL DESCRIPTION. The FMU-143 Series electronic fuze systems are derivatives of the Air Force FMU-143/B and FMU-143B/B and are interchangeable with them (see figure 2-29) There are internal differences in some of the mechanical and electronic components which were modified to improve the low temperature performance of the FMU-143E/B. The only external difference results from a modification which changed the relative location of the arming lanyard and warning flag assemblies.

2.11.1.1 The FMU-143 bomb fuze system consists of one FMU-143E/B, FMU-143H/B, FMU-143L/B, or FMU-143M/B bomb fuze, one retractile cable assembly, one arming lanyard, one safety pin WARNING flag, one fuze mounting retainer, one FZU-32B/B initiator, one Fuze/Safe Jettison Lanyard, (except FMU-143E/B) one BLU-116 cable and associated packing and packing material. The FMU-143(D-2)/B and FMU-143B(D-2)/B bomb fuze systems are similar to the FMU-143 Series bomb fuze system except that detonators, bellows motors and all explosive items have been removed. Leading characteristics of the FMU-143 Series bomb fuze system components are listed in table 2-11. Shelf and service lifes are listed in table 2-12.

2.11.1.2 The FMU-143 bomb fuze is housed in a cylinder eight inches long and three inches in diameter. The fuze is equipped with a safety release mechanism (housing and safety release shaft), a connector to accept operating power and a screwdriver adjustable selector switch to select arming delay times. The retractile cable connects the connector plug of the fuze to the FZU-32B/B initiator installed in the arming well. All fuzes are shipped in the safe condition with the safety release shaft (hereafter called gag rod) held in the depressed position by means of both a safety pin and an arming pin. A red WARNING flag with instructions is attached to the safety pin. The arming Lanyard is attached to the arming pin.

2.11.1.3 Components associated with the FMU-143 Series bomb fuze are listed below.

a. Fuze Mounting Retainer. The fuze mounting retainer is an externally-threaded ring used to secure the fuze into the fuze well of the BLU-109A/B or BLU-116 bomb. Two slots are provided on the face of the retainer to permit use of a spanner wrench or screwdriver.

b. Safety Clip and Lanyard Assembly. The safety clip and lanyard assembly is approximately 30 inches long and contains the arming pin on one end (attached to the fuze safety release mechanism) and a detachable clip and swivel assembly on the other end. During lanyard installation to the aircraft, the clip and swivel assembly is removed from the lanyard. The lanyard is fed up through a hole in the wing assembly opening and the clip and swivel assembly are reattached. The swivel ring of the lanyard is connected directly to the aft arming solenoid on the ejector rack.

c. Retractile Cable Assembly. The retractile cable assembly is a 19-inch coiled (64-inch extended) cable with puller clips at both ends. The cable extends through the BLU-109A/B bomb internal charging tube conduit when installing the fuze and connect the fuze to the FZU-32B/B. The puller clips must be removed to enable mating the cable to the fuze and initiator.

d. FZU-32B/B Initiator. The FZU-32B/B initiator is a turbine generator that fits into the arming well. A decal on top of the initiator shows proper installation position. It connects to the retractile cable from the fuze and provides AC power to arm the fuze. Upon weapon release, the top of the initiator is pulled away by the lanyard allowing the hinged air scoop intake assembly to pop open. Rushing air drives the turbine generator to deliver 41-53 VAC minimum at an indicated air speed of 270 knots. The turbine does not start at indicated air speeds less than 133 knots. The AC generator voltage varies from 40 to 70 VAC. This voltage is converted in the fuze quadupler circuit to DC voltage for use by the fuze arming circuits and for detonator firing.

e. Fuze/Safe Jettison Lanyard. The Fuze/Safe Jettison Lanyard is approximately 18 inches long and consists of a wire rope with a loop swedged on both ends. The lanyard is used to keep the arming lanyard from being pulled due to wind forces during flight.

f. BLU-116 Cable. The BLU-116 cable (figure 2-30) is used to connect the fuze to the FZU-32B/B when installed in the BLU-116 bomb body.

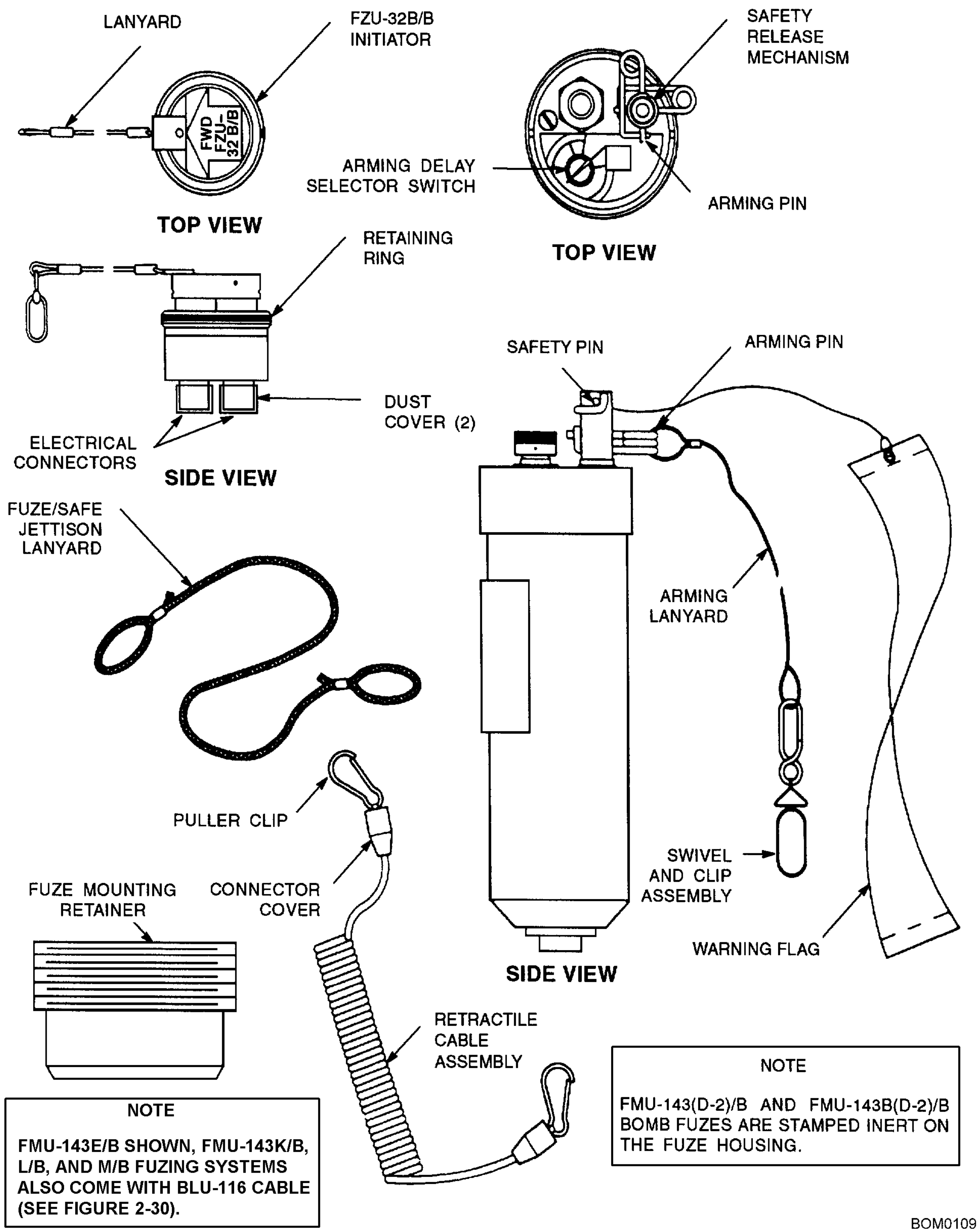


Figure 2-29. FMU-143 Series Bomb Fuze System (Sheet 1 of 2)

Figure 2-29. FMU-143 Series Bomb Fuze System (Sheet 2 of 2)

Table 2-11. General Characteristics of the FMU-143 Series Bomb Fuze

NOMENCLATURE	DIMENSIONS (INCHES)				WEIGHT		DIMENSIONS (INCHES) OUTER PACK
	LENGTH	WIDTH	HEIGHT	DIAMETER	GROSS (LBS)	NEW[1] (Grams)	
Fuze, System, Bomb, FMU-143 Series (two systems per container)					20.7	2.88	12 x 6 3/32 x 13-23.64
Each System Contains; Fuze, Bomb, FMU-143	9.0625			2.9	3.6	144	
Fuze, System, Bomb, FMU-143(D-2)/B (two systems per container)					20.7		12 x 6 3/32 x 13-23.64
Each System Contains; Fuze, Bomb, FMU-143E(D-2)/B	9.0625			2.9	3.6		
Retainer, Fuze Aft Mounting	1.75			3.5	1.1		
Swivel and Clip Assembly	30.0						
WARNING Flag Assembly	19.0	1.5					
Retractile Cable Assembly	64.0 extended 19.0 retracted			0.5	0.10		
Initiator, Bomb Fuze, Assembly FZU-32B/B			2.078	2.0	0.5		
Fuze Safe/Jettison Lanyard	18.0			0.094			
BLU-116 Cable	40.0			0.5	0.10		

Explosive Weights: (approx)	Booster Bellows (2 ea)	143 g PBXN-7 50 mg LMNR and Black Powder Mix 4 mg Lead Styphnate
	Explosive Lead Delay Detonator	725 mg CH6 35 mg HMX; 40 mg Lead Azide; 30 mg Calcium Chromate, 5 mg Lead Tetraozide

FUZE	ARM TIMES	DELAY TIMES
FMU-143E/B	5.5 and 12 seconds	0.060 seconds
FMU-143K/B	12 and 21 seconds	0.030 seconds
FMU-143L/B	12 and 21 seconds	0.060 seconds
FMU-143M/B	12 and 21 seconds	0.120 seconds

[1] Net Explosive Weight (NEW) in accordance with AFI 91-201.

Table 2-12. FMU-143 Series Shelf and Service Life

	FMU-143E/B	FMU-143K/L/M	FZU-32B/B
Shelf Life[1]:	17 years	10 years	Indefinite
Service Life:	2 years	2 years	10 years

[1] If shelf life has expired, do not use. Request disposition from Item Manager.

NOTE:
THE BLU-116 CABLE IS NOT PRESENT IN, OR USED WITH FMU-143E/B BOMB FUZE SYSTEM.

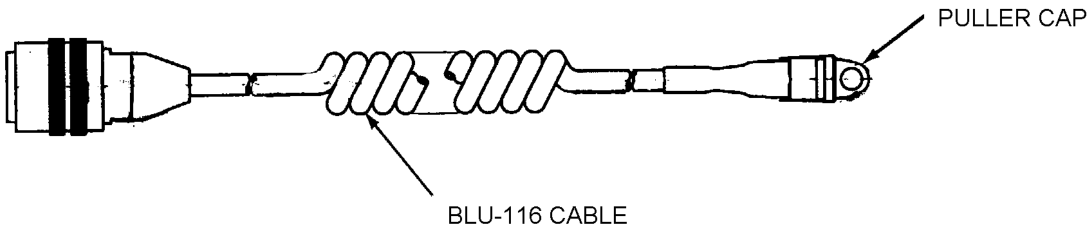


Figure 2-30. BLU-116 Cable

2.11.2 OPERATIONAL CHARACTERISTICS. The FMU-143(D-2)/B and FMU-143B(D-2)/B bomb fuzes are physically identical to the FMU-143 series fuze except they are completely inert and are stamped INERT. Selected arming delay is initiated when the bomb is released from the aircraft. The FZU-32B/B initiator is used to generate and supply power to arm the fuze.

2.11.3 EXPLOSIVE COMPONENTS. The FMU-143 Series fuze contains a Delay Detonator, Explosive Lead, Two (2) Bellows, and a booster. The fuze contains a total of approximately 144 grams of various explosives.

2.11.4 SAFETY FEATURES. Ordnance handling procedures outlined in NAVSEA OP 3347 will be followed at all times when handling FMU-143E/B, FMU-143(D-2)/B and FMU-143B(D-2)/B fuzes.

2.11.5 FUNCTIONAL DESCRIPTION. The fuze can only be armed if it is connected to an electrical power source and the gag rod is extended. The fuze is safe when the gag rod is retracted into the safety release mechanism housing and either or both the safing pin and arming pin are installed. The FMU-143 series bomb fuzes have a selectable arming delay, and a fixed detonation delay after impact (table 2-11). An impact of 160g or greater for 6.7 milliseconds is required to detonate the fuze.

2.11.5.1 Upon installation, the arming delay selector switch is manually preset to the desired mode. When the bomb is released from the aircraft, the arming pin is extracted from the safety release mechanism. This starts the mechanical timer. The mechanical timer applies electrical power from the FZU-32B/B initiator one second after the arming lanyard (with arming pin) is pulled.

2.11.5.2 After power has been applied, the arm delay and secondary arm delay circuits begin their timing cycle. Power is also applied to the impact energy circuit. The gag rod in the safety release mechanism unlocks the rotor four seconds after the arming pin is removed. The arming circuit provides firing signals to actuate the bellows at selected arming delay time after arming pin is removed.

2.11.5.3 Bellows activation causes the rotor to rotate, aligning the explosive train and placing the four rotor switches in the armed position. The fuze is now armed. A fire signal is generated when any one of the four impact switches closes. This allows the energy storage circuit output to fire the detonator. The pyrotechnic delay detonator in the fuze detonates the bomb after impact.

2.11.6 INSTALLATION REQUIREMENTS. Installation of the fuze is accomplished by inserting the fuze (with retractile cable assembly attached) into the fuze well, at the same time drawing the cable assembly through the charging tube conduit. The fuze is secured by the fuze mounting retainer. The retractile cable assembly drawn through the charging tube conduit is connected to the FZU-32B/B initiator which is installed in the arming well and secured with an integral retaining ring. Figure 2-31 is a cutaway view of the FMU-143 fuze.

2.12 PROXIMITY SENSOR, DSU-33 SERIES.

2.12.1 GENERAL DESCRIPTION.

NOTE

The DSU-33 series is classified CONFIDENTIAL and shall be handled in accordance with DOD 5200.1 R/AFI-31-401.

The DSU-33 series Proximity Sensor (figure 2-32) is an adverse-weather, self-powered, active, radio frequency, single mission device capable of operating in an electronic

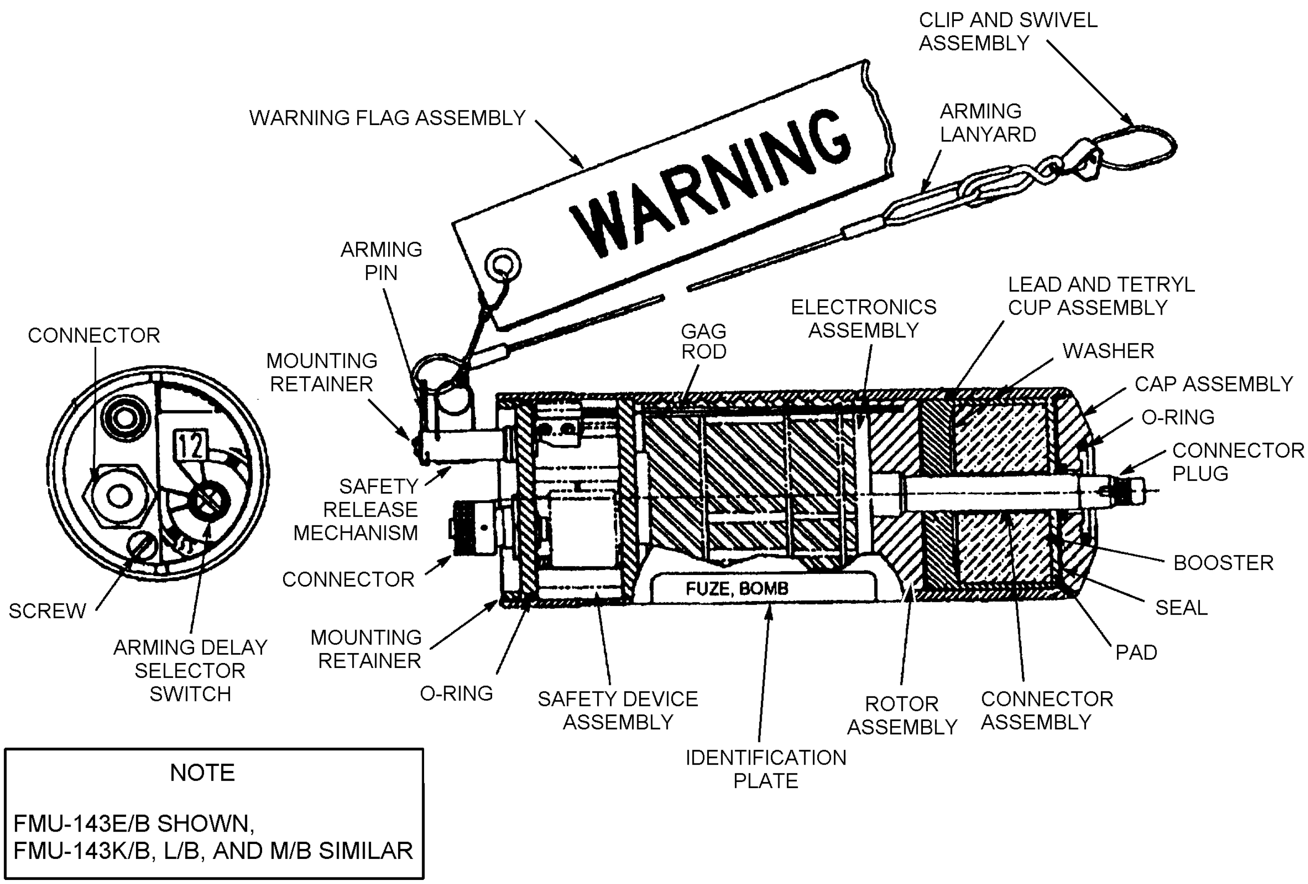


Figure 2-31. Cutaway View of FMU-143 Series Bomb Fuze

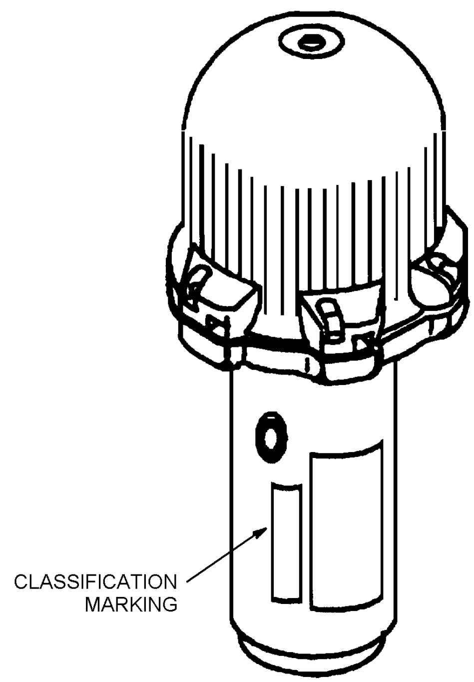


Figure 2-32. Proximity Sensor DSU-33 Series

countermeasures environment. The sensor interfaces with, and provides a proximity function for the BLU-110/111/117 and MK 80 series general purpose bombs. It is capable of both high and low drag release and provides a stable height of burst (HOB) above ground level (AGL) over all surfaces, in all projected environments and all meteorological conditions encountered in air attack missions.

The DSU-33 series is a battery operated, radio frequency, Doppler radar proximity sensor. The sensor is used to provide low altitude proximity function for MK 80 series and BLU-110/111/117 general purpose bombs. The DSU-33 series operates in both low and high drag deliveries and incorporates electronic countermeasures (ECM) resistance. The DSU-33(D-2) series is a dummy version of the DSU-33 series sensor. It is capable of duplicating the requirements for assembly, loading and handling. General characteristics of the DSU-33 series proximity sensor are listed in table 2-13. Shelf and Service lifes are listed in table 2-14.

2.12.2 OPERATIONAL CHARACTERISTICS. The DSU-33 series is cylindrical in shape with a larger diameter, hemispherical radome attached to the forward end (figure 2-33). The radome section contains the Doppler ranging radar, voltage regulator, and ECM circuitry. The sensor subassembly contains all other electrical components, thermal battery, and the power cable interface connector. There is a small window located on the side of the sensor housing for observing the thermal battery condition. The battery contains a small pyrotechnic (match) device for initiation. In order to get an instantaneous fuze function with a DSU-33 series, it is necessary to set up the cockpit for a delay function (+/- 195 V) and set the fuze delay to instantaneous. The DSU-33(D-2) series is of the same diameter, weight, center of gravity and shape as the DSU-33 series. It is cylindrical in shape with a larger diameter, hemispherical radome attached to the forward end. The radome section contains the voltage regulator and ECM circuitry. The dummy sensor does not have the RF printed circuit board assembly installed. This allows the DSU-33(D-2) series sensor to be unclassified.

2.12.3 EXPLOSIVE COMPONENTS. The DSU-33 series Proximity Sensors do not contain any explosive or pyrotechnic components other than an electric match and heat powder (which liquifies the battery's solid electrolyte) that are all components of the thermal battery. These items do not represent a handling hazard, since none are present in sufficient quantity or have the explosive strength to rupture the thermal battery can, much less the DSU-33 series encasing can.

2.12.4 SAFETY FEATURES. The thermal battery powering the DSU-33 series can only be initiated by an external signal. This signal must be generated by electrical signal from the drop aircraft (initiated by the MK 122 safety switch or FZU-48/B upon release). A battery inspection window is provided on the side of DSU-33 series to indicate battery status. The battery paint band when viewed through the inspection window will appear a light color (e.g. white or light gray) if the battery has not been activated. The paint band will appear a dark color (e.g. black or dark gray) if activation has occurred and the DSU-33 series must be considered unserviceable. This inspection window is not present on DSU-33C/B and later model sensors. The DSU-33(D-2) Series Dummy can be identified by a blue band around the radome of the sensor. A blue color in the battery inspection window will identify the thermal battery contained in the Dummy Sensor as inert.

2.12.5 FUNCTIONAL DESCRIPTION. The DSU-33 series provides a proximity signal to the bomb fuze through the M70 Series Fuze Control Cables. The sensor receives a thermal battery initiation signal from the MK 122 switch as the bomb is released from the aircraft. Once the sensor is operating, the nominal height of burst (HOB) above ground level (AGL) is 20 feet over all surfaces. The HOB is derived from the comparison of two Doppler signal differential amplitudes. When the Doppler signal differential amplitudes meet the preset requirements of the sensor, a proximity signal is generated. This signal is processed and applied to the bomb fuze. The digital signal processing approach provides immunity to false fire due to electromagnetic interference (EMI), and different weapon approach velocities. The sensor interfaces with the MK 80 series and BLU-110/111/117 general purpose bombs in both high and low drag configurations. In order to get an instantaneous fuze function with a DSU-33 series, it is necessary to set up the cockpit for a delay function (+/- 195 V) and set the fuze delay to instantaneous. All operations required for assembly, loading, handling and dry run operations can be accomplished using the DSU-33(D-2) Series Dummy Sensor.

2.12.6 INSTALLATION REQUIREMENTS. Installation of the DSU-33 series Proximity Sensor is accomplished by inserting the sensor into the nose fuzing well of the bomb body. Turn by hand clockwise until fully tight and tighten fuze well setscrew.

2.13 DELETED.

2.13.1 DELETED.

2.13.2 DELETED.

2.13.3 DELETED.

2.13.4 DELETED.

2.13.4.1 DELETED.

2.13.5 DELETED.

2.13.5.1 DELETED.

Table 2-13. General Characteristics of the DSU-33 Series Proximity Sensor

NOMENCLATURE	DIMENSIONS (INCHES)				WEIGHT (LBS)		DIMENSIONS (INCHES) OUTER PACK
	LENGTH	WIDTH	HEIGHT	DIAMETER	GROSS	NEW[1]	
Proximity Sensor, DSU-33 Series	12.50	NA	NA	5.56	4.0	NA	18 19/32 x 8 9/32 x 14 19/32
Proximity Sensor, Dummy DSU-33(D-2) Series	12.50	NA	NA	5.56	4.0	NA	18 19/32 x 8 9/32 x 14 19/32

[1] Net Explosive Weight (NEW) in accordance with AFI 91-201.

Table 2-14. DSU-33 Series Shelf and Service Life

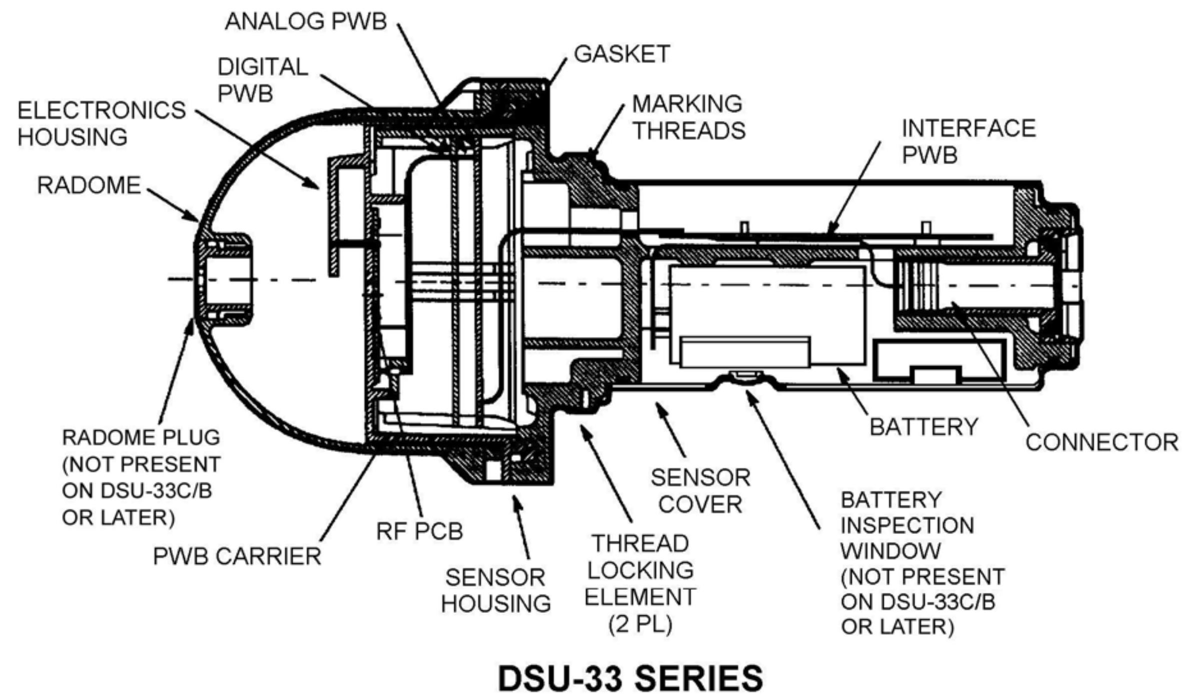
Shelf Life[1]:	10 years
Service Life:	5 years

[1] If shelf life has expired, do not use. Request disposition from Item Manager.

2.13.5.2 DELETED.

2.13.5.3 DELETED.

2.13.6 DELETED.



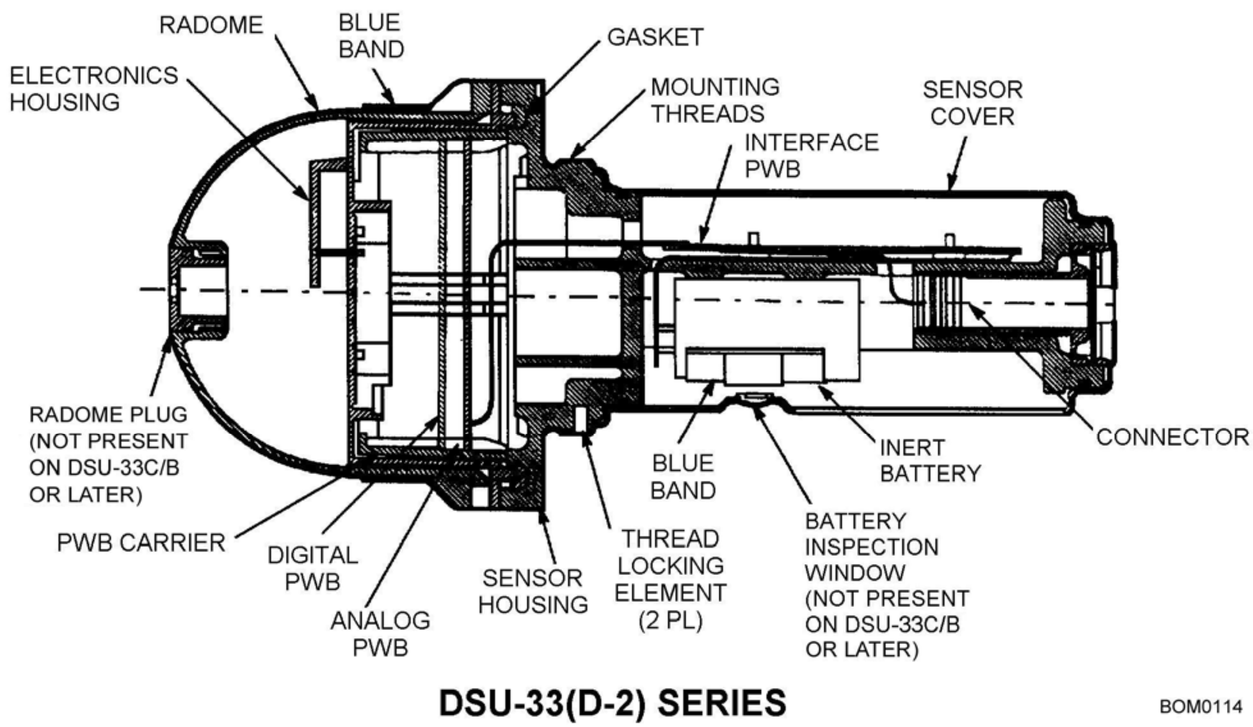


Figure 2-33. DSU-33 Series - Internal View

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Figure 2-35. Deleted

Table 2-15. Deleted

Table 2-16. Deleted

Figure 2-36. Deleted

CHAPTER 3

AIRBORNE SUBMUNITION FUZES

3.1 FUZING SYSTEM, BOMB, MK 1 MOD 0.

3.1.1 GENERAL DESCRIPTION. The Fuzing System, Bomb, MK 1 MOD 0 is an impact fuze system and was designed for and is an integral part of the Bomb, Anti-Tank, MK 118 MOD 0 (figure 3-1). General characteristics of the Fuze System, Bomb, MK 1 and the Fuze, MK 1 are listed in tables 3-1 and 3-2.

3.1.1.1 The Bomb, Anti-Tank, MK 118 MOD 0 was designed for use against such targets as tanks, parked aircraft, artillery, missile sites, and personnel. With 247 MK 118 bombs assembled into a Dispenser, Bomb, MK 7 the assembly is designated as Bomb, Cluster, Anti-Tank, MK 20/CBU-99/CBU-100. Its popular designation is ROCKEYE II.

3.1.1.2 The Fuzing System, Bomb, MK 1 MOD 0 consists of an impact sensing element assembly and a base fuze assembly. The combination provides two modes of operation: super-quick on hard target contact (armor) or short delay on soft target contact (earth, water, or sand). (The magnitude of the delay is due to the inherent time response of the inertia firing mechanism.) The impact sensing element assembly provides the super-quick capability. The base fuze assembly contains the arming mechanism, the explosive train, and the inertia firing mechanism.

3.1.1.3 The arming time range for the MK 1 MOD 0 is 0.85 to 1.4 seconds.

3.1.1.4 The Fuzing System, Bomb, MK 1 design requirements were that the fuzing system should function if the MK 118 bomb impacted a $^{1}/_{16}$-inch steel plate at speeds of 250 feet per second or greater and at impact angles of 30 degrees (measured from the horizontal) or greater. If the MK 118 bomb impacted 1/4-inch plywood at 1000 feet per second or less, the fuzing system should not function. The latter simulated foliage or light camouflage. The 1000 feet per second was the projected MK 118 bomb impact velocity when the ROCKEYE was released at a speed of 600 KIAS and at low altitude. Due to the drag of the MK 118 bomb, the highest impact velocity that can be expected is about 500 feet per second. With this maximum velocity, a low reaction time inertia firing mechanism can discriminate plywood at 500 feet per second and function reliably on 1/16-inch steel plate at 250 feet per second. The Fuze, MK 1 MOD 0 eliminates the impact sensing element. The electric detonator in the base fuze assembly is replaced by an explosive relay. Outside these two changes and the design of the inertia firing mechanism, the Fuze, MK 1 MOD 0 is physically and mechanically identical to the base fuze assembly of the Fuze System, Bomb, MK 1.

3.1.2 OPERATIONAL CHARACTERISTICS. The Fuze System, Bomb, MK 1 MOD 0 and the Fuze, MK 1 MOD 0 require a vane rotational speed of 18,300 rpm minimum to accomplish fuze enabling and vane rotation to accomplish fuze arming. A weapon velocity of 200 KIAS will provide the minimum required vane rotational speed. At weapon velocities below 130 KIAS, enabling and arming will not occur. At weapon velocities between 130 and 200 KIAS, enabling and arming are uncertain and if arming does occur the fuze arming timing could be too long to satisfy the minimum altitude requirement. At weapon velocities above 225 KIAS, the maximum arming time will not exceed 1.4 seconds thus permitting releases at the desired minimum altitude. The minimum recommended release speed has, therefore, been established as being 225 KIAS.

3.1.2.1 Arming occurs in three steps. When the ROCKEYE cluster opens, the MK 118 bombs are released. If the weapon's velocity is greater than 225 KIAS, the vane's rotation will initiate the enable step. A runaway escapement controls rotor movement and the time required to complete this step. After enabling, the vane's rotation provides the motive power to actually drive the out-of-line feature into line.

3.1.2.2 The MK 118 bomb fuze arming time is the sum of the vane spin up time, the enable time and the time required to actually drive the out-of-line feature into line. For the Fuze System, Bomb, MK 1 MOD 0 and Fuze, MK 1 MOD 0, the maximum arming time is 1.4 seconds at 225 KIAS and 1.2 seconds at 600 KIAS.

3.1.2.3 The safe separation time for the MK 118 bomb is the sum of the MK 118 bomb fuze minimum arming time and the minimum operating time of the fuze that controls the opening of the cluster. The minimum operating time for the MK 339 fuze is 1.2 seconds. The safe separation times (measured from arming wire extraction) are therefore 2.05 to 2.6 seconds for an MK 118 bomb with the Fuze System, Bomb, MK 1 MOD 0 and the Fuze, MK 1 MOD 0 and 1.85 to 2.4 seconds for a MK 118 bomb with the Fuze System, Bomb, MK 1 MOD 0 and the Fuze, MK 1 MOD 0.

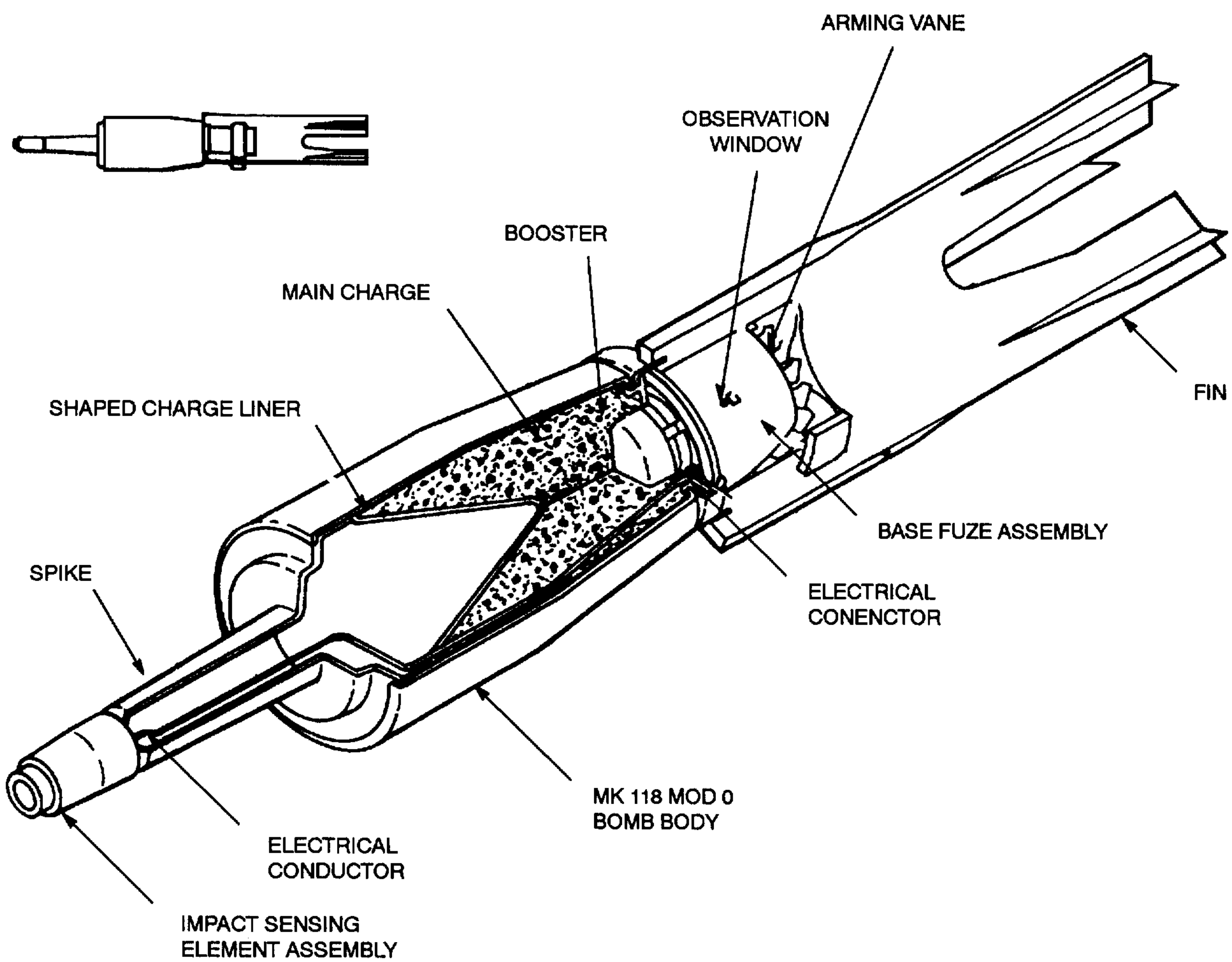


Figure 3-1. Bomb, Anti-Tank, MK 118 MOD 0 with Fuzing System, Bomb, MK 1 MOD 0

Table 3-1. General Characteristics of the Fuze System, Bomb, MK 1

	Impact Sensing Element Assembly	Base Fuze Assembly
Drawing #	PL 2424974	PL 2424987
Type	Mechanical	Mechanical
Firing Action	Impact	Impact
Position	Nose	Base
	(Both components are an integral part of bomb, MK 118 MOD 0)	
	Functioning Delay Hard Target - 0.000 seconds Soft Target - 0.5 to 2 milliseconds	
Arming:		
Type	N/A	Vane rotation (velocity discrimination)
Rev. to enable	N/A	N/A - vane rotation must be 18300 rpm or greater
Air velocity to enable	N/A	225 KIAS min. (see text)
Time to enable	N/A	Range 0.8 to 1.1 seconds
Rev. to arm	N/A	160 to 280 at vane rotation or 18300 rpm or greater
Air velocity to arm	N/A	225 KIAS min (see text)
Time to arm	N/A	Range 0.85 to 1.4 seconds
Physical Characteristics:		
Overall Length (in.)	1.35	1.65
Widest Body Diameter (in.)	0.6	1.6
Intrusion into Weapon (in.)	N/A	None
Total Weight (lbs)	0.9	2.8
Thread Size	N/A	N/A
Explosive Weights:	Detonator, Stab, MK 95 MOD 0 18 mg NOL #130 priming mix 53 mg lead azide 19 mg RDX	Detonator, Stab, MK 95 MOD 0 18 mg NOL #130 priming mix 53 mg lead azide 19 mg RDX Detonator, Electric, MK 96 MOD 5 mg ignition charge 85 mg lead azide 65 mg PETN Lead 135 mg tetryl

Table 3-2. General Characteristics of the Fuze, MK 1

Drawing #	PL 2424987
Type	Mechanical
Firing Action	Impact
Position	Base (The fuze is an integral part of bomb, MK 118 MOD 0)
Function Delay	0.000 second
Arming:	
Type	Vane rotation (velocity discrimination)
Rev. to enable	N/A - vane rotation must be 18300 rpm or greater
Air velocity to enable	225 KIAS min. (see text)
Time to enable	Range 0.8 to 1.1 seconds
Rev. to arm	160 to 280 at vane rotation or 18300 rpm or greater
Air velocity to arm	225 KIAS min (see text)
Time to arm	Range 0.85 to 1.4 seconds
Physical Characteristics:	
Overall Length (in.)	1.65
Widest Body Diameter (in.)	1.6
Intrusion into Weapon (in.)	None
Total Weight (lbs)	2.8
Thread Size	N/A
Explosive Weights:	Detonator, Stab, MK 95 MOD 0 18 mg NOL #130 priming mix 53 mg lead azide 19 mg RDX Explosive relay 85 mg lead azide 65 mg PETN Lead 135 mg tetryl

3.1.3 EXPLOSIVE COMPONENTS. The Fuzing System, Bomb, MK 1 MOD 0 contains two MK 95 MOD 0 stab detonators, a MK 96 MOD 0 electric detonator and a lead. A fuzing system contains a total of approximately 470 milligrams of various explosives.

3.1.3.1 The Fuze, MK 1 MOD 0 contains MK 95 MOD 0 stab detonator, an explosive relay and a lead. A fuze contains a total of approximately 375 milligrams of various explosives.

3.1.3.2 The Bomb, Anti-Tank, MK 118 contains a 5.1 gm booster (tetryl) and a main charge of 181 gms of either octal or COMP B. The total weight of a MK 118 bomb (includes weight of the MK 1 fuzing system or the MK 1 fuze and the fin assembly) is approximately 1.23 pounds.

3.1.4 SAFETY FEATURES. The MK 1 fuzing system and the MK 1 fuze incorporate an air-velocity discrimination feature (a pair of arming-vane-driven centrifugal detents) which permits enabling at aircraft release speeds of 225 KIAS or greater. The fuze velocity discrimination feature prevents fuze arming by merely turning the vane.

3.1.4.1 Once the enabling is completed, the vane rotation is employed to actually drive the rotor (out-of-line feature) into line.

3.1.4.2 The MK 1 fuze system base fuze assembly and the MK 1 fuze have an observation window to provide visual indication of the SAFE or the ARMED condition of the explosive train. Green shows in this window if the fuze is safe; red shows if the fuze has armed.

3.1.5 FUNCTIONAL DESCRIPTION. The description of the arming cycle is identical for the MK 1 fuzing system MOD 0.

3.1.5.1 The arming cycle begins as the MK 118 bomb is released from and separates from the ROCKEYE cluster. The arming of the MK 1 fuzing system and the functioning of the MK 1 fuzing system is as follows (refer to figures 3-2, 3-3 and 3-4):

a. When the MK 118 bombs are released from the dispenser case, the vane of each bomb fuze senses the wind stream. If the weapon velocity is 225 KIAS or greater, two centrifugally operated detents will open, allowing the spring-loaded arming pin to move through the opening between the detents. The other end of the arming pin clears and unlocks the rotor. The rotor can now be driven approximately 40 degrees by a spring driven cam. Rotation of the cam is governed by an escapement. It takes between 0.8 to 1.1 seconds for the rotor to rotate these 40 degrees. This is the enable phase of the arming sequence.

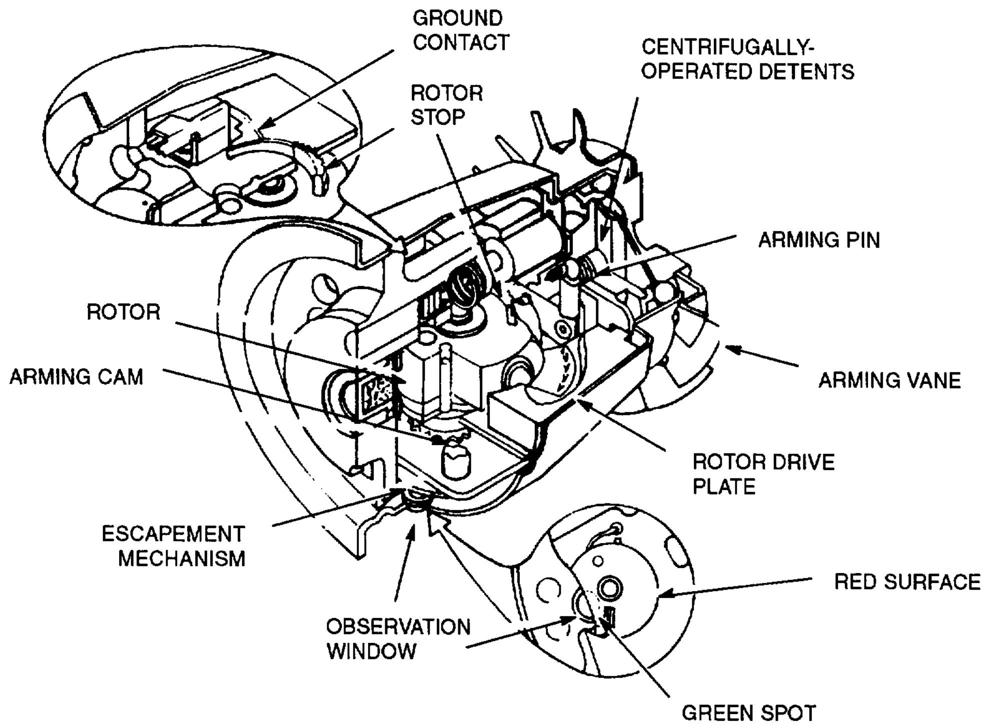
b. At the end of this enable phase, the rotor drive plate is engaged by the vane friction drive, and is rotated by the vane the remaining 50 degrees to this in-line position, thus completing the arming cycle. When the rotor is in-line (1) a lock is removed from the inertia-firing mechanism, (2) a short is removed from the electric detonator, and (3) the circuit between the piezoelectric crystal in the impact sensing element and the electric detonator is completed. At this point, the fuzing system is armed.

c. On contact with a hard target, the shear washer in the sensing element shears. The firing pin in the sensing element is driven into the stab detonator and causes it to fire. The resulting energy does not directly initiate the firing train, but instead, is imparted through a wave-shaper to a piezoelectric crystal in the sensing element. This approach assures a uniform electrical input to the detonator independent of impact conditions (i.e., velocity, angle). The output of the piezoelectric crystal is transmitted by a conductor to the base fuze where the voltage is transferred to the electric detonator via an electrical contact. (Ground return is via the mechanical structure.) The electric detonator is thus ignited and in turn initiates the bomb main explosive charge. When impacting hard target, functioning is super-quick. The time from sensing element contact to lead explosive output is about 20 microseconds.

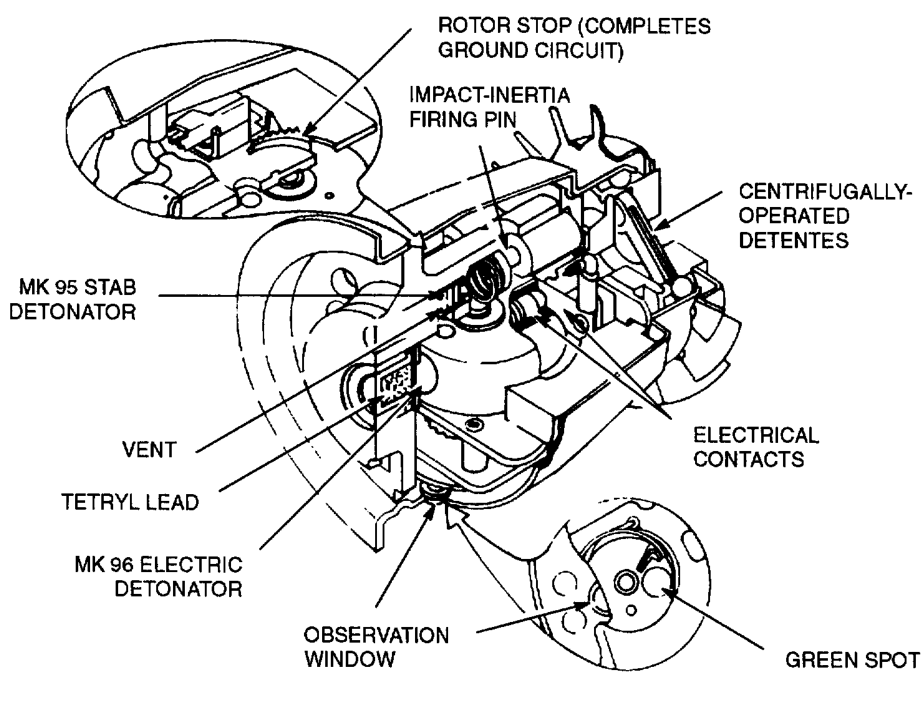
d. On impact with a soft target, the shear washer in the sensing element remains intact and the sensing element does not operate. Impact with the soft target causes rapid bomb deceleration due to the interference caused by the flange or necked-in shape of the MK 118 bomb and the target material. The rapid deceleration causes the inertia firing pin to strike and initiate the stab detonator in the base fuze. A vent in the rotor allows the blast from the stab detonator to fire the electric detonator which ignites the tetryl lead in the firing train. Fuze functioning against soft targets occurs only after some penetration of the target. The time from contact to lead explosive output is in the 500- to 2000-microsecond range.

e. On impact with foliage or light camouflage (defined as being equal to 1/4-inch plywood) the shear washer in the sensing element remains intact. The target material does not offer enough resistance to cause the inertia mechanism to react. Hence, the MK 1 fuzing system will not function on impact with target materials equivalent to 1/4-inch plywood or less.

3.1.5.2 The inertia firing mechanism of the MK 1 fuzing system is a spring mass system (figure 3-5). The firing sequence of the MK 1 fuze is as follows:



BASE FUZE ASSEMBLY-UNARMED



BASE FUZE ASSEMBLY-ARMED

Figure 3-2. MK 1 MOD 0 Bomb Fuzing System, Base Fuze Assembly - Internal Views

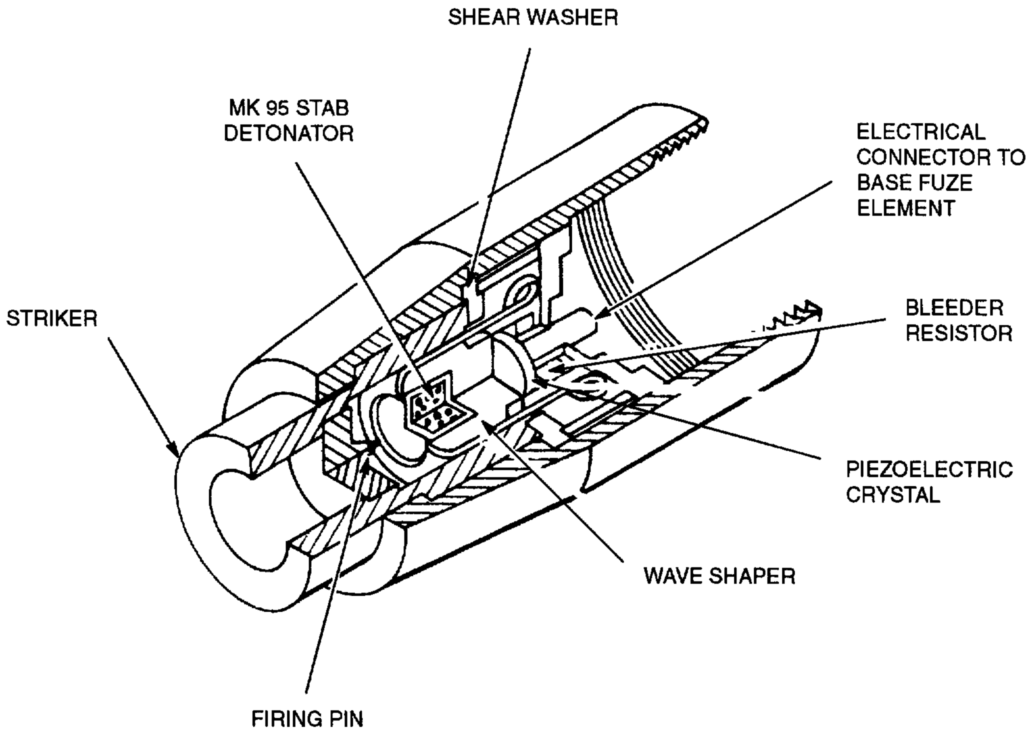


Figure 3-3. MK 1 MOD 0 Bomb Fuzing System, Impact Sensing Element Assembly - Internal Views

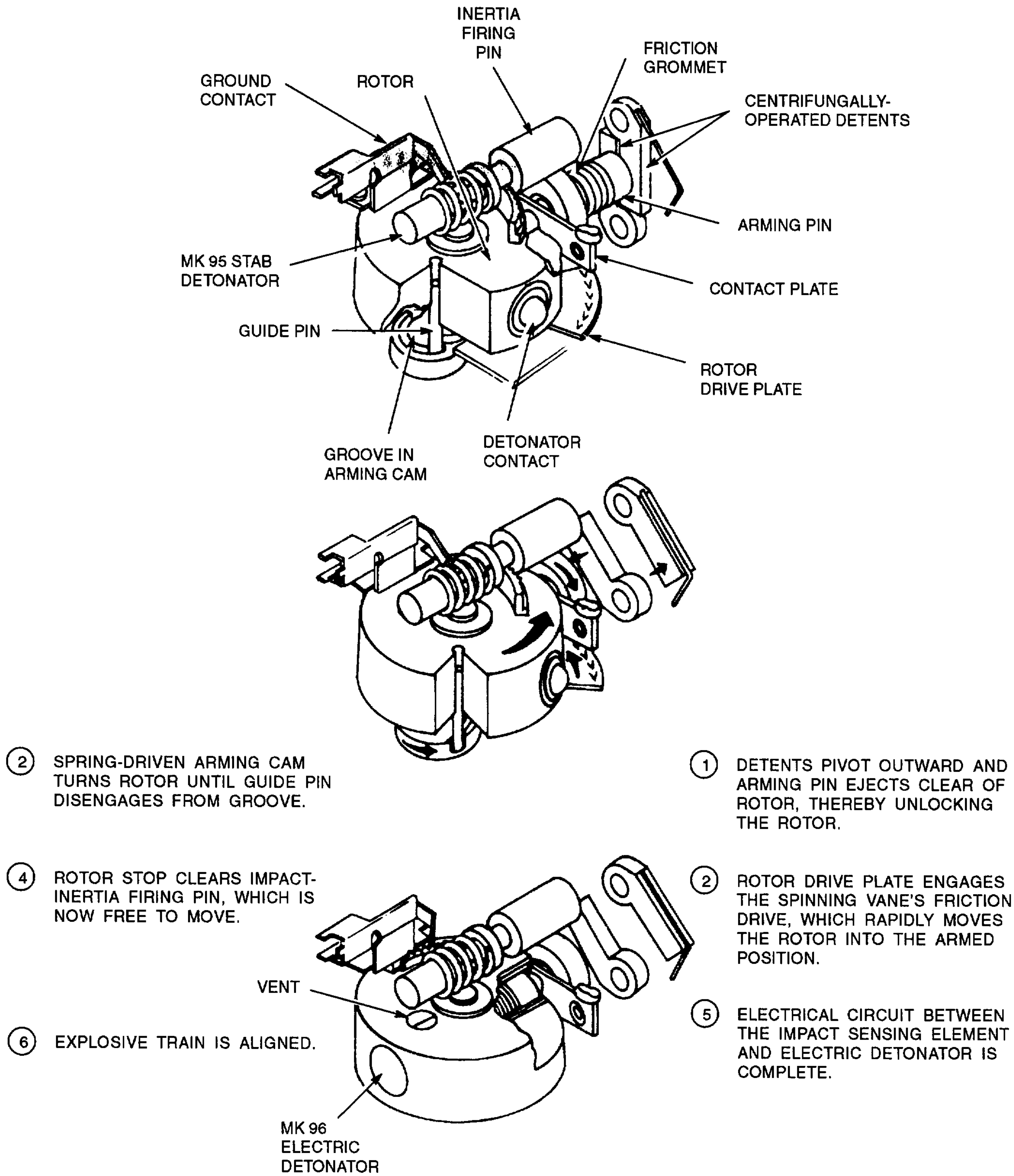


Figure 3-4. MK 1 MOD 0 Bomb Fuzing System - Arming and Functioning

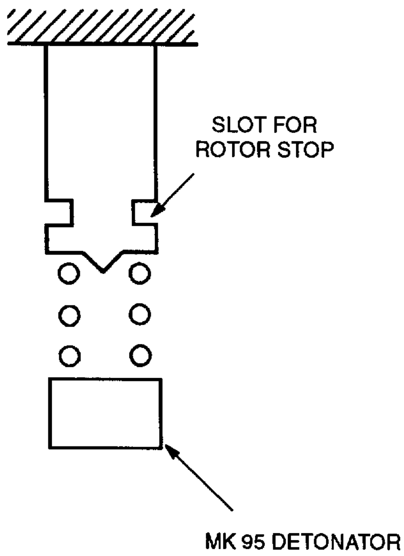


Figure 3-5. Inertia Firing Mechanism - Fuzing System, Bomb, MK 1

a. At arming, a lock is removed from the inertia mass. A light spring moves this mass (firing pin) until it rests on the detonator closing disk.

b. On contact with a hard target, the hardened end of the spike "bites" into the target and the high "g" shock plus the duration of the shock associated with impact on such a target is transmitted to the mass (firing pin). Very little movement of the mass is needed to pierce the detonator. The reaction time is, therefore, very short. The function is super-quick as demonstrated by the depth of penetration into an infinitely thick armor target.

c. Contact of the spike with a soft target does not produce sufficient "g's" to cause the mass (firing pin) to penetrate the detonator. The bomb continues to penetrate the target, and when the necked-in section of the bomb body comes in contact with the target, there are sufficient "g's" and shock duration to cause mass movement and the resulting ignition of the detonator.

d. On contacting a plywood target, the MK 118 bomb penetrates and passes through the target in a very short period of time. This time period is too short for the mass (firing pin) to react (move) and pierce the detonator. Hence, the MK 1 fuze will not function on impact with target materials equivalent to 1/4-inch plywood or less.

3.1.6 INSTALLATION REQUIREMENTS. The Fuzing System, MK 1 MOD 0 is an integral part of Bomb, Anti-Tank, MK 118 MOD 0. MK 118 bombs are assembled into a Dispenser, Bomb, MK 7. The complete unit is issued as Bomb, Cluster, Anti-Tank, ROCKEYE; an all-up round. There are, therefore, no installation procedures.

CHAPTER 4

AIRBORNE ROCKET FUZES

4.1 INTRODUCTION.

4.1.1 The term "rocket" describes a free flight missile which depends on a rocket motor for propulsion and whose flight path is an extension of its launch direction. A guided missile, by contrast, can change its flight path after launch. This section is limited to fuzes for unguided airborne rockets.

4.1.2 Current Navy airborne rocket fuzes have no external pull pins, do not utilize arming wires, and have no provisions for the inflight control or selection of fuzing functions. All current rocket fuzes utilize the setback forces encountered during weapon acceleration to accomplish arming. The mechanism employed to react to these setback forces is mechanical in design so all rocket fuzes are generally type classified as being mechanical.

4.1.3 Rocket fuzes may be further subdivided according to their mode of functioning; the action which initiates the explosive train: impact, time, and proximity. A further subclassification would be a function of the fuze's position in the rocket's warhead: nose or base. The vast majority of airborne rocket fuzes are mounted in the warhead nose. There is only one fuze in the present inventory which is installed in the base of a warhead.

4.1.4 Impact fuzes form the majority of rocket fuzes presently in service. They function when the rocket strikes the target. The firing train is initiated through crushing or distortion of the fuze structure or due to deceleration occurring during impact (inertia).

a. A fuze which functions due to crushing is mounted in the rocket warhead nose and is designated as a point detonating (PD) fuze. At impact with a target, distortion of the fuze structure causes a hammer and firing pin to be driven inward, striking a primer, and initiating the explosive train.

b. A fuze which functions due to the movement of an inertia weight is usually located in the base of the rocket warhead and is designated as a base detonating (BD) fuze. A base detonating fuze is designed to function at some short time after impact with a target to allow warhead penetration of the target.

c. Due to the high velocity of aircraft rockets, the functioning delays provided in rocket impact fuzes are much shorter than those provided in bomb impact fuzes. Some rocket impact fuzes are relatively insensitive and will not detonate on impact with water.

4.1.5 A rocket time fuze operates at a specific preset time after rocket launch and motor burn-out. The time is determined by a clock. This type of fuze is utilized in special types of warheads such as the MK 33 MOD 1 flare warhead or the MK 84 MOD 4 chaff warhead.

4.1.6 Proximity fuzes sense the nearness or the proximity of a target and function at some designed distance from that target. The sensitivity of rocket proximity fuzes has been held at a fairly low level to preclude mutual interference between fuzes when rockets are ripple-fired. The sensitivity is, therefore, too low to be effective against other aircraft, and rocket proximity fuzes are thus restricted to an air-to-ground role.

4.2 SAFETY.

4.2.1 Fuzes are designed to be safe while unarmed and as reliable as possible when armed. These requirements are not necessarily exclusive. Improving safety can decrease reliability.

4.2.2 Safety during handling, shipping, aircraft loading, after rocket launch, and if impact occurs before arming, is absolutely necessary if catastrophic accidents are to be avoided. This type of safety is provided in all rocket fuzes, and meeting this goal has led to complexity in fuze design. In addition to providing safety, a fuze is required to withstand extremes of environmental conditions and rough handling without degradation of the fuze's normal operating characteristics.

4.2.3 The first explosive in an explosive train (the fuze primer or detonator) is the most sensitive. The last (the fuze booster and the warhead explosive) is the least sensitive. All rocket fuzes employ a barrier or out-of-line feature to separate or isolate the two types of explosives. A fuze is defined as being armed when the barrier is removed or when the out-of-line feature is placed in-line. Arming of a rocket fuze cannot take place until the fuze has sensed the normal acceleration experienced in a clean rocket launch. Rocket fuzes provide a safe separation distance between the launching aircraft and the warhead by delaying the arming of the fuzes for a specific distance or length of time for a given minimum acceleration level after launch. Distance is determined by an acceleration time integration mechanism in the fuze. Time is determined by motor burn-out and/or a clock mechanism. These then are the two approaches used in rocket fuzes to control and determine when arming should occur.

4.2.4 ACCELERATION-TIME INTEGRATION.

a. The safety-arming mechanism utilized in current rocket fuze designs is a two mass system. The first mass (setback weight) works against a spring, thus establishing an acceleration threshold. This mass in its normal position locks the second mass in its normal safe or out-of-line position, thus preventing the second mass from creeping to the armed position during rough handling or multiple drops.

b. The second mass (in the form of an eccentric weight or unbalanced rotor) works against a clockwork escapement. The escapement regulates the motion of the second mass while it moves to the armed position so that the acceleration-time product is a constant; i.e., the mechanism provides a constant arming distance regardless of variations in the rocket thrust. A nominal of 40 "g's" of acceleration for about 1 second are required to arm a fuze. Variations in the arming distance that do occur are due to manufacturing tolerances and temperature effects on the mechanism. The arming cycle continues as long as the minimum acceleration level is maintained. During this time the first mass is held in the "setback" position. If the rocket acceleration period is very short (below a design minimum) the loss of acceleration allows the first mass to return to its normal position (due to the springs). In returning, the first mass will drive the second mass back to its normal safe position, assuring an unarmed fuze for this abnormal launch condition.

c. When the rotor reaches the armed position it is locked in this position by a detent.

4.2.5 MOTOR BURNOUT.

a. This safety-arming mechanism incorporates all the mechanisms of the acceleration-time integration mechanism, except the second mass is in the form of an eccentric weighted mass and the rotor is spring driven and located so that the first mass in the "setback" position can lock the rotor in the safe position.

b. The acceleration-time integration part of the mechanism removes a lock on the rotor at a given distance from the launch point. At this point, the safety-arming mechanism is committed to arming. Since the rocket motor is still burning, the first mass is still in the "setback" position, so the rotor is still locked in the safe position. At motor burn-out, acceleration ceases and the first mass returns to its normal position, the lock is removed from the rotor and the rotor snaps into the in-line position.

**4.3 FUZE, PROXIMITY, M414A1 (MK 93)
FUZE, PROXIMITY, MK 93 MOD 0.**

4.3.1 GENERAL DESCRIPTION. The Fuze, Proximity, M414A1 (MK 93) or the Fuze, Proximity, MK 93 MOD 0 (figures 4-1 and 4-2) were designed to be employed in the 5-inch (ZUNI) rocket system operating against ground targets at low target approach angles (measured from the horizontal). This fuze coupled with an antipersonnel warhead is highly effective for air-to-ground operations, especially for flak suppression and antipersonnel missions. The fuzes feature two modes of operation: airburst (primary mode) and impact (secondary mode), a backup in the event of proximity failure. General characteristics of the M414A1 (MK 93) and MK 93 MOD 0 fuzes are listed in table 4-1.

4.3.1.1 The M414A1 (MK 93) and the MK 93 MOD 0 proximity fuzes are nose mounted and are functionally identical. The only difference between the two models of this proximity fuze is the burst height range. The MK 93 MOD 0 provides a higher burst height which meets the requirements of the Warhead, 5-Inch Rocket, Fragmentation, MK 63 MOD 0.

4.3.2 OPERATIONAL CHARACTERISTICS. The M414A1 (MK 93) and the MK 93 MOD 0 proximity fuzes employ a transverse loop antenna. Points of equal signal strength form a geometric shape or pattern that has lobes which are at right angles to the rocket axis (figure 4-3). This pattern configuration is effective at shallow ground approach angles. At approach angles between 20 degrees and 40 degrees (measured from the horizontal) the burst height for the M414A1 (MK 93) will be between 15 feet and 40 feet; for the MK 93 MOD 0 the burst height will be between 35 feet and 60 feet. These burst height ranges are for average ground. Wet ground (or water) will raise the burst heights and extremely dry ground will lower the burst heights. The fuze will sense trees and will function above the tree tops; the height of functioning depends on growth density and its water content.

4.3.2.1 Neither the M414A1 (MK 93) or the MK 93 MOD 0 proximity fuze is suitable for an air-to-air combat role because both the fuzes lack the sensitivity required for this application. Rockets equipped with either fuze can be ripple-fired for the fuze is not sensitive to mutual interference.

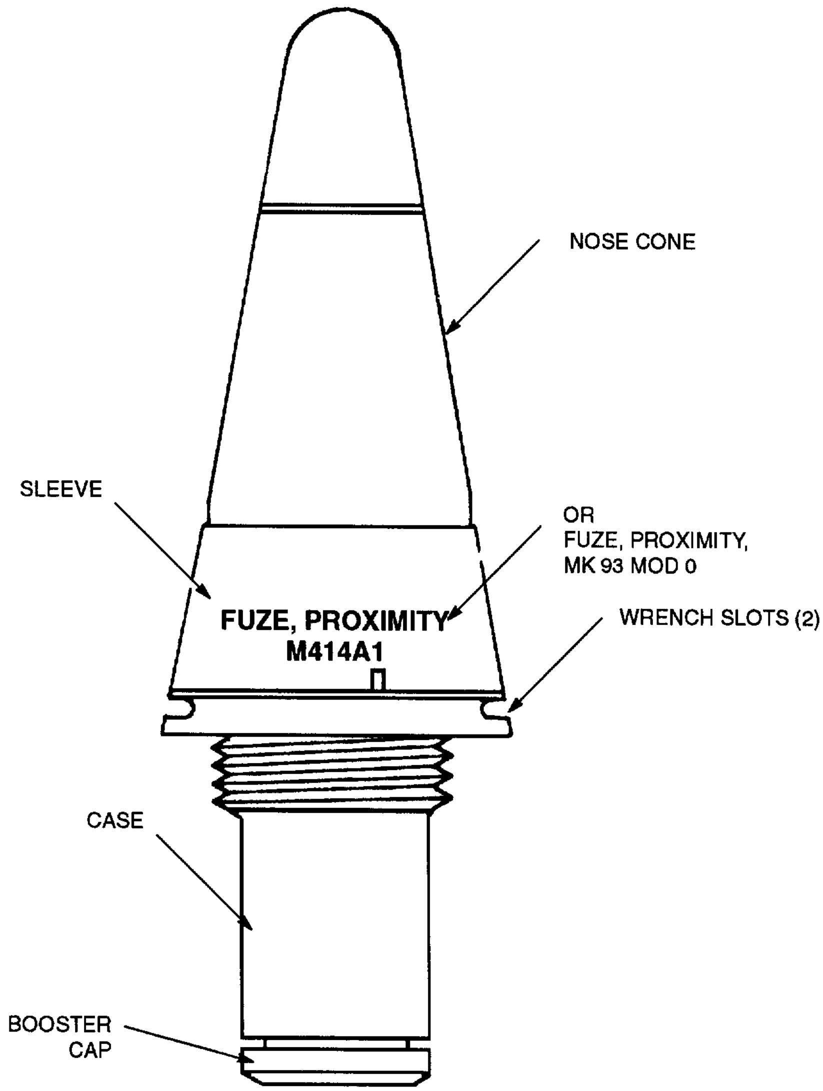


Figure 4-1. Fuze, Proximity, M414A1 (MK 93) or Fuze, Proximity, MK 93 MOD 0 - External View

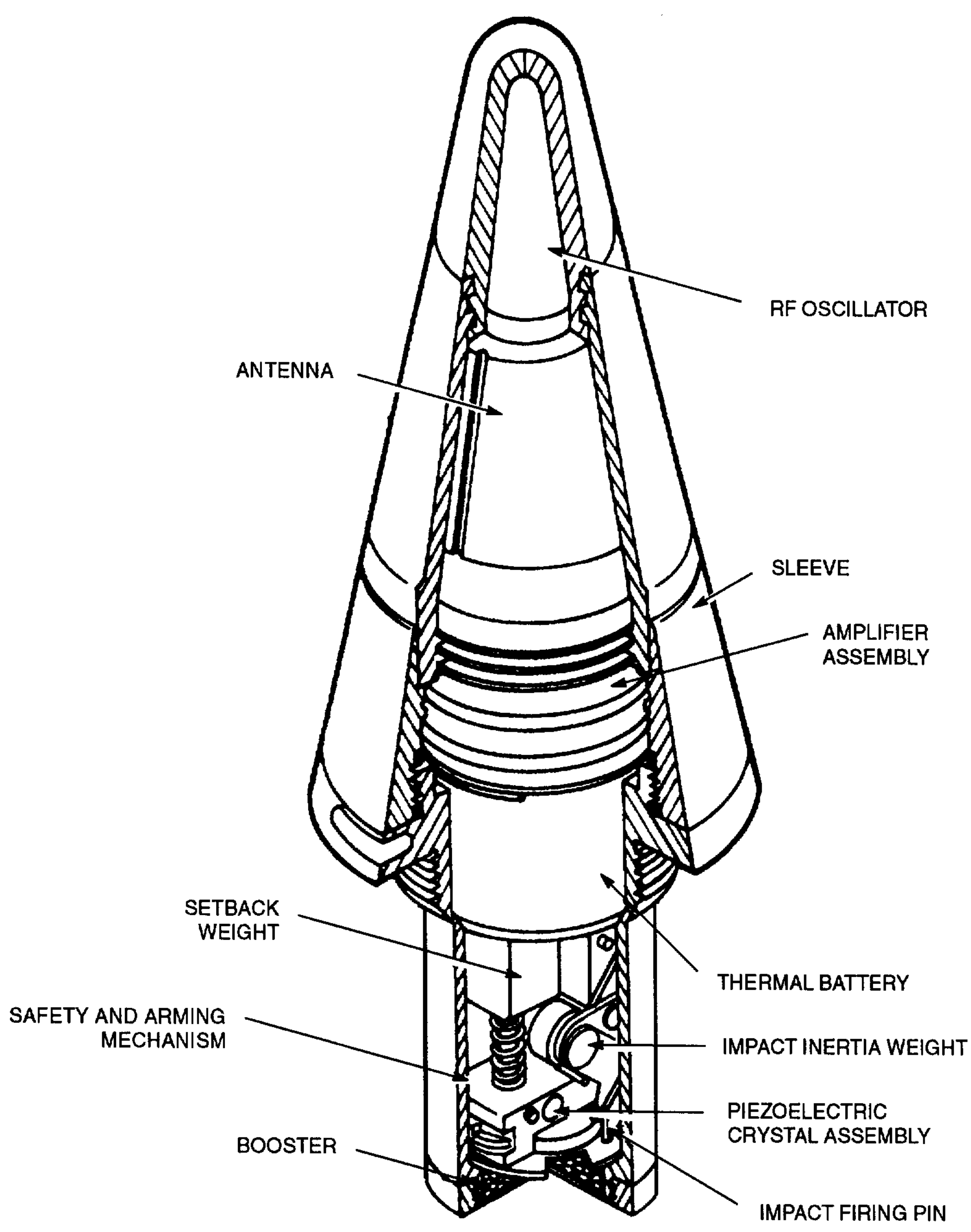


Figure 4-2. M414A1 (MK 93) and MK 93 MOD 0 Proximity Fuzes - Internal View

Table 4-1. General Characteristics of the M414A1 (MK 93) and MK 93 MOD 0 Fuzes

Model	M414A1 (MK 93)	MK 93 MOD 0
Drawing #	EPL 754420	LD 550008
Type	Proximity	
Position	Nose	
Burst Height	15 to 40 feet (approach angle-20 to 40 degrees)	35 to 60 feet (approach angle 20 to 40 degrees)
Arming:		
Type	Motor burn out	
Acceleration to arm	30 g min	
Air travel to commit	400 to 600 feet	
Time to commit	0.65 to 0.80 second at 60 g	
Air travel to arm	Approximately 1000 feet	
Time to arm	Approximately 1 second	
Physical Characteristics:		
Overall Length (in.)	9.18	
Widest Body Diameter (in.)	1.61	
Intrusion into Weapon (in.)	2.98	
Total Weight (lbs)	2.6	
Thread Size	2-12UN-2A	
Explosive Weights:		
	Primer, Stab, MK 157 MOD 0 16 mg primer mix (2505135)	
	Primer, Stab, MK 102 MOD 1 63 mg NOL #103 priming mix	
	Detonator, Electric, M62 2 mg lead styphnate 90 mg lead azide 80 mg PETN	
	Lead 150 mg tetyl	
	Booster 11.1 gms CH6	

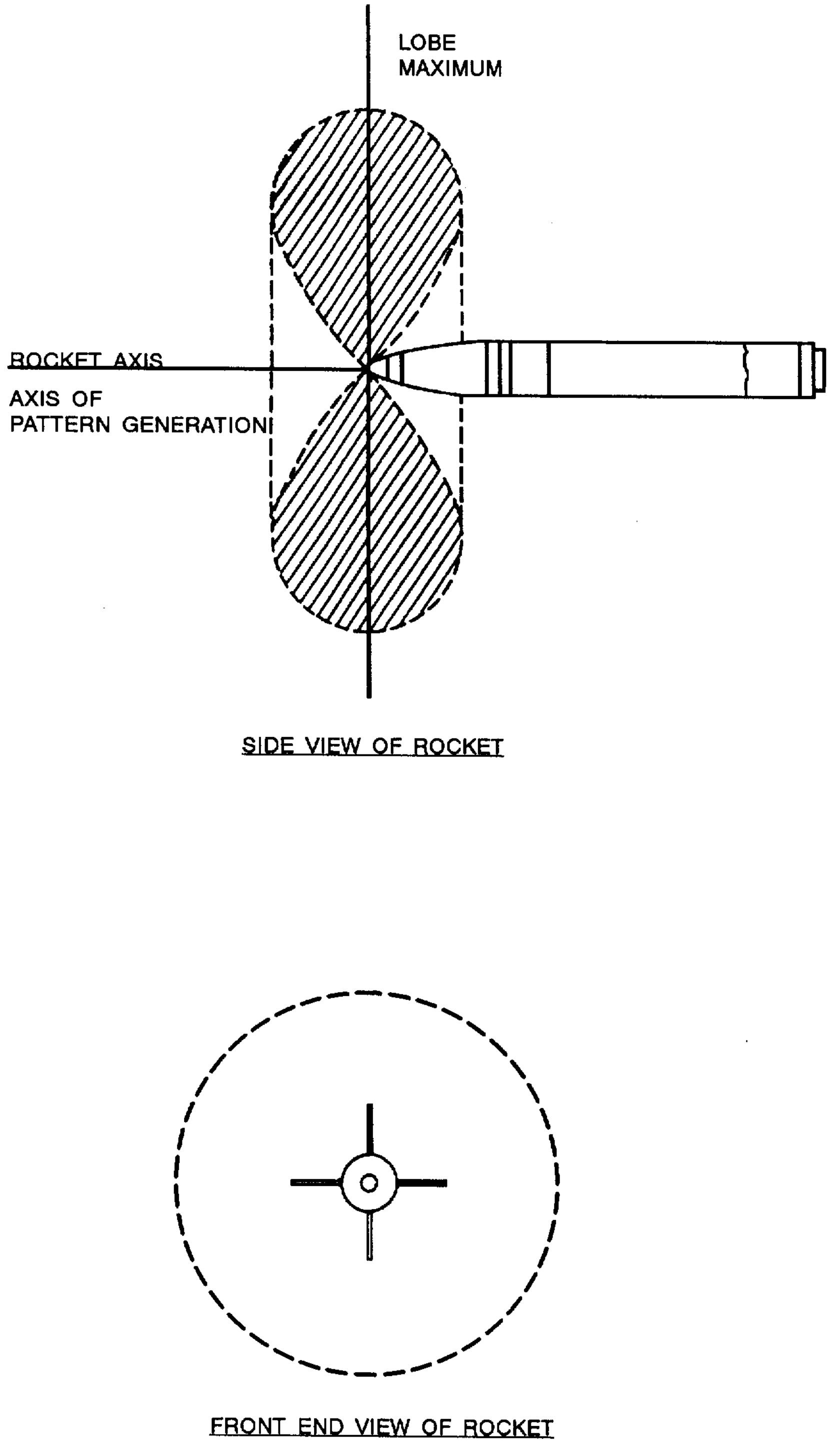


Figure 4-3. M414A1 (MK 93) and MK 93 MOD 0 Proximity Fuzes - Antenna Pattern

4.3.3 EXPLOSIVE COMPONENTS. The M414A1 (MK 93) and the MK 93 MOD 0 proximity fuzes contain a Primer Stab, MK 102 MOD 1, a Detonator, Electric, MK 62 MOD 0, a Primer Stab, MK 157 MOD 0, a lead, and a booster. In addition the fuzes contain a thermal battery. The battery consists of a percussion primer (M42G) and heat powder (which liquifies the battery's solid electrolyte). These battery located items do not represent a handling hazard, since none are present in sufficient quantity or have the explosive strength to rupture the thermal battery can, much less the fuze outer can. A fuze contains a total of approximately 11.5 grains of various explosives.

4.3.4 SAFETY FEATURES. The M414A1 (MK 93) and the MK 93 MOD 0 proximity fuzes are committed to arming on the acceleration-time integration principle. A fuze must experience a sustained acceleration of at least 30 "g" in order to arm. The "no arm" acceleration level is 13 "g".

4.3.4.1 If the acceleration decays to less than 13 "g" before the commit point is reached, the mechanism will reset to its original position.

4.3.4.2 If the second mass (the mass which works against the clockwork escapement) moves too fast (due to a failure in the clockwork gear train), the mass is locked by an interlock latch. The safety-arming mechanism now cannot arm or automatically reset.

4.3.4.3 The safety arming mechanism contains a mal-assembly feature which prevents the assembly into a fuze body of a safety arming mechanism with an armed rotor.

4.3.5 FUNCTIONAL DESCRIPTION. The M414A1 (MK 93) and the MK 93 MOD 0 proximity fuzes are acceleration-time integration committed to arm and arm at motor burnout (i.e., acceleration decays to below 13 "g"). The description of the operation of such a system is covered in 4.2.5.

a. As the rocket accelerates and the second mass moves against the clockwork escapement, the first event occurs; a firing pin is released which initiates the thermal battery. This battery provides electrical power for operation of the electronic circuitry. This first step in the arming sequence occurs approximately 0.2 to 0.5 second after rocket launch. As soon as the battery is up to its operating voltages, the electronics is active.

b. If the acceleration is sustained for at least 400 feet, the safety arming mechanism removes a lock from the rotor, thus committing the fuze to arming. Arming occurs at rocket burnout. At this time, the rotor snaps into the in-line position, connecting the detonator to the electronic circuitry and enabling the impact sensor mechanism.

c. The oscillator produces a radio frequency signal which is radiated in a global pattern. As the rocket approaches the ground, the interaction between the emitted and reflected RF energy causes a doppler signal to appear at the detector. This doppler signal is amplified and when it reaches a predetermined level, the electronics circuitry provides electrical energy to initiate the M62 detonator.

d. If the proximity section fails to function, upon impact with the target an inertia mass moves, freeing a spring driven firing pin. This pin strikes the MK 102 stab detonator which stresses a pair of piezoelectric crystals. The electric energy generated by stressing these crystals initiates the M62 detonator. Battery power is not required for the impact mode operation.

4.3.6 INSTALLATION REQUIREMENTS. This fuze requires no special installation or assembly procedures. The fuze should not be unpacked until it is to be used. Any fuze with the seal of the individual fuze packing box broken should not be used.

4.4 FUZE, MK 188 MOD 0.

4.4.1 GENERAL DESCRIPTION. The Fuze, MK 188 MOD 0 (figures 4-4 and 4-5) was designed to be employed in the 5-inch (ZUNI) rocket system. The fuze is nose mounted and point detonating in operation. General characteristics of the MK 188 fuze are listed in table 4-2.

4.4.2 OPERATIONAL CHARACTERISTICS. The MK 188 fuze nose and striker assembly design assures that the fuze is capable of functioning at low angles of impact. The nose design also permits the fuze to function on impact with water targets.

4.4.3 EXPLOSIVE COMPONENTS. The MK 188 fuze contains a Primer, Stab, MK 125 MOD 1, a Detonator, Flash, MK 59 MOD 0, a lead, and a booster. A fuze contains a total of approximately 27.4 grams of various explosives.

4.4.4 SAFETY FEATURES. The MK 188 fuze arming is the result of acceleration-time integration. A fuze must experience a sustained acceleration of at least 20 "g" in order to arm. The "no arm" acceleration level is 13 "g".

4.4.5 FUNCTIONAL DESCRIPTION. The MK 188 fuze arming mechanism functions on the basis of acceleration-time integration. The description of the operation of such a system is covered in 4.2.4.

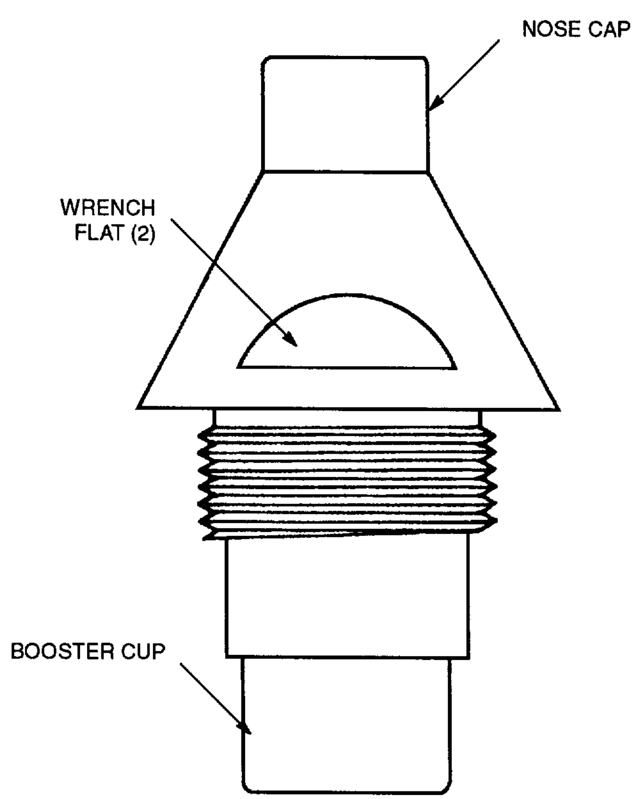


Figure 4-4. Fuze, MK 188 MOD 0 - External View

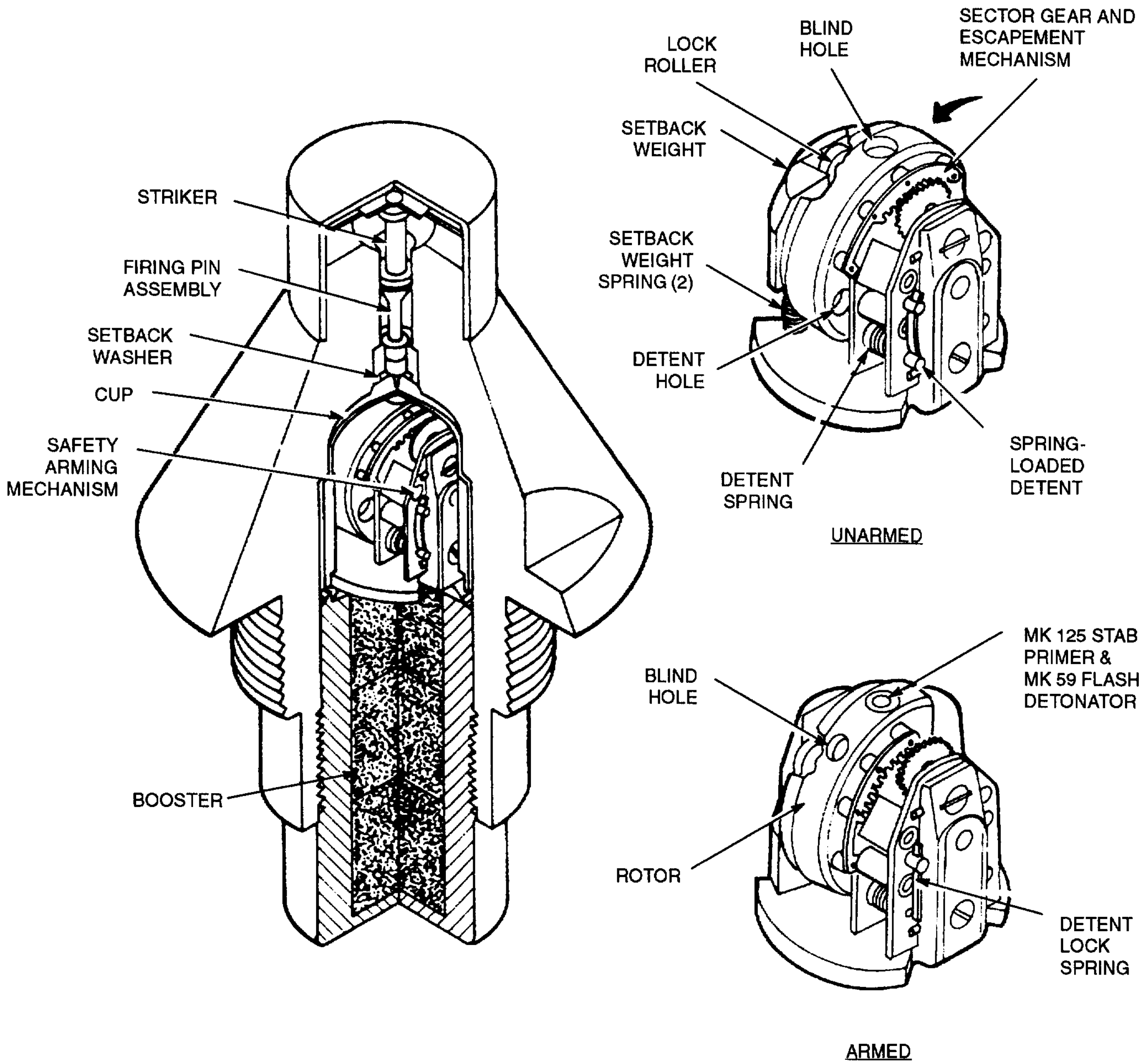


Figure 4-5. MK 188 MOD 0 Fuze - Internal Views

Table 4-2. General Characteristics of the MK 188 Fuze

Drawing #	LD 175380
Type	Impact
Position	Nose
Function Delay	0.00 second
Arming:	
Type	Acceleration-time integration
Acceleration to arm	20 g min
Air travel to arm	400 to 800 feet
Time to arm	0.080 to 1.00 sec @ 50 g
Physical Characteristics:	
Overall Length (in.)	5.114
Widest Body Diameter (in.)	2.98
Intrusion into Weapon (in.)	2.71
Total Weight (lbs)	.75
Thread Size	2-12UN-2A or 2-12UNS-1A
Explosive Weights:	
	Lead, 82 mg tetryl
	Primer, Stab, MK 125 MOD 1 47 mg NOL #130 priming mix 55 mg lead azide
	Detonator, Flash, MK 59 MOD 0 116 mg lead azide 60 mg tetryl
	Booster 21 gms tetryl

4.4.6 INSTALLATION REQUIREMENTS. This fuze requires no special installation or assembly procedures.

4.5 FUZE, ROCKET, MK 191 MOD 1.

4.5.1 GENERAL DESCRIPTIONS. The Fuze, Rocket, MK 191 MOD 1 (figures 4-6 and 4-7) was designed to be employed in the 5-inch (ZUNI) rocket system when that weapon system utilizes the Warhead, 5-Inch Rocket, MK 24 MOD 0. The MK 24 MOD 0 warhead is issued with the MK 191 fuze permanently installed. The fuze is base mounted and is base-detonating in operation. The fuze functions with a short delay after impact. This is the only rocket base fuze in the Navy inventory. General characteristics of the MK 191 fuze are listed in table 4-3.

4.5.2 OPERATIONAL CHARACTERISTICS. The 191 fuze was designed to allow warhead penetration of a hard target. When it is planned to employ the rocket against

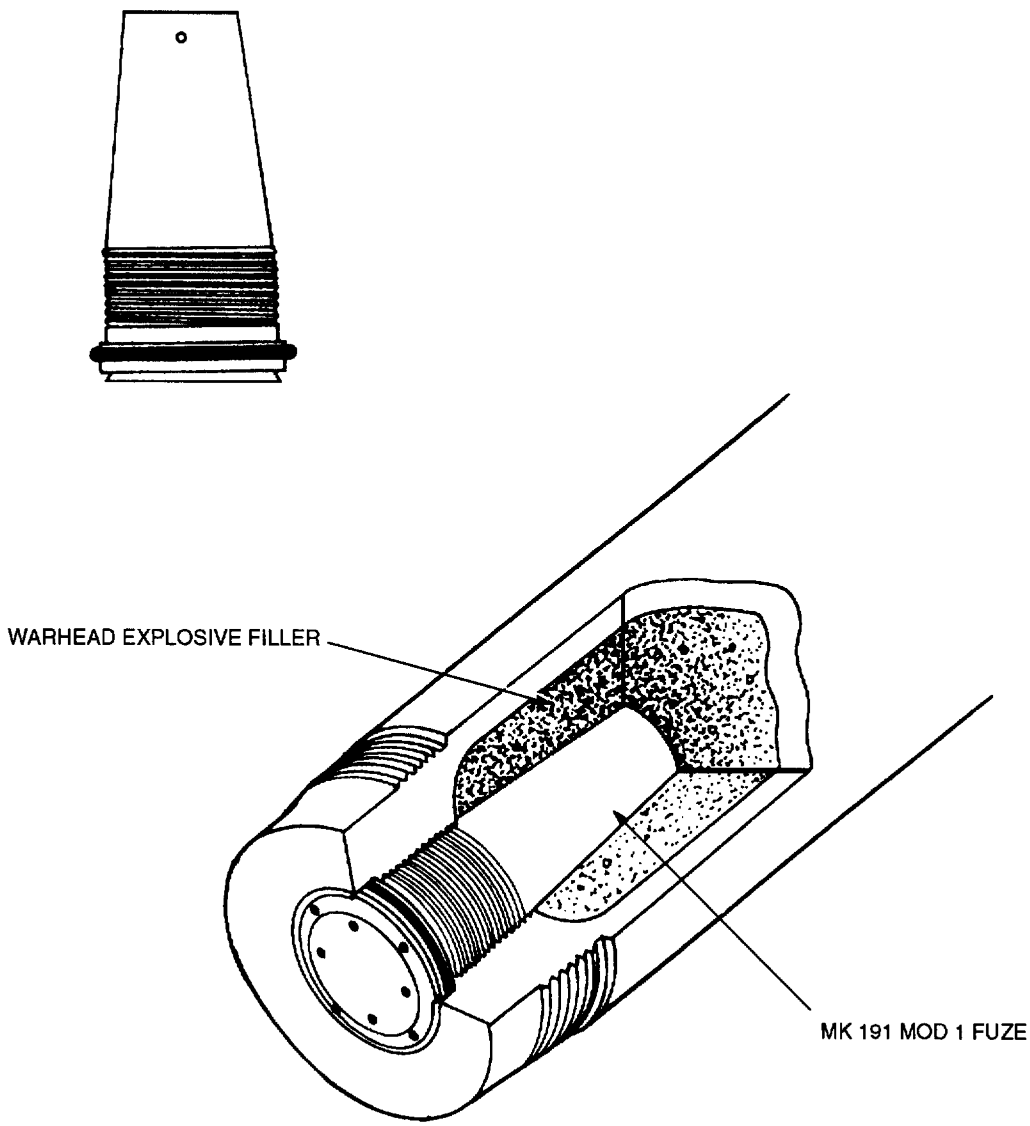


Figure 4-6. Fuze, Rocket, MK 191 MOD 1 - External View and Warhead Mounting

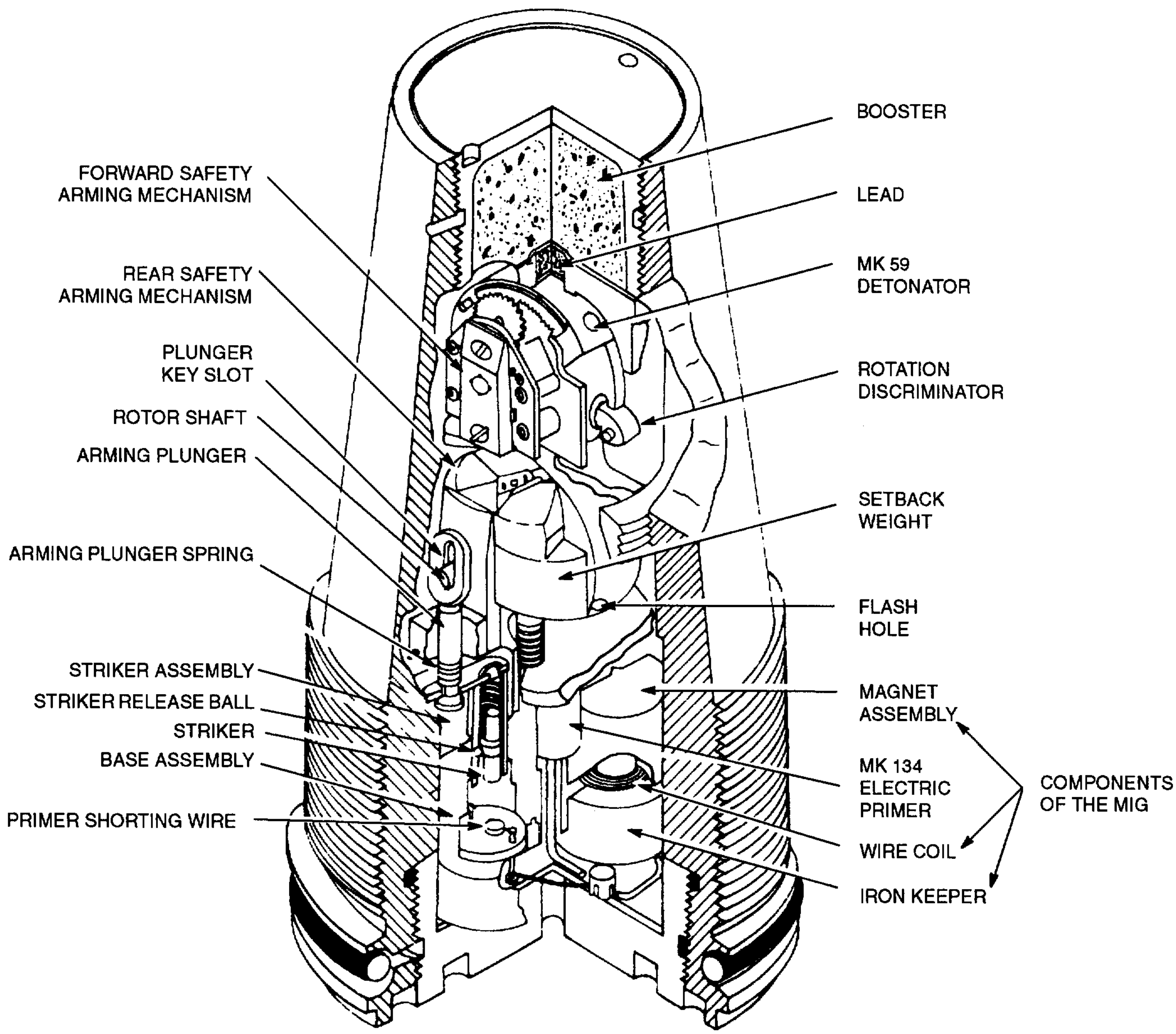


Figure 4-7. MK 191 MOD 1 - Internal View

Table 4-3. General Characteristics of the MK 191 Fuze

Drawing #	LD 497047
Type	Impact
Position	Base (Permanently installed in the MK 24 MOD 0 warhead)
Function Delay	2 to 7 milliseconds
Arming:	
Type	Acceleration-time integration
Acceleration	30 g min
Air travel to arm	400 to 800 feet
Time to arm	0.080 to 1.0 sec at 50 g
Physical Characteristics:	
Overall Length (in.)	5.26
Widest Body Diameter (in.)	2.48
Intrusion into Weapon (in.)	5.26
Total Weight (lbs)	3.1
Thread Size	2 3/8-12UN-2A
Explosive Weights:	
	Primer, Electric, MK 134 MOD 0 14 mg normal lead styphnate 13 mg base lead styphnate 83 mg lead azide 15 mg dry plaster parts
	Detonator, Flash, MK 59 MOD 0 116 mg lead azide 60 mg tetryl
	Lead, 125 mg tetryl
	Booster 19 gms tetryl

this type of target, the nose fuze must be removed and replaced with a hardened steel nose plug. The MK 191 fuze will not function reliably on impact with a water target.

4.5.2.1 The Primer, Electric MK 134 MOD 0 has a designed delay function interval between 2 to 7 milli-seconds. The actual function delay time in use, however, may be slightly longer due to the reaction time of the inertia firing device.

4.5.2.2 The inertia firing device utilized is a magnetic induction generator (MIG). The MIG consists of a keeper, a coil, and a magnet assembly. The keeper and magnet assembly are cylindrical and have an E cross section. The coil is located in the keeper, in the space between the three legs of the E. Normally the magnet assembly is mated to the keeper, therefore, all lines of magnetic flux are contained within the keeper. At impact, the magnet assembly moves away from the keeper. Due to the air gap, flux lines appear outside the keeper cutting the conductors in the coil. This generates an EMF which initiates the electric primer.

4.5.3 EXPLOSIVE COMPONENTS. The MK 191 fuze contains a Primer, Electric MK 134 MOD 0, a Detonator, Flash, MK 59 MOD 0, a lead, and a booster. A fuze contains a total of approximately 19.4 grams of various explosives.

4.5.4 SAFETY FEATURES. The MK 191 fuze arming is the result of acceleration-time integration. A fuze must experience a sustained acceleration of at least 30 "g" in order to arm. The "non-arm" acceleration level is 13 "g".

4.5.4.1 During an arrested landing, a rocket can leave the launcher tube or the rocket pod could be accidentally released while the aircraft was taking off. 'Me warhead/rocket motor joint is structurally the weakest point and during situations such as above could at subsequent impacts separate at this joint. A tumbling warhead would generate a centrifugal force that, to a base mounted acceleration-sensitive fuze, would appear to be the result of acceleration and, therefore, if the tumbling were of sufficient duration, result in fuze arming. A mechanism has been incorporated that, if the warhead is tumbling, moves in the opposite direction to the setback weights, locking the acceleration sensitive mechanism. During normal acceleration, both the rotational discrimination mechanism and the setback weights move in the same direction, so the lock is not in operation.

4.5.4.2 The primer is always connected to the MIG. In order to prevent primer initiation during rough handling, a shunt or shorting wire is connected across both. Any electrical energy generated prior to arming is dissipated in this shunt. The shunt is broken during the arming cycle.

4.5.5 FUNCTIONAL DESCRIPTION. The MK 191 fuze arming mechanism functions on the accelerationtime integration principle. The description of the operation of such a system is covered in 4.2.4.

4.5.5.1 The MK 191 fuze contains two such mechanisms.

a. The forward arming mechanism serves as the out-of-line feature. It contains a detonator which lines up with the lead under sustained acceleration. The aft arming device, similar to the forward arming device, has an out-of-line channel but without explosives. The aft arming mechanism severes the primer shorting wire or shunt.

b. As the aft mechanism operates, its rotor shaft rotates to a point where it releases the arming plunger. A spring moves the arming plunger, releasing the striker release ball mechanism. The freed striker moves, severing the shorting wire.

c. At impact the MIG generates sufficient energy to ignite the electric primer. The flash from the primer is transmitted to the detonator, lead, and booster.

4.5.6 INSTALLATION REQUIREMENTS. The MK 191 fuze is permanently installed in the Warhead, 5-Inch Rocket, MK 24 MOD 0.

4.6 FUZE, ROCKET, MK 193 MOD 0.

4.6.1 GENERAL DESCRIPTION. The Fuze, Rocket, MK 193 MOD 0 (figures 4-8 and 4-9) was designed to be employed in the 5-inch (ZUNI) rocket system when that weapon system utilizes the Warhead, 5-Inch Rocket, Illuminating, MK 33 MOD 1. (The MK 33 MOD 1 warhead is issued with the MK 193 fuze permanently installed.) The fuze provides a fixed time interval. At the end of this interval, the illuminating compound (candle) is ignited and the candle and the attached parachute are expelled from the warhead case. General characteristics of the MK 193 fuze are listed in table 4-4.

4.6.2 OPERATIONAL CHARACTERISTICS. The MK 193 fuze clockwork time is factory set and cannot be changed or set in the field. The timer is set to function at between 12.5 and 13.5 seconds after clock starting. Since the timer is started at motor burnout, the weapon operating time is the timer time plus the motor bum time or approximately 13 to 17 seconds after launch.

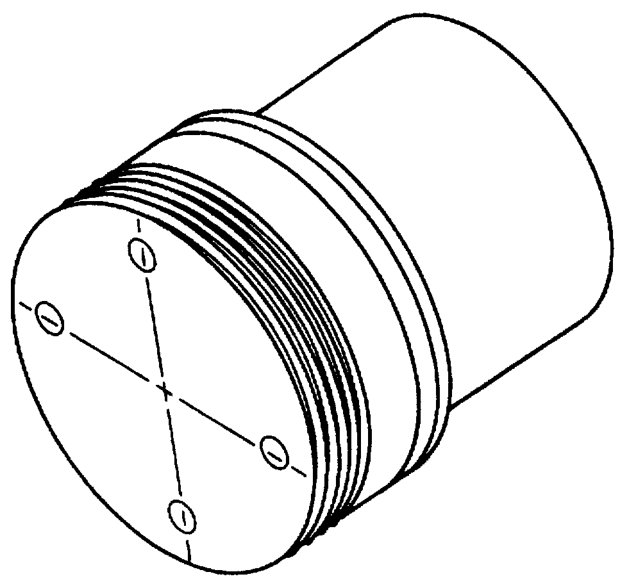


Figure 4-8. Fuze, Rocket MK 193 MOD 0 - External View

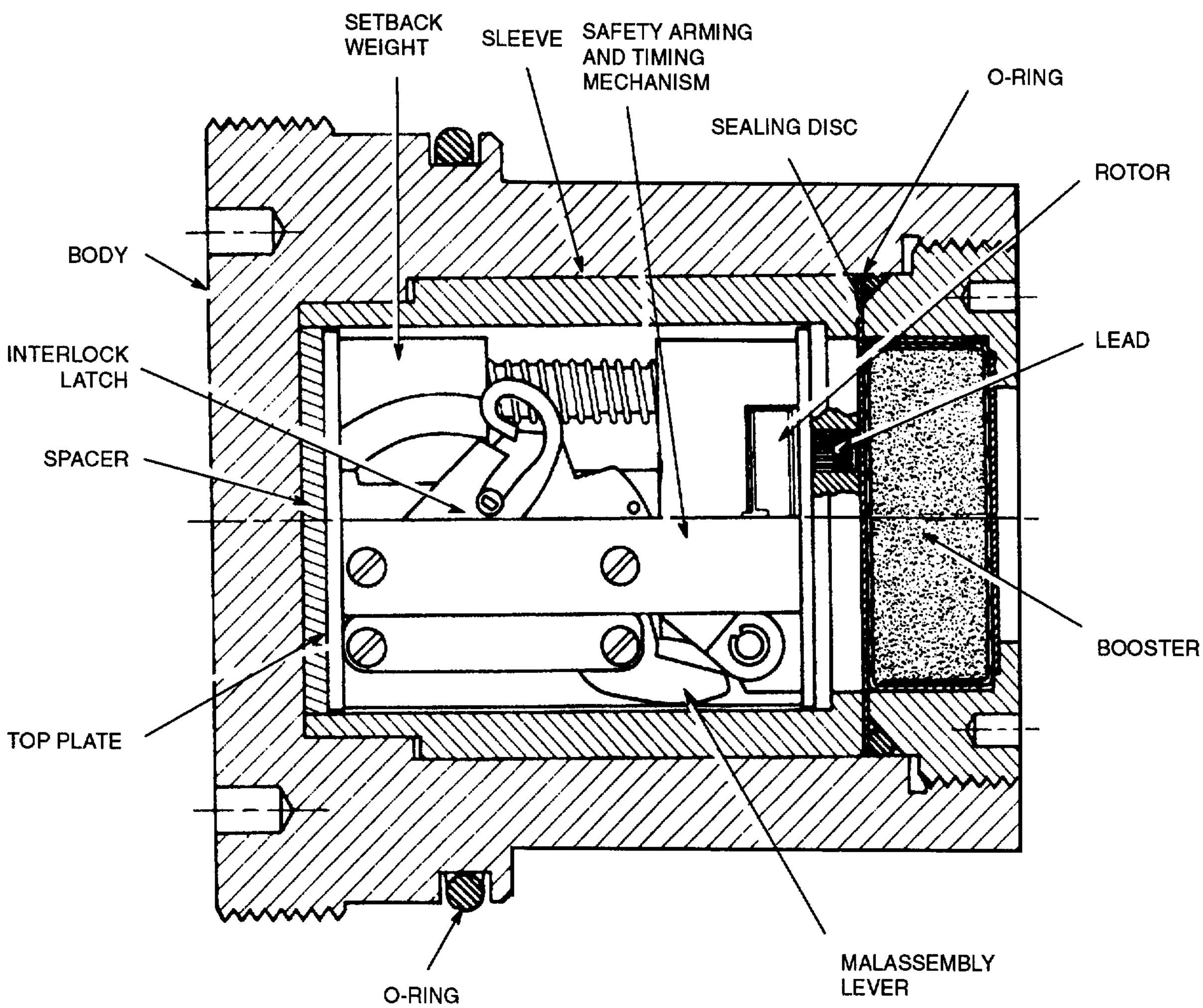


Figure 4-9. MK 193 MOD 0 Fuze - Internal View

Table 4-4. General Characteristics of the MK 193 Fuze

Drawing #	LD 486298
Type	Mechanical Time
Position	Nose (Permanently installed in the MK 33 MOD 1 warhead)
Function Delay	Approximately 13 to 17 seconds after launch
Arming:	
Type	Motor burnout
Acceleration to arm	30 g min
Air travel to commit	400 to 500 feet
Time to commit	0.65 to 0.85 second at 60 g
Air travel to arm	Approximately 1000 feet
Time to arm	Approximately 1 second
Physical Characteristics:	
Overall Length (in.)	3.16
Widest Body Diameter (in.)	3.125
Intrusion into Weapon (in.)	3.16
Total Weight (lbs)	2.0
Thread Size	3 1/8-12UN-2A
Explosive Weights:	
	Primer, Stab, MK 125 MOD 0 47 NOL #130 priming mix 55 mg lead azide
	Detonator, Flash, MK 66 MOD 0 120 mg lead azide
	Lead, 82 mg tetryl
	Booster 10 gms black powder

4.6.3 EXPLOSIVE COMPONENTS. The MK 193 fuze contains a Primer, Stab, MK 125 MOD 1, a Detonator, Flash, MK 66 MOD 0, a lead, and a booster. A fuze contains a total of approximately 10.3 grams of various explosives.

4.6.4 SAFETY FEATURES. The MK 193 fuze is committed to arming as the result of acceleration-time integration. A fuze must experience a sustained acceleration of at least 30 "g" in order to arm. The "no arm" acceleration level is 13 "g".

4.6.4.1 If the acceleration decays to less than 13 "g" before the interlock latch is released, the mechanism will reset to its original position.

4.6.4.2 If the second mass (the mass which works against the clockwork escapement) moves too fast (due to a failure in the clockwork gear train) the mass is locked by the interlock latch. The safety arming mechanism now cannot arm or automatically reset.

4.6.4.3 The safety arming mechanism contains a malassembly feature which prevents the assembly into a fuze body of a safety arming mechanism with an armed rotor.

4.6.5 FUNCTIONAL DESCRIPTION. The MK 193 fuze is acceleration-time integration committed and the clockwork timer is started at motor burnout (i.e., acceleration decays to below 13 "g"). The description of the operation of such a system is covered in 4.2.5.

a. If the acceleration is sustained for at least 400 feet, the safety arming mechanism removes a lock from the rotor, thus committing the fuze to arming. Arming and timer start occur at rocket burnout.

b. After the set time interval has elapsed, the fuze explosive charge output ignites the candle and expels the candle and its attached parachute from the warhead case.

4.6.6 INSTALLATION REQUIREMENTS. The MK 193 fuze is permanently installed in the Warhead, 5-Inch Rocket, Illuminating, MK 33 MOD 1.

4.7 FUZE, POINT DETONATING, MK 352 MOD 2.

4.7.1 GENERAL DESCRIPTION. The Fuze, Point Detonating, MK 352 MOD 2 (figures 4-10 and 4-11) was designed to be employed in the 2.75-inch rocket system. With an Adapter Booster, BBU-15/B, it can be utilized in the 5-inch (ZUNI) rocket system (figure 4-12). General characteristics of the MK 352 fuze are listed in table 4-5.

4.7.2 OPERATIONAL CHARACTERISTICS. The MK 352 MOD 2 fuze nose and striker assembly design assures that the fuze is capable of functioning at low angles of impact. The MK 352 fuze in the 2.75-inch rocket system will function when it impacts a 0.016-inch-thick aluminum sheet at angles as small as 3 to 5 degrees from the horizontal. The nose design also permits the fuze to function on impact with water targets.

4.7.3 EXPLOSIVE COMPONENTS. The MK 352 fuze contains a Primer, Stab, MK 125 MOD 1, a Detonator, Flash, MK 59, MOD 0, a lead, and a booster. A fuze contains a total of approximately 11.4 grams of various explosives.

4.7.4 SAFETY FEATURES. The MK 352 fuze arming is the result of acceleration-time integration. A fuze must experience a sustained acceleration of at least 20 "g" in order to arm. The "no arm" accelera tion level is 11 "g".

4.7.4.1 The safety arming mechanism contains a malassembly feature which prevents the assembly into a fuze body of a safety arming mechanism with an armed rotor.

4.7.5 FUNCTIONAL DESCRIPTION. The MK 352 fuze arming mechanism functions on the acceleration-time integration principle. The description of the operation of such a system is covered in 4.2.4.

4.7.6 INSTALLATION REQUIREMENTS. This fuze requires no special installation or assembly procedures.

4.8 FUZE, ROCKET, M423.

4.8.1 GENERAL DESCRIPTION. The Fuze, Rocket, M423 (figures 4-13 and 4-14) was designed to be employed in the 2.75-inch rocket system. General characteristics of the M423 fuze are listed in table 4-6.

NOTE

The M423 fuze was designed to be used in rockets fired from helicopters and low-speed aircraft. Because of the shorter arming time, this fuze must not be used in rockets which are to be fired from high-speed aircraft.

4.8.2 OPERATIONAL CHARACTERISTICS. The M423 fuze nose design is capable of functioning at angles as low as 5 degrees from the horizontal and on impact with soft targets. The fuze is also sensitive to water targets.

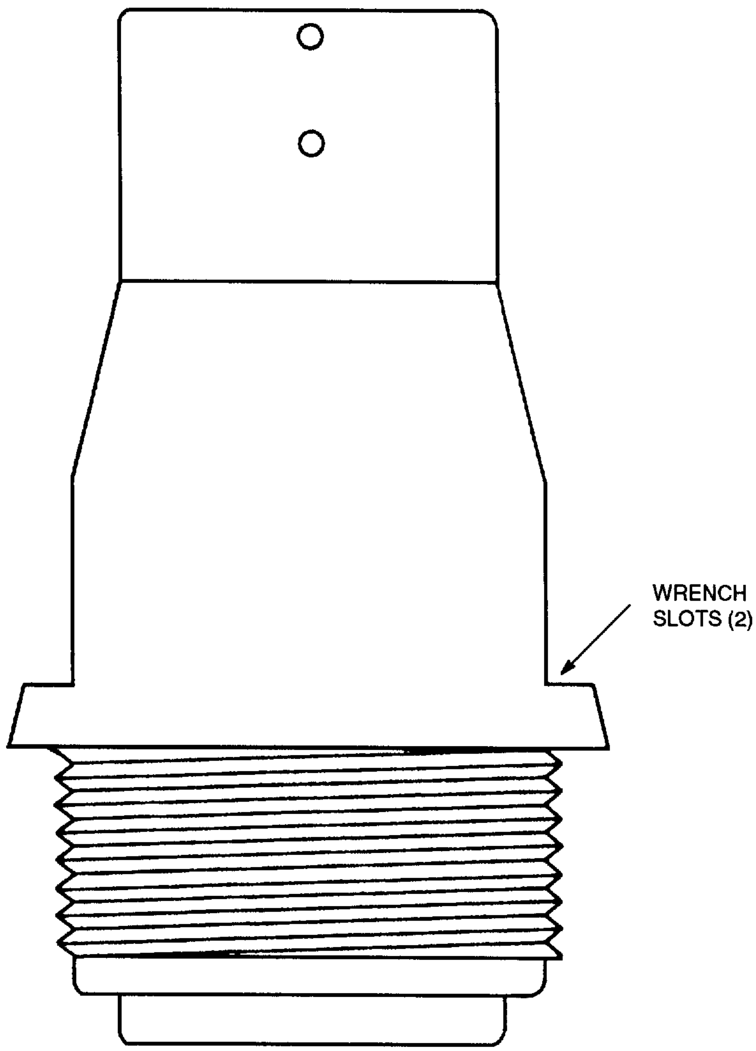


Figure 4-10. Fuze, Point Detonating, MK 352 MOD 2 - External View

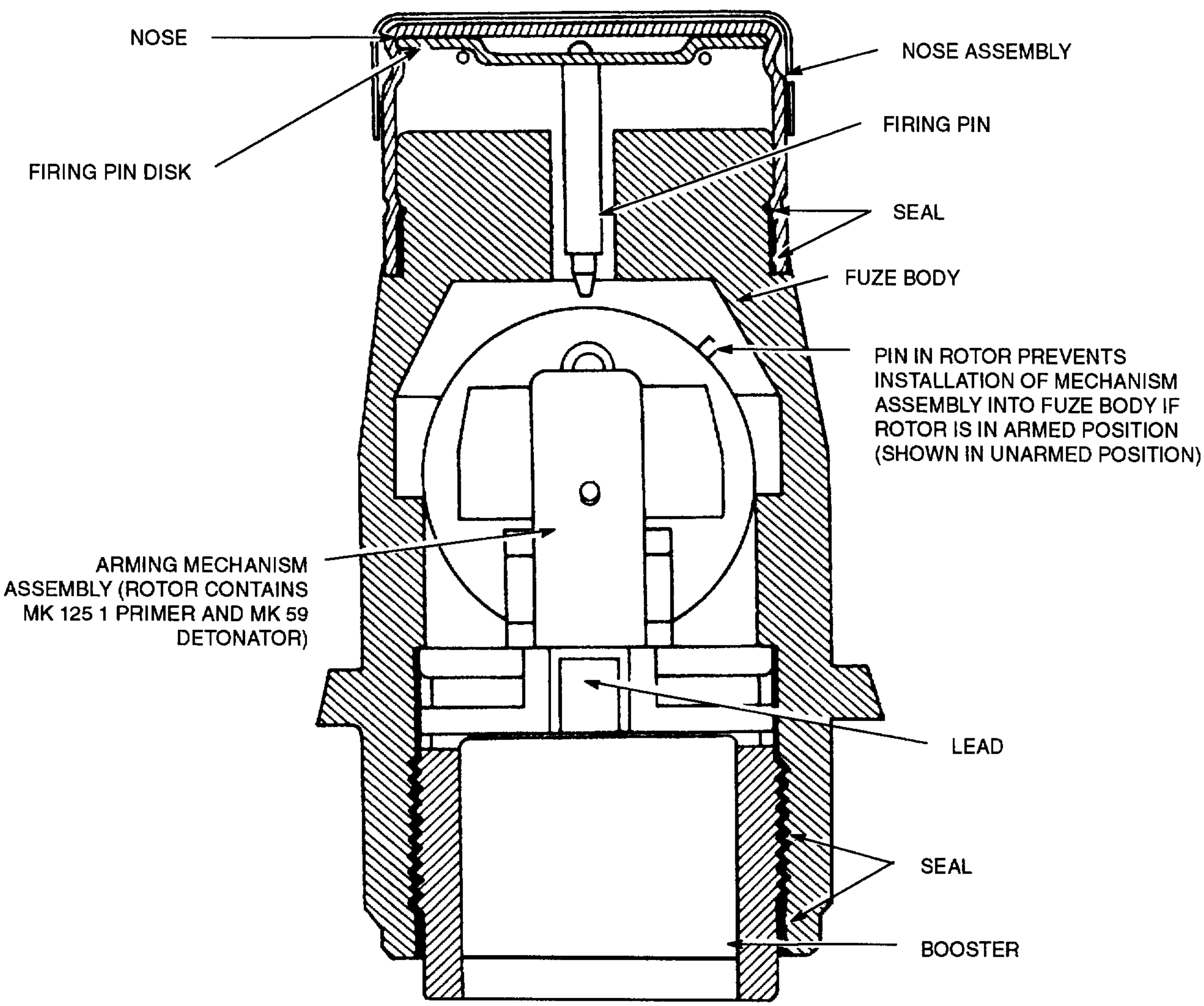


Figure 4-11. MK 352 MOD 2 Fuze - Internal View

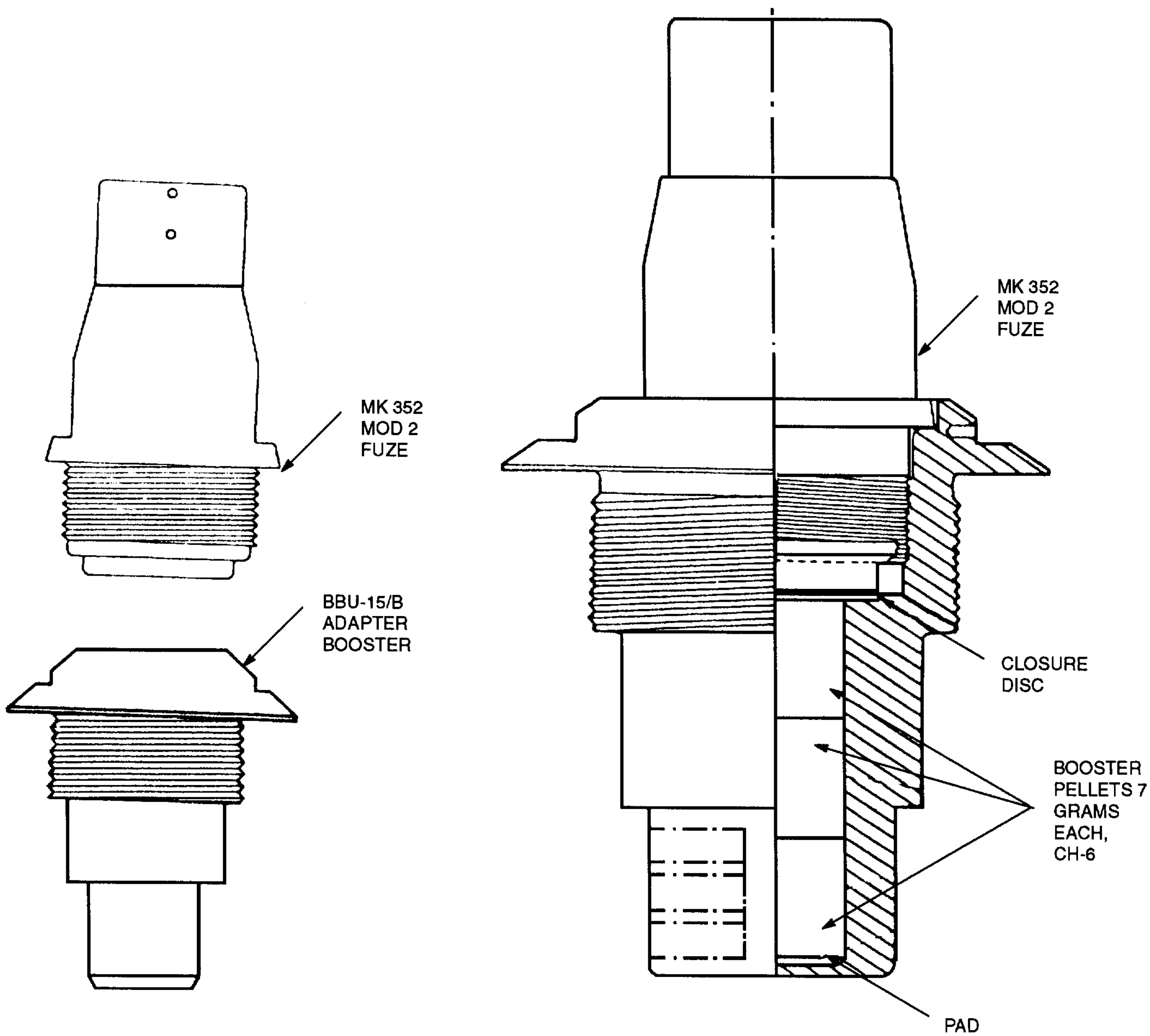


Figure 4-12. MK 352 MOD 2 Fuze and BBU-15/B Adapter Booster - 5-Inch Rocket Application

Table 4-5. General Characteristics of the MK 352 MOD 2 Fuze

Drawing #	DL 67A90D001
Type	Impact
Position	Nose
Function Delay	0.00 second
Arming:	
Type	Acceleration-time integration
Acceleration to arm	20 g min
Air travel to arm	800 to 1200 feet
Time to arm	1.07 to 1.36 seconds at 40 g
Physical Characteristics:	
Overall Length (in.)	2.981
Widest Body Diameter (in.)	1.695
Intrusion into Weapon (in.)	0.864
Total Weight (lbs)	0.42
Thread Size	1 7/16-12UN-2A
Explosive Weights:	
	Primer, Stab, MK 125 MOD 0 47 NOL #130 priming mix 55 mg lead azide
	Detonator, Flash, MK 59 MOD 0 116 mg lead azide 60 mg tetryl
	Lead, 84 mg CH-6
	Booster 11 gms CH-6

4.8.3 EXPLOSIVE COMPONENTS. The M423 fuze contains a Primer, Stab, M104, a Detonator, Flash, M85, a lead, and a booster. A fuze contains a total of approximately 9.4 grams of various explosives.

4.8.4 SAFETY FEATURES. The M423 fuze arming is the result of acceleration-time integration. A fuze must experience a sustained acceleration of at least 20 "g" in order to arm. The "no arm" acceleration level is 11 "g".

4.8.5 FUNCTIONAL DESCRIPTION. The M423 fuze arming mechanism functions on the acceleration-time integration principle. The description of the operation of such a system is covered in 4.2.4.

4.8.6 INSTALLATION REQUIREMENTS. This fuze requires no special installation or assembly procedures.

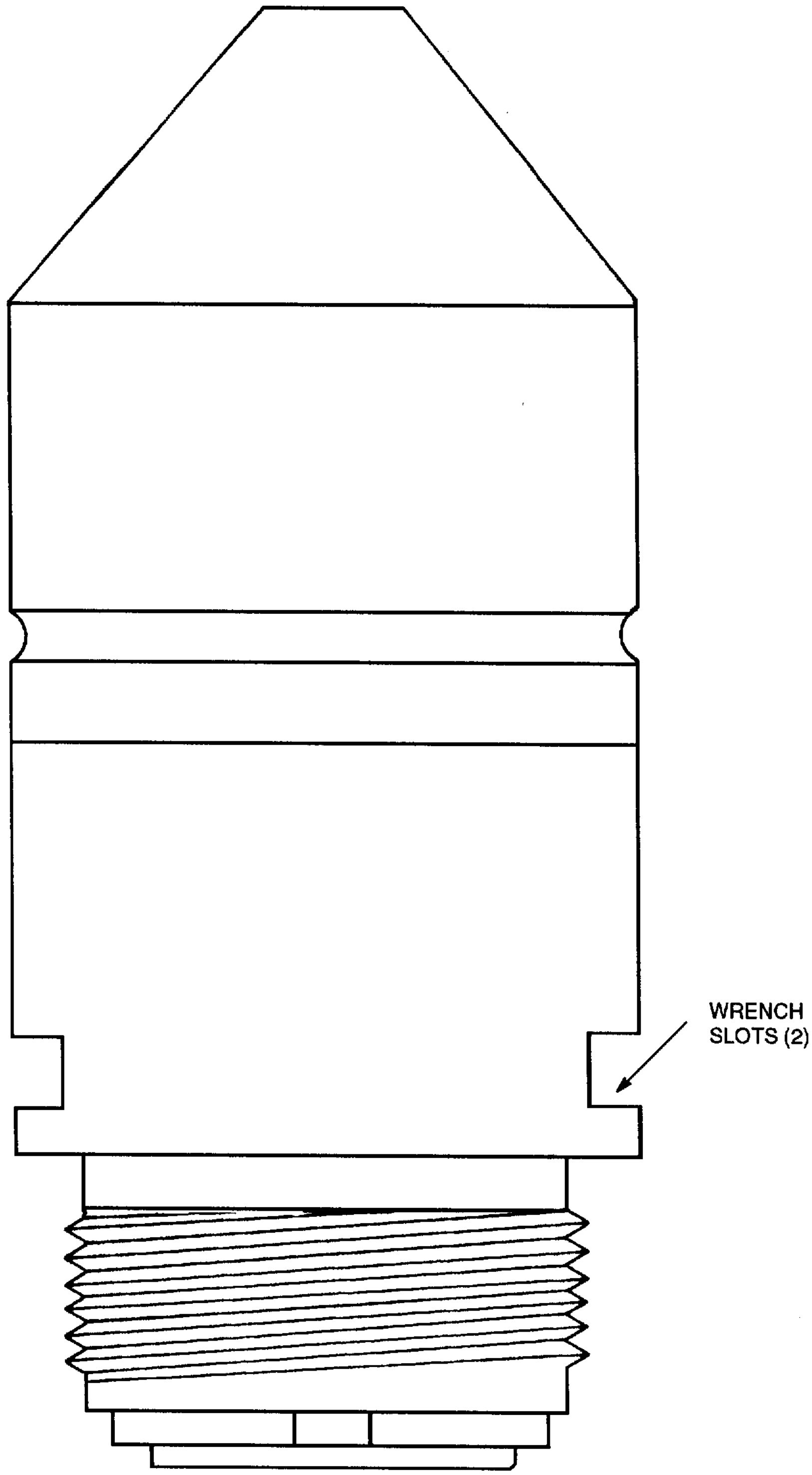


Figure 4-13. Fuze, Rocket, M423 - External View

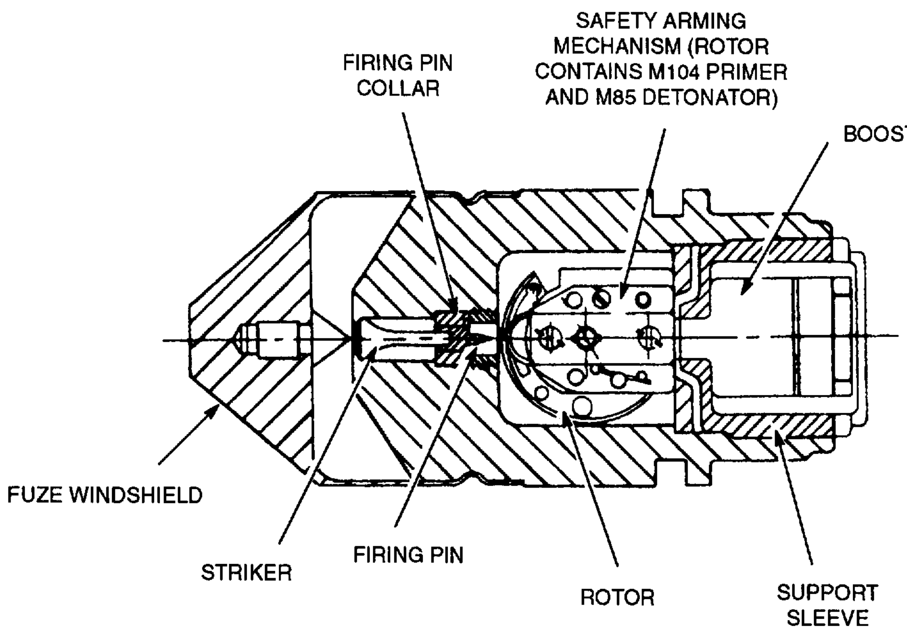


Figure 4-14. M423 Rocket Fuze - Internal View

Table 4-6. General Characteristics of the M423 Fuze

Drawing #	PL 8883683
Type	Impact
Position	Nose
Function Delay	0.00 second
Arming:	
Type	Acceleration-time integration
Acceleration to arm	20 g min
Air travel to arm	140 to 300 feet
Time to arm	0.63 to 0.82 seconds at 27 g
Physical Characteristics:	
Overall Length (in.)	4.04
Widest Body Diameter (in.)	1.75
Intrusion into Weapon (in.)	0.90
Total Weight (lbs)	0.42
Thread Size	1 7/16-16UN-2A
Explosive Weights:	
	Primer, Stab, M104 49 mg NOL #130 priming mix 68 mg lead azide
	Detonator, Flash, M85 80 mg lead azide 88 mg RDX
	Lead, 98 mg tetryl
	Booster 9 gms RDX

4.9 FUZE, ROCKET, M427.

4.9.1 GENERAL DESCRIPTION. The Fuze, Rocket, M427 (figures 4-15 and 4-16) was designed to be employed in the 2.75-inch rocket system used on high-speed aircraft. Except for a longer arming distance, this fuze is identical to the M423 fuze. The M427 fuze can be deployed from low-speed aircraft, but due to the longer arming distance (1250 feet maximum for the M427 vs. 300 feet maximum for the M423) this fuze must be launched at longer distances from the target. General characteristics of the M427 fuze are listed in table 4-7.

4.9.2 OPERATIONAL CHARACTERISTICS. The M427 fuze nose design is capable of functioning at angles as low as 5 degrees from the horizontal and on impact with soft targets. The fuze is also sensitive to water targets.

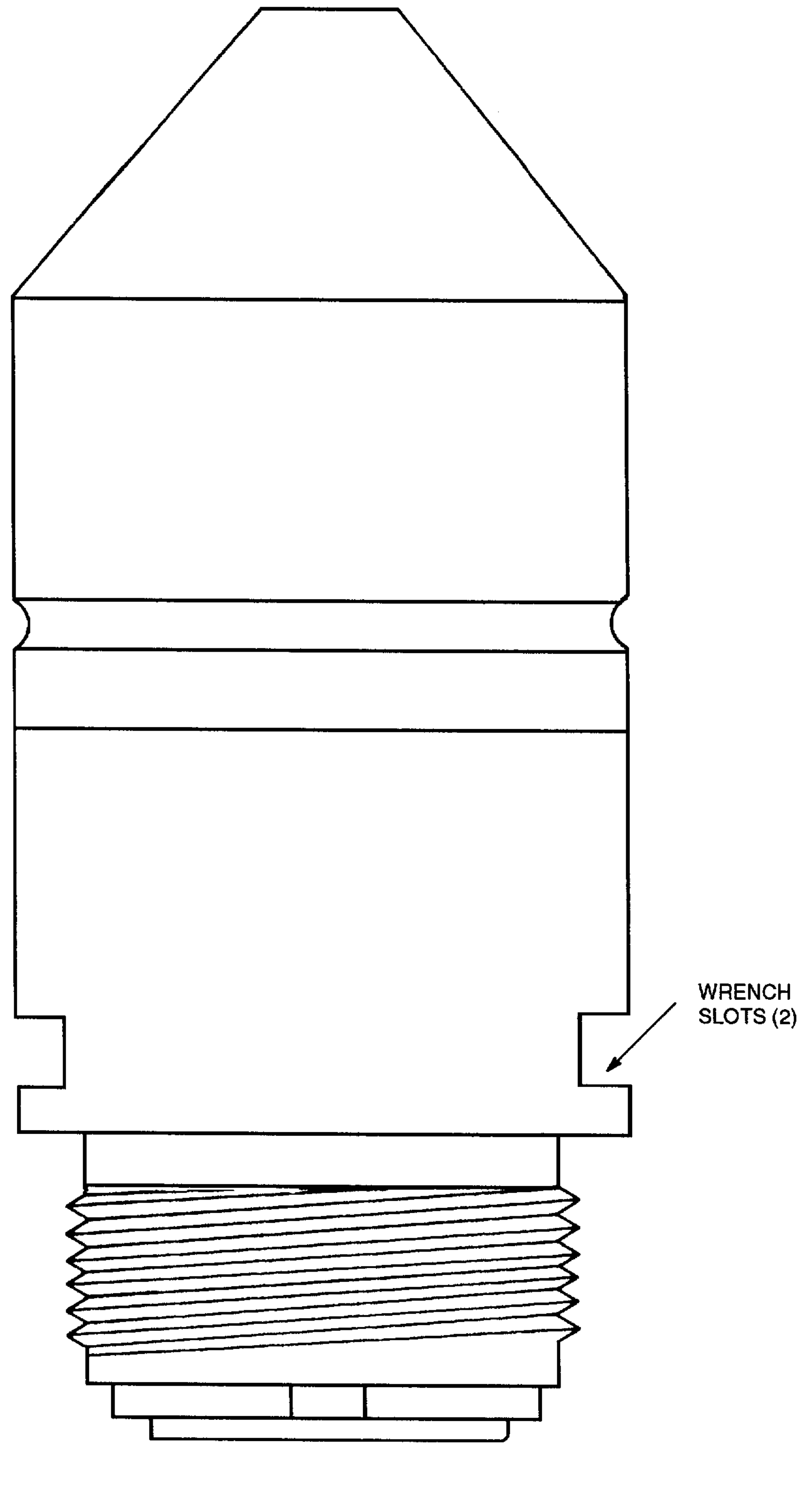


Figure 4-15. Fuze, Rocket, M427 - External View

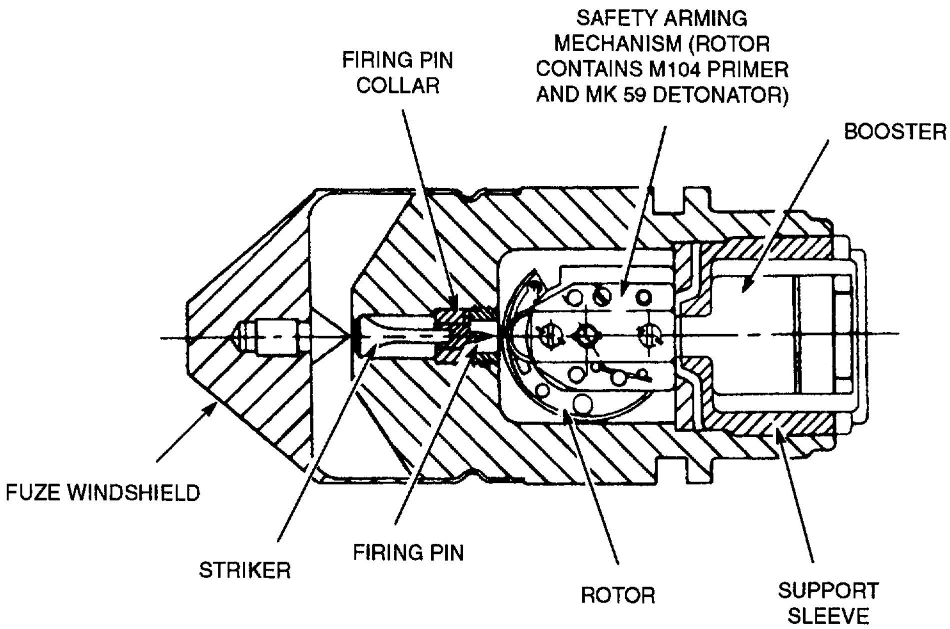


Figure 4-16. M427 Rocket Fuze - Internal View

Table 4-7. General Characteristics of the M427 Fuze

Drawing #	PL 8883745
Type	Impact
Position	Nose
Function Delay	0.00 second
Arming:	
Type	Acceleration-time integration
Acceleration to arm	20 g min
Air travel to arm	750 to 1150 feet
Time to arm	1.07 to 1.36 seconds at 40 g
Physical Characteristics:	
Overall Length (in.)	4.04
Widest Body Diameter (in.)	1.755
Intrusion into Weapon (in.)	0.89
Total Weight (lbs)	0.62
Thread Size	1 7/16-16UN-2A
Explosive Weights:	
	Primer, Stab, M 104 49 mg NOL #130 priming mix 68 mg lead azide
	Detonator, Flash, M85 80 mg lead azide 88 mg RDX
	Lead, 98 mg tetryl
	Booster 9 gms RDX

4.9.3 EXPLOSIVE COMPONENTS. The M427 fuze contains a Primer, Stab, M104, a Detonator, Flash, M85, a lead, and a booster. A fuze contains a total of approximately 9.4 grams of various explosives.

4.9.4 SAFETY FEATURES. The M427 fuze arming is the result of acceleration-time integration. A fuze must experience a sustained acceleration of at least 20 "g" in order to arm. The "no arm" acceleration level is 11 "g".

4.9.5 FUNCTIONAL DESCRIPTION. The M427 fuze arming mechanism functions on the acceleration-time integration principle. The description of the operation of such a system is covered in 4.2.4.

4.9.6 INSTALLATION REQUIREMENTS. This fuze requires no special installation or assembly procedures.

4.10 FUZE, ROCKET, FMU-90/B.

4.10.1 GENERAL DESCRIPTION. The Fuze, Rocket, FMU-90/B (figures 4-17 and 4-18) was designed to be employed in the 2.75-inch rocket system. With an Adapter Booster, BBU-15/B, it can be utilized in the 5-inch (ZUNI) rocket system (figure 4-19) The FMU-90/B Fuze is identical to the MK 352 MOD 2 Fuze except for the functioning delay. General characteristics of the FMU-90/B fuze are listed in table 4-8.

4.10.2 OPERATIONAL CHARACTERISTICS. The FMU-90/B fuze nose and striker assembly design assures that the fuze is capable of functioning at low angles of impact. The FMU-90/B fuze in the 2.75-inch rocket system will function when it impacts a 0.016-inch-thick aluminum sheet at angles as small as 3 to 5 degrees from the horizontal. The nose design also permits the fuze to function on impact with water targets.

4.10.3 EXPLOSIVE COMPONENTS. The FMU-90/B fuze contains a Primer, Delay, a BBU-19/B, a Detonator, Flash, MK 59, MOD 0, a lead, and a booster. A fuze contains a total of approximately 11.4 grams of various explosives and pyrotechnic mixes.

4.10.4 SAFETY FEATURES. The FMU-90/B fuze arming is the result of acceleration-time integration. A fuze must experience a sustained acceleration of at least 20 “g” in order to arm. The “no arm” acceleration level is 11 ‘‘g’’.

4.10.4.1 The safety arming mechanism contains a mal-assembly feature which prevents the assembly into a fuze body of a safety arming mechanism with an armed rotor.

4.10.5 FUNCTIONAL DESCRIPTION. The FMU-90/B fuze arming mechanism functions on the acceleration-time integration principle. The description of the operation of such a system is covered in 4.2.4.

4.10.6 INSTALLATION REQUIREMENTS. This fuze requires no special installation or assembly procedures.

4.11 FUZE, MECHANICAL TIME, FMU-136/B.

4.11.1 GENERAL DESCRIPTION. The fuze, Mechanical Time, FMU-136/B (figure 4-20) was designed to be employed in the 5-inch (ZUNI) rocket system when that weapon system utilizes the Warhead, 5-Inch, Chaff, MK 84 MOD 4. (The MK 84 MOD 4 warhead is issued with the FMU-136/B fuze permanently installed.) The fuze provides a single preflight-set functioning time interval. General Characteristics of the FMU-136/B fuze are listed in table 4-9.

4.11.2 OPERATIONAL CHARACTERISTICS. The FMU-136/B fuze can provide a single time interval in the 2.5- to 80-second range. The setting dial is marked in 1/4-second increments.

4.11.2.1 For any setting between 0 and 2.5 seconds, the fuze will operate at 2.5 to 3 seconds after launch.

4.11.2.2 The setting head can be rotated in one direction only. The proper direction is indicated by an arrow.

4.11.3 EXPLOSIVE COMPONENTS. The FMU-136/B fuze contains a Primer, Stab, MK 125 MOD 1, a detonator, and a Lead, MK 12 MOD 1. A fuze contains a total of approximately 0.394 gram of various explosives.

4.11.4 SAFETY FEATURES. The FMU-136/B fuze arming mechanism functions on the acceleration-time integration principle. A fuze must experience a sustained acceleration of at least 30 “g” in order to arm. The ‘no arm” acceleration level is 13 “g”.

4.11.4.1 If the acceleration decays to less than 13 “g” before the interlock latch is normal released, the mechanism will reset to its original position.

4.11.4.2 If the second mass (the mass which works against the clockwork escapement) moves too fast (due to a failure in the clockwork gear train), the mass is locked by the interlock latch. The safety arming mechanism now cannot arm or automatically reset.

4.11.4.3 The safety arming mechanism contains a mal-assembly feature which prevents the assembly of a safety arming mechanism with an armed rotor into a fuze body.

4.11.5 FUNCTIONAL DESCRIPTION. The FMU-136/B fuze is armed on the acceleration-time integration principle. The description of the operation of such a system is covered in 4.2.4.

a. If the acceleration is sustained for at least 400 feet, the fuze becomes armed. The timer is started when the interlock latch is released. This occurs about 0.2 second after launch.

b. After the selected time interval has elapsed, the fuze explosive charge ignites a charge in the warhead which expels the chaff cassettes from the warhead case.

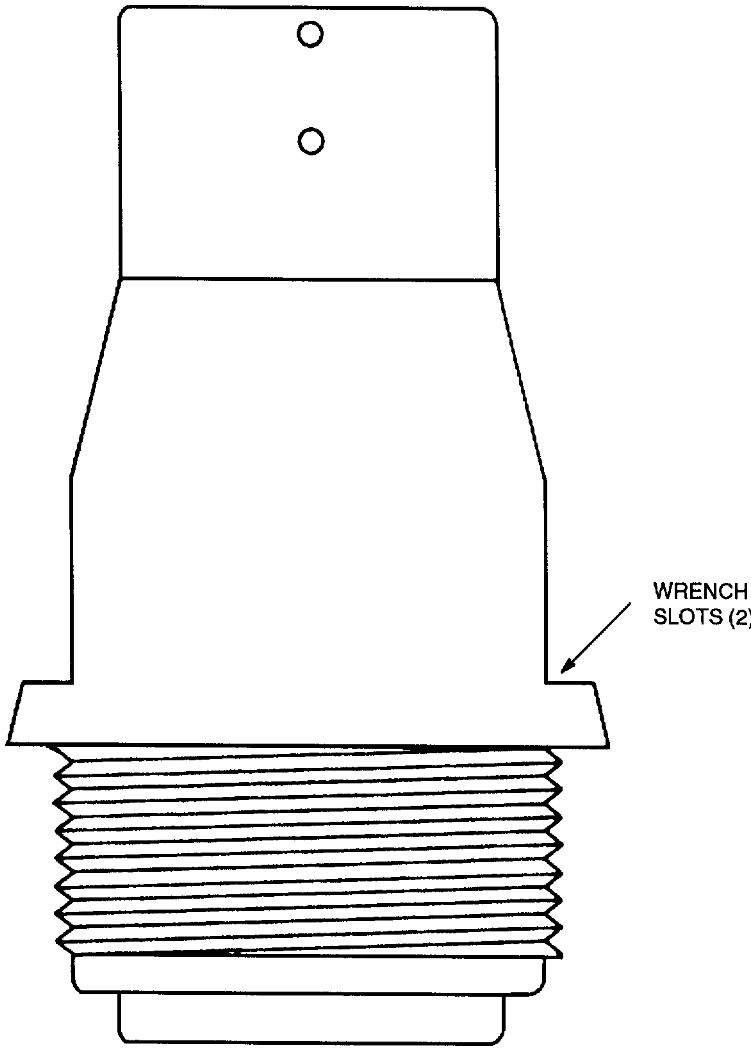


Figure 4-17. Fuze, Rocket, FMU-90/B - External View

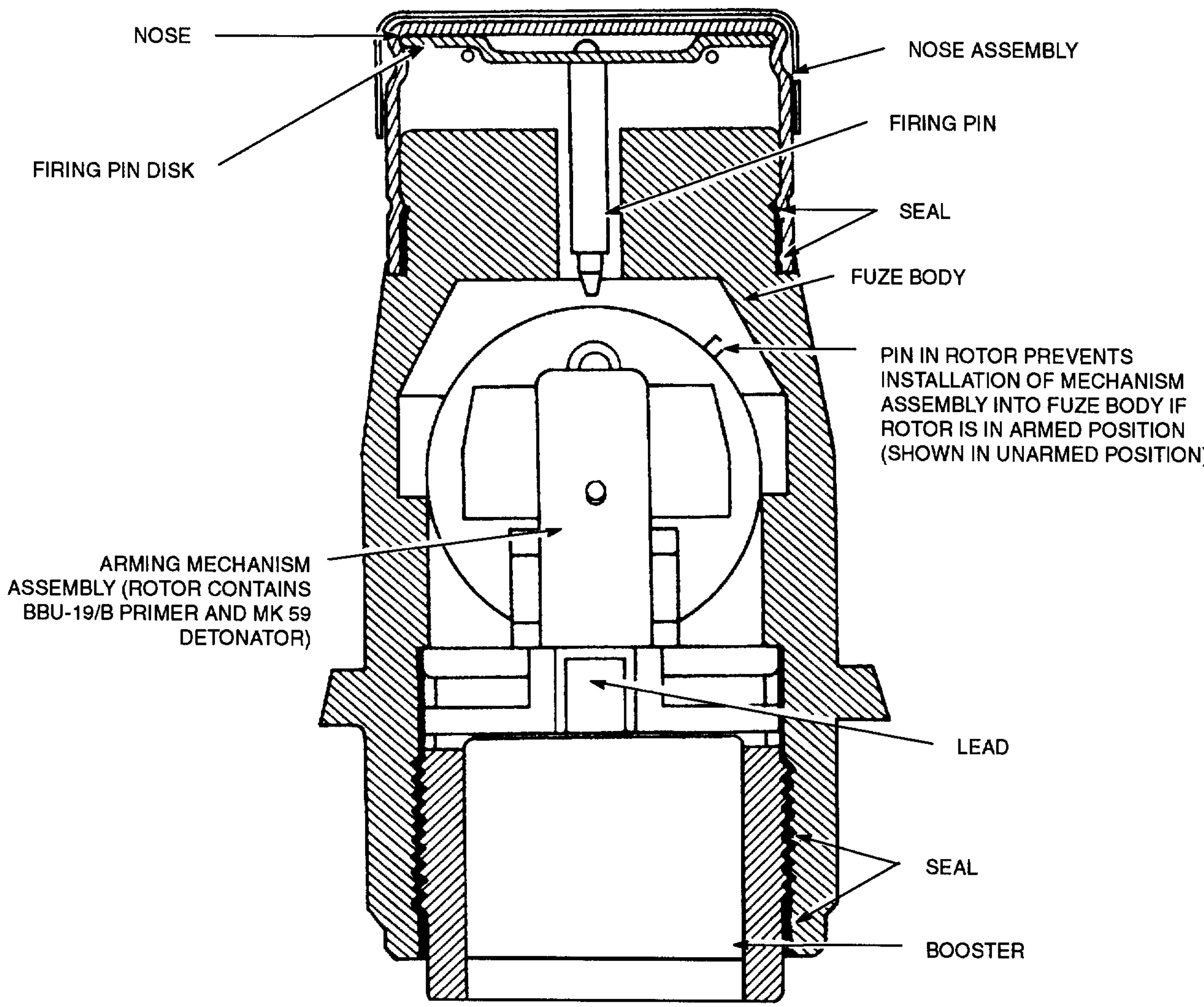


Figure 4-18. FMU-90/B Fuze - Internal View

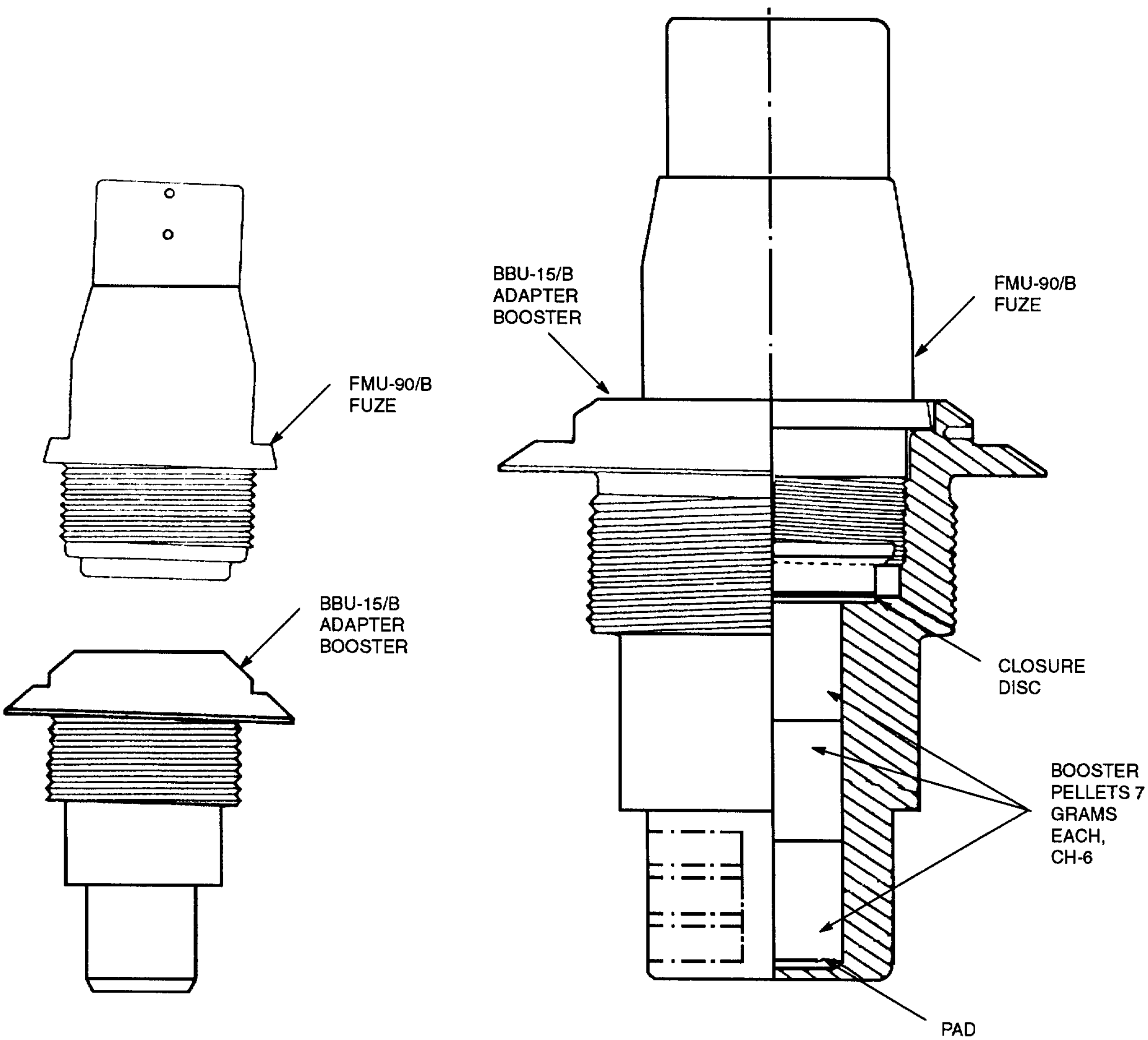


Figure 4-19. FMU-90/B Fuze and BBU-15/B Adapter Booster - 5-Inch Rocket Application

Table 4-8. General characteristics of the FMU-90/B Fuze

Drawing #	DL 67A90D050
Type	Impact
Position	Nose
Function Delay	0.06 second
Arming:	
Type	Acceleration-time integration
Acceleration to arm	20 g min
Air travel to arm	800 to 1200 feet
Time to arm	1.07 to 1.36 seconds at 40 g
Physical Characteristics:	
Overall Length (in.)	3.03
Widest Body Diameter (in.)	1.7
Intrusion into Weapon (in.)	0.86
Total Weight (lbs)	0.42
Thread Size	1 7/16-16UN-2A
Explosive Weights:	
	Primer, Delay, BBU-19/B 52 mg lead azide 74 mg MBX delay powder
	Detonator, Flash, MK 59 MOD 0 116 mg lead azide 60 mg tetryl
	Lead 84 mg CH-6
	Booster 11 gms CH-6

4.11.6 INSTALLATION PROCEDURES. The FMU-136/B is permanently installed in the Warhead, 5-Inch, Chaff, MK 84 MOD 4.

4.11.6.1 The fuze must be set to the desired function time. This is accomplished by rotating the nose cone in the direction noted by the arrow until the desired time is under the setting arrow.

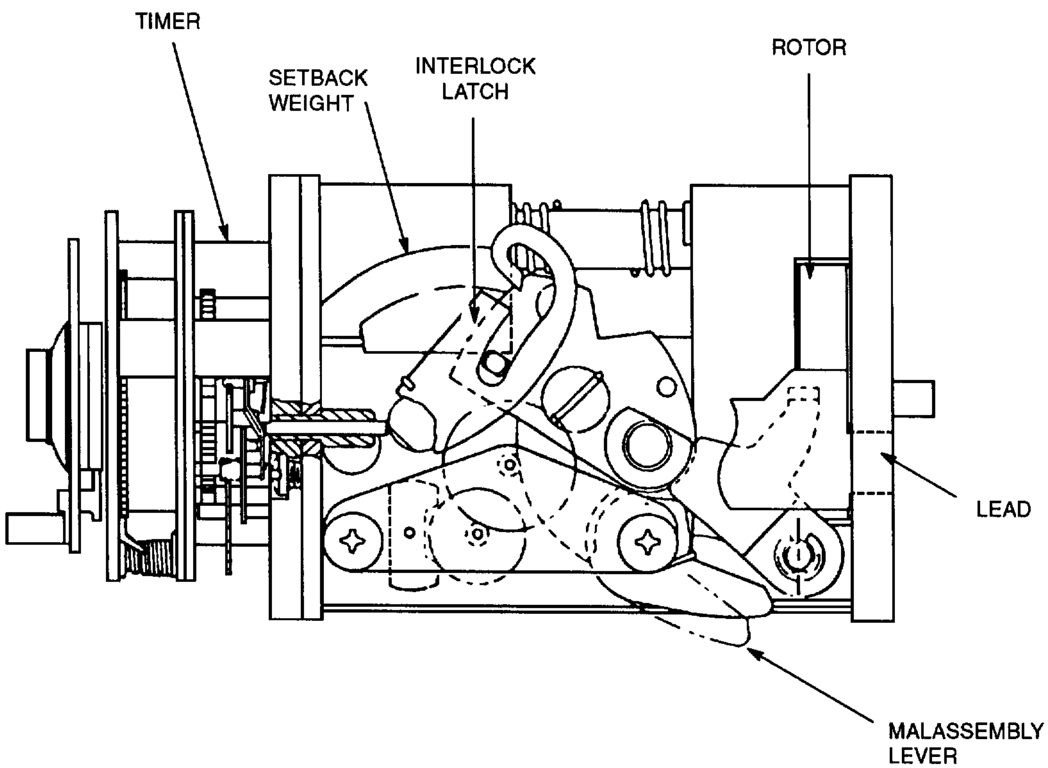


Figure 4-20. Fuze, Mechanical Time, FMU-136/B - External View

Table 4-9. General Characteristics of the FMU-136/B Fuze

Drawing #	PL 1260AS100
Type	Mechanical Time
Position	Nose (Permanently installed in the MK 84 MOD 4 warhead)
Function Delay	2.75 to 80 seconds after launch in 1/2-second increments
Arming:	
Type	Acceleration-time integration
Acceleration to arm	30 g min
Air travel to arm	400 to 600 feet
Time to arm	0.65 to 0.85 seconds at 60 g
Physical Characteristics:	
Overall Length (in.)	3.038
Widest Body Diameter (in.)	1.5
Intrusion into Weapon (in.)	Permanently installed in the MK 84 MOD 4 warhead
Total Weight (lbs)	0.3
Thread Size	N/A
Explosive Weights:	
	Primer, Stab, MK 125 MOD 1 47 mg NOL #130 priming mix 55 mg lead azide
	Detonator (1260AS104) 60 mg lead azide 70 mg RDX
	Lead 162 mg CH-6

A.1 APPENDIX A-COOK-OFF STUDIES.

A.1.1 Cook-off is defined as the spontaneous detonation (high-order explosion) or deflagration (low-order explosion) of a bomb as a result of exposure to extreme heat such as would be encountered in a fire fed by aviation gasoline, jet fuel, etc. Fires aboard aircraft carriers have been severely complicated by exploding bombs, most notably, the fire aboard USS FORRESTAL in July of 1967. In this case, the crew responded automatically and rapidly but in less than two minutes, a bomb cooked off and exploded, spreading the fire to a group of aircraft loaded for a strike. As a result of subsequent cook-off type explosions which opened the flight deck and destroyed hoses used in combating the fire, more than 100 personnel lost their lives.

A.1.2 In order to minimize the possibility of such catastrophic fires in the future, the Navy embarked upon a series of studies concerned with ways of maximizing the length of time required for a bomb to detonate when exposed to fire. These "cook-off" studies have resulted in several current and pending improvements to Naval aviation ordnance.

A.1.3 Bombs are composed of three major elements which are vulnerable to cook-off: the fuze, the booster, and the main charge. Cook-off improvements have never been able to eliminate spontaneous explosion of any weapon. The object, rather, has been to take each of these elements and insulate or thermally protect it so that it can endure exposure to fire for a sufficiently long time to enable fire fighters to successfully fight the fire.

A.1.4 All MK 80 series general purpose bombs are available in both thermal protected and non-thermal protected configurations. BLU series general purpose bombs are available in thermal protected configurations only. The fuzes have also been thermally protected specifically by adding a collar to the M904 fuze (the M904E4). Existing electric tail fuzes are suitably thermally protected because of their inherent design and physical location within the bomb.

GLOSSARY

A

Adapter Booster - A device fitted into the fuze well of a bomb which allows a fuze of smaller diameter to be used. Adapter boosters contain explosive which transmits the firing train output of the fuze to the main explosive charge of the bomb.

AGL - Above ground level.

Airborne Weapon (Ordnance) - All missiles, rockets, bombs, mines, torpedoes, pyrotechnics, ammunition, guns and gun pods, and all similar items intended for carriage internally or externally by aircraft. This definition applies to items which are normally separated from the aircraft in flight.

Airburst - An explosion of a weapon above the surface, caused either intentionally to maximize weapon fragmentation or to disperse canister-type ordnance, or unintentionally due to weapon malfunction or other cause.

All-arm speed - That air speed at which all fuzes in a given group can be expected to arm.

Arming delay - The lapsed time between weapon release from the delivery aircraft and fuze arming. A fuze is armed when in-flight safety mechanisms are removed, the explosive train is aligned, and the fuze is ready to function.

Arming vane - An air-driven mechanical device which arms a fuze by means of rotation when the fuze is released into the airstream.

Arming wire - A metal wire used to lock the fuze in the unarmed condition until the weapon is separated from the aircraft. At release, the arming wire is withdrawn and the fuze arming sequence begins.

B

BLU - Bomb or Mine Unit.

Bomblet - A generic term used for any sub-weapon contained in a cluster or dispenser weapon which functions independently after dispersal from the dispenser.

C

CBU - Cluster Bomb Unit; a type of dispenser weapon.

Conical fins - A smoothly faired, detachable tail assembly which is assembled to the bomb body.

Cook-off time - The time required for a weapon to explode or deflagrate (go low-order) when exposed to heat or fire.

D

Dispenser - A container designed to release bomblets or other items. One type of dispenser, sometimes referred to as a cluster or canister bomb, is designed to open in mid-air to provide dispersal of the dispenser contents over a wide area.

Dud - A weapon or fuze which for some reason fails to detonate. Dudding may be intentional to protect the delivery aircraft from a weapon released at too low an altitude or to protect handlers against a mishandled fuze by causing it to fail-safe.

E

Early burst - The term used to describe the detonation of a fuze at or after arming but prior to the time intended. For purposes of safe-separation calculation, the early burst is assumed to occur at the instant of fuze arming, although it may occur later.

Electric fuzing - A fuze in which arming and functioning power is supplied by electrical instead of mechanical means. Fuzes presently in the Navy inventory are supplied by power from equipment in the delivery aircraft at weapon release.

EOD - Explosive Ordnance Disposal - The handling, disarming, or destroying of unsafe bombs or other explosive ordnance. This function is normally performed by an Explosive Ordnance Disposal Unit consisting of specially trained personnel and specialized equipment.

Explosive Train - A series of explosive elements arranged inside the fuze in order of decreasing sensitivity which transmits the firing pulse to the main charge of the weapon.

F

Fragmentation envelope - The pattern made by weapon fragments which surround a high explosive weapon at any point in time at or after detonation.

Functionary delay - The controlled time interval between initiation of the firing device or explosive train and the actual detonation of the weapon. Delay may be provided by pyrotechnic. Electrical, or clockwork devices and may commence at weapon release from the aircraft or at impact.

Fuse - In ordnance applications, a pyrotechnic device which is usually a length of combustible cord used to initiate an explosive charge.

Fuze - A mechanical device with explosive components designed to initiate the detonation of a weapon by an action such as hydrostatic pressure, electrical energy, impact, mechanical time, or a combination of these.

G

G-force - Forces compared to one gravity; when, for example, a fuze is subjected to a force of 13 g's, a single component of the fuze parallel to the direction of the force weighs 13 times as much as it does when the fuze is at rest. G-forces can be used to arm or fire fuzes. See also set back" force.

GBU - Guided Bomb Unit.

H

Hydrostatic fuze - A fuze used with depth bombs for underwater detonation. Initiation is caused by hydro-static pressure.

I

Impact fuze - A fuse in which detonation is initiated by the force of impact and which usually functions instantaneously or after a short delay. With rocket fuzes, the term Point Detonating is used.

Intrusion - The distance into the fuze well which a fuze extends when it is fully screwed in.

J

Jettison - Releasing an airborne weapon/store by an emergency or secondary release system. Weapons are normally jettisoned in a safe condition.

K

KCAS - Knots Calibrated Air Speed; Indicated air speed corrected for aircraft instrument errors. Errors are usually insignificant. For most purposes, KCAS can be equated with KIAS.

KIAS - Knots Indicated Air Speed; A measurement of aircraft speed not corrected for effects of air density and temperature. For a given true air speed, indicated air speed decreases as air density decreases or temperature increases. It is indicated air speed which is sensed by fuze arming vanes.

KTAS - Knots True Air Speed; The actual speed of the aircraft through space. True air speed is computed by correcting indicated air speed for effects of air density and temperature. The actual speed of the aircraft over the ground is determined by correcting KTAS for effects of wind.

L

Long delay - Term applied to fuzes in which detonation is delayed for a relatively long period of time after impact for purposes other than providing weapon penetration (e.g., area denial). These delays may range from several minutes to days.

Low-drag bomb - A loosely applied term which can refer to a conical-finned bomb body or to a bomb fitted with retarding fins which knot allowed to open at weapon release. Applied to MK 80 series bombs due to their slender, pointed shape.

M

Mechanical fuzing - A fuze which depends primarily upon events of a mechanical or physical nature for arming and functioning. Most mechanical bomb fuzes utilize an arming vane which rotates in the airstream to provide arming energy.

MSL - Main Sea Level.

N

No-arm speed - That air speed at which no fuzes in a given group can be expected to arm. The no-arm speed is critical in determining safety factors involved in take-off, landings, and on-deck handling.

Nose fuze - A fuze which is mounted in the nose well of a bomb, rocket, or missile.

O

Out-of-line safety - A safety feature on most fuzes in which one or more components of the explosive train are not aligned with respect to the other components until the fuze arms.

P

Pickle - An informal term used to describe the action of releasing a weapon by the pilot or to the bomb release control (pickle switch) used for this action.

Positively rigged - A method of rigging an arming wire so that the arming wire is always pulled from the bomb when the weapon is released. In this case, there is no option available to the pilot with respect to arming wire withdrawal.

Proximity - An electronic device for detonating warheads as they near a target.

QR

RADHAZ - An acronym for Radiation Hazards which refers to the electromagnetic radiation field from radio and radar transmitters which may have adverse effects of ordnance equipments. A RADHAZ-free area is one in which certain ordnance can be handled and stored without risk of malfunction caused by nearby electro-magnetic sources. (Also referred to as HERO-Hazards of Electromagnetic Radiation to Ordnance, HERP - Hazards of Electromagnetic Radiation to Personnel and HERF - Hazards of Electromagnetic Radiation to Fuel.)

Retarded delivery - The term used to describe a weapon delivered with the retarding fins or other retardation device open. Informally referred to as “Snakeye” delivery.

Ripple release - The sequential release of weapons from the bomb rack at specific intervals.

S

Safe escape distance - The minimum distance between the delivery aircraft and the weapon impact point which will ensure that the risk of fragmentation damage to the aircraft is at or below an acceptable level. This distance determines the minimum release speed and altitude.

Safe separation - The distance between a bomb and the delivery aircraft when the bomb arms is called the safe separation distance. It is based on the assumption that a percentage of bombs will detonate at fuze arming. A safe separation, therefore, is a distance from the bomb which will provide little or no damage to the delivery aircraft from its own bomb fragments. Because this distance is dependent upon fuze arming time and the probability that a fuze might early-burst, the arming time must be selected carefully so that it is compatible with the aircraft type, delivery maneuver, air speed, altitude, and other factors.

Salvo - To release several bombs at the same time. A high risk of bomb-to-bomb collision exists with this type of release.

Set-back force - The general term used to describe the action of acceleration forces on rocket or projectile fuzes. Set-back can be used as an environmental feature to arm a rocket fuze.

Side drive - An anemometer·type device mounted on the side of bomb which imparts rotary action to arm a tail fuze.

Solenoid - An electrically operated device on the aircraft bomb rack to which the arming wire is attached. When energized, the solenoid retains the arming wire a weapon release. If the fuze is to be dropped “SAFE”, the solenoid is de-energized and the arming wire is dropped with the weapon.

Stick - Term applied to several bombs released in ripple sequence with a preselected interval between each bomb. This interval is usually 60 milliseconds or more; the complete release can then be expressed as a “stick length” (a stick length of 240 milliseconds, etc.). Also referred to as “Stik.”

Surface burst - Detonation of ordnance at or close to the surface. Normally this implies detonation of a bomb without any significant penetration into the ground. It may also imply a malfunction of a weapon designed to airburst.

T

Tail drive - A mechanical device with arming vane used to impart rotary motion to a tail-mounted fuze which is not exposed to the airstream.

Tail fuze - a fuze which is mounted in the tail well of a bomb.

Time fuze - A fuze which is designed to operate after the lapse of a pre-determined time. Time fuzes may be designed to provide an airburst, but the term may also refer to long delay fuzes which function after the weapon strikes the target.

U

Unretarded delivery - The term used to describe bomb delivery in which the trajectory of the weapon is not shortened by the use of retard fins or a parachute. Sometimes referred to as "freefall."

V

VT - The designation of a proximity sensing device which causes weapon detonation in proximity to the intended target. In air-to-surface weapons, a VT device produces weapon detonation prior to weapon impact.