

NAVAIR OP 2216

PART 2

SECOND REVISION

INCREMENT 2

0609 221 6610

**AIRCRAFT BOMBS, FUZES AND
ASSOCIATED COMPONENTS**

FUZES AND ACCESSORIES

**THIS PUBLICATION IS OBSOLETE,
BUT IS MAINTAINED FOR
REFERENCE (HISTORICAL) PURPOSES.**

**PUBLISHED BY DIRECTION OF
COMMANDER, NAVAL AIR SYSTEMS COMMAND**

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FOREWORD

OP 2216 Part 2 covers all aircraft bomb fuzes and bomb accessories (arming wires, arming vanes, VT firing devices, etc.) currently in use with the Navy's stockpile of free-fall conventional weapons. It is used in conjunction with OP 2216 Part 1 which provides complementary coverage for conventional free-fall weapons.

A full description of each fuze and accessory is provided. This includes a short summary description at the beginning of each coverage, operational characteristics of the device, safety and delivery hazards, and procedures for installation into a variety of weapons. This manual does not provide aircraft weapon delivery data such as is found in NATOPS; users should use this manual and the appropriate NATOPS manual in close conjunction for complete understanding of optimum weapon and fuze delivery methods.

The first incremental release in October, 1966 covers Electric Fuzes of the M990 series, mechanical fuzes of the AN-M103A1/M163 series and associated equipments. The second release covers Mechanical Long Delay Fuze Mk 346 and its associated arming assemblies, and the Mk 28 Safety Device (the "Retard Sensor"). This data supersedes comparable coverage for these equipments in the existing Volumes 1 and 2 of OP 2216. Until other releases are issued, the remaining portions of OP 2216 shall remain current and in force.

Additional information is contained on pages 3-1, 3-3, 3-7, 3-8 and 3-9 of Volume 2 of the existing OP 2216 (Confidential). Because the information on these pages (and backing pages 3-2, 3-4 and 3-10) has been downgraded to unclassified, these pages may be removed from Volume 2 and inserted in this binder, if desired. More thorough coverage will be provided in a future release of material for this OP.

This partial release has been promulgated in its present format in order to expedite the distribution of this new fuze information. Refinement of format and presentation will be incorporated in subsequent releases.

Although this manual is published by direction of Commander, Naval Air Systems Command, stocking, ordering and distribution will until further notice be handled using the currently established procedures for Ordnance Pamphlets (OP's).

Comments on this portion should be directed to:

Commander, U. S. Naval Ordnance Laboratory
White Oak, Silver Spring, Maryland 20910
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SAFETY SUMMARY

LISTED BELOW IS EVERY "WARNING" CONTAINED IN THIS PUBLICATION AND THE PAGE ON WHICH THE "WARNING" IS LOCATED. ALL PERSONNEL INVOLVED IN THE OPERATION AND MAINTENANCE OF THIS EQUIPMENT MUST FULLY UNDERSTAND THE "WARNINGS" AND THE PROCEDURES BY WHICH THE HAZARD IS TO BE REDUCED OR ELIMINATED.

WARNINGS

Oscillator plug-in units and fuzing templates of the Fuze Function Control Set AN/AWW-1 should be removed from the aircraft prior to operation with DC fuzes. This prevents accidental application of RF voltages and resulting change in arming and functioning delay times. Page 2-2

The M990D1 and M990D2 should be used only in those cases where a longer arming delay is excessive and causes reduced bombing accuracy. The 4.5-second arming delay permits a strike at lower altitude but materially increases the probability of damage to the delivery aircraft from bomb fragmentation. Page 2-13

Note the WARNING on the tag on the cotter pin. Do not pull the cotter pin until the safety pin is secured by the arming wire. Failure to observe this warning will result in an unsecured rotor which is capable of arming the bomb if the bellows are initiated for any reason. Page 2-25

If the arming wire of an M990 fuze has been accidentally withdrawn when the aircraft returns from a strike, the fuze could be fully armed and should be treated as such. Do not attempt to remove the fuze from the tail well of the bomb or the bomb from the aircraft. Notify EOD personnel immediately. Page 2-26

The AN-M103A1/M163 series fuze always arms in the delay mode before it arms in the instantaneous mode. Safe separation of the bomb and aircraft is determined by delay mode arming time, even though the fuze is set for instantaneous. Therefore the pilot must always consider the bomb armed as though the fuze functioning delay setting pin is in the delay mode position. Page 3-3

SAFETY SUMMARY (Cont.)

Upon arming, vane assembly, cup, and arming disks are ejected into the airstream beneath the delivery aircraft. This presents a hazard to other aircraft to the rear unless appropriate measures are taken in attack formation. Page 3-3

Never install a damaged or deformed vane of any type on these fuzes. A defective vane will cause erratic operation of the fuze and may cause it to arm prematurely. Page 3-11

If the arming disks (Figs. 3-2 and 3-3) are missing, the fuze must be treated as though it is armed. An AN-M103A1/M163 fuze contains a lethal amount of tetryl in the booster and should be handled carefully at all times. If the shear pin has been severed on an armed fuze, the fuze becomes critically sensitive to shock and can detonate easily. Known armed fuzes, either installed or uninstalled, should be handled only by EOD personnel. Page 3-12

The setting pin must be undamaged inasmuch as it acts like another shear pin to prevent early bursts. Additionally it must be seated properly in one of the two setting slots, or safety is reduced. Page 3-14

Do not use a fuze with a defective or missing shear pin. Do not remove the cotter pin which locks the vane strap and eyelet strap until after the bomb is installed on the bomb rack and arming wire installed. Page 3-16

Always keep an arming vane secured, either by an arming wire or safety cotter pin. Unsecured vanes will windmill from prop wash and cause arming before take off. Page 3-16

Before attempting to remove the fuze from a bomb, ensure that it is not armed and that the arming disks are in place (see Fig. 3-3). Page 3-18

If, when reseating the safety pin, the pin binds or rubs or will not seat, it is probably the result of premature rotor operation and arming. The fuze should immediately be turned over to EOD personnel for disposal. Page 5-9

All weapons which are returned from a strike unused should be examined as soon as possible. If evidence of malfunction is present, the Mk 346 fuze should immediately be removed from the bomb on the flight deck. A partially armed fuze (identified by the red band in the safe-armed window) is safe for handling but could complete the arming cycle if the weapon is jarred or jolted. Page 3-26

If upon attempted removal of a partially armed Mk 346 fuze, the fuze binds in the adapter-booster and will not unscrew easily, the

SAFETY SUMMARY (Cont.)

fuze is functioning and will detonate the weapon at the completion of its delay. Clear the area immediately and initiate emergency procedure to render the bomb ineffective. Page 3-27

If the initiating rod will not depress after a few attempts, it is possible that the bellows may have operated and the fuze is armed. Notify EOD personnel at once. Page 5-16

SUMMARY SHEET

Note: This sheet is issued in reproducible form to facilitate making of reproductions locally. It presents a summary of information contained in the following section, and may be used for convenient reference. It is NOT intended to replace the OP.

M990 ELECTRIC TAIL FUZE

KEY POINTS

1. Used primarily in MK80 series low-drag and SNAKEYE I bombs.
2. Used with M20 or MK43 VT devices for airburst.
3. May be used with RF initiation from AWW-1 or with DC-only initiation. Those shown with asterisk below can be used with both RF and DC-only initiation.

FUZE	DECAL		ARMING TIMES SECONDS	FUNCTIONING TIMES SECONDS
M990C		*	2/4.5/8/20	0/.004/.01/.025/.05/5/20
M990D		*	2/4.5/8/20	0/.004/.01/.025/.05/5/20
M990D1	□	DC	4.5	.004
M990D2	◻	DC	4.5	.025
M990E	⬡	*	2.6/5.5/8/20	0/.004/.01/.025/.05/5/20
M990E1	△	DC	5.5	.050
M990E2	◇	DC	2.6 RETARDED	0 — SNAKEYE —
			5.5 NON-RET.	0

NOMINAL. MAY VARY
BY +50% -15%

4. M990E2 is only M990 fuze which can be used to initiate SNAKEYE I retarded.
5. Don't use the M990C without a MK26 safety device.
6. RF initiation allows in-flight pilot option of arming and functioning times.
7. Read all tactical and delivery restrictions and select the proper M990 accordingly.

WARNINGS

The following procedures must be observed when handling these fuzes:

Don't remove the warning tag and safety cotter pin from the fuze until the safety wire is in place.

The short arming time of 4.5 sec. for -D1 and -D2 requires special delivery tactics to escape fragments! Same with 5.5 sec.!
See the appropriate NATOPS manual.

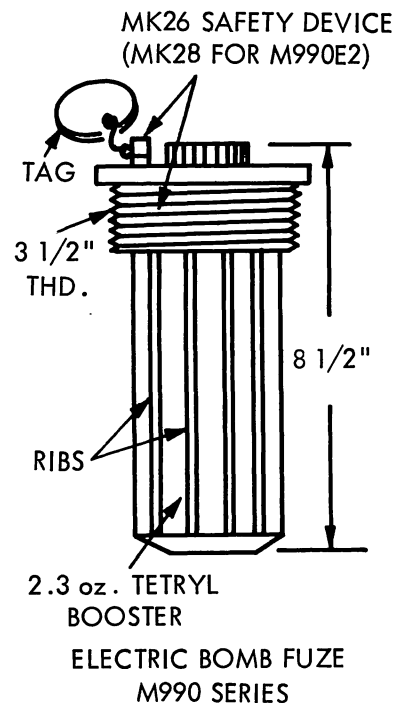
Don't use less than 5.5 sec. arming time for MK83 and MK84 bombs!

Don't ever use the 2 sec. arming time!! Don't use the 2.6 sec. time except with SNAKEYE I retarded!!

Don't use RF with -D1, -D2, -E1 or -E2! Don't use both RF and "DC-ONLY" fuzes on same ship or base!

The 300V on the AWW-1 must be within ±6 volts!

Don't use the M990C without MK26 safety device!



Chapter 2

ELECTRIC FUZES

Section 1 - Electric Bomb Fuze M990 Series

GENERAL

Electric Bomb Fuzes of the M990 series may be used in all Mk 80 series General Purpose Low Drag Bombs and the SNAKEYE I weapon. Installed in the tail fuze well, it is designed to provide pilots with a range of selectable arming and functioning delay times. These fuzes are used with Fuze Function Control Set AWW-1.

The fuze is produced in three basic configurations (M990C, M990D, and M990E) and several modifications thereof. The M990D may be modified to form the -D1 and -D2; the E to form the -E1 and -E2. The basic fuze (C, D, or E with no numerical suffix) is designed for pilot-selection of arming and functioning delays while in flight; the -D1, -D2, and E1 and E2 are "pre-selects." Each of these numbered modifications provides its own unique arming and functioning delay times.

Although physically interchangeable throughout the Mk 80 series of bombs, only specific bomb/fuze combinations are authorized. Consideration must be given to a number of factors when considering a specific bomb/fuze configuration, among which are delivery tactics, explosive envelope of the bomb, delivery aircraft, fuze arming time, release altitude, etc. Reference should be made to the NATOPS manuals for additional data which governs the selection of the particular combination.

The C, D, and E pilot-selected variable delays are selected in flight by the application of specific RF frequencies from the AWW-1 Fuze Function Control Set. The D1, D2, and E1 and E2 are "DC-only" fuzes. They are used operationally with the RF capability of the AWW-1 disabled and are initiated by a DC voltage.

There are advantages and disadvantages to both systems of fuze initiation. RF initiation provides a range of four selectable arming and functioning delays, any one of which may be selected according to on-the-spot tactical requirements.

Selectable arming delays place an additional burden on the pilot, however. Incorrect selection of arming and functioning delays can result in damage or loss of delivery aircraft due to bomb fragmentation, or dudding of the bomb if impact occurs before arming is complete.

DC-only initiation results in improved system reliability and reduces the possibility of human error, but is purchased at the expense of system flexibility. When targets and tactics can be defined in advance, DC-only initiation can simplify the logistic and maintenance problems associated with the oscillator units of the AWW-1 system. Turn-around time between strikes can be reduced, and the possibility of application of improper RF signals is reduced.

WARNING

Oscillator plug-in units and fuzing templates of the Fuze Function Control Set AN/AWW-1 should be removed from the aircraft prior to operation with DC fuzes. This prevents accidental application of RF voltages and resulting change in arming and functioning delay times.

ASSOCIATED EQUIPMENTS

Fuze M990 is used with a variety of accessory equipments, depending upon the mission configuration of the Mk 80 series bomb into which it is fitted.

A summary of these equipments and their functions are given in Table 2-1.

DESCRIPTION

Fuze M990 is shown in Figures 2-1 and 2-2. Figure 2-1 is Fuze M990C; Figure 2-2 is typical of modifications D, D1, D2, E, and E1. Fuze M990C is electrically identical to M990D, the only difference being in the inclusion of the Mk 26 Safety Device in the -D and subsequent modifications. (When Safety Device Mk 26 is installed on the M990C, it becomes by definition, an M990D.) Fuze M990E2 utilizes Safety Device Mk 28, described in Chapter 5.

NOTE: Early production runs of M990C-labeled fuzes were sometimes shipped with a Mk 26 Safety Device already installed.

PHYSICAL DESCRIPTION. Dimensions of Fuze M990 are given on the summary sheet at the beginning of this section.

To aid in identification of the various fuzes under adverse red-lighting conditions present during night-time loading operations, high visibility reflective decals are affixed to the fuze bodies. Table 2-2 summarizes the decal identification characteristics.

Each decal is silver with black lettering as indicated in the table. Further identification is provided by an identically shaped identification tag affixed to the sleeve at the end of the fuze by the safety wire. The tag is lettered with the fuze mod number (D1, E2, etc.) and the standard M990 fuze warning as follows:

"Warning -- Remove after arming wire has been inserted.
If bomb is not dropped, replace before removing arming wire."

THEORY OF OPERATION. Fuzes in the M990 series are initiated electrically from either DC or DC/RF from the delivery aircraft. Additional

Table 2-1

FUZE M990; ASSOCIATED COMPONENTS

Associated Component	Function	Comment
Safety Device Bomb Fuze, Mk 26	Provides a positive lock on internal switching circuits (rotor) until bomb release	Used with M990D, D1, D2, E, and E1. Not provided with M990C (See Chapter 5)
Switch, Wafer Mk 93 Mod 0	Reduces RADHAZ** dangers; prevents charging of fuze prior to bomb release	Used with all series. Connected externally into bomb cable assembly (See Chapter 5)
Proximity Sensing Element M20* (tan nose cone)	Provides VT airburst capability for weapon	Installed in nose well. Used with all Mk 80 series bombs except SNAKEYE. In combination with M990, nomenclature as Proximity Bomb Fuze M913
Target Detecting Device Mk 43 Mod 0 (green nose cone)	Provides VT airburst capability for both SNAKEYE and low-drag weapons	Used primarily with Fuze M990E2 in SNAKEYE retarded applications
Safety Device Mk 28 Mod 0 (Retard Sensor)	Provides additional safety in SNAKEYE applications by "sensing" fin opening as a prerequisite to arming	Factory-installed on M990E2 in place of Safety Device Mk 26
Special Purpose Electrical Cable Assemblies M71, 72, 73C, and 74	Provides electrical connection between M990 and nose element and aircraft	Used with Low Drag Bombs Mk 81, 82, 83, and 84, respectively (See Chapter 5)

* May also be designated M20A1 (identified by brick-red nose cone)

** Hazards of possible initiation of explosive components due to electromagnetic radiation from radar, radio transmitters, etc. (Also referred to as HERO)



Figure 2-1 Electric Fuze M990C

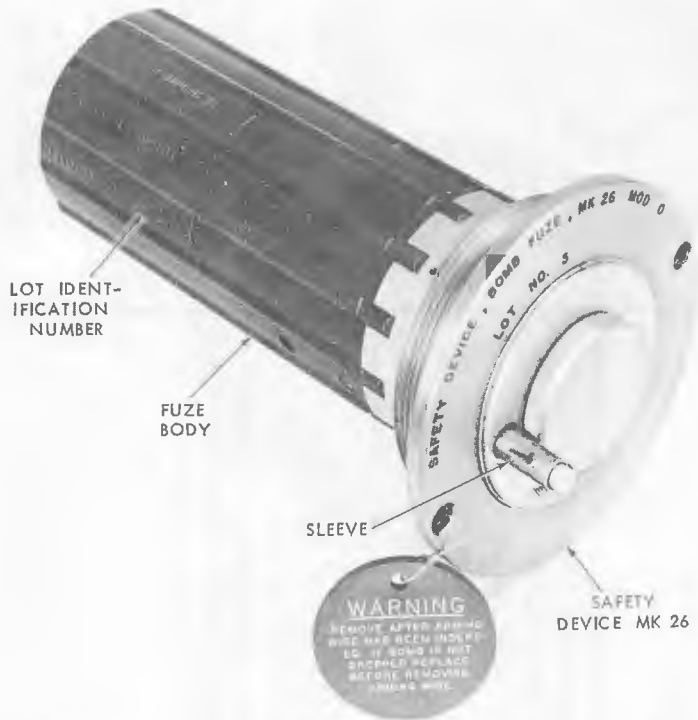







Figure 2-2 Electric Fuze M990D, D1, D2, E, and E1

Table 2-2

M990 DECAL IDENTIFICATION

Fuze Mod	Decal Shape	Lettering	Comment
M990C	none	--	Identified by lack of Mk 26
M990D	none	--	Unmarked; warning tag may be circular in shape
M990D1		D1 4.5/.004	Early-issue D1's may not be marked
M990D2		D2 4.5/.025	--
M990E		E	Arming and functioning times not shown
M990E1		E1 5.5/.050	--
M990E2		E2 (R)2.6/.000 (U)5.5/.000	Refers to "retarded" and "unretarded" times

mechanical safety is provided in flight by an arming wire which is secured through the sleeve of the safety device.

Figures 2-3 and 2-4 are schematics of fuzes M990C and D, and Fuze M990E, respectively. Circuit differences between the C and D series and the E series are indicated by the shaded areas on Figure 2-3.

As noted above, -C, -D, and -E fuzes are DC/RF-initiated while the numbered mods (-D1, -D2, -E1, and -E2) are DC-only initiated. RF operation allows pilot selection of arming and functioning delay times as a function of the RF frequencies fed to the fuze from the oscillators of the AWW-1 Fuze Function Control Set.

NOTE: It should be noted that, although commonly referred to as "RF initiated", Fuzes M990C, D, and E also require a DC component; RF is used to select the arming and functioning delay and DC is used to power the fuze. Therefore, the term "DC/RF" is more accurate.

RF OPERATION. Operation with RF selection is as follows:

1. DC and RF voltages are applied simultaneously to the input of the fuze from the AWW-1 Fuze Function Control Set. The DC voltage immediately charges Capacitors C1 and C3 and initiates the pyrotechnic delay squib S8. Switch S8 then operates and isolates the fuze input and prevents subsequent capacitor bleed-off through the charging receptacle in the bomb case.
2. One or more RF frequencies are coupled to the tuned LC circuits across the input transformer; the specific tuned circuits which are activated are a function of the RF frequency.
3. As shown in Figure 2-3, each tuned circuit is associated with one of the squibs S1 through S6. When the circuit is actuated, the associated squib is blown and its switch (shown by means of the broken lines) is thereby operated. Switches in the figure are shown in their unoperated positions.
4. Resistors R1, 2, 3, and 4 control the time-constant discharge rate of C1 and the associated charging rate of C2. When C2 is charged to the operating level of the cold-cathode Gas Diode V1, the tube fires, causing the arming bellows to operate (Fig. 2-5) (Various combinations of R1, 2, 3, and 4 will provide the appropriate arming delay time as indicated in Table 2-3).
5. After the arming bellows have operated the rotor, the fuze is fully armed and all switches are in position for detonation.
6. Upon impact, the trembler switches close when subjected to the required G forces. The firing circuit is thus completed to the detonator if S4 (instantaneous functioning delay) has been operated. If a finite functioning delay has been selected, S7 operates on impact and the delay firing train to the detonator is initiated. The detonator will operate only when capacitor

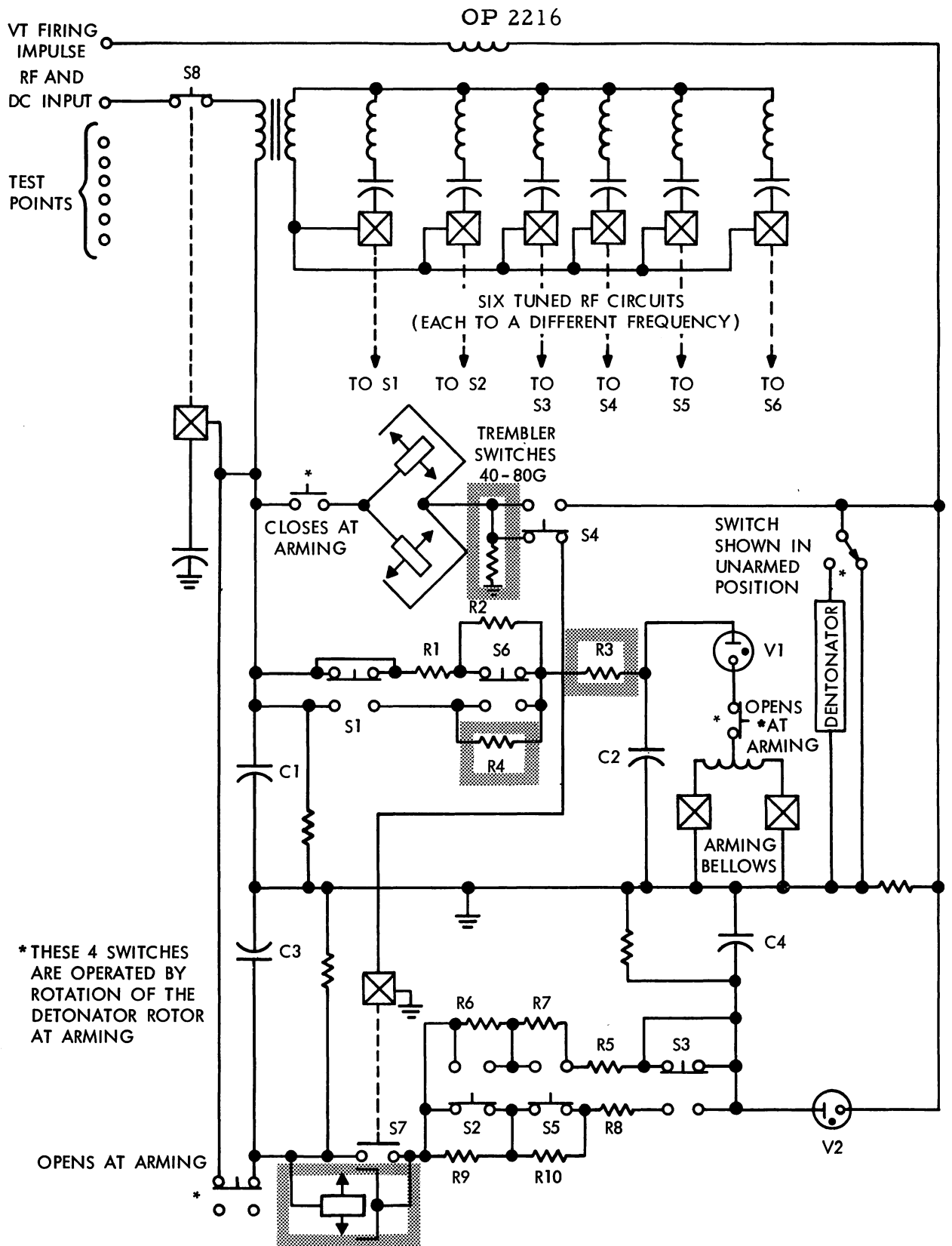


Figure 2-3 Fuze M990C and D; Schematic

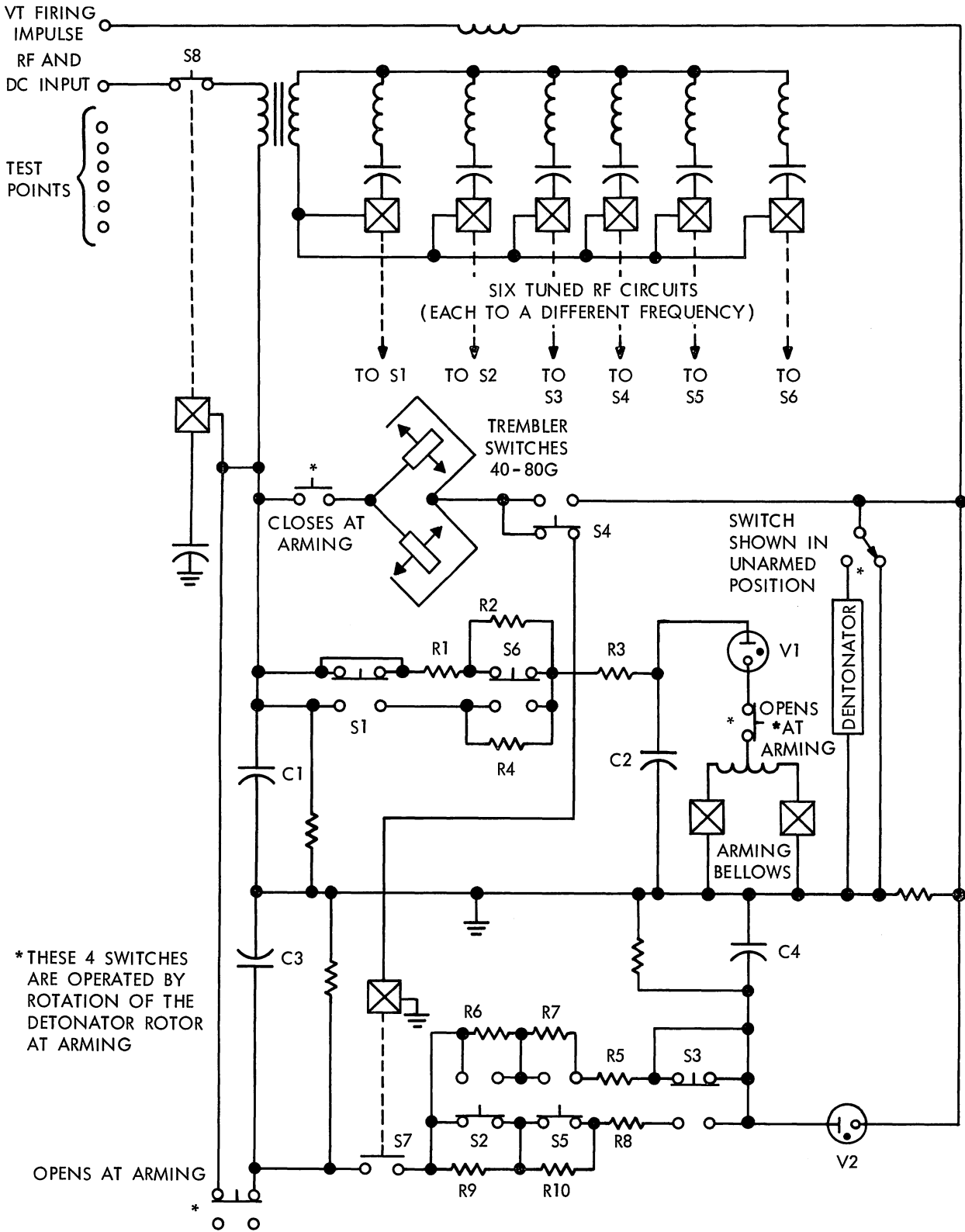


Figure 2-4 Fuze M990E; Schematic

Table 2-3

RF OPERATION OF M990 CIRCUITRY

Delay Time	Tuned RF Circuits Actuated	Associated Squib	Resistors Utilized	Applicable Mod
8 sec arming	none	none	R1, R3	M990C, D, and E (will arm in 8 sec if used with DC initiation only)
4.5 sec arming	1	S1	R3, R1 in parallel to R4	M990C and D
2 sec arming	1, 6	S1, S6	R3 only	M990C and D
20 sec arming	6	S6	R1, R2, R3	M990C, D, and E
2.6 sec arming	1, 6	S6, S1	R3 only	M990E
5.5 sec arming	1	S1	R3, R1 in parallel to R4	M990E
Inst. functioning	4	S4	none	M990C, D, E; arming places trembler switches in series with detonator
.004 sec functioning	3	S3	R6, 7, and 5 in parallel to R8	M990C, D, E
.010 sec functioning	3, 2	S3, S2	R8, R9 in parallel to R7, R5	M990C, D, E
.025 sec functioning	3, 5	S3, S5	R8, R10 in parallel to R6, R5	M990C, D, E

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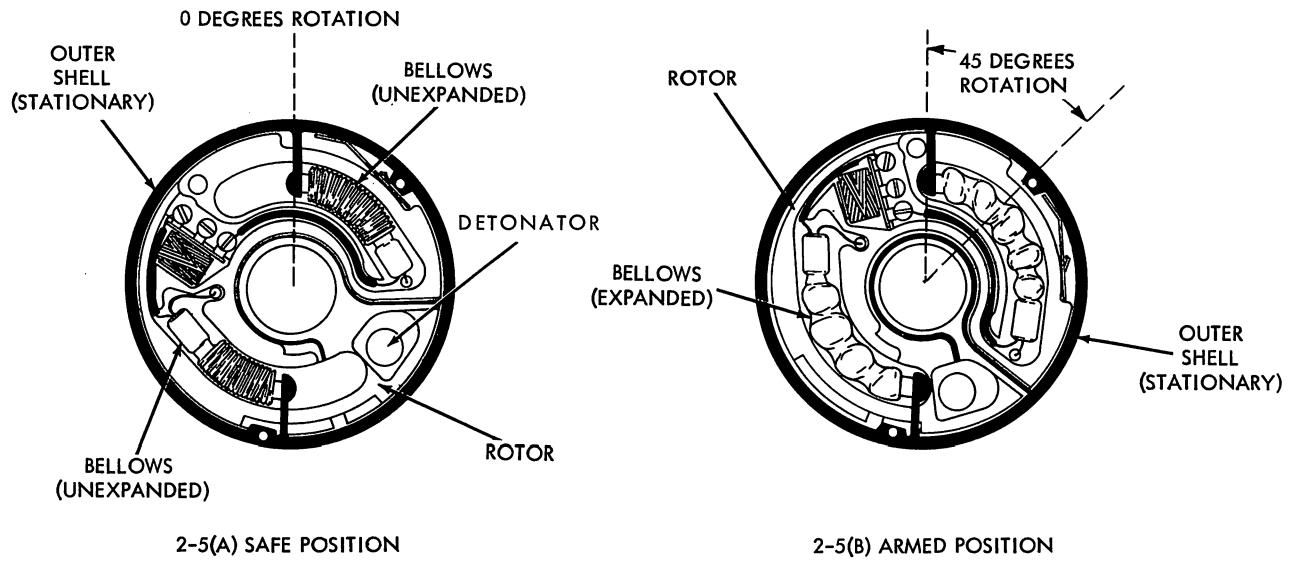
Table 2-3 (Cont.)

Delay Time	Tuned RF Circuits Actuated	Associated Squib	Resistors Utilized	Applicable Mod
.050 sec functioning	2, 5	S2, S5	R5	M990C, D, E
5.0 sec functioning	5	S5	R5, R6	M990C, D, E
20 sec functioning	none	none	R5, R6, R7	M990C, D, E (will function at 20 sec if fuze is DC initiated)

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Figure 2-5 M990 Rotor; Safe and Armed Positions
2-11



C4 charges and causes Diode V2 to conduct; the point in time when this occurs is governed by the discharge time of C3 through a selected combination of Resistors R5, 6, 7, 8, 9, and 10 (See Table 2-3).

7. If a proximity sensing element is used in conjunction with the M990, fuze detonation is caused by a different process: The VT Firing signal pulse is connected directly to the detonator and will over-ride any functioning delay that the fuze may have (Figs. 2-3 and 2-4). Should the sensing element fail to provide the VT firing pulse, the selected M990 functioning delay will operate at impact, thus acting as a backup.

DC PRESELECTION. With DC-only operation, the function of the fuze is slightly less complex. As noted previously, Fuzes D1, D2, E1, and E2 are "preselected." That is, the various squibs required to produce a specific arming and functioning delay time are fired at the depot prior to issue. Thus, only the DC voltage is required to initiate the fuze. Other than this pre-firing of squibs, operation is identical to that described above.

Preselection of any fuze is accomplished by pre-firing those squibs which will provide the delay times shown in Table 2-3. This is performed only at the depot level and is not an authorized field modification.

NOTE: To expedite delivery to the Fleet, approximately 50,000 M990E1 fuzes are preselected to their 5.5 sec arming time by a method other than that described below. These units have only one arming time available (RF cannot change arming time) and can be identified by the lot number series FWS-1-1 through FWS-1-10.

NOTE: Fuzes M990C, D, and E, although intended primarily for in-flight selections, may be operated with DC-only initiation. As indicated in Table 2-3, these fuzes will arm in eight seconds and function in 20 seconds.

OPERATIONAL CHARACTERISTICS

Although similar in design, each modification of the M990 fuze has distinct operational characteristics and applications. These are summarized in the following paragraphs.

NOTE: Arming and functioning delay times given below are nominal values only. In practice, the actual times may vary. At 70 degrees F and above, times should be calculated to fall within a range of +20 percent to -15 percent. Between -65 degrees and +70 degrees F, tolerances may be from +50 percent to -10 percent.

M990C. Fuze M990C is identical to M990D but does not use Safety Device Mk 26. The fuze in this configuration should never be used. Instructions for installation of the Safety Device into the fuze are presented in Appendix A of this manual. Characteristics of the -C, being identical to the D, are summarized in the next paragraph.

M990D. Fuze M990D is intended for use with RF initiation and provides arming delay times of 2.0, 4.5, 8.0, and 20 seconds. Functioning delay times available with RF initiation are instantaneous, .004, .010, .025, .050, 5.0, and 20 seconds. When initiated without RF, arming and functioning delays are eight and 20 seconds.

M990D1. The M990D1 is the first in the series of preselected DC-only fuzes. It is designed for medium to low-altitude attacks where the M990D (with DC initiation) would provide an excessive arming time.

Arming delay time for the -D1 is 4.5 seconds and functioning delay is .004 seconds.

WARNING

The M990D1 and M990D2 should be used only in those cases where a longer arming delay is excessive and causes reduced bombing accuracy. The 4.5-second arming delay permits a strike at lower altitude but materially increases the probability of damage to the delivery aircraft from bomb fragmentation.

M990D2. The M990D2 is similar to the -D1 but provides an increased functioning delay time of .025 seconds to provide a better penetration capability. The tactical delivery restrictions which apply to the D1 are equally applicable to the D2.

M990E. The M990E is the third RF-initiated fuze in the M990 series. It differs from the -C and -D fuzes in its available arming delay times. Arming delays on the M990E are 2.6, 5.5, 8 and 20 seconds as opposed to 2.0, 4.5, 8, and 20 seconds for the -C and -D. Available functioning delay times are identical in all three series.

When used with DC-only initiation, arming and functioning delays of the -E are identical with other RF fuzes used with DC initiation, 8.0 seconds arming and 20 seconds functioning.

M990E fuze manufacture is almost completely designated for preselection into -E1 and -E2 mods at the depot level. However, inasmuch as some M990E fuzes may be issued unmodified, it is covered as a distinct modification.

M990E1. Fuze M990E1 is preselected to provide a 5.5-second arming delay and a .050-second functioning delay. The preselected 5.5-second arming delay represents an optimum compromise between the short arming delay of the -D1 and -D2 and the longer arming delay of the DC-initiated -D and -E fuzes. The .050-second functioning delay provides good penetration capabilities.

M990E2. The M990E2 differs from other preselected fuzes in that it has two available arming delay times, one of 2.6 seconds for use with SNAKEYE retarded, another of 5.5 seconds for use with either SNAKEYE unretarded or low-drag Mk 80 series bombs. (For additional information on SNAKEYE/

M990 operation, refer to the following subsection, OPERATION WITH SNAKEYE WEAPONS,)

The dual arming delay function is made possible by the use of two discrete arming voltages -- the +300 volts DC normally used to initiate M990 fuzes, and a separate +195 volt DC supply.

The lower voltage causes a change in the RC time constant in the network associated with Diode V1 (Fig. 2-4). With a +300 volt initiation, arming is complete in 2.6 seconds; with the lower voltage, 5.5 seconds is required. (+300 volts is supplied by position "E" on the Fuze Function Control Panel of the AWW-1; +195 volts by position "F".)

Fuze M990E2 operates in conjunction with Safety Device Mk 28, commonly referred to as the "retard sensor". The -E2 is the only M990 fuze which can be utilized with SNAKEYE in the retarded mode; the retard sensor provides an additional margin of safety for operation in this mode.

Functioning delay time in both the retarded and unretarded mode is instantaneous.

OPERATION WITH SNAKEYE WEAPONS

As noted above, the only electric fuze designed for full SNAKEYE operation is the M990E2, operating in conjunction with the retard sensor.

When used with other DC-initiated M990 series fuzes, the SNAKEYE weapon is electrically initiated only in the unretarded mode (where its characteristics are substantially the same as in the low-drag configuration). When dropped in the retarded mode, the weapon is initiated by mechanical nose fuzing (AN-M103A1/M163, M904E2, etc.) and the M990 tail fuze is released inert.

SNAKEYE retarded operation at low altitude requires a short arming delay time to prevent dudding due to impact before arming is complete. The shortest preselected arming time available, 4.5 seconds, using M990D1 and -D2, is excessively long for retarded operation. RF initiation of -D and -E series fuzes can provide the shorter 2.0 and 2.6-second arming delay time required for SNAKEYE retarded operations, but is not authorized inasmuch as these fuzes are not fitted with the retard sensor and as such, are materially less safe.

With the M990E2/retard sensor combination, complete electric fuzing is possible in both the retarded and unretarded mode. The retard sensor provides protection against two inherently dangerous conditions: (1) mechanical failure of the weapon to retard when released in the retard mode; and (2) pilot error, by the selection of the 2.6 second arming delay time (instead of the correct 5.5-second delay) with an unretarded delivery. If the pilot selects the shorter delay time when he releases the weapon unretarded, or if mechanical failure prevents the weapon from retarding, the retard sensor prevents the rotor of the fuze from turning to the armed position, thus causing the weapon to dud.

NOTE: The shorter arming time is inherently dangerous in the **unre-**tarded mode due to the tendency of the bomb to follow the delivery aircraft after release. Additionally, M990 fuzes will occasionally detonate at arming (approximately 1%), particularly with VT (approximately 4%).

The retard sensor is covered in detail in Chapter 5.

OPERATION WITH SENSING ELEMENT M20

Sensing Element M20 is a VT accessory device fitted in the nose well of Mk 80 series low-drag bombs. It provides an airburst capability when used in conjunction with any M990 fuze except the -E2 in the SNAKEYE retarded mode. The M20 may be initiated either by an RF pulse from the delivery aircraft at bomb release (if RF initiation of the M990 is utilized) or by withdrawal of an arming wire from the striker rod. (See Chapter 5 for a full description of the M20.) The latter is used with DC-only initiation.

Burst height of the M990/M20 combination can be varied by means of the setting of the HI-LO switch. Because of the reduced impact velocities and low impact angle, the M20 cannot be used with SNAKEYE retarded (burst height is reduced to zero).

The M990 fuze is detonated by a firing pulse from the M20 as shown in Figures 2-3 and 2-4. In the absence of a VT pulse, a backup function is provided by the trembler switches as in non-VT operation.

OPERATION WITH TARGET DETECTING DEVICE MK 43

Target Detecting Device Mk 43 provides a VT capability for SNAKEYE retarded. The +300-volt DC pulse which is used to initiate the retard mode of the M990E2 fuze also initiates the Mk 43. Unlike the earlier M20, however, the Mk 43 cannot be initiated by an RF pulse. However, the Mk 43 can be initiated by withdrawal of the arming wire from the striker rod, in the same manner as with the M20. The Mk 43 is not affected by the +195-volt DC pulse required for unretarded SNAKEYE operation, however. Therefore, it can provide the VT-non-VT options shown in Table 2-4.

When used with the M990E2 fuze, the Mk 43 provides a nominal 16-foot burst height in the retarded mode, given an angle of approach of 10 to 60 degrees over average terrain.

The Mk 43, also designated Sensing Element M20E1 by the Army, is covered in detail in Chapter 5. Its firing functions with respect to the M990 fuze are the same as with the M20.

APPLICATION OF M990 ELECTRIC FUZES WITH MK 80 SERIES BOMBS (DC INITIATION ONLY)

The purpose of this subsection is to promulgate Mk 80 bomb/M990 fuze combinations currently authorized for DC-only initiation.

WARNING

Each bomb-fuze combination listed here imposes specific aircraft restrictions during tactical delivery under various operational conditions. No attempt is made to detail these restrictions here; users must be governed by the applicable NATOPS manuals.

Table 2-4

Mk 43/M990E2 CONFIGURATION: VT OPTIONS

Arming Wire Configuration	Selected M990E2 Arming Delay Time	Options (VT or Non-VT)	Burst Characteristics	Comment
No arming wire	2.6 seconds (retarded)	No	VT*only	No arming wire needed to initiate Mk 43. Mk 43 is initiated by the +300-volt DC charge which initiates M990E2
	5.5 seconds (unretarded)	No	Impact only	Mk 43 is not initiated due to lack of +300-volt DC. (+190 Volts used to initiate M990E2)
Arming wire from Mk 43 to bomb rack Solenoid	2.6 seconds (retarded)	No	VT*only	Mk 43 initiated by +300 Volts DC which overrides slipped arming wire by inactivated solenoid
			5.5 seconds (unretarded)	Yes
	Impact	Arming wire is slipped by solenoid at release; Mk 43 not initiated		

* Impact backup function always present

BOMB/FUZE CONFIGURATIONS. Fuzes M990D1, D2, E1, and E2 (and also the D and E, if initiated by DC only) are used with Mk 80 series bombs in the following configurations:

M990 only (steel nose plug)
 M990 with M20 (VT capability)
 M990 with Target Detecting Device Mk 43
 (Primarily for use with M990E2)
 M990 with mechanical nose fuze
 (redundant fuzing in low-drag configuration)
 M990 with mechanical nose fuze (non-
 redundant fuzing for SNAKEYE retarded)

REDUNDANT FUZING. Redundant fuzing in the low-drag weapon configuration can improve functional reliability providing that the more complex procedures for weapon rigging and weapon release associated with this configuration are used. Coupled with the increased reliability, however, is a corresponding degradation of inherent safety. If redundant fuzing is used, decreased safety versus increased reliability must be considered as a trade-off for any tactical situation. See item 8 of Table 2-5.

USE OF STEEL NOSE PLUG. Certain M990/Mk 80 series bomb configurations require the use of the M990 tail fuze only, with no VT element or mechanical nose fuze in the nose well. In this case, a steel nose plug with a liner insert (see Chapter 5) must be installed in the nose well. The steel nose plug does two things: It increases the penetration capability of the weapon when a finite functioning delay is employed. It also reduces the chance of deflagration or breakup of the bomb case on impact. The latter can be important even when an M990E2 fuze (with instantaneous functioning delay) is used against hard targets.

SAFE JETTISON. Mk 80 series bombs armed solely with M990 fuzes can be jettisoned safe by placing the AWW-1 Fuze Function Control Panel in the SAFE position and releasing the bomb. This prevents the fuze from charging and causes the bomb to dud. When mechanical fuzes are used in the nose, they are released with the arming wire intact. (Nose fuze arming wires are never positively secured, but are connected to the bomb rack solenoid.)

SNAKEYE RETARDED CONFIGURATION. As indicated in Table 2-5, SNAKEYE retarded requires a short arming time to ensure that arming will have occurred before impact, particularly with low-level delivery. The only current fuzes capable of providing this are the family of mechanical nose fuzes indicated on column 5 of the table and the M990E2.

When used with a mechanical nose fuze, the SNAKEYE tail is interlocked with the fuze to ensure that it will not arm unless the tail operates. (A dangerous condition could exist if the mechanical fuze were allowed to arm and the tail failed to retard the bomb.)

Upon occasions, however, the tail has been known to operate prematurely, as on catapult launch of the aircraft. This requires emergency safe jettison

of the bomb from the bomb rack. To maintain the nose fuze in an unarmed condition during launch, a second arming wire is connected directly from the nose fuze to the unenergized nose solenoid. Additional details are given in the aircraft loading manual, SNAKEYE I publications, and AAB-357 and -358.

PROCEDURAL INFORMATION

The following procedures describe M990 fuze installation and removal with Mk 80 series bombs. Installation and removal procedures for other Mk 80 bomb accessories (M20, cables, etc.) are described under their own sections in Chapter 5. Procedures relating to bomb assembly and loading are covered in OP 2216 Part 1, OP 3339, OP 3147, and in the appropriate aircraft loading manual. Refer to Chapter 5 for data on Wafer Switch Mk 93, required for each installation.

INSTALLATION OF M990 SERIES FUZES IN MK 80 SERIES BOMBS. The following procedures are applicable to all Fuzes M990D and E series and Bombs Mk 81, 82, 83, and 84. Refer to appendix A for procedures applicable to Fuze M990C. (M990C fuzes do not have Safety Device Mk 26 installed.)

CAUTION

Installation procedures for M990 fuzes should not be conducted in any area in close proximity to any radar antenna or EMR operating communications equipment as prescribed by current EMR restrictions. Strong EMR fields can initiate the arming bellows or squibs. Although the Mk 26 or 28 Safety Device will prevent arming, the rotor will not operate at bomb release and the bomb will dud.

The following materials are required.

1. Electric Bomb Fuze M990
2. Bomb Fin Assembly
3. Selected Low-Drag Bomb Body
4. 3/16-inch sockethead screw wrench (to remove or install the tail shipping cap on Bombs Mk 81 and 82, to loosen or tighten the nose plug set screw on all bombs, and to install or remove the fin on Bombs Mk 81 and 82)
5. 1/2-inch open-end wrench (to remove or install the tail shipping cap on Bomb Mk 83)
6. 3/8-inch open-end wrench (to remove or install the tail shipping cap on Bomb Mk 84)
7. 3-3/4 inch hex spanner wrench (to remove or install the base fuze plug on Bombs Mk 81 and 82)
8. 7/32-inch socket head screw wrench (to loosen or tighten the base fuze plug set screw on bombs Mk 83 and 84)

TABLE 2-5 AUTHORIZED MK80/M990

MK80 BOMB CONFIGURATION	NOSE ELEMENT	M990 FUZE MODIFICATION	ARMING DELAY TIME (SEC)	FUNCTIONING DELAY TIME (SEC)	ARMING CONNECTION	
					NOSE	TARGET
<u>AIR BURST</u> 1. MK80 SERIES LOW DRAG OR SNAKEYE I UNRETARDED	SENSING ELEMENT PROXIMITY, M20	M990D	8	VT* OR 20 SEC	NOSE SOLE-NOID	POSITIVE
		M990D1	4.5	VT* OR 0.004 SEC		
		M990D2	4.5	VT* OR 0.025 SEC		
		M990E	8	VT* OR 20 SEC		
		M990E1	5.5	VT* OR 0.050 SEC		
2. MK80 SERIES LOW DRAG OR SNAKEYE I UNRETARDED	SENSING ELEMENT PROXIMITY, M20	M990D	8	VT ONLY; 20 SEC BACK UP	POSITIVE	POSITIVE
		M990D1	4.5	VT ONLY; 0.004 SEC BACK UP		
		M990D2	4.5	VT ONLY; 0.025 SEC BACK UP		
		M990E	8	VT ONLY; 20 SEC BACK UP		
		M990E1	5.5	VT ONLY; 0.050 SEC BACK UP		
3. SNAKEYE I RETARDED SNAKEYE I UNRETARDED	TARGET DETECTING DEVICE MK 43 MOD 0	M990E2	2.6 (RE-TARDED MODE)	VT ONLY INSTANTANEOUS IMPACT BACK UP	NO CONNECTION	POSITIVE
			5.5 (UNRE-TARDED MODE)	INSTANTANEOUS IMPACT ONLY		
4. SNAKEYE I RETARDED SNAKEYE I UNRETARDED	TARGET DETECTING MK43 MOD 0	M990E2	2.6 (RE-TARDED MODE)	VT ONLY; INSTANTANEOUS IMPACT BACK UP	NOSE SOLE-NOID	POSITIVE
			5.5 (UNRE-TARDED MODE)	VT OR IMPACT		

* NOTE: VT OPTION ALWAYS INCORPORATES IMPACT FIRING BACK UP AT APPROPRIATE FUNCTIONING DELAY TIME.

90 CONFIGURATIONS (DC INITIATION ONLY)

L	G WIRE CONNECTIONS		SAFE JETTISON	LIVE DROP	PILOT OPTION		COMMENTS
	SNAKEYE I FIN				RETARDED VS NON-RETARDED	VT VERSUS NON-VT	
I-	NO CONNECTION		AWW-1 IN SAFE; NO VOLTAGE TO M990	AWW-1 ON "E" NOSE SOL. ACTUATED FOR VT	NO	YES	PILOT OPTION OF VT VERSUS NON-VT AVAILABLE, DEPENDING UPON ACTUATION OF M20 SENSING ELEMENT AT RELEASE. M20 IS ACTUATED MECHANICALLY BY ARMING WIRE TO NOSE SOLENOID.
I-	NO CONNECTION		AWW-1 IN SAFE; NO VOLTAGE TO M990	AWW-1 ON "E"	NO	NO	NO OPTION, VT ONLY. M20 IS ACTUATED AUTOMATICALLY ON RELEASE DUE TO POSITIVE ARMING WIRE CONNECTION.
I-	TAIL SOLENOID		AWW-1 IN SAFE; NO VOLTAGE TO M990	AWW-1 ON "E"	YES	NO	MK43 INITIATED BY THE +300 VOLTS WHICH SELECTS THE 2.6 SEC ARMING DELAY OF M990E2 FUZE. VT OPERATION ONLY.
				AWW-1 ON "F"			IMPACT ONLY. WITHOUT ARMING WIRE, MK43 CANNOT BE INITIATED. MK43 DOES NOT RESPOND TO THE +195 VOLTS WHICH SELECTS THE 5.5 SEC ARMING DELAY OF M990E2 FUZE.
I-	TAIL SOLENOID		AWW-1 IN SAFE; NO VOLTAGE TO M990	AWW-1 ON "E"	YES	NO	MK43 INITIATED BY THE +300 VOLTS WHICH SELECTS THE 2.6 SEC ARMING DELAY VT OPERATION ONLY.
				AWW-1 ON "F" NOSE SOL. ACTUATED FOR VT		YES	MK43 IS INITIATED BY ARMING WIRE WITHDRAWAL DOES NOT RESPOND TO +195 VOLTS DC TO M990E2.

MK80 BOMB CONFIGURATION	NOSE ELEMENT	M990 FUZE MODIFICATION	ARMING DELAY TIME (SEC)	FUNCTIONING DELAY TIME (SEC)	NO	
<u>SURFACE BURST</u> 5. SNAKEYE I RETARDED	MECHANICAL NOSE FUZES AN-M103A1 AN-M139A1 AN-M140A1 M163 M164 M165 M904E2	M990D M990D1 M990D2 M990E M990E1 UNENERGIZED IN RETARDED CONFIGURATION	ARMING DELAY VARIES WITH NOSE FUZE AND ARMING VANE. SEE CHAPTER 3 FOR SPECIFIC ARMING DELAYS.	PREFLIGHT SELECTION OF INSTANTANEOUS OR FINITE DELAYS DEPENDING ON NOSE FUZE. SEE CHAPTER 3.	(1) INTE LOC WITH SNAKEYE TAIL AND NOS SOLE (2) ARMING WIRE NOS SOLE	
						SNAKEYE I UNRETARDED
<u>SURFACE OR SURFACE PENETRATION</u> 6. MK80 SERIES LOW DRAG OR SNAKEYE I UNRETARDED	STEEL NOSE PLUG		M990D	8	20 SEC	NON
			M990D1	4.5	0.004 SEC	
			M990D2	4.5	0.025 SEC	
			M990E	8	20 SEC	
			M990E1	5.5	0.050 SEC	
7. SNAKEYE I UNRETARDED	STEEL NOSE PLUG	M990E2	5.5	INSTANTANEOUS	NON	
SNAKEYE I RETARDED			2.6			
<u>REDUNDANT FUZING</u> 8. MK80 SERIES LOW DRAG OR SNAKEYE I UNRETARDED	AN-M103A1 AN-M139A1 AN-M140A1 M163 M164 M165 M904E2	M990D M990D1 M990D2 M990E M990E1	ARMING DELAY WITH NOSE FUZE AND ARMING VANE. SEE CHAPTER 3 FOR SPECIFIC ARMING TIMES. ARMING DELAY FOR M990 AS SHOWN ABOVE.	PREFLIGHT SELECTION OF DELAY FOR MECHANICAL FUZE AS SHOWN IN (5) ABOVE. M990 FUNCTION DELAYS AS SHOWN ABOVE.	NOSI SOLE NOIC	

TABLE 2-5 (CONTINUED)

ARMING WIRE CONNECTIONS			SAFE JETTISON	LIVE DROP	PILOT OPTION		COMMENT
SE	TAIL	SNAKEYE I FIN			RETARDED VS NON-RETARDED	VT VERSUS NON-VT	
R-K K- E NOISE - TO E NOISE	POSITIVE	TAIL SOLENOID	AWW-1 IN SAFE; NO VOLTAGE TO M990. TAIL SOLENOID ON, SAFE NOSE SOLENOID ON SAFE	AWW-1 ON "OFF" NOSE SOLENOID ACTUATED	YES	NO	MECHANICAL FUZING PROVIDES SHORT ARMING DELAY REQUIRED FOR SNAKEYE RETARDED. M990 FUZE MUST BE DE-ENERGIZED BY PLACING AWW-1 IN SAFE POSITION. TAIL SOLENOID IS ENERGIZED TO ACTUATE BOTH SNAKEYE TAIL AND MECHANICAL NOSE FUZE. NOSE SOLENOID MUST ALSO BE ACTUATED TO PULL SECOND ARMING WIRE TO MECHANICAL NOSE FUZE.
				AWW-1 ON "E" NOSE SOLENOID ON SAFE			NOSE SOLENOID ON SAFE, ARMING WIRE IS SLIPPED. NOSE FUZE AND SNAKEYE TAIL IN-OPERATIVE. WEAPON IS DETONATED BY M990 FUZE IN UNRE-TARDED MODE.
IE	POSITIVE	NONE	AWW-1 IN SAFE; NO VOLTAGE TO M990	AWW-1 ON "E"	NO	NO	STEEL NOSE PLUG ALLOWS BETTER PENETRATION OF WEAPON AGAINST HARD STRUCTURES.
IE	POSITIVE	TAIL SOLENOID	AWW-1 IN SAFE; NO VOLTAGE TO M990	AWW-1 ON "F"	YES	NO	IMPACT INSTANTANEOUS BURST, NOSE PLUG OPTIONAL. TAIL SOLENOID IS NOT ENERGIZED.
				AWW-1 ON "E"			INSTANTANEOUS ON IMPACT.
E D	POSITIVE	NONE	AWW-1 IN SAFE; NO VOLTAGE TO M990. NOSE SOLENOID ON SAFE	AWW-1 ON "E" NOSE SOLENOID ACTUATED	NO	NO	IMPACT BURST WITH FUNCTIONING DELAY GOVERNED BY THE MECHANICAL OR ELECTRICAL FUZE, WHICH-EVER HAS THE SHORTER FUNCTIONING DELAY. ARMING DELAY TIME IS DETERMINED BY THE SELECTED NOSE MECHANICAL FUZE, AND USUALLY OCCURS BEFORE THE ELECTRIC FUZE. SEE TEXT FOR ADDITIONAL DETAILS. RELIABILITY MAY BE INCREASED BY USE OF THIS CONFIGURATION BUT REDUCES SAFETY.

9. Adjustable spanner wrench (to remove or install the base fuze plug on Bombs Mk 83 and 84)

10. 1/4-inch sockethead screw wrench (to install or remove the fin on Bomb Mk 83)

11. 1/2-inch socket head screw wrench (to install or remove the fin on Bomb Mk 84).

With reference to OP 2216 Part 1 for details of low drag bomb configurations, install the fuze as follows:

1. Remove the shipping cap from the after end of the bomb, and set it aside for possible reinstallation if the bomb is later defuzed.

2. Remove the base plug.

NOTE: On the 1000-pound Bomb Mk 83 Mod 3 and the 2000-pound Bomb Mk 84 Mod 1, it is necessary to loosen a set screw before removing the base plug. These bombs have circular base plugs, whereas the other bombs in the low-drag series have hexagonal base plugs.

3. Remove the hoisting lug and packing material from the fuze well.

4. Check to be sure the fuze well is clean and that the threads are not damaged. Check to see that the bomb cable assembly is assembled properly in the bomb; the fuze charging plug must seat firmly in its retaining clip in the fuze well and the receptacle must be attached securely in the athwartship well. If the cable assembly is not installed properly, reject the bomb. Refer to Chapter 5 for instructions on installation of the bomb cable assembly.

5. Recent lots of M990 fuzes are packed three to a tape-sealed polystyrene shipping container. Each fuze is marked by a characteristic identifying decal (see Table 2-2) on the fuze body. Remove a fuze and two of the additional decals packed in the shipping container. (Note that the fuze is of the proper modification (D1, D2, etc.)) Set the identifying decals aside.

6. Referring to Figure 2-6, insert the fuze into the tail well and screw the threaded flange of the Safety Device with the well. For conical-fin bombs, tighten the fuze until the safety pin assembly on the Safety Device is in the 12 o'clock position (in line with the bomb suspension hooks). The fuze should be tightened sufficiently with the spanner wrench to compress the O-ring slightly.

NOTE: Reference should be made to the appropriate aircraft loading manual for variations in these procedures. With certain aircraft bomb racks, installation procedures may vary slightly. In the case of conflict, the instructions in the aircraft loading manual should be followed.

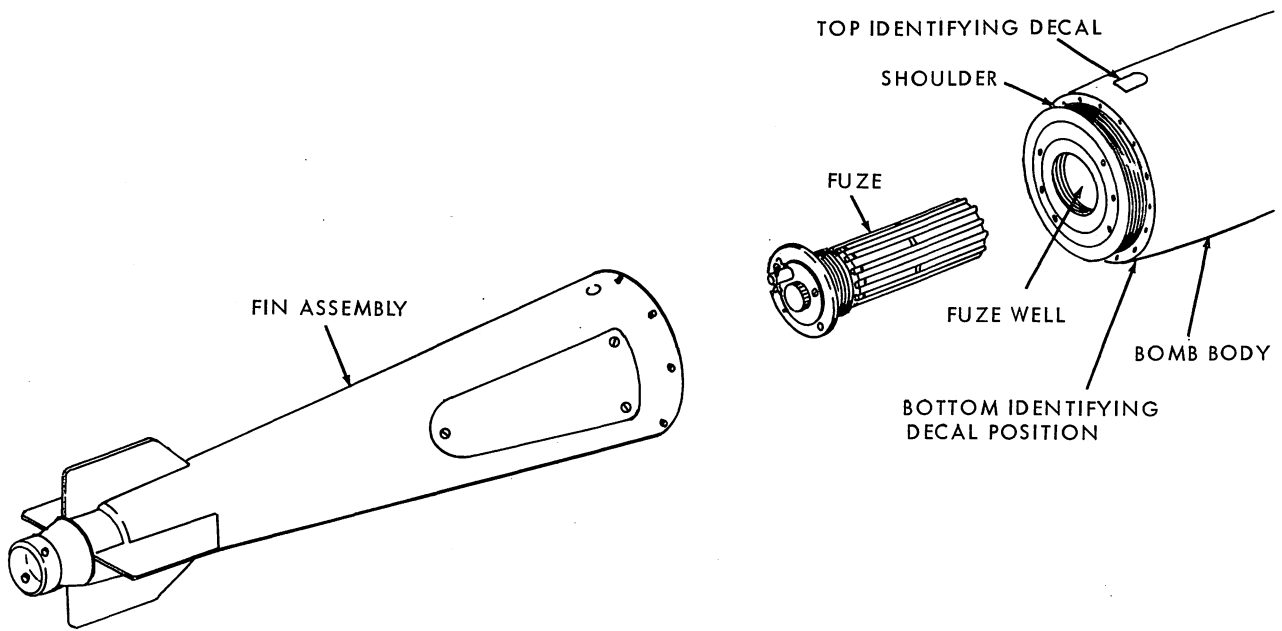


Figure 2-6 M990 Installation in Mk 80 Series
Low Drag Bomb

7. Install the two identifying decals on the bomb body in the six-and-twelve-o'clock position as shown in Figure 2-6. Procedures for affixing decals are packed with the decals.

8. Remove the fin assembly and suspension lugs from the fin shipping crate.

9. Orienting the fin assembly so that the safety wire feed-through hole is in the 12 o'clock position, butt the fin against the aft end of the bomb and secure it using the setscrews on the leading edge of the fin.

Arming Wire Installation. Before loading the bomb on the carrying aircraft, the arming wire is installed through the grommeted hole in the fin, and then through the sleeve of the safety pin assembly in the fuze.

The following materials are required:

1. Steel arming wire, .033-inch diameter, for SNAKEYE I or .064 diameter arming wire for low-drag configuration.
2. Screwdriver
3. Cutting pliers
4. Fahnestock clips, 2 required for conical fins only (none for SNAKEYE)

Proceed as follows:

1. Remove the hand hole cover on the tail fin assembly.
2. Pass the safety wire through the grommeted hole in the tail fin assembly.

CAUTION

At this point, the fuze should be checked to ensure that the rotor has not operated due to shock, EMR radiation, etc. Leaving the safety cotter pin in place, depress the head of the safety pin and release it. It should move smoothly within the sleeve of the Mk 26 Safety Device. If it binds or sticks, the rotor has partially rotated and has jammed the safety pin. The fuze is inoperative and should be so marked.

WARNING

Note the WARNING on the tag on the cotter pin. Do not pull the cotter pin until the safety pin is secured by the arming wire. Failure to observe this warning will result in an unsecured rotor which is capable of arming the bomb if the bellows are initiated for any reason.

3. Insert the arming wire through the empty hole in the sleeve of the safety pin assembly and pull the wire through removing all slack.
4. Cut off excess wire so that approximately 3 inches of wire protrude through the sleeve.
5. Attach two Fahnestock clips and push them up snugly against the sleeve.
6. Pull out the cotter pin with warning tag attached. Retain the cotter pin for possible reuse if the bomb is defuzed.
7. Replace the hand hole cover on the tail fin assembly.
8. Refer to Part 1 of this manual and the appropriate aircraft loading manual for final preparation and loading of the bomb on the aircraft. Refer to OP 3339 and OP 3374 or appropriate current AAB's for SNAKEYE installation.

REMOVAL OF M990 FUZE FROM BOMB. If a bomb has been returned from a strike undropped, it may be defuzed if the arming wire is still installed properly in the sleeve of the safety pin.

WARNING

If the arming wire of an M990 fuze has been accidentally withdrawn when the aircraft returns from a strike, the fuze could be fully armed and should be treated as such. Do not attempt to remove the fuze from the tail well of the bomb or the bomb from the aircraft. Notify EOD personnel immediately.

Because the M990 fuze contains electronic and explosive components, its shelf life is materially reduced if its moisture-resistance is impaired. The fuze is made resistant to moisture by means of a foil seal, covering the charging receptacle. This seal is automatically ruptured when the fuze is installed in the fuze well. If the fuze is subsequently removed from the well (or if the foil has been accidentally ruptured), it becomes susceptible to moisture and should be used on the next strike if possible.

The following procedures should be followed in removing fuzes.

1. Check to ensure that the arming wire is installed.
2. Replace the safety cotter pin and warning tag in the vacant hole in the safety pin.
3. Remove the arming wire and Fahnestock clips.
4. Disassembly the bomb fin according to applicable procedures.
5. Remove the fuze with the spanner wrench.

6. Return the fuze to its original container and seal with moisture-proof adhesive tape as soon as practicable.

7. Tag or label clearly the date of seal rupture and indicate an expiration date of 90 days from this date.

8. As opportunity permits, utilize any such fuzes before the expiration date.

9. Fuzes whose shelf life expiration date has been exceeded shall be turned in to the nearest ammunition activity, marked for "QEL Examination and TEST." Fuzes which cannot be returned to their original containers during the day on which they were removed or which have been exposed to unusual moisture such as driving rain or spray for any length of time should be disposed of by dumping in deep water.

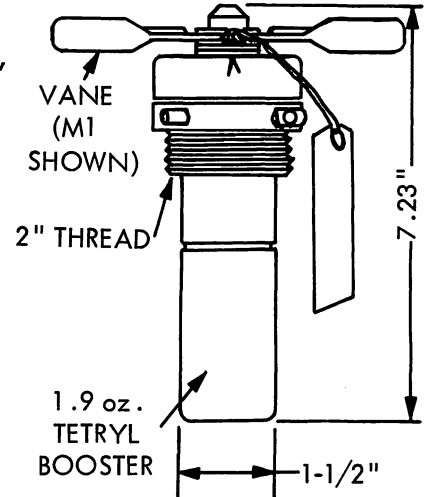
SUMMARY SHEET

Note: This sheet is issued in reproducible form to facilitate making of reproductions locally. It presents a summary of information contained in the following section, and may be used for convenient reference. It is NOT intended to replace the OP.

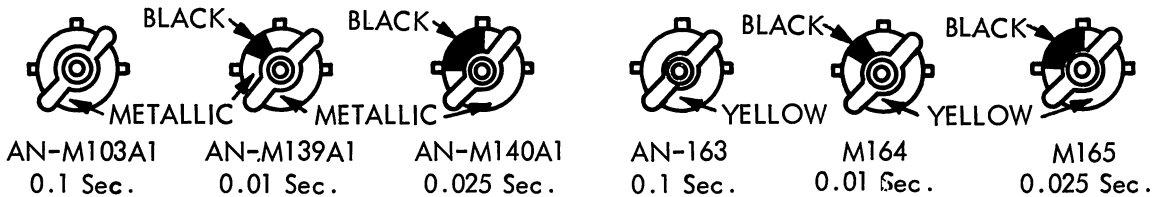
AN-M103A1/M163

KEY POINTS

1. Fuzes in this series are AN-M103A1, AN-M139A1, AN-M140A1, M163, M164, and M165.
2. UNIVERSAL MECHANICAL NOSE FUZE; FITS CURRENT HE BOMBS.
3. 2" thread - needs no adapter booster for GP(FAT) bombs - T45E4 for low drag bombs.
4. Arming vane MK6 and MK7 recommended. M1 may be used as an alternate but arming time is extremely short.
5. No special installation tools required. Unpack fuze, check as specified in OP, screw into nose well hand-tight, and affix arming vane and arming wire.
6. See text for arming delay times. Function at either instantaneous or delay.
7. Functioning delay times are as indicated below:



MECHANICAL IMPACT NOSE FUZE
AN-M103A1/M163 SERIES



8. Instantaneous setting preferred for reliability.

WARNINGS

The following safety precautions must be observed when handling these fuses:

See the text to learn to identify armed and partially armed fuses. These fuses contain a lethal amount of tetryl in the booster and can kill if they are improperly handled when armed.

Fuses can be armed by rotating the arming vane or vane strap. Always keep them secured by a cotter pin and safety wire.

Rough handling can make the fuze dangerous to all hands. Handle fuzes like eggs, not like rocks and cordwood.

Choose the proper fuze and vane for the mission. Read "Operational Characteristics".

Don't ever use a damaged fuze or vane.

Chapter 3

Mechanical Fuzes

Section 1 - Mechanical Impact Nose Fuzes AN-M103A1,
AN-M139A1, AN-M140A1, M163, M164, and M165INTRODUCTION

Mechanical Impact Nose Fuzes AN-M103A1, -139A1, -140A1, M163, -164, and M165 are a family of widely used impact nose fuzes which may be used with any HE bomb in the present stockpile. These fuzes are available to the Fleet in large quantity and will fulfill the majority of fuzing requirements until the M904E2 fuze becomes more widely available.

Fuzes in this family, are all similar in design and application, differing principally in their arming and functioning delay times. Under identical conditions, fuzes AN-M103A1, -139A1, and -140A1 will arm in approximately one-half the time required by the M163, -164, or -165. Functioning delay times are the same for both groups, 0.1 second for the AN-M103A1 and M163, 0.01 for the -139A1 and M164, and 0.025 for the -140A1 and M165. (The delay functioning element of certain lots has deteriorated to the point where the fuze should be used only in the instantaneous impact mode. (See OD 17190 and supplementary NAR's.) Each fuze mod is identified by a characteristic color wedge as shown in Figure 3-1. The arming times are not shown in the figure inasmuch as they will vary according to a number of factors, principally the arming vane used. Arming times also vary with the bomb configuration, irregularities of manufacture, and in many cases, speed of the delivery aircraft at bomb release. (The latter is not a factor if governor arming vanes Mk 6 or 7 are used.)

All fuzes in the AN-M103A1-M163 family are shear-safe (this term is explained later). For this reason, Fuze AN-M103 (without the -A1 designation) should never be used. The unmodified AN-M103 can detonate without arming if subjected to multiple impact.

The AN-M103A1/M163 fuze family provides a safe and reliable fuzing system if employed properly. The correct arming vane must be selected commensurate with the tactical requirements of the mission, and the fuze must be undamaged, properly tested and properly installed. The arming wire must be properly rigged, and proper delivery tactics must be employed.

OPERATIONAL CHARACTERISTICS

The two sub-groups of fuzes (AN-M103A1 series and M163 series) are identical with one exception - the threading of their arming screws. Because of this, the M163 series requires twice as many revolutions to arm as the AN-M103A1 series. Therefore, under comparable delivery conditions, with any given arming vane, the M163 series provides an arming time factor of twice

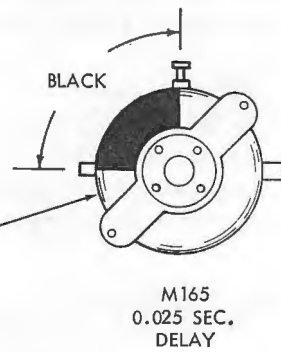
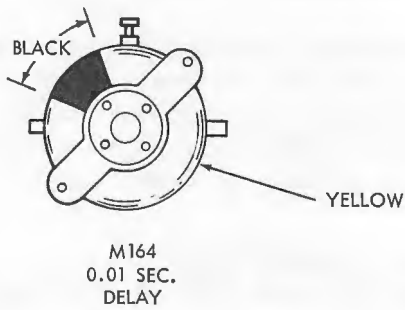
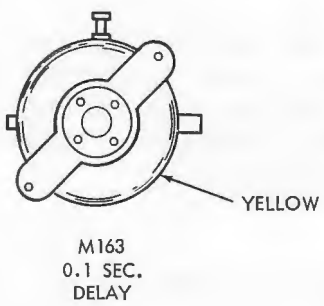
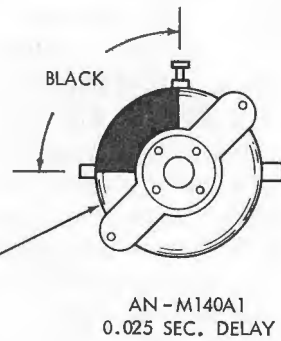
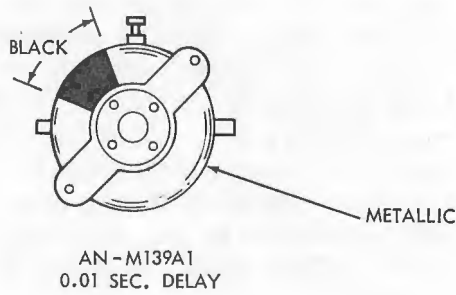
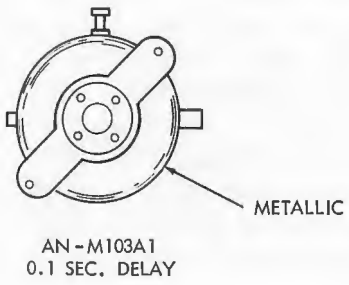
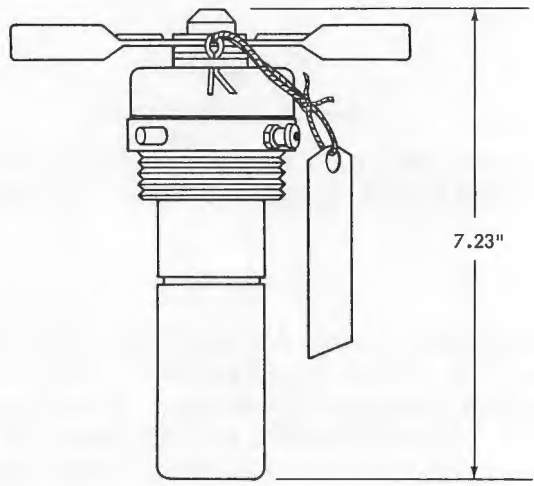


Figure 3-1 Fuzes AN-M103A1/M163 Family, Identification of

that of the AN-M103A1 series. This longer arming time is an asset in high-speed non-retarded weapon delivery.

Both series of fuzes provide the pre-flight option between instantaneous functioning delays and finite functioning delays of 0.1, 0.01, and 0.025 seconds. With respect to functioning delay, the AN-M103A1 and M163 are identical, providing a delay of 0.1 second; the -139A1 and -164 provide 0.01 second; and -140A1 and -165 provide 0.025-second delays.

Arming delays, as noted previously, are determined by the vane, speed of the delivery aircraft, type of bomb, and obviously, by the series of fuze.

A summary of these delays is presented in Table 3-1.

WARNING

The fuze always arms in the delay mode before it arms in the instantaneous mode. Safe separation of the bomb and aircraft is determined by delay mode arming time, even though the fuze is set for instantaneous. Therefore the pilot must always consider the bomb armed as though the fuze functioning delay setting pin is in the delay mode position.

WARNING

Upon arming, vane assembly, cup, and arming disks are ejected into the airstream beneath the delivery aircraft. This presents a hazard to other aircraft to the rear unless appropriate measures are taken in the attack formation.

DELIVERY HAZARDS. As shown in Table 3-1, arming times with the AN-M103A1/M1 fuze-vane combination is critically short and should not be used if the Mk 6 or Mk 7 vanes are available. Further, it should be understood that no fuze-and-vane combination can provide guaranteed safety to the delivery aircraft under all tactical conditions. The pilot plays an important part in avoiding the effects of an early burst through the use of safe delivery techniques. Because the AN-M103A1/M163 fuzes have relatively short arming delay times, they permit bombing at low level; for the same reason, they are susceptible to detonation through midair collision shortly after release.

For optimum reliability, the fuzes should, when tactically practical, be pre-flight selected in the instantaneous functioning delay mode. (Certain lots* of fuzes are limited to this mode only and others should not be used in the delay mode due to the deterioration of the delay elements which increases the possibility of a dud.) When used in the instantaneous mode and fitted with the arming vane appropriate to the delivery tactics, the AN-M103A1/M163 provides a highly reliable and satisfactory mechanical fuze.

*See OD 17190 and supplementary NAR's.

Table 3-1
AN-M103A1/M163 SERIES OPERATIONAL
CHARACTERIESTIC SUMMARY

	AN-M103A1	-139A1	-140A1	M163	M164	M165
Functioning Time at Impact	Inst. or 0.1 sec.	Inst. or 0.01 sec.	Inst. or 0.025	Inst. or 0.1 sec.	Inst. or 0.01 sec.	Inst. or 0.025
Arming Screw Revolutions to Arm	190 revs. (315 required to produce Inst. functioning)			380 revs. (630 required to produce Inst. functioning)		
Arming Time or Distance ^①						
Vane Mk 6	1.6 sec. Nominal (1.2 sec. min. to 2.0 sec. max.)			3.2 sec. Nominal (2.4 sec. min. to 4.0 sec. max.)		
Vane Mk 7 ^③	3.4 sec. Nominal (2.5 sec. min. to 4.2 sec. max.)			6.8 sec. Nominal (5.1 sec. min. to 8.5 sec. max.)		
Vane M1	510 feet to 1080 feet ^② along trajectory			1140 feet to 2420 feet ^② along trajectory		
Time or Distance Required for Inst. Function on Impact						
Vane Mk 6	2.6 sec. Nominal (1.9 sec. min. to 3.3 sec. max.)			5.2 sec. Nominal (3.9 sec. min. to 6.5 sec. max.)		
Vane Mk 7 ^③	5.5 sec. Nominal (4.1 sec. min. to 6.9 sec. max.)			11 sec. Nominal (8.3 sec. min. to 13.7 sec. max.)		
Vane M1	760 to 1600 feet ^② along trajectory			1710 to 3625 feet ^② along trajectory		

NOTES:

¹Bomb is fully armed at this time and will detonate with a finite functioning delay upon impact. Further arming action is required to provide instantaneous functioning upon impact.

²The large variations obtained with the M1 vane are caused by varying shapes of the associated bombs. The smaller values represent a nominal distance when used with the 100-lb. AN-M30A1 bomb; larger values are typical of larger bombs such as the 2000-lb. AN-M66A2. Other variations may occur due to fuze manufacturing tolerances.

³Early-production Mk 7 vanes produce delays somewhat shorter (10 to 15%) than those indicated here. With these vanes, refer to the data sheets in their packing boxes.

MALFUNCTIONS AND ERRATIC OPERATION. Malfunctions of the fuze can result in either a dudded bomb or destruction of the delivery aircraft. Virtually all malfunctions can be traced to rough and improper handling of the fuze or vane prior to installation in the bomb, bomb to bomb collision due to improper delivery, or failure of the arming wire to remain secured prior to bomb release. If a fuze with defective shear and setting pins is deployed, aerodynamic forces alone can cause detonation after arming. (The shear pins in an undamaged fuze would normally prevent this.) Deformed arming vanes can also produce erratic and premature arming upon release.

SAFETY FEATURES. A high degree of operational and handling safety in the AN-M103A1/M163 fuzes is maintained by the out-of-line detonator slider, the arming disks located between the striker and the fuze body, the "shear-safe" feature, and the shear pins.

During shipping and stowage, a lead-sealed safety wire is threaded through the holes in the vane hub, vane strap, and eyelet strap. The wire and a cotter pin, inserted through another set of holes, prevent rotation and accidental operation of the arming mechanism.

The arming disks provide a solid barrier between the striker and fuze body, barring any inward movement of the striker prior to the release of the disks at arming. Additional safety is maintained after arming by the shear pin and setting pin which hold the striker in place until impact.

RESTRICTIONS IN USAGE. Use of these fuzes in external stores should be governed by BUWEPS INSTRUCTION 08024.1, latest issue, and by OD 17190. Fuzes AN-M103, -139, and -140 (all without the "A1" designation) must not be used because these earlier fuzes are not shear-safe. That is, upon initial impact the arming vane assembly and vane cup may shear off; the arming stem will immediately move forward, clear the detonator slider and allow the bomb to arm. The next impact can then detonate the bomb. A non-shear safe fuze would be a hazard in carrier landings if a bomb is jarred loose from a defective or damaged bomb rack. Upon initial impact with the deck, the vane cup could shear off. If so, the bomb would detonate on the second bounce.

The 103A1/M163 series are shear safe. The arming stem is set adjacent to the arming screw such that the collar of the stem is beneath the arming screw. If the forward part of the fuze is sheared off, the arming stem will be blocked from further forward movement by the stub end of the broken arming screw. With the arming stem still in place, the detonator slider will be prevented from moving into the armed position and the bomb will be dudded.

DESCRIPTION

Fuzes of the AN-M103A1/M163 series are impact nose fuzes designed for use in a variety of HE bombs. They are vane-armed and function upon impact either instantaneously or at a finite delay.

FUNCTIONAL DESCRIPTION. Figures 3-1 and 3-2 show the AN-M103A1/M163 series fuze in exterior and cutaway views, respectively. (Fig. 3-2

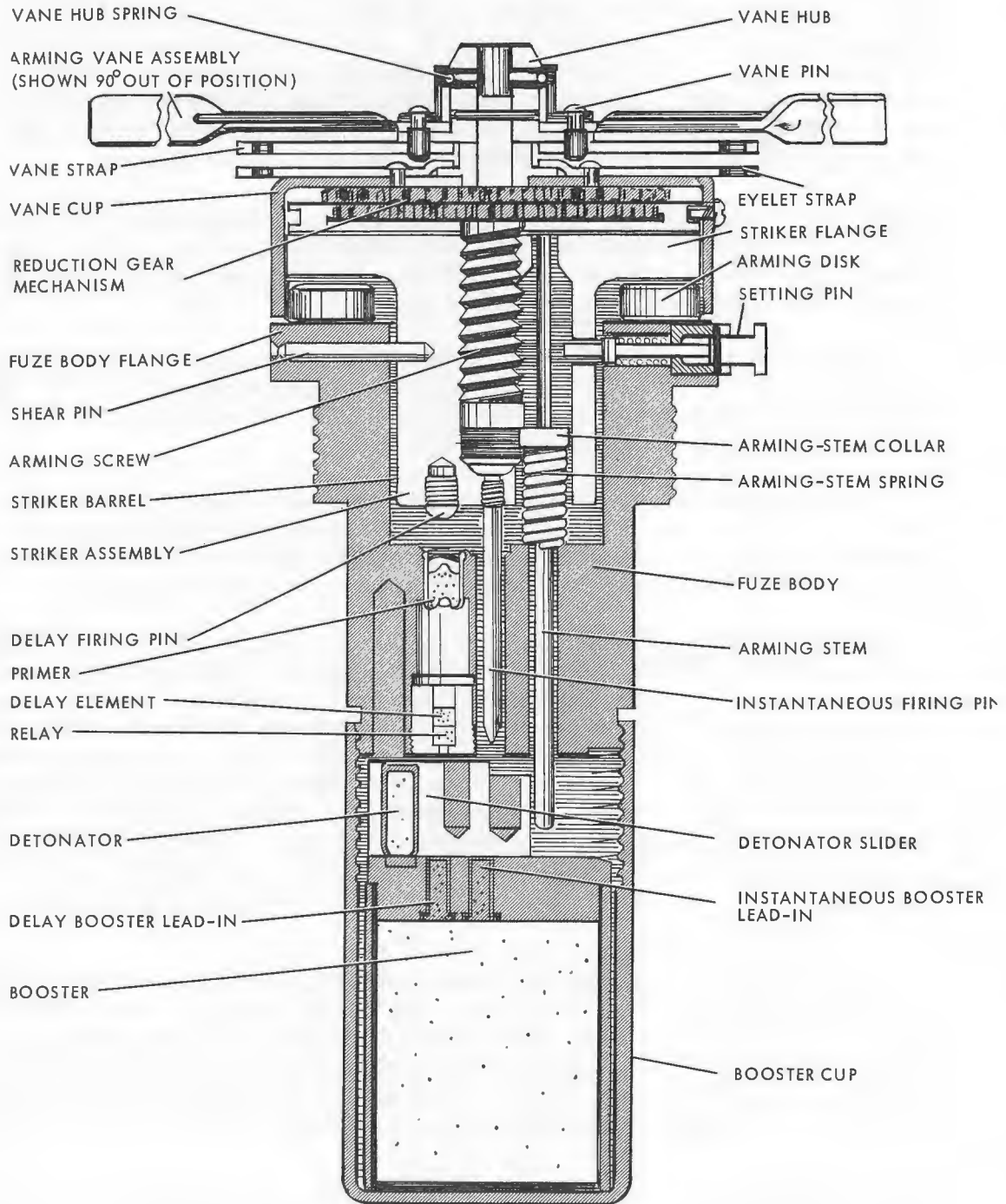


Figure 3-2 Fuze AN-M103A1/M163 Series,
Typical Cross-Section

actually shows the AN-M103A1 series; the M163 series differs only in the threading on the arming screw.)

An arming vane assembly is attached to the vane strap by two pins and is held in place by the vane hub spring. A reduction gear mechanism connects the arming vane and strap to the arming screw. The reduction gear mechanism rotates the arming screw one full revolution for every 65 revolutions of the arming vane.

As the arming vane rotates in the air stream, the arming screw, driven by the gear reduction mechanism, is unscrewed from the striker assembly. As it unscrews, it carries the entire upper assembly, arming vane, strap, reduction gear and vane cup, outward with it. When the vane cup has moved sufficiently forward, 13 arming disks are spring-ejected into the air stream. (The purpose of these arming disks is to provide an additional physical barrier between the fuze body flange and the striker.)

The arming stem (see Figs. 3-2 and 3-3) is a spring-loaded rod which bears against the inner surface of the vane cup. As the arming screw advances and carries the vane cup outward, the arming stem follows. When the fuze is unarmed, the lower end of this stem prevents the detonator slider from moving to the armed position; during arming however, the arming stem moves upward and clears the detonator slider. As shown in Figure 3-3(b) and (c), the detonator is then free to move to the right, in line with the firing train.

Continued operation of the AN-M103A1/M163 fuze depends upon its functioning delay mode, either instantaneous or delay.

INSTANTANEOUS MODE. When a fuze is set for instantaneous functioning, the setting pin (Fig. 3-3) is set in the shallower of the two slots on the sleeve surrounding the setting pin. This position keeps the inner end of the setting pin clear of the channel through which the arming stem moves. (See Fig. 3-3(c) for the position of the setting pin in the instantaneous setting.)

As the arming screw moves the reduction gear assembly vane cap and vane outward, the spring loaded arming stem follows. Eventually all parts forward of the striker are unscrewed and usually fall away into the air stream*. The arming stem is then free to move to the position shown in 3-3 (c). The full withdrawal of the arming stem permits the detonator slider to move fully to the right (as viewed in the illustration). The detonator is then placed under the instantaneous firing pin and arming is complete.

DELAY MODE. For selection of the delay mode, the setting pin is pre-set in the deeper of the two slots in its sleeve. This allows the setting pin to protrude into the channel above the arming stem collar. The unscrewing of the arming screw and the jettisoning of the vane and vane cup occurs, as

*Occasionally, aerodynamic pressures will prevent the vane cup from falling free of the fuze. This is of no consequence in the arming process.

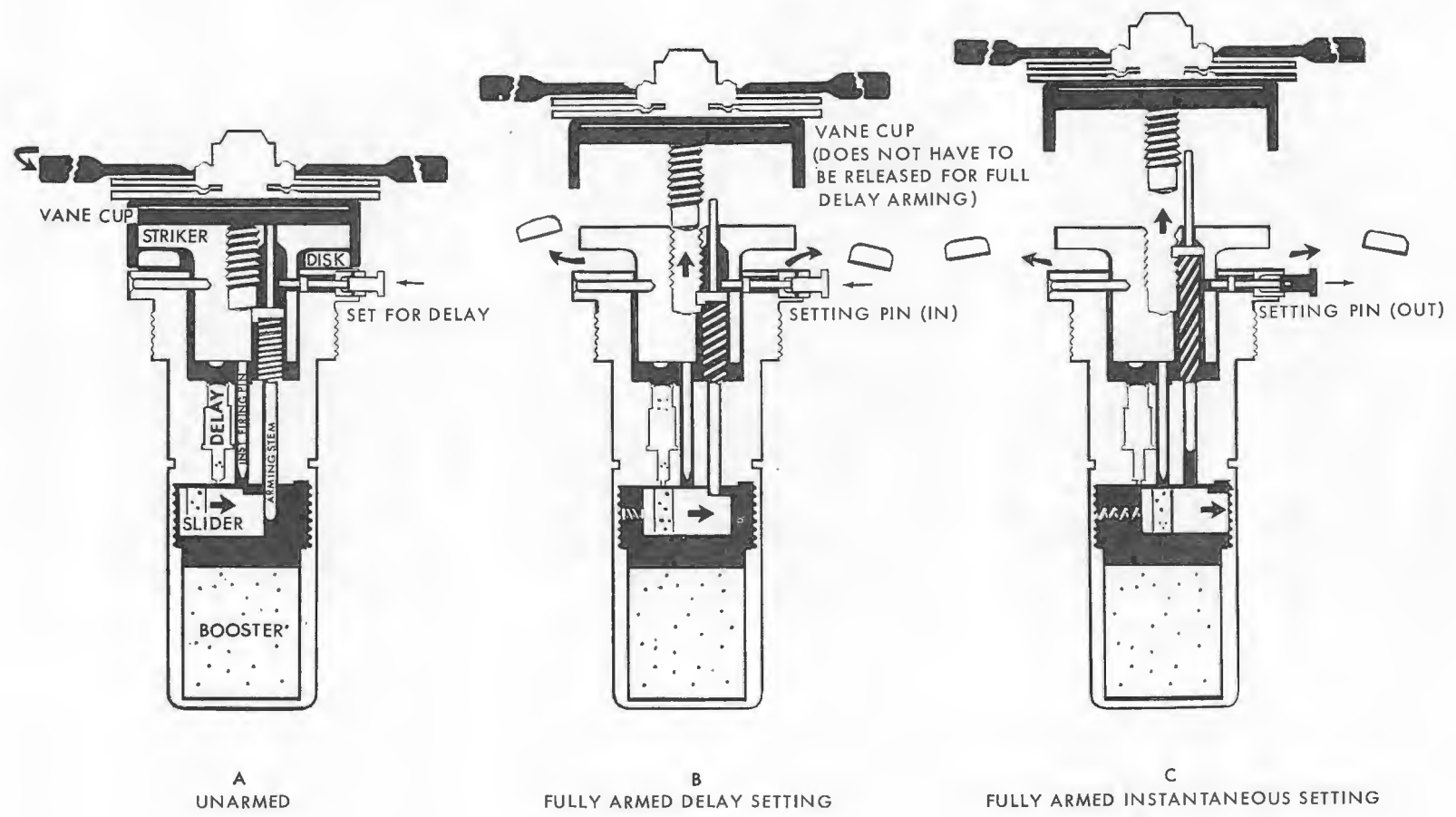


Figure 3-3 Arming Actions, Delay and Instantaneous Modes

in the instantaneous mode, but, in the delay mode, the arming stem is prevented from moving outward for its full throw by the end of the setting pin protruding into the channel.

The arming stem, when thus blocked, can move only far enough to clear the first step of the detonator slider (Fig. 3-3(c)). The detonator is thus brought in line beneath the black powder delay element firing pin and arming is complete.

DETONATION AND FUNCTIONING. In either the instantaneous or delay mode, the arming disks, vane cup, and vane drop away, leaving the striker exposed. Upon impact, the striker moves back, shearing both the shear pin (Fig. 3-2) and the setting pin. Detonation is thus initiated, with the detonator beneath either the delay or instantaneous firing pin. If the delay setting is chosen, the instantaneous firing pin is driven into a cavity in the detonator slider, as is the arming stem. On instantaneous, only the arming stem is driven into a cavity.

In the delay mode, the delay time is governed by the composition of the black powder delay element. Upon impact, the delay firing pin initiates the primer which, in turn, ignites the delay element. The delay element burns through with a pre-determined time delay and then ignites in turn the relay, detonator, booster lead-in, and booster.

For instantaneous functioning, the instantaneous firing pin is driven directly into the detonator.

PHYSICAL DESCRIPTION. There are six fuzes in the AN-M103A1/M163 family, the AN-M103A1, AN-M139A1, AN-M140A1, M163, M164, and M165. The AN-M103A1, -139A1, and -140A1 fuzes constitute one sub-grouping; the M163, -164, and -165 the other. The -103A1 series is identified by a metallic finish on the vane cup; the M163 series by a yellow-painted finish.

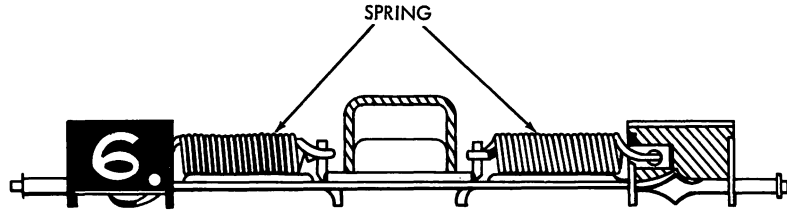
The functioning delay times can be identified by a black angular marking band on the vane cup as shown in Figure 3-1. The AN-M103A1 and M163 have no identifying band, indicating a functioning delay of 0.1 second. A 45-degree black marking identifies the AN-M139A1 and M164, indicating a functioning delay of 0.01 seconds. A 90-degree segment identifies the AN-M140A1 and M165 as having a 0.025-second delay.

The lot number and date of manufacture are stamped on the fuze body immediately above the booster cup.

Physical characteristics of the fuze are summarized on the sheet at the front of this section.

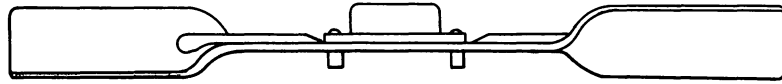
ARMING VANES

Any one of six types of arming vanes can be installed on fuzes in the AN-M103A1/M163 family. These vanes are illustrated in Figure 3-4.

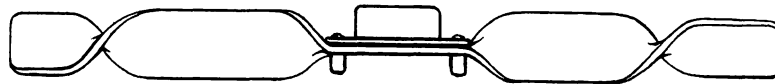


MK 6 MOD O VANE (GOVERNOR ARMING VANE)
 FOR MOST APPLICATIONS
 (BLADES COLORED BLUE WITH NUMERAL 6)

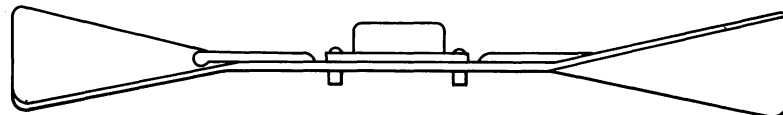
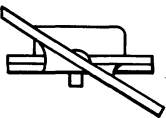
MK 7 MOD O VANE (GOVERNOR ARMING VANE)
 FOR LONGER ARMING TIMES
 (BLADES ALUMINUM COLORED WITH NUMERAL 7)



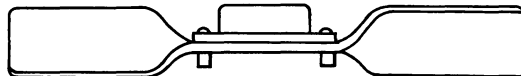
M1 VANE
 STANDARD VANE - 60° PITCH



M2 VANE
 LONG AIR TRAVEL VANE - 90° PITCH
 ON INNER PART OF EACH BLADE



FLAT VANE - 30° PITCH



SHORT VANE - 60° PITCH

Figure 3-4 Arming Vanes for AN-M103A1/M163 - Series Fuzes

WARNING

Never install a damaged or deformed vane of any type on these fuzes. A defective vane will cause erratic operation of the fuze and may cause it to arm prematurely.

ARMING VANE MK 6 MOD 0. The Mk 6 is a governor-type arming vane, that is, it operates at a constant speed irrespective of aircraft delivery speeds. Thus, time-along-trajectory rather than distance-traveled is the determining factor. (This provides a greater margin of safety for high-speed delivery.) Refer to the preceding subsection, OPERATIONAL CHARACTERISTICS for details of arming times.

Governing action is provided by the spring-loaded variable-pitch blades. At higher rotational speeds, the blades move out further to the ends of the vane. The angled surfaces upon which they move cause them to change pitch, thus maintaining a constant rotational speed.

The Mk 6 vane is recommended for most applications. It is identified by blue-painted blades with the figure "6" in white on each blade.

CAUTION

When Arming Vane Mk 6 Mod 0 has been assembled to a fuze, it cannot be removed due to its tapered internal sleeve. This provides a locking arrangement to keep the vane from becoming disattached due to SNAKEYE I fin-opening shock.

ARMING VANE MK 7 MOD 0. Arming Vane Mk 7 Mod 0 is similar in appearance and operating principles to the Mk 6. The blades however are aluminum-colored with the black numeral "7" painted on each blade.

The Mk 7 is designed to provide longer arming times than the Mk 6, and should be used where tactics warrant it. Times are provided in the preceding subsection, OPERATIONAL CHARACTERISTICS.

VANE M1. Arming Vane M1 is presently shipped with AN-M103/M163 fuzes but is not recommended for use with Mk 80 series or GP AN-M series bombs if the Mk 6 or Mk 7 arming vanes are available. Arming with the M1 is a function of air travel along the trajectory rather than time, and with high-speed delivery, arming times can be dangerously short. The M1 has a 60-degree pitch.

VANE M2. This vane is obsolete and is no longer procured because of erratic operation. Mk 6 or Mk 7 vanes should be used in its place. The M2 has a 90-degree pitch on the inner half of the blade to lengthen arming distance.

FLAT VANE. This vane is for use with flat-nosed depth bombs. It has a 30-degree pitch.

SHORT VANE. This vane has a 60-degree pitch and should be used only with Cluster M27, no longer used by the Navy.

SAFE JETTISON

If necessary to release bombs over friendly terrain, set the aircraft arming controls to the safe or off position; this allows the arming wire to slip through the solenoid and release with the bomb. With the arming wire in place, the arming vane is locked and the fuze does not arm.

Although the fuze does not arm, there remains the possibility of detonation upon impact due to structural damage, particularly against hard surfaces. Therefore, bombs should not be jettisoned at low altitudes.

ACCIDENTIAL ARMING

Accidental arming can be caused by several things: loss of an arming wire on the delivery aircraft; structural damage to the fuze sufficient to shear the vane cup; or rotation of the vane for any reason, even though the vane cup is still in place. This subsection details the method for recognizing armed or partially-armed fuzes and the procedures to be followed if they are encountered.

RECOGNITION OF FULLY ARMED FUZES. The following procedures should be scrupulously observed when handling a fuze which may be armed:

WARNING

If the arming disks (Figs. 3-2 and 3-3) are missing, the fuze must be treated as though it is armed. An AN-M103A1/M163 fuze contains a lethal amount of tetryl in the booster and should be handled carefully at all times. If the shear pin has been severed on an armed fuze, the fuze becomes critically sensitive to shock and can detonate easily. Known armed fuzes, either installed or uninstalled, should be handled only by EOD personnel.

1. If the arming vane has been allowed to rotate, check to ensure that the arming disks are still in place. If they have ejected (or if the entire vane cap assembly is missing), the fuze is fully armed. (See Figs. 3-2 and 3-3 and related functional description.)
2. If the fuze is armed, carefully slip a pencil or wedge of wood between the striker flange and fuze body flange and tape it into place. This substitutes for the arming disks and affords a measure of protection. Call for EOD personnel immediately. Do not move the setting pin.

RECOGNITION OF PARTIALLY ARMED FUZES. Fuzes in which the clearance between the vane cup and fuze body is greater than 5/32-inch but, which still have the arming disks in place are partially armed. They are safe for handling and disposal although the detonator slider has probably operated to bring the detonator in line with the delay firing train. (The disks prevent inward movement of the striker assembly.) A partially armed fuze should never be used and it can't be "disarmed" by screwing the vane cup

back into the body of the fuze. Disarming is impossible because the detonator slider cannot be made to return to its unarmed position.

Test for a partially armed fuze as follows:

1. Construct a steel test gage as shown in Figure 3-5. (This gage should be constructed in advance of requirements and retained for use in routine checking of fuzes.)
2. With the fuze sitting upright on its booster, attempt to slide the 0.156-inch feeler blades of the test gage between the vane cup and fuze body flange (Fig. 3-2) directly above the shear pin and setting pin. Do not attempt to force it. If the fuze is partially armed, the feeler blades can go in as far as the arming disks. If unarmed, the blades will not have clearance to move between the edge of the vane cup and the fuze body flange.
3. Mark all partially armed fuzes for EOD disposition.

INSPECTION, TEST, AND INSTALLATION PROCEDURES. The following procedures are for use by ordnance personnel responsible for handling and installing AN-M103A1/M163 series fuzes.

Fuzes must be handled with care at all times. They are delicate and can cause loss of aircraft if damaged or defective fuzes are installed in bombs. Fuzes such as the AN-M103A1/M163, which contain integral boosters often

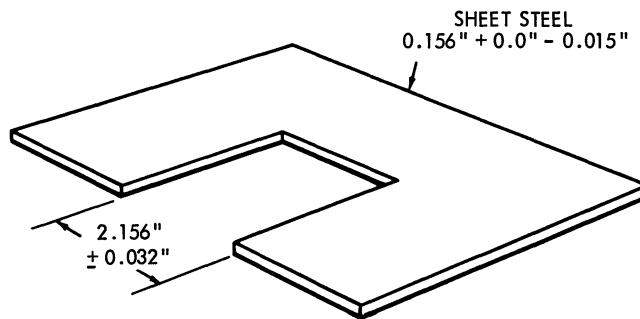


Figure 3-5 Feeler Gage, Typical

can explode lethally if mishandled. Although a high degree of safety is built into the fuze, rotating the arming vanes, dropping the fuze, or striking it can create a hazardous condition.

Handle fuzes like eggs, not like rocks and cordwood!

UNPACKING AND INSPECTION. Proceed as follows:

1. Unseal the fuze container and remove the fuze.
2. Inspect the fuze visually. Note that the threads are in good condition, the fuze free of corrosion, and that the container did not leak.
3. When removed from the containers, store fuzes in racks or some other type of container to keep them from banging together. (A plywood board can provide good protection if several holes slightly larger than the booster (1-1/2-inches) are bored in it to seat the fuzes and protect them prior to use.)
4. Check the setting pin for damage as follows:
 - a. Check that the arming disks (Fig. 3-2) are all in place.
 - b. Pull the setting pin (Fig. 3-2) out as far as it will go. Rotate it. It should move smoothly without binding or sticking. If it sticks or binds, reject the fuze.

WARNING

The setting pin must be undamaged inasmuch as it acts like another shear pin to prevent early bursts. Additionally it must be seated properly in one of the two setting slots, or safety is reduced.

- c. Set the setting pin in the shallow slot for instantaneous functioning unless otherwise instructed.
5. Check for partial arming of the fuze according to the procedures given under ACCIDENTAL ARMING; RECOGNITION OF PARTIALLY ARMED FUZES in the subsection preceding this.
6. Check for a defective or missing shear pin (Fig. 3-2) as follows:
 - a. Check again that the arming disks are in place.
 - b. Set the fuze upright as shown in Figure 3-6. Place the shipping tag in the slot between the vane cap and fuze body flange directly above the shear pin. (The shear pin is located 180-degrees away from the setting pin.)
 - c. Using an assistant to pull and hold the setting pin out as far as it will go, press directly down on the top of the vane cup (Fig. 3-6). A wooden tool such as shown in the figure will protect the hand and equalize the pressure. Use 25 to 50 pounds of pressure.

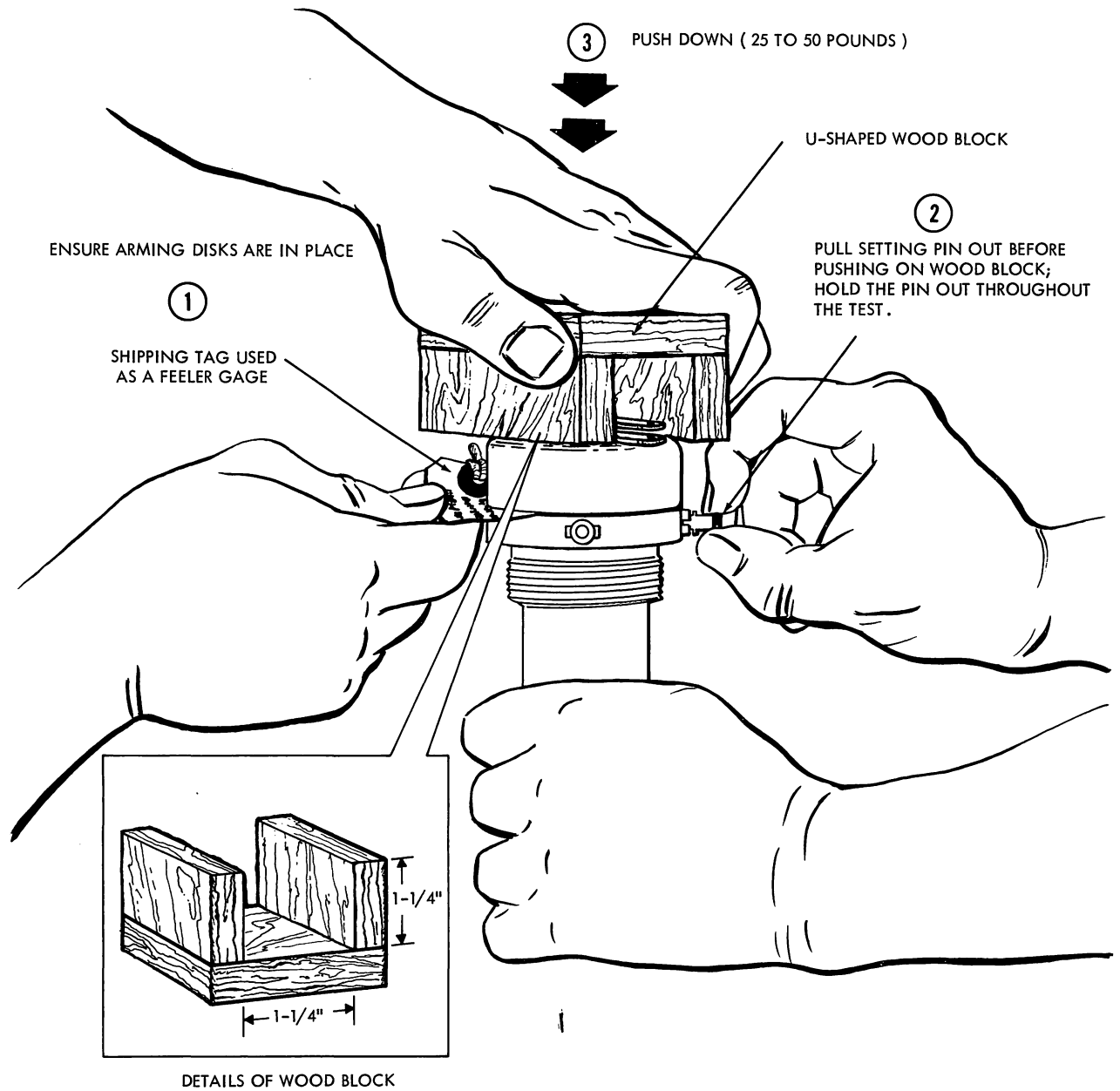


Figure 3-6 Shear Pin Testing Procedure

d. Attempt to withdraw the shipping tag. If it binds, the striker has moved, indicating a defective shear pin. Reject the fuze.

e. Reset the setting pin in the instantaneous (shallow) slot unless otherwise instructed.

WARNING

Do not use a fuze with a defective or missing shear pin. Do not remove the cotter pin which locks the vane strap and eyelet strap until after the bomb is installed on the bomb rack and arming wire installed.

7. Cut and remove the seal wire.

INSTALLATION OF FUZE IN BOMB. The following procedures may vary in sequence according to the requirements of the tactical situation and the need to build up a stockpile of aircraft-ready bombs. The following procedures are suggested for safe, adequate installation.

1. Install the proper arming vane on the fuze (as required by the mission) as follows:

a. Align the two pins on the arming vane with the two matching holes on the vane hub (Fig. 3-7).

b. Slip the vane over the vane hub, and press down with the hand directly on the center of the vane to force it over the vane hub. Never press on the blades and never strike the vane to drive it in place.

NOTE: Vanes ideally should be installed after the fuze is installed in the bomb, if time permits. This minimizes the possibility of damage to the vane.

2. Remove the nose plug (and sleeve for Mk 80 series bombs). Install a T46-type adapter booster in Mk 80 series bombs.

3. Screw the fuze into the nose well of the bomb hand-tight. Description of bomb preparation is contained in Part 1 of this publication.

ARMING WIRE INSTALLATION. Refer to the proper aircraft loading manual for installation of bomb into bomb rack and connection of the arming wire to the aircraft. Install the arming wire as follows:

1. Thread the arming wire through the upper pair of holes (12 o'clock with respect to the bomb) in the vane strap and eyelet strap (Fig. 3-7). If the upper holes have a safety cotter pin installed, fit a spare pin in the bottom holes before removing the top cotter pin.

WARNING

Always keep an arming vane secured, either by an arming wire or safety cotter pin. Unsecured vanes will windmill from prop wash and cause arming before takeoff.

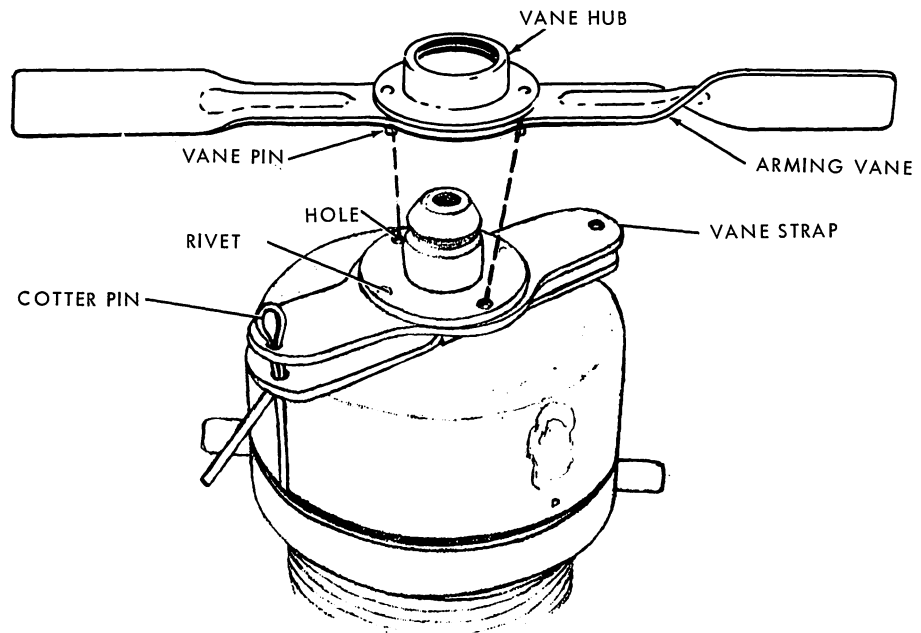
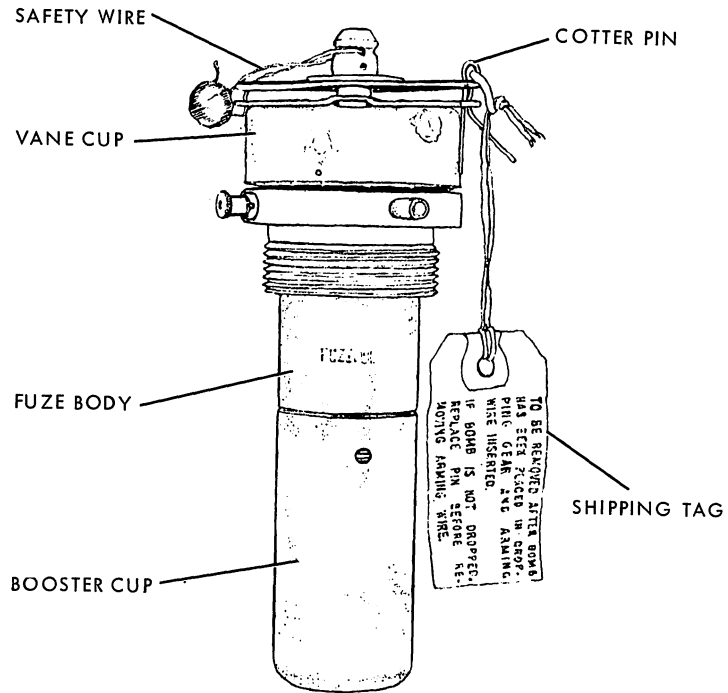


Figure 3-7 Arming Vane - Vane Strap Details

2. Draw the arming wire through the hole until excess slack is removed. Avoid pulling the arming wire so tight that it is stressed against the solenoid. Cut off the excess arming wire so that only three to four inches extends past the vane strap.

3. Slip two Fahnestock clips over the free end of the arming wire until they touch the vane strap. Refer to OP coverage on the specific bomb being loaded for additional data.

4. Remove the safety cotter pin. If a second arming wire for SNAKEYE is to be installed, insert it in this hole and secure it with two additional clips.

DEFUZING

The following procedures apply to the removal of an undamaged fuze from a bomb.

WARNING

Before attempting to remove the fuze from a bomb, ensure that it is not armed and that the arming disks are in place (see Fig. 3-3).

1. Check that the arming disks are all in place beneath the vane cup. If they are missing, notify EOD personnel immediately.
2. Replace the cotter pin and tag. (Use a short length of arming wire and twist ends together if cotter pin is not available.)
3. Remove the Fahnestock safety clips.
4. Remove the arming wire and discard.
5. Unscrew the fuze from the bomb and replace it in a suitable handling and stowage container. Use this fuze for the next applicable flight; do not stow it any longer than necessary because humidity may cause deterioration.

PACKAGING AND MARKING

FUZE CONTAINER. One fuze, including the standard arming vane M1, not marked as such, is packed in a cylindrical metal container having a maximum diameter of 3.46 inches and a maximum length of 7.51 inches. The weight of the fuze and container together is approximately 4.5 pounds. The container is sealed, and opened, by a metal tear-strip soldered to it. The container is painted black and is marked as follows:

FUZE, BOMB, NOSE AN-M103A1 (or as appropriate)

Loader's Initials Loaded (Month and Year)

Drawing No. Revision Date of Drawing

PACKING BOX. Twenty-five fuzes in container are normally packed in a wood packing box. However, one fuze and container may be removed, if necessary, to make room for a package of other arming vanes and instructions.

OP 2216

Its dimensions are 22-1/4 by 17-1/8 by 9-3/16 inches. The lid of the box is secured by wood screws, and the end of the box is marked as follows:

(No.) FUZES, BOMB, NOSE
AN-M103A1
LOT NO.

Section 2 - Mechanical Long-Delay Tail Fuze Mk 346 Mod 0

GENERAL

Mechanical Long Delay Tail Fuze Mk 346 Mod 0 is an all-mechanical clockwork time fuze which is used in the tail well of Mk 81, 82, and 83 low-drag bombs* and SNAKEYE I. It features relatively constant arming time over a wide range of delivery air speeds, and greatly improved safety in handling, loading, and delivery. Functioning delay accuracy is vastly superior to that of the earlier chemical long delay fuzes of the AN-M123A1 series. The available functioning delays are pre-selected for the total number of hours in increments of 15 minutes. The Mk 346 fuze is not fitted with an anti-withdrawal booby-trap mechanism as is the chemical fuze series. Instead, it utilizes an anti-removal feature which makes removal of an armed fuze difficult.

The maximum functioning delay time available with the Mk 346 Fuze is classified CONFIDENTIAL. Details are provided in the classified supplement to OP 2216, Part 2, Revision 2.

Because it is a tail fuze, the Mk 346 must be fitted with an arming assembly. Arming Assembly Mk 3 is used with the Mk 83 1000-lb. low-drag bomb, arming assembly Mk 4 with the Mk 81 and Mk 81 SNAKEYE I, and arming assembly Mk 5 with the Mk 82 and Mk 82 SNAKEYE I. The arming assemblies are covered in detail in Chapter 5.

OPERATIONAL CHARACTERISTICS

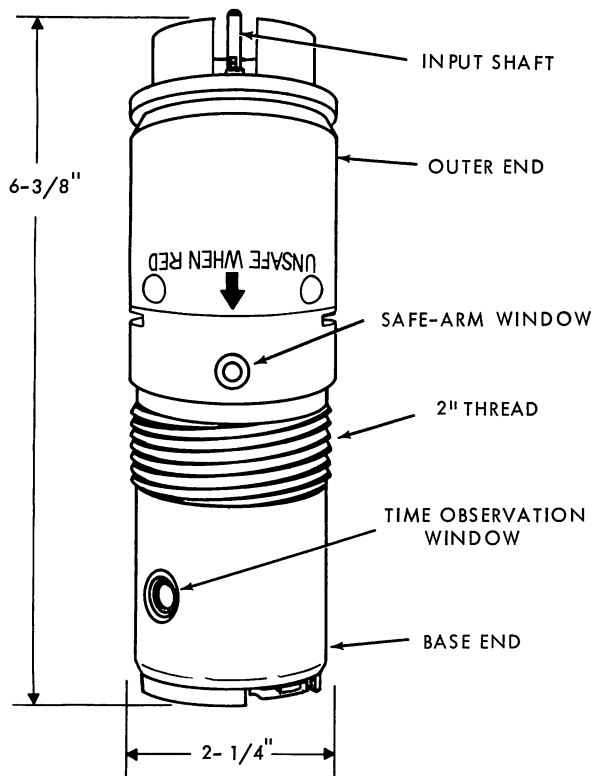
Mechanical Time Fuze Mk 346 is a long-delay fuze used primarily in area denial and neutralization missions. It differs from the chemical long-delay fuzes of the AN-M123 family in a number of significant respects: (1) it uses a mechanical clockwork timer with no chemical agents in the timing mechanism; (2) it provides more flexible handling and loading procedures and simplifies logistics; and (3) it is measurably safer in handling and delivery and has none of the inherent dangers of the chemical fuzes.

This subsection covers the operational and safety characteristics of the Mk 346, and discusses the capabilities of the fuze when used with SNAKEYE and low-drag bombs, operating restrictions and tactical limitations, and the arming and functioning sequence of the fuze under tactical conditions.

WEAPON CAPABILITIES. Fuze Mk 346 has sufficient sensitivity to be effective against most targets. In general, impact must occur with sufficient force to initiate the functioning delay cycle. Therefore, low speed, low altitude delivery will result in only marginal operability because of reduced impact shock. At the opposite extreme, high speed delivery of unretarded low drag bombs against hardened targets can cause weapon deflagration or failure of the fuze due to excessive shock. Good results may be expected however with most delivery tactics.

*At present no Navy arming assembly is available to adapt the Mk 346 to the 2000-lb. Mk 84.

SUMMARY SHEET
MK 346 MOD O MECHANICAL LONG DELAY TIME FUZE



NOTE : This material is prepared in reproducible form for convenient reference. It is not intended to replace the information in the OP.

ARMING: 1st. Stage : 1.5 to 4 sec. nominal after release. See text
2nd. Stage : At impact.

FUNCTIONING DELAY: Classified

DETONATOR: Mk 44 Mod 1

LEAD: 148 Mg of RDX CH-6

USED WITH: Mk 81, 82, 83 low-drag and SNAKEYE I bombs

INSTALLATION IN LOW DRAG BOMB:

1. Install adapter booster, using long locking pin.
2. Install fuze all the way into the booster with no threads showing.
3. Use spanner wrench to tighten, if necessary.
4. Install Arming Assembly and tail on bomb.

KEY POINTS

1. Safer than any other long delay fuze.
2. All mechanical clockwork operation; no chemical components.
3. One fuze can give a variety of pre-selected burst times.
4. Not sensitive to temperature changes.
5. Out-of-line detonator; can be installed below flight deck.
6. Two-stage arming for inflight and delivery safety.
7. Used with: Arming Assembly Mk 4 for MK 81 Low Drag and MK 81-SNAKEYE I Bombs
Arming Assembly Mk 5 for Mk 82 Low Drag and MK 82-SNAKEYE I Bombs
Arming Assembly Mk 3 for Mk 83 Bomb
8. Requires Adapter Booster T46E4 or equivalent for tail well installation.
9. Mk 346 equipped weapons can be returned to field or carrier and reset (if desired) for future missions.
10. Fuze is locked in bomb after impact prevents enemy from defuzing bomb.

The fuze may be expected to function when a weapon is dropped in rivers or lakes, providing that the impact force is sufficient to initiate the functioning delay. Additional data providing specific test results at a variety of impact velocities and angles against various targets are available in the classified supplement to OP 2216, Part 2. This supplement will be available upon request through standard supply channels after 1 Jan 1967. See Chapter 1.

Upon weapon impact, the anti-removal mechanism of the fuze operates. This mechanism consists of a toothed cam on the inner or base end of the fuze which effectively jams the fuze into the adapter booster. The T46-type adapter booster is retained in the bomb fuze well by means of a locking pin fitted into the grooves of the well (see Chapter 5). Thus the entire assembly is locked into the bomb in such a way that removal under field conditions is extremely difficult. The enemy is further impeded by being unable to see or alter the remaining time to burst indicated in the time window (Fig. 3-8).

Note that the Mk 346 fuze does not have the booby-trap anti-withdrawal mechanism of the AN-M123 series chemical long delays. Removal of the Mk 346 is possible but only after the tail fin is removed and if a large wrench is employed. Removal of the fuze is made more difficult by the probable deformation of the tail fin on impact.

DESIGN SAFETY. Handling and operational safety of the Mk 346 fuze results from a number of design features, the most important of which are as follows:

1. Relatively constant arming time irrespective of delivery speeds. A governor in the arming assembly limits rotational speeds applied to the input of the fuze to 1800 ± 100 rpm. Arming time (discussed in greater detail later) is thereby held relatively constant over a wide range of delivery speeds and tactical delivery methods.
2. Clutch arming. A clutch in the first stage of the arming gear train will not engage unless the input shaft is rotated at 1200 rpm or more and the locking key on the input shaft is depressed. Except by deliberate means, manual rotation of the input shaft will have no effect on first-stage arming.
3. Two-stage arming. The Mk 346 employs two-stage arming. The first stage is complete after 45 revolutions of the arming input shaft (Fig. 3-8) and requires a minimum of 1.5 seconds time after weapon release. To arm, this stage must be completed before impact. Impact causes second-stage arming to occur. The firing train is held out of alignment until second-stage arming is complete.
4. "Status" of fuze visible through observation windows. The selected functioning delay-to-burst time is visible through the time observation window until the fuze is installed, and a green-colored band is visible through the safe-arm window if the fuze is unarmed. If the fuze is accidentally fully armed, the anti-removal cam will be in the "cocked" position. Additionally, an audible ticking can be heard and the remaining time-to-fire will be visible in the time observation window. The safe-arm window will show the red band.

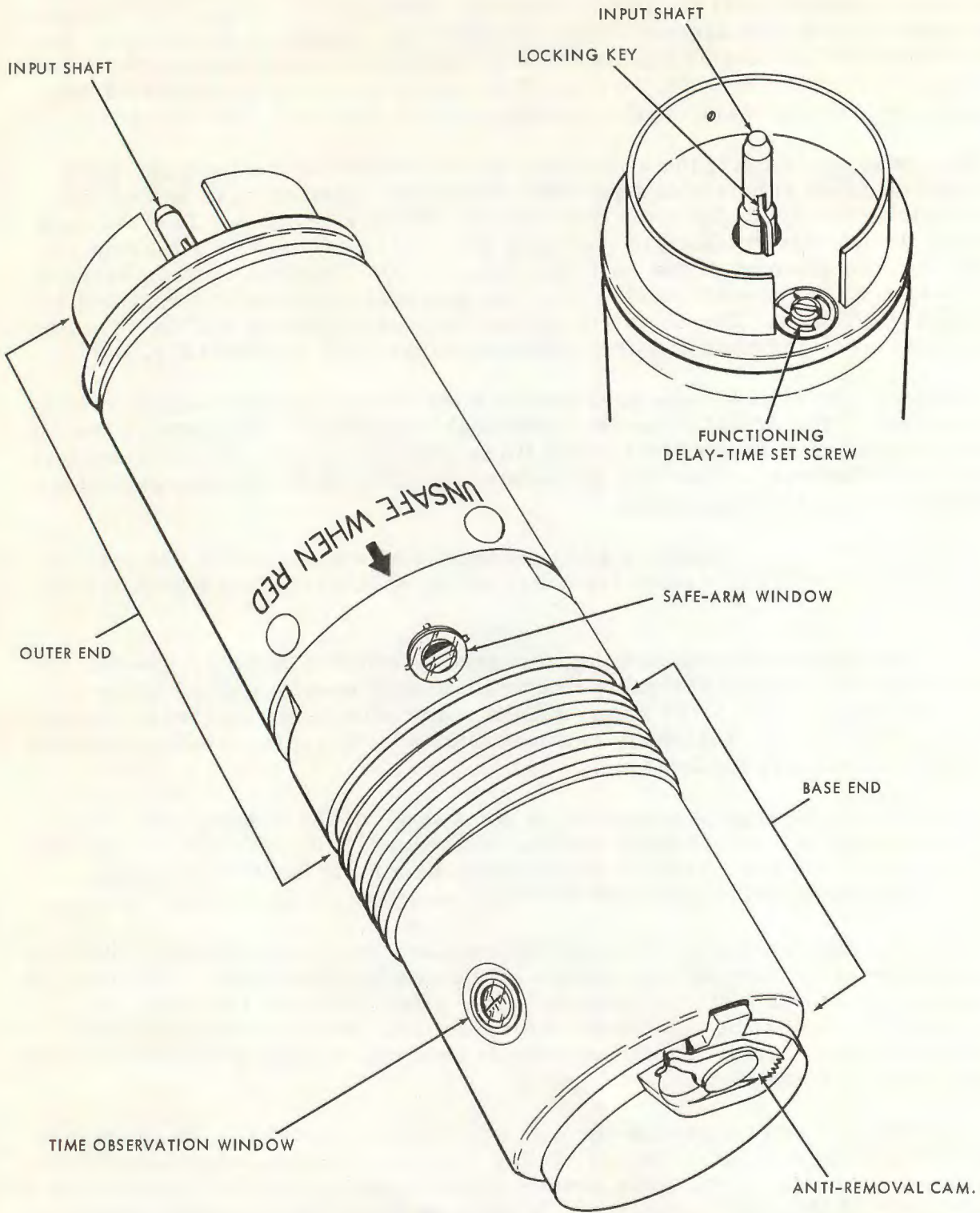


Figure 3-8 Mechanical Long Delay Fuze Mk 346 Mod 0;
Exterior Details

If only the first stage of arming is completed, the red band will also be visible, but the ticking will not be heard and the anti-removal cam will remain in place. Although the fuze is safe for disposal in this condition, it should nevertheless be treated as dangerous ordnance as it requires only a mechanical shock (such as being dropped) to start the clockwork functioning delay.

5. Explosive Components. The only explosive components integral to the fuze are the detonator and lead. These are of low explosive force and present only a minimal hazard to personnel if a bare fuze were to detonate. Detonation of an unarmed fuze will do no more than blow out the time observation window.

6. Locking key on input shaft. A key on the input shaft must be manually and intentionally depressed if the input arming shaft is to be rotated by hand. This key is held in by the arming assembly when installed in a weapon.

ARMING CHARACTERISTICS. The first or "enabling" stage of the two-stage arming is initiated upon weapon release. Approximately 45 revolutions of the input shaft at 1200 rpm or more are required to complete this stage. Delivery speeds of 180 to 600 knots IAS are acceptable. Speeds within this range will arm the fuze and will ensure functioning on impact under most conditions.

First-stage. Arming times are in the 1.5-to-2-second range with low-drag bombs (and unretarded SNAKEYE I weapons). With SNAKEYE retarded, arming times may be as long as four seconds; the shock of fin opening causes the arming vanes to lose speed momentarily, thus extending the arming time.

Second-stage arming is completed on impact. First stage arming must be complete and the impact shock must be sufficient to cause initiation. Second-stage arming aligns the fuze firing train, initiates the delay-to-burst timer, and releases the anti-removal cam.

FUNCTIONING AND DELAYED BURST CHARACTERISTICS. The Mk 346 fuze provides a distinct advantage over present chemical long-delay fuzes in that one basic fuze can provide a wide range of pre-selected delay functioning times. This simplifies logistics by allowing the stockpiling of a single fuze type. (With the chemical fuzes, it is necessary to maintain a large number of separate modifications to provide functioning delays commensurate with the mission.)

Functioning delay times in hours and increments thereof are pre-set by means of a screwdriver setting slot (Fig. 3-8) before the fuze is fitted in the tail well. If mission requirements change, the fuze may be removed and the new delay set in as required. (Removal is necessary because the delay time observation window (Fig. 3-8) is not visible when the fuze is secured in the fuze well.) At impact, the pre-set functioning delay is locked in, thus preventing the enemy from countering by changing the time-to-burst setting.

Functioning time is independent of normal temperature ranges, and will

occur with but little deviation to the time shown in the observation window. Exact tolerances are classified CONFIDENTIAL.

OPERATIONAL RESTRICTIONS. A distinct advantage of the Mk 346 is its lack of handling and logistic restrictions. No restrictions are placed upon carriage speed, time-in-flight, time from loading to take-off, or returning of unused stores.

Because of the two-stage arming requirements, out-of-line detonator, and inherent functioning delay, the possibility of aircraft damage by an early burst is drastically reduced.

Fuze Mk 346 may be assembled in all weapons, including SNAKEYE, below the flight deck for carrier operation.

DESCRIPTION

Fuze Mk 346 is shown in Figure 3-8. It is approximately 6-3/8-inches long and is threaded for a two-inch adapter booster well. For purposes of description, the term "outer" end and "base" end are used. The outer end is that which couples to the arming assembly; the base end is that which fits into the adapter booster well.

OUTER END. The input shaft and the delay function setting shaft are located on the outer end of the fuze. The input shaft is coupled directly to a centrifugal clutch which engages the speed reduction gearing at 1200 rpm of the input shaft. The input shaft is fitted with a key which engages a locking slot to prevent accidental rotation. The key is automatically freed when an arming assembly is fitted to the input shaft.

The delay function setting shaft is located in the outer end and may be rotated in either direction by means of a screwdriver. The setting shaft is coupled through a gear train to the dial seen in the time delay observation window.

The safe-arm band is visible through its observation window and is coupled into the speed reduction gear. Its red band covers the observation window when the input shaft and clutch have rotated 45 revolutions, thus completing first-stage arming. The red band will begin to appear after the input shaft and clutch have rotated approximately 22 of the required 45 revolutions.

A slip clutch allows the setting shaft to be rotated past the minimum or maximum delay setting without further rotation of the indicator dial or damage to the mechanism.

BASE END. The base end of the fuze houses the timer, firing pin, detonator-rotor, lead, the arming shaft and the functioning delay indicator dial. On the face of the base end plate is the toothed cam which operates as an anti-removal device. The arming shaft moves forward at impact to initiate the timer mechanism, allows the detonator-rotor to align with the firing pin, and releases the anti-removal cam.

The specific location of mechanical components within the fuze body, and associated drawings, are classified CONFIDENTIAL.

SAFE JETTISON. A weapon fitted with a Mk 346 fuze may be dropped safe by releasing it with the arming wire in place. This prevents rotation of the arming assembly.

When dropped safe, the fuze will function neither at impact nor at the pre-set delay time. However, the weapon will deflagrate if it impacts with boulders, concrete, or other hard objects.

PROCEDURAL INFORMATION

This section provides data for installation and removal of the Mk 346 fuze in the tail well of Mk 81, 82, or 83 bomb.

The following material is required:

Arming Assembly Mk 3, for Mk 83 low-drag bombs

Arming Assembly Mk 4, for Mk 81 and Mk 81 SNAKEYE I

Arming Assembly Mk 5, for Mk 82 and Mk 82 SNAKEYE I

Screwdriver for setting functioning delay setting shaft

Spanner wrench to install adapter-booster

Adapter-Booster T46E4 or equivalent

UNPACKING AND INSPECTION. Mk 346 fuzes should not be unpacked until immediately before installation in a weapon to provide maximum protection from rough handling. The fuze should be handled carefully to prevent damage to external parts.

1. Prior to installation, check that the green band is visible in the safe-arm observation window (Fig. 3-8). If a portion of the red band is visible, the fuze is partially enabled (partial first-stage arming has occurred) and it should not be used. The fuze is safe for handling however. If the red band covers the window, set the fuze aside, away from explosive stores, and notify EOD personnel.

2. Check the fuze for evidences of damage or corrosion, and that the anti-removal toothed cam does not extend past the exterior circumference of the fuze base. If the cam faces outward, the fuze may be armed. Set it aside, away from explosives, and notify EOD personnel immediately.

3. Check the input shaft for free movement. Depress the key (Fig. 3-8) and slowly rotate the shaft one turn. It should move freely without binding.

4. Using the screwdriver, check for free rotation of the functioning delay time setting mechanism and the setting dial in the time observation window (Fig. 3-8).

INSTALLATION OF FUZE IN FUZE WELL. The following procedures apply to Mk 80 series low-drag bombs, and with specific exceptions, to SNAKE-EYE weapons. For additional data on SNAKEYE, refer to OP 3339 and 3374. Procedures for installation of the appropriate arming assembly are contained in Chapter 5.

1. Prepare the bomb for assembly according to Part 1 of this OP.

CAUTION

Be sure to use the steel nose plug in the nose fuze well. The plug is required for structural rigidity of the weapon and decreases the possibility of deflagration on impact.

2. Loosen the locking screw in the flange of Adapter-Booster T46E4 and remove the 1-1/2-inch fuze adapter sleeve. The Mk 346 has a two-inch diameter thread.

3. Install the adapter booster in the tail fuze well and secure with a spanner wrench.

4. Place the longer of the two locking pins packed with each fuze into the hole in the threads of the adapter booster. This will lock the adapter booster in the fuze well when the fuze is installed. (The shorter pin was designed for installation in GP bombs and may not be included in certain procurement lots.)

5. Using the screwdriver, set the selected time as indicated in the time observation window by means of the setting shaft slot at the outer end of the fuze (Fig. 3-8). The mechanism can be rotated in either direction.

6. Screw the fuze hand-tight in the adapter booster until it seats fully and firmly and no threads are visible. If necessary, use the special wrench which is supplied. Remove all tags, wires, tape, and the extra lock pins from the fuze body and discard them.

7. Install the arming assembly as instructed in Chapter 5.

IDENTIFICATION OF FULLY OR PARTIALLY ARMED FUZES. Under normal circumstances, Mk 346 fuzes can be removed from an unused bomb, returned to its shipping container, and reset and reinstalled for a subsequent mission. However, loss of an arming wire, or faulty arming wire installation can cause first stage arming to occur aboard the aircraft.

A first-stage armed condition can be identified by the red band covering all or part of the safe-arm observation window on the body of the fuze.

WARNING

All weapons which are returned from a strike unused should be examined as soon as possible. If evidence of malfunction is present

(loss of arming wire, structural damage, etc.), the Mk 346 fuze should immediately be removed from the bomb on the flight deck. A partially armed fuze (identified by the red band in the safe-armed window) is safe for handling and disposal but could complete the arming cycle if the weapon is jarred or jolted.

Second stage arming will not occur unless the weapon has (1) completed first-stage arming and (2) been accidentally jolted or jarred. The fuze will then be locked in the bomb and cannot be easily removed. Further, it will detonate the weapon at the end of its pre-set functioning delay cycle. Although this is a highly unlikely condition, it could occur with a hung bomb or with a bomb which is released on landing due to rack structural failure. A highly dangerous condition exists and appropriate measures according to ship or station emergency bill should be initiated immediately.

WARNING

If, upon attempted removal of a partially armed Mk 346 fuze, the fuze binds in the adapter-booster and will not unscrew easily, the fuze is functioning and will detonate the weapon at the completion of its delay. Clear the area immediately and initiate emergency procedures to render the bomb ineffective.

DEFUZING THE BOMB. The following procedures are routine and should be performed after every strike in which weapons are returned.

1. Check for partial arming as described in the previous subsection.
2. Remove the arming assembly and tail fins of the weapon. Procedures for removal of the arming assembly are contained in Chapter 5.
3. Unscrew the fuze from the adapter booster using the special fuze wrench if required.
4. Remove the locking pin from the adapter booster threads and unscrew the adapter booster from the tail well using the spanner wrench if needed.
5. Return the fuze and adapter booster to their container.

Chapter 5
BOMB FUZE ACCESSORIES

VT DEVICES FOR MK 80 SERIES BOMBS

GENERAL. Two separate VT nose elements are available to provide an air-burst capability with M990-fuzed Mk 80 series bombs. These are Sensing Element, Proximity M20 and Target Detecting Device Mk 43. The latter device is sometimes referred to by its Army nomenclature, Sensing Element, Proximity M20E1 or M66; in service use, it may bear either designation, depending upon date of manufacture.

Proximity Sensing Element M20 (or subsequent designation of M20A1) is designed for use with all M990 fuzes except the M990E2. The Mk 43 Target Detecting Device is designed for use with Fuze M990E2.

Figure 5-1 shows the characteristic VT radiation patterns of the two VT elements. The Sensing Element M20 is designed for free-fall applications and as such, directs its radiated RF energy in a fore-and-aft direction, the most efficient design for bombs with approach angles above 60 degrees. The Mk 43 radiates RF in a pattern normal to the longitudinal axis of the bomb. This design is more efficient for low altitude approaches and SNAKEYE retarded operations. Additionally, the circuit characteristics of the Mk 43 allow it to function with the lower weapon approach speeds characteristic of SNAKEYE retarded approaches. The Mk 43 can also be used in unretarded applications.

Neither the M20 nor the Mk 43 have explosive components and as such must be used with a tail fuze.

TARGET DETECTING DEVICE MK 43. Target Detecting Device Mk 43 is initiated by the +300 volt DC pulse used to initiate the M990 tail fuze, as opposed to the RF initiation of the earlier M20 (see Table 5-1). (The DC-initiation feature of the Mk 43 Mod 0 will allow pilot option of VT, impact instantaneous, or impact delay functioning modes when used with the Mk 344 all-DC electric fuze currently under development.) The Mk 43 may also be initiated mechanically through the actuation of the striker rod, thus providing a limited pilot option of VT versus non-VT operation (as listed in Table 2-4) with the M990E2.

Description. Target Detecting Device Mk 43 is designed to fit into the nose well of Mk 80 series bombs and may also be used with Fire Bomb Mk 79 Mod 1. It is designed primarily to provide a VT airburst capability for SNAKEYE in the retarded mode.

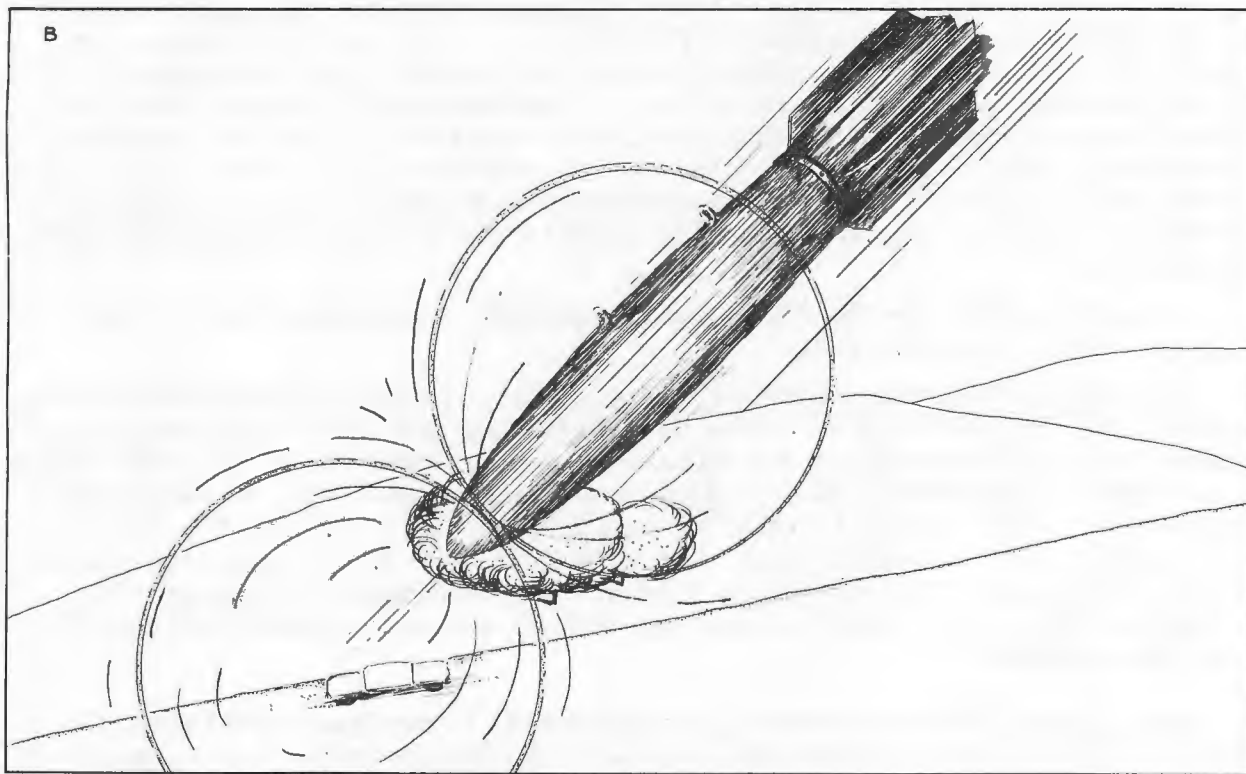
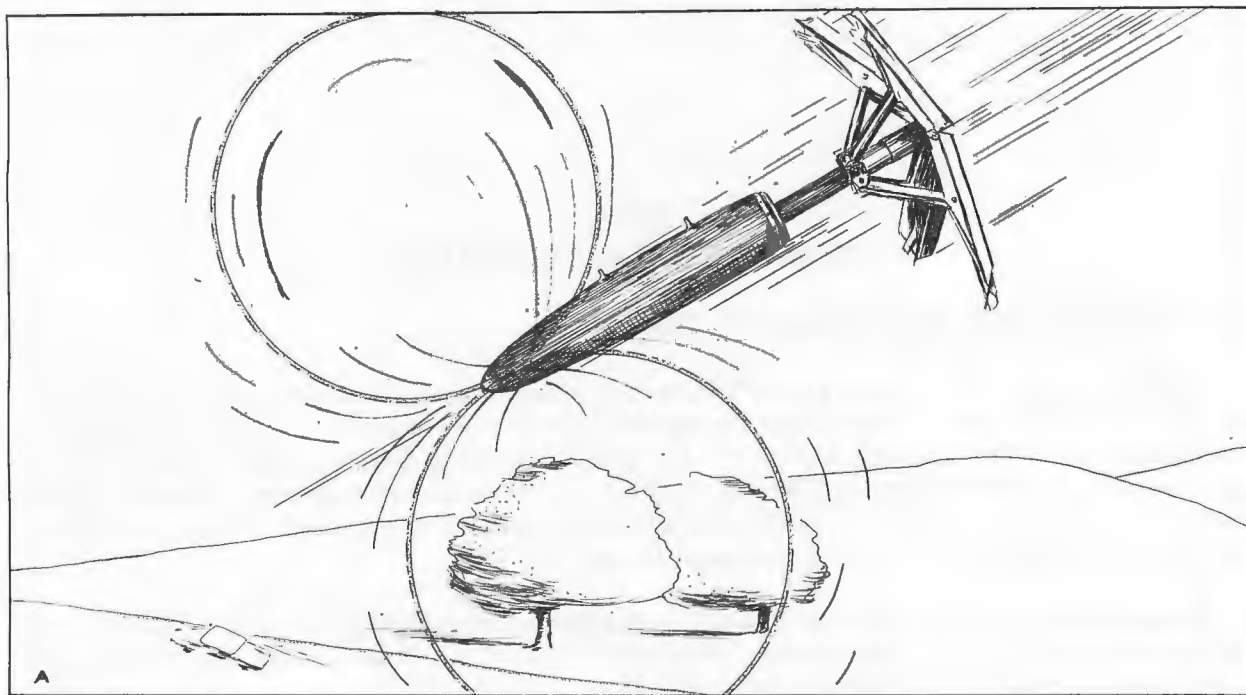


Figure 5-1 Lobe Pattern, Mk 43(A) and M20/M20A1(B)

Table 5-1

TARGET DETECTING DEVICE MK 43 MOD 0;
SUMMARY OF CHARACTERISTICS

Nomenclature	Detecting Device, Target, Mk 43 Mod 0
Identifying color	Dark green
Energizing Delay	2 sec. (warm-up to proper operation)
Optimum Approach Angle	10 to 60 degrees
Burst Height	16 feet nominal (Burst height decreases as approach angle increases.)
Initiation	+300 volts DC or mechanical
Weight	6 pounds
Drawing	BuWeps LD 549764
Appropriate M990 fuze	M990E2

To facilitate identification of the Mk 43 under red lighting conditions the nose cone is colored dark green and appears black under red lights. (The M20 may be either a neutral tan or red; in either case it appears light in color under red lighting conditions.)

Operation. Target Detecting Device Mk 43 is initiated upon weapon release either by the +300 Volt DC pulse used to initiate fuze action, or by withdrawal of a mechanical arming wire (Fig. 5-2). This action ignites the thermal battery through an electric pyrotechnic match. In approximately two seconds, the thermal battery comes up to its operational voltage. The target signal amplifier output is then fed to the radio frequency oscillator detector where pulsed RF energy is radiated outward in the lobal pattern shown. As the weapon approaches its target, the interaction between the emitted and reflected RF energy causes a Doppler signal to appear at the oscillator detector. This signal is then applied to the target signal amplifier where it is amplified sufficiently to trigger a thyration in the firing circuit. Energy is thus applied to the tail fuze where it initiates the firing sequence of the bomb.

Application. The principal application of the Mk 43 is with the M990E2 fuze in SNAKEYE retarded operations, a capability not available with the earlier M20. The Mk 43 may be used with other M990 fuzes but its DC initiation restricts its use to no-option VT only operations. (The Mk 43 is automatically initiated by the +300 volts DC applied to the M990 fuze.)

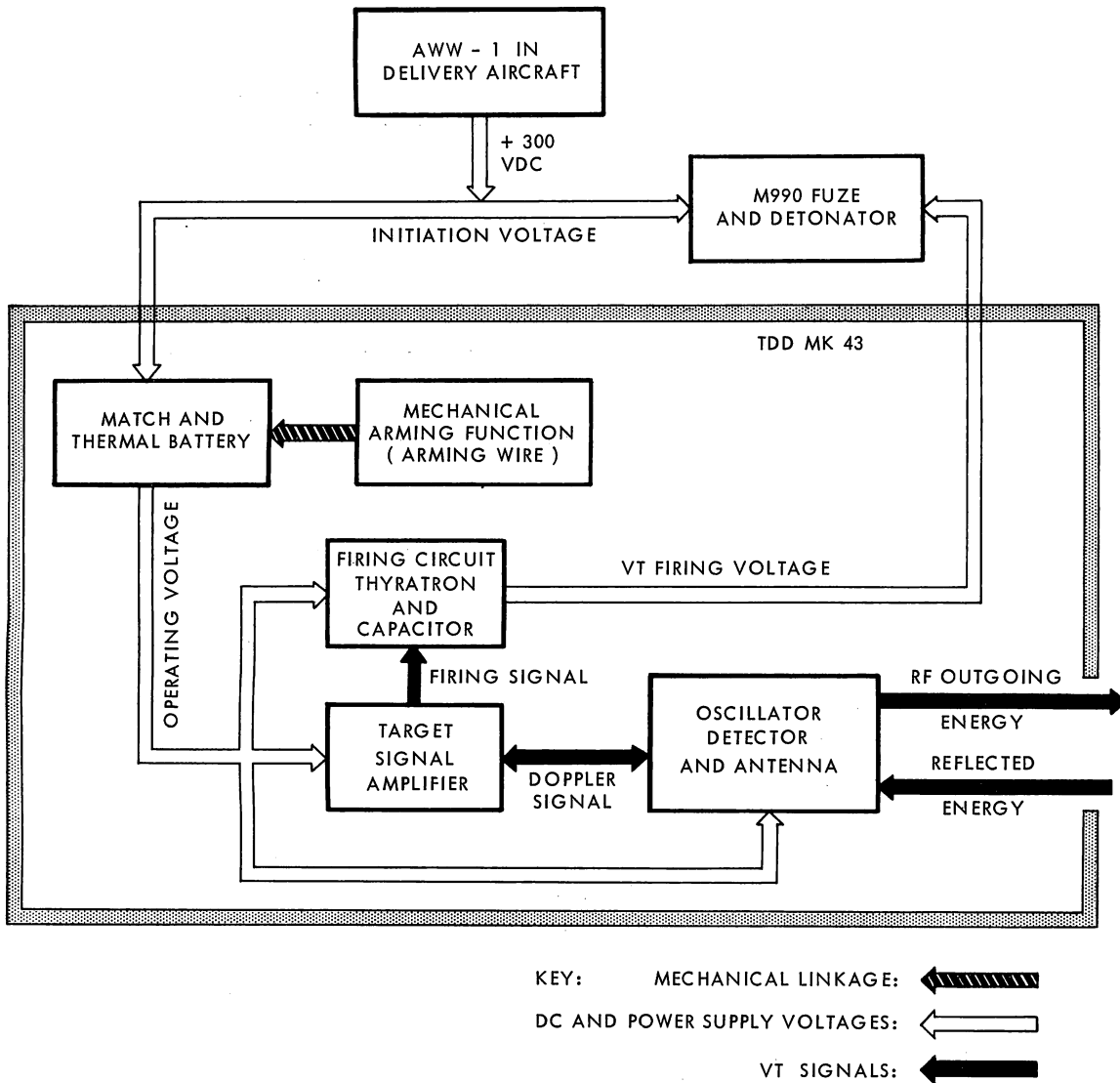


Figure 5-2 Target Detecting Device Mk 43 Block Diagram

CAUTION

If the Mk 43 is used in conjunction with any modification of the M990 other than the E2, there is no pilot option available and operation is always in the VT mode. Table 2-4 lists the options available with the M990E2/Mk 43 combination.

It is recommended that the Mk 43 be fitted with an arming wire for mechanical initiation when used with the M990E2 electric tail fuze. In this manner, a pilot option of VT versus non-VT is available in the unretarded SNAKEYE mode. The M990E2 is initiated by +195 volts for an unretarded release; the Mk 43 is not automatically initiated by this lower voltage. For a retarded release, the M990E2 is initiated by +300 volts DC. Thus, in the retarded release the Mk 43 is automatically initiated, precluding pilot option.

Refer to the coverage on the M990 fuze, Chapter 2 and Table 2-5, for additional coverage on the Mk 43. (Coverage of operation with DC fuze Mk 344 will be provided in Fiscal Year 1967.)

Handling.* The thermal battery of the Mk 43 may become accidentally initiated due to stray electromagnetic radiation or to accidental withdrawal of the arming wire or safety pin. Because the Mk 43 has no explosive elements, there is no safety hazard present, but it is no longer operable. If the device feels abnormally warm to touch, it is probably due to the heat generated by the thermal battery in operation. In this case, or if the shear wire is broken, the power supply has probably been expended and the Mk 43 should be disposed of or deformed to prevent installation in a bomb. (The firing capacitor is discharged by a bleeder resistor to prevent stray voltages from being applied to a fuze if the Mk 43 is ever installed in a weapon inadvertently.)

The Mk 43 should be handled as would any item of electronic equipment, carefully.

SENSING ELEMENT PROXIMITY M20. Sensing Element, Proximity, M20 (or M20A1) is similar in design and operating principles to the Mk 43 Target Detecting Device described in the previous subsection. Characteristics of the M20 are given in Table 5-2 below:

Table 5-2

SENSING ELEMENT, PROXIMITY, M20 AND M20A1;
SUMMARY OF CHARACTERISTICS

Nomenclature	Sensing Element Proximity M20
Identifying color M20 M20A1	Neutral Tan Dark red
Energizing Delay	3.5 sec for warmup to proper operation

* Equally applicable to M20 and M20A1

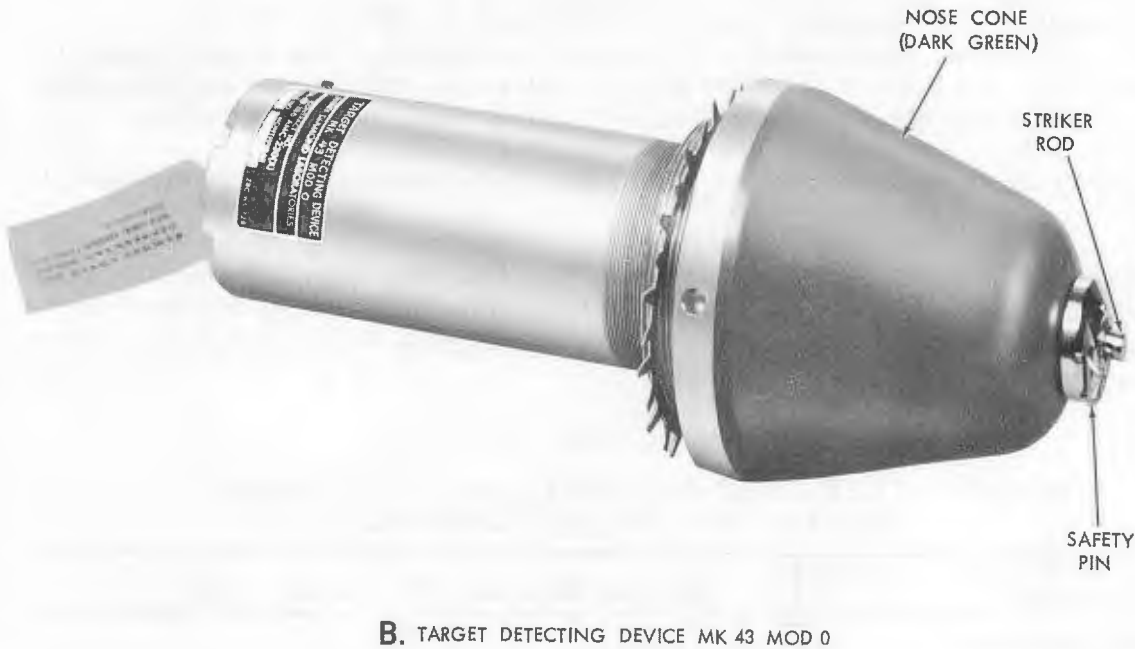
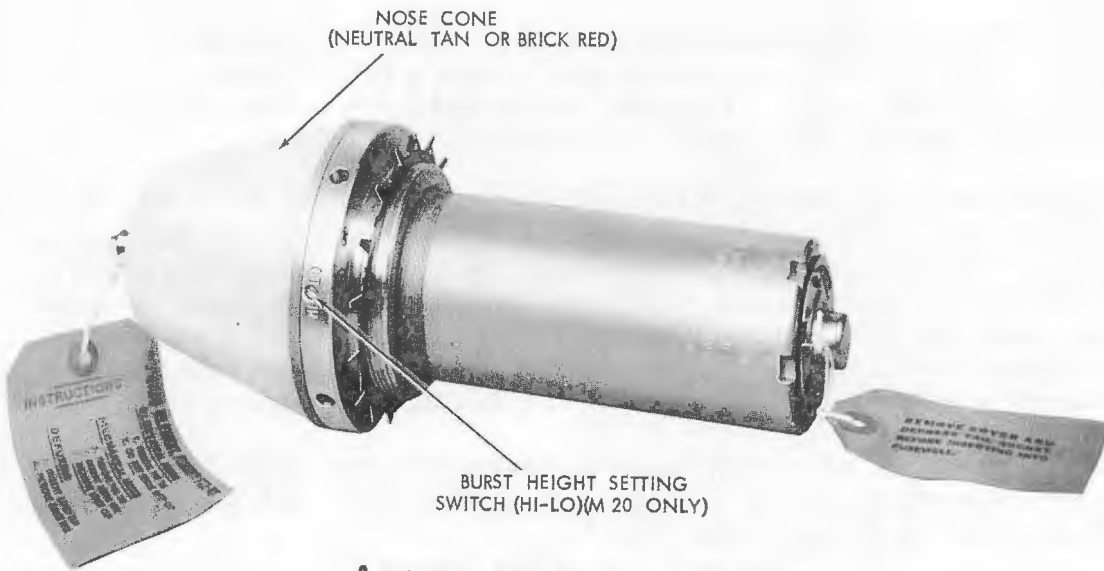


Figure 5-3 Target Detecting Device Mk 43 and Proximity Sensing Element M20, External Views

Table 5-2 (Cont'd)

Burst Height High Setting Low Setting	100 to 160 feet 20 to 60 feet
Initiation	RF or mechanical
Weight	4.3 pounds
Drawing	AOC EPL 10403068
Appropriate M990 Fuze	M990D, D1*, D2*, E, E1*

* Must be mechanically initiated.

Operation. Sensing Element, Proximity M20, is initiated by the RF frequency applied to the M990D or -E fuze. With this exception, the block diagram of the Mk 43 in Figure 5-2 applies to the M20.

Application. The M20 Proximity Device must be used with low drag or SNAKEYE unretarded weapons only. Used with SNAKEYE retarded, its response characteristics are such that it will produce a surface burst rather than an air burst.

The M20 is used with Fuzes M990D, D1, D2, E, and E1. When these fuzes are used with DC-only initiation, the M20 must be mechanically initiated by withdrawal of the arming wire from the striker rod. If pilot option (RF initiation) of arming and functioning delays is employed with the -D or -E fuze, the M20 can be electrically initiated.

Refer to Chapter 2 and Table 2-5 for details of M20 employment with the M990 series fuze.

Installation. The following procedures are applicable to both the M20 and Mk 43.

CAUTION

Do not use Sensing Element, Proximity M20, with the M990E2 fuze. The M20 will not provide a VT airburst in the SNAKEYE retarded delivery mode.

There are three different methods for installing the M20 or Mk 43 sensing elements, depending upon the required method of initiation and the tactical requirements of the strike (see Table 2-5). These are as follows:

1. Positive arming wire connection (VT only; no pilot option)
2. Arming wire to nose solenoid (pilot option of VT vs non-VT)

3. Electrical initiation (RF or DC; may be used in conjunction with (1) or (2) above.

The following tools are required:

1. Wire Cutter
2. 3-inch screwdriver, for setting HI-LO switch on M20
3. Spanner wrench (supplied with sensing elements)

Install the sensing element in the nose well of the Mk 80 series bomb as follows:

1. Ensure that the proper sensing element (M20 or Mk 43) compatible with the mission is available.

CAUTION

Do not remove the safety clip from the nose of the Sensing Element.

2. Remove the instruction tag from the nose of the sensing element and the shipping cap and tag from the tail end. Set these items aside for reinstallation if the element is removed from the bomb.

3. If an M20 is being installed, set the HI-LO switch to the required setting.

4. Remove the steel nose plug and sleeve from the nose of the bomb. Details for this procedure appear in OP 2216 Part 1.

5. Check that the charging plug is present in the nose fuze well. Clean the well to remove any foreign matter.

6. Check that the safety clip is in place and that the striker rod is visible. If not, discard the sensing element.

7. Insert the sensing element into the nose well and rotate clockwise until it is hand-tight. Using the spanner wrench, tighten the element one-quarter turn farther.

8. Insert the arming wire (when required) through the open hole in the striker rod, pull through and take up the slack.

9. Cut off the excess arming wire (if bomb is mounted on aircraft) so that approximately three to four inches protrudes through the striker rod.

10. Attach a Fahnestock clip on the free end of the arming wire and push the clip against the striker rod.

11. Remove the safety clip and set aside for possible re-use.

NOTE: Mk 43/M20E1 Detecting Devices are colored dark green and appear black under red lighting conditions.

SAFETY DEVICE MK 26

Safety Device Mk 26 Mod 0 (Fig. 5-4) is supplied integral with Fuze M990D, D1, D2, E, and E1. It is mandatory that it be installed on Fuze M990C prior to issuance for use.

OPERATION. The purpose of the Mk 26 Safety Device is to secure the rotor of the M990 fuze in the safe or unarmed position. It accomplishes this by means of the safety pin assembly. When secured in the safe position by either the safety cotter pin or by an arming wire, the free end of the safety pin extends down into a hole in the rotor (Fig. 2-5). Thus, if the explosive bellows are accidentally detonated, the rotor is blocked and is prevented from turning to the armed position.

When the arming wire is withdrawn from the sleeve at bomb release, the safety pin is released and is driven outward approximately two inches by an internal coil spring. The rotor is thus free to rotate when arming occurs. The pin is not jettisoned free from the sleeve, being retained by the stop. This ensures that the safety pin does not come completely out of the bomb and also preserves the water-tight integrity of the fuze.

ACCIDENTAL REMOVAL OF SAFETY COTTER PIN. If the safety pin is accidentally freed prior to installation of the fuze in a bomb, it does not cause automatic operation of the rotor. The safety pin can be safely pushed back into the sleeve and the safety cotter pin and warning tag reinstalled in the bottom hole. The pin should be reseated without delay.

WARNING

If, when reseating the safety pin, the pin binds or rubs or will not seat, it is probably the result of premature rotor operation and arming. The fuze should immediately be turned over to EOD personnel for disposal.

INSTALLATION ON FUZE. If any fuze is encountered without a Mk 26 (or Mk 28) Safety Device, a Mk 26 should be installed prior to issue. Procedures for this operation are given in Appendix A, and will normally be required only for early-production M990C fuzes.

A safety device should not be removed once it is properly installed on a fuze.

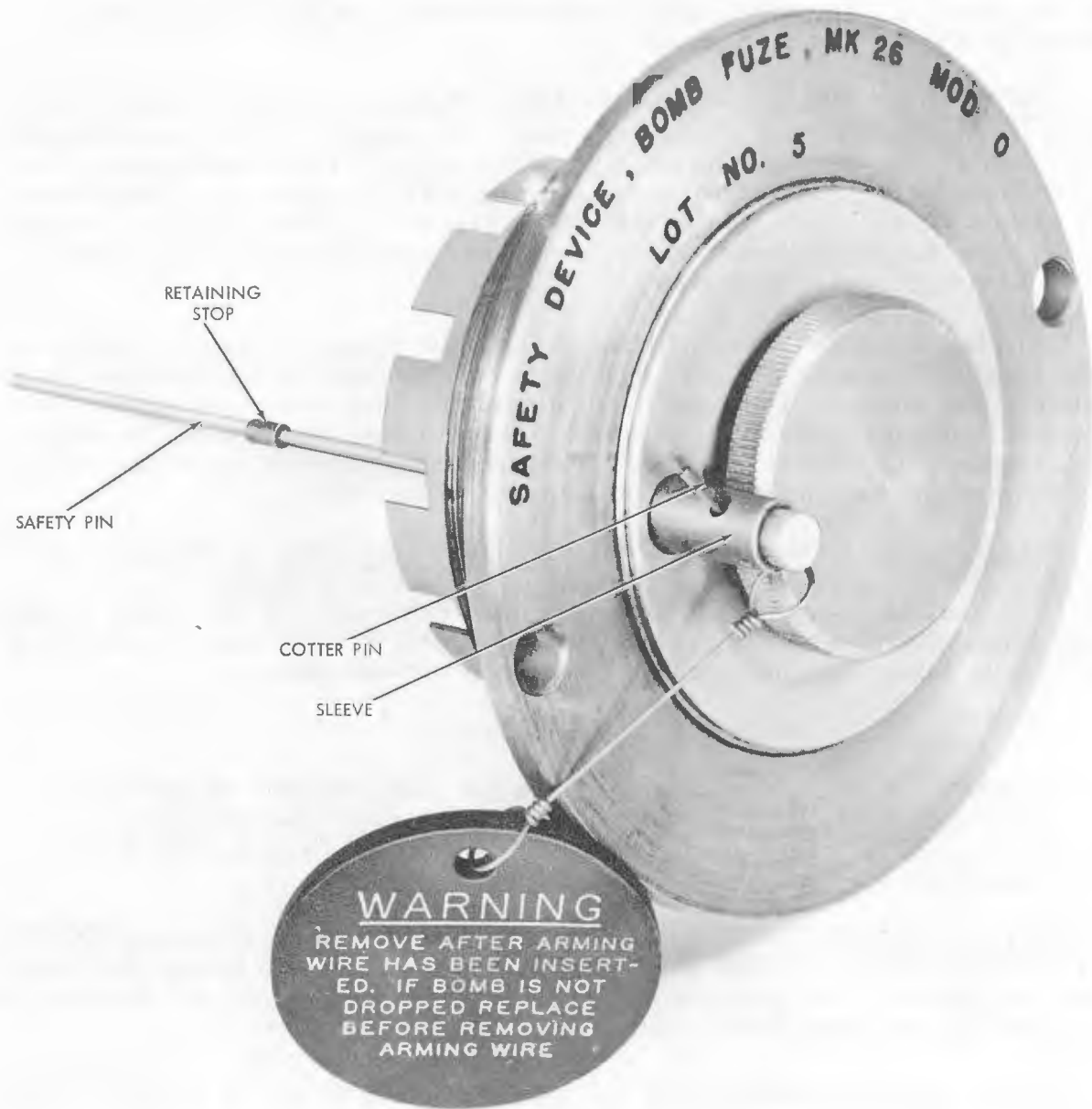


Figure 5-4 Safety Device Mk 26

WAFER SWITCH MK 93 MOD 0

Wafer Switch Mk 93 Mod 0 is an expendable device which is attached to the aircraft arming unit to provide make-then-break charging of electric bomb fuzes. It is used with M990 series fuzes and Fuzes Mk 255 and 257. Interim coverage is provided here, pending final detailed coverage in a later release, because of its application with the M990 fuzes covered in Chapter 2.

The purpose of the wafer switch is to provide an open circuit between the bomb fuze and the aircraft until the bomb is released. The principal reason for its use is to reduce the possibility of premature fuze circuit actuation due to spurious electromagnetic radiation. (A direct connection between the fuze, internal cabling, and the aircraft charging equipment can act like an antenna, picking up stray RF energy and causing detonation of fuze squibs through heating or through RF coupling.) The wafer switch also prevents charging of a fuze prior to bomb release.

Upon bomb release, an insulating tape is withdrawn, causing momentary connection between the fuze circuits and the charging voltage present at the bomb arming unit.

CAUTION

The wafer switch is a "one-shot" item. After release of one bomb, the wafer switch, if still attached to the bomb arming unit, must be removed and replaced with a new wafer switch for the next bomb. Failure to do so can cause fuze malfunction and result in premature arming or a dudded bomb.

SAFETY DEVICE MK 28 MOD 0 ("RETARD SENSOR")

GENERAL. Safety Device Mk 28 Mod 0 ("Retard Sensor") is an integral component part of Electric Tail Fuze M990E2. Its function is similar in one respect to that of Safety Device Mk 26 Mod 0 in that it prevents premature operation of the fuze rotor due to accidental initiation of the arming bellows (Fig. 2-5) prior to bomb release. Its most important function however, is to provide the required safety factor to delivery aircraft when operating with electric fuzes in the SNAKEYE retarded mode.

OPERATING PRINCIPLES. The retard sensor duds any M990E2 fuze set for 2.6 seconds if the SNAKEYE tail fails to retard the bomb or if the pilot inadvertently selects low drag release. It accomplishes this by means of a safety pin, similar in appearance to that used on the Mk 26 Safety Device (Fig. 5-4), inserted through a hole in the fuze detonator rotor. On the Mk 26, this safety pin is a solid steel rod which extends through the sleeve and is withdrawn from the rotor when the arming wire is pulled. With the retard sensor however, the safety pin is not withdrawn at the instant of arming wire removal. Withdrawal of the safety pin from the detonator rotor is delayed by means of a clockwork-G-weight mechanism within the retard sensor.

Operation in the 2.6 second (nominal) retarded mode and the 5.5 second (nominal) unretarded mode is as follows:

Retarded Mode. The retarded mode of operation is principally determined by the +300-volt DC initiation charge applied to the fuze at the instant of bomb release. This voltage, regardless of anything else, will cause the arming bellows in the rotor (Fig. 2-5) to operate at 2.6 seconds. However if through pilot error, the weapon is released in the unretarded mode, or if, through mechanical failure, the tail fails to open, the safety pin is retained in place in the rotor. At 2.6 seconds, the bellows operate and the detonator rotor, attempting to turn, is jammed in the safe position. Thus, the weapon is duded and the probability of an armed, unretarded bomb following along with the delivery aircraft is virtually eliminated.

However, if the weapon is properly retarded, the fuze is allowed to arm. This sequence is as follows:

1. The weapon is dropped and the arming wire is withdrawn from the initiating shaft in the fuze (Fig. 5-5). Deceleration of the retarded weapon begins.
2. The initiating shaft is released and initiates operation of the retard sensing mechanism. An escapement is freed to operate and unlocks a G-weight.
3. When the G-weight is unlocked, it moves forward due to deceleration. The mechanical characteristics of the retard sensor are such that this action causes the safety pin to be withdrawn from the rotor at this time.
4. Arming occurs at 2.6 seconds after release and the detonator rotor bellows (Fig. 2-5) are operated.

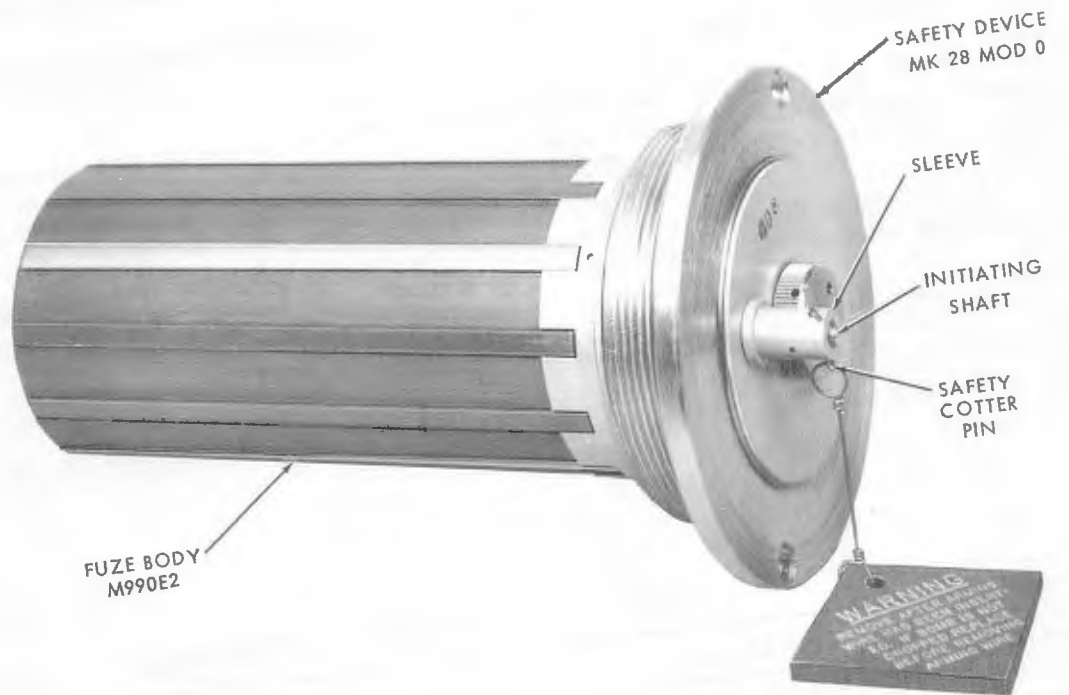


Figure 5-5 Safety Device Mk 28 Mod 0 (Retard Sensor)

Unretarded Mode. The unretarded mode of operation is initiated by the application of a +195-volt DC voltage at weapon release. This causes the bellows to operate the detonator rotor at 5.5 seconds.

Operation in the unretarded mode is as follows:

1. The weapon is released and the arming wire is withdrawn from the initiating shaft. The escapement is initiated and G-weight is released as described previously.
2. The G-weight awaits the retarding action of the SNAKEYE fins as described above. Because the bomb is unretarded, there is no deceleration, the G-weight remains in place, and the safety pin is not withdrawn from the rotor.
3. The G-weight is re-locked in the unoperated position and the escapement continues to operate.
4. At 2.6 seconds, the safety pin is still in place in the detonator rotor. But because the bellows are not initiated at this time, there is no jamming of the rotor in the safe position.
5. At approximately 3.6 seconds the safety pin has run through the escapement and is withdrawn from the rotor.
6. The fuze is armed at 5.5 seconds after release.

Table 5-3 summarizes the operational times of the retard sensor in both the retarded and unretarded modes.

Table 5-3

RETARD SENSOR OPERATIONAL SEQUENCE

Retarded Mode		Unretarded Mode	
Time (sec.)	Event	Time (sec.)	Event
0.0	Fuze charged to +300 volts DC. Weapon Released, Retard Sensor operation initiated by withdrawal of arming wire. Escapement begins operation.	0.0	Fuze charged to +195 volts DC. Weapon Released, Retard Sensor operation initiated by withdrawal of arming wire. Escapement begins operation.
0.2 to 0.5	SNAKEYE fins operate to decelerate weapon.		
.75±.25	G-weight unlocks and moves forward due to	.75±.25	G-weight unlocked and remains in place.

Table 5-3 (Cont.)

Retarded Mode		Unretarded Mode	
Time (sec.)	Event	Time (sec.)	Event
	deceleration. Safety pin pulled out of detonator rotor.		Safety pin remains in place.
		1.2 (nominal)	G-weight relocked. Escapement continues to operate.
2.6 (nominal)	Bellows of fuze are fired and detonator rotor rotated to armed position.		*
		3.6±0.4	Safety pin pulled out of detonator rotor.
		5.5 (nominal)	Bellows of fuze are fired and detonator rotor rotated to armed position.

*If bellows operate in unretarded mode at this point, rotor is jammed in open position by safety pin.

HANDLING. A Mk 28 Safety Device (retard sensor) should never be removed from an M990E2 fuze, nor installed in place of a Mk 26 Safety Device on any other M990 series fuze. If an M990E2 fuze is encountered without a retard sensor, the fuze should not be used, and should be turned in to EOD personnel for disposal.

If the safety cotter pin (Fig. 5-5) is accidentally removed and the initiating shaft released prior to installation of the fuze in a weapon, the clockwork escapement mechanism will run down and the safety pin will be withdrawn from the rotor. An inherently hazardous condition will exist however, only if the bellows of the detonator rotor (Fig. 2-5) are somehow initiated.

If the initiating shaft is accidentally released, the fuze may be returned to its "as before" condition by gently and slowly depressing the shaft with the thumb. Pressing inward on the shaft for four to eight seconds will rewind the escapement and resecure the detonator rotor. The safety cotter pin may then be re-installed.

Excessive force in this action can strip the internal gears. Four or five pounds of pressure is usually adequate. If more force is required, release pressure momentarily to allow the internal gears to re-align themselves.

OP 2216

WARNING

If the initiating rod will not depress after a few attempts, it is possible that the bellows may have operated and the fuze is armed. Notify EOD personnel at once.

NOTE: Certain lots of non-preselected M990E fuzes may be fitted with Mk 28 Safety Devices. These fuzes are intended for SNAKEYE use with RF initiation where so authorized. Operation of the Mk 28 retard sensor is identical with both the M990E and M990E2.

ARMING ASSEMBLIES MK 3, 4, AND 5 (FOR LOW-DRAG AND SNAKEYE WEAPONS)

Arming Assemblies Mk 3, 4, and 5 are used with the tail assemblies of both low-drag and SNAKEYE bombs to provide arming action for the long-delay mechanical time fuze Mk 346. These assemblies may also be used with Mechanical Fuzes M905 and M906 although at present, these fuzes are not being procured for Navy use. The arming assemblies consist basically of a driving vane with a governor assembly, and an extension drive shaft which couples into the input shaft of the fuze. Figure 5-6 shows a typical arming assembly; the three Marks are identical with the exception of the length of the extension shafts.

Characteristics of the three Marks are as follows:

Nomenclature	Extension Drive Shaft Length (approx.)	Color	Used With
Mk 3	38.3 inches	Red	1000-lb. Mk 83 low-drag bomb
Mk 4	24 inches	Orange	250-lb Mk 81 low-drag bomb and 250-lb SNAKEYE I
Mk 5	22 inches	Blue	500-lb Mk 82 low-drag bomb and 500-lb SNAKEYE I

Each drive shaft is color-coded and labeled to indicate the bomb with which it is used.

The arming assembly provides a maximum rotational output of 1800 rpm, \pm 100 rpm. This is accomplished by means of a centrifugally operated governor which limits the rotational speed delivered to the input shaft of the fuze. The effect of this governor is to provide a degree of constant arming time for the fuze between 200 and 600 knots delivery speed. At rotational speeds below 1800 rpm, the governor has no effect and rotation is imparted to the fuze input shaft on a one-for-one basis.

DESCRIPTION. The arming assembly consists of four basic components, Fuze Drive Mk 5, an adapter, the appropriate drive shaft, and a funnel guide. Figure 5-6 shows the complete arming assembly.

Fuze Drive Mk 5 Mod 0. This device is common to all Marks of the Arming Assembly. It consists of a four-blade, seven-inch wire-shrouded arming vane, the governor, and the fuze drive barrel with a locknut and a toothed retaining spring (Fig. 5-7). The fuze drive is designed to be quickly and securely affixed to either the conical fins of low-drag bombs or the SNAKEYE I tail.

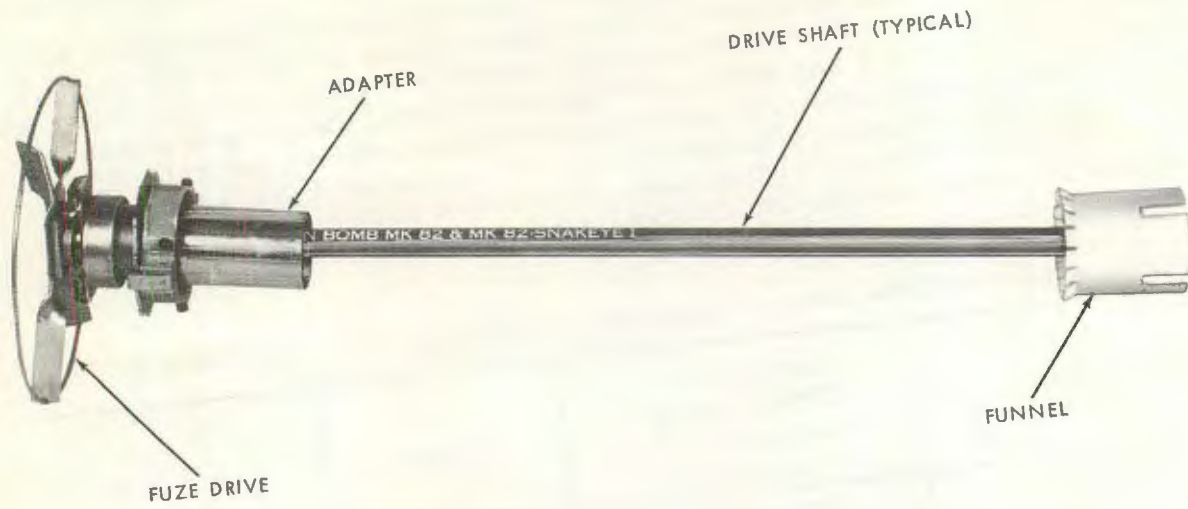


Figure 5-6 Complete Arming Assembly (Typical)

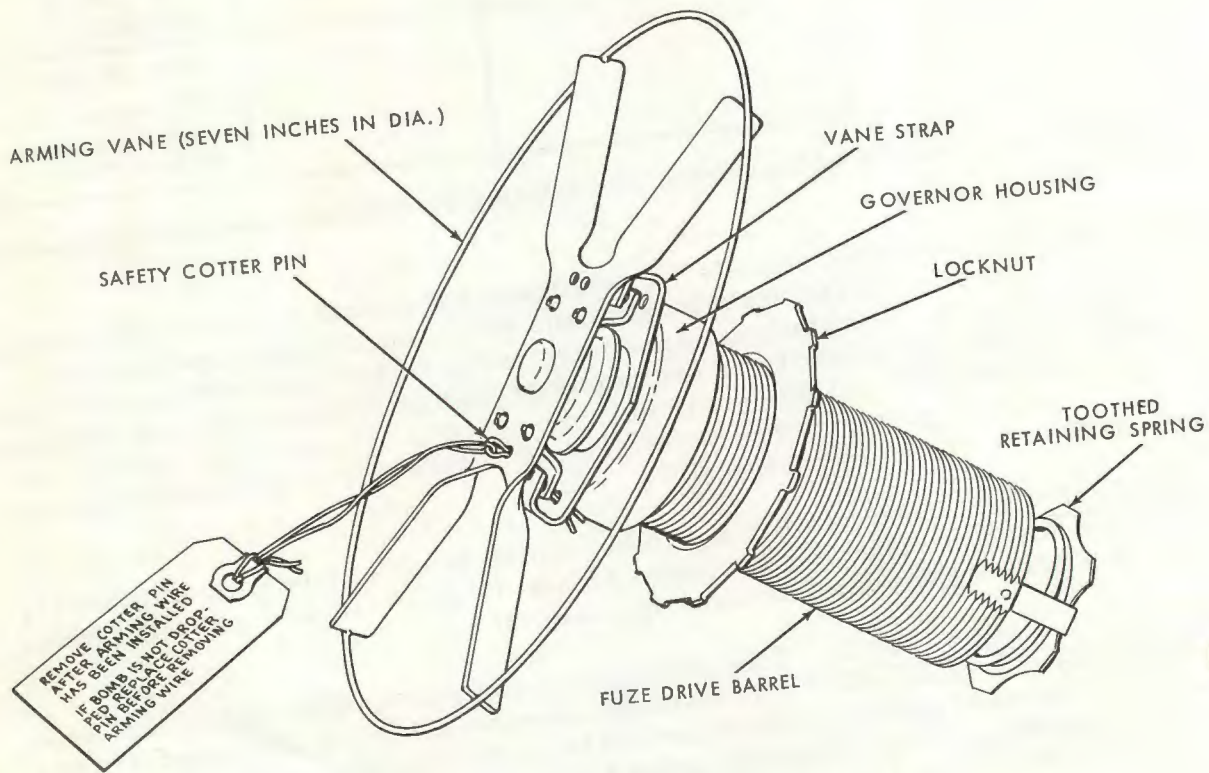


Figure 5-7 Fuze Drive Mk 5 Mod 0

Adapter. The adapter (Fig. 5-8) is affixed to the conical tail by means of the three socket-head set screws. With SNAKEYE, the threads beneath the adapter collar are screwed into mating threads on the tail of the weapon. Then the adapter is further secured by means of set screws which are run down into the threads on the SNAKEYE tail. With the conical fins, the set screws alone secure the adapter in place.

The two latches on the adapter collar are secured over the fuze drive locknut when the entire assembly is installed in a weapon. Figure 5-9 shows the assembled fuze drive and adapter as it would be installed in a weapon.

Extension Drive Shaft. The extension drive shaft couples the output spindle of the fuze drive to the input shaft of the fuze. Each end of the extension drive shaft contains an identical spring assembly which keys the shaft to the output spindle of the fuze drive and the input shaft of the fuze. The drive shaft also serves to depress the locking key (Fig. 3-8) on the input shaft of the Mk 346 fuze, thus freeing the input shaft for rotation. Both ends of the extension drive shaft are identical and no particular orientation is required.

Funnel. The funnel guide is a molded polyethylene sleeve which snaps over the outer end of the fuze. Its purpose is to facilitate the installation of the extension drive shaft to the fuze after the tail has been installed on the bomb body.

INSTALLATION OF ARMING ASSEMBLY IN BOMB. The following procedures are applicable to low-drag bombs Mk 81, 82, and 83 and the 250- and 500-pound SNAKEYE weapons. The only specialized tool required is a 1/4-inch socket-head wrench.

1. Prepare the weapon tail section for assembly as described in OP2216 Part 1 for low-drag bombs or OP's 3339 and 3374 for SNAKEYE I.
2. Install the fuze in the bomb tail well according to procedures in Chapter 3 of this OP. Push the funnel over the outer end of the fuze until it snaps into position.
3. For installation on a conical tail, loosen the set screws in the adapter collar and insert the adapter through the hole in the rear of the conical tail until it is firmly seated. For SNAKEYE, loosen the screws and mate the adapter to the SNAKEYE tail using the threads under the adapter collar.
4. Tighten the screws to secure the adapter to the SNAKEYE tail or to the conical tail, whichever is applicable.
5. Screw the locknut on the fuze drive barrel all the way out toward the arming vane (Fig. 5-7).
6. Open the latches on the adapter collar.
7. Place the appropriate drive shaft into the fuze drive barrel until the locking key in the drive shaft engages the output spindle of the fuze drive.

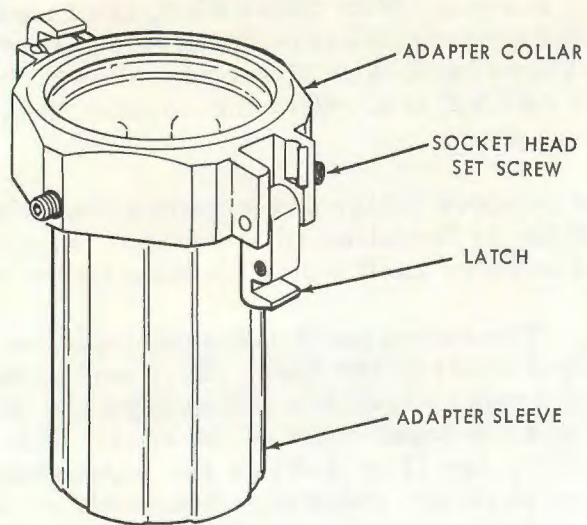


Figure 5-8 Arming Assembly Adapter

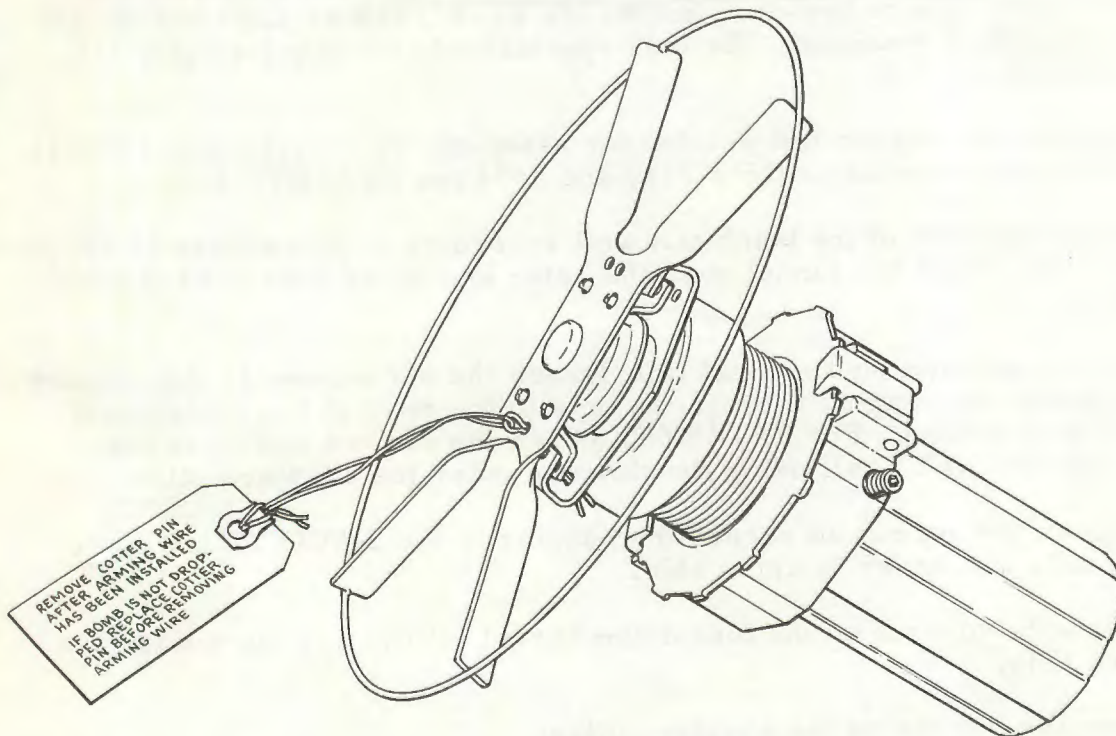


Figure 5-9 Adapter Coupled to Fuze Drive

8. With the drive shaft and the fuze drive as one unit, orient the fuze drive unit so that the arming vane strap is aligned with the bomb suspension lugs. Insert the drive shaft through the adapter and into the tail section of the bomb.

9. Secure the arming assembly to the weapon as follows:

a. For low-drag conical fin weapons, open the fin hand hole cover and guide the fuze drive and shaft inward. Guide the shaft into the mouth of the funnel by slowly pushing on the outer end of the fuze drive. The drive shaft will then seat firmly against the outer end of the fuze, and engage the fuze input shaft.

b. For SNAKEYE tails, press the fuze drive and drive shaft inward until the drive shaft seats firmly against the outer end of the fuze.

NOTE: The fuze drive is held in alignment by the contact of the toothed retaining spring against the inside of the adapter sleeve.

10. Hand-tighten the locknut down the fuze drive barrel until it contacts the adapter. Back it off as little as necessary so that the two latches can be secured to the locknut as shown in Figure 5-9.

11. When loaded aboard the aircraft, install the arming wire through the vane strap (Fig. 5-7) and secure the arming wire with two Fahnestock clips. Approximately three or four inches of the arming wire should extend past the vane strap. Do not stress the arming wire too tightly against the solenoid.

12. Remove the safety cotter pin from the vane strap.

REMOVAL OF ARMING ASSEMBLY FROM BOMB. These procedures apply to the removal of the arming assembly from low-drag bombs Mk 81, 82, and 83 and SNAKEYE weapons.

1. Remove the tail of the weapon. See OP's 3339 or 3374 for SNAKEYE I procedures and Part 1 of this OP for applicable procedures for the low-drag series.

2. Remove the plastic funnel from the outer end of the fuze and withdraw the drive shaft from the fuze drive.

3. Using the socket head wrench, loosen the three 1/4-inch set screws around the adapter collar. Withdraw the adapter and the fuze drive as a unit from the conical tail. The adapter must be unscrewed from the threads on the rear of the SNAKEYE tail.

4. Open the latches on the adapter and screw the locknut all the way back out to the arming vane.

5. Grasp the adapter firmly in one hand. Using an evenly applied pressure, press inward on the fuze drive with the other hand. Do not bend or

deform the vane. This forces the fuze drive barrel (Fig. 5-7) all of the way through the adapter sleeve. At the completion of this step, the fuze drive barrel and the retaining spring should be protruding through the end of the adapter sleeve.

6. With the flat edges of the retaining spring aligned with the corresponding flat inner surface of the adapter sleeve, pull backward on the fuze drive assembly. This action causes the retaining spring to "reverse" and the fuze drive assembly is readily withdrawn from the adapter.

7. If not already done, replace the safety cotter pin in the vane strap and set the fuze drive assembly aside for future use.

SUMMARY SHEET

Note: This sheet is issued in reproducible form to facilitate making of reproductions locally. It presents a summary of information contained in the following section, and may be used for convenient reference. It is NOT intended to replace the OP.

M990 ELECTRIC TAIL FUZE

KEY POINTS

1. Used primarily in MK80 series low-drag and SNAKEYE I bombs.
2. Used with M20 or MK43 VT devices for airburst.
3. May be used with RF initiation from AWW-1 or with DC-only initiation. Those shown with asterisk below can be used with both RF and DC-only initiation.

FUZE	DECAL		ARMING TIMES SECONDS	FUNCTIONING TIMES SECONDS
M990C		*	2/4.5/8/20	0/.004/.01/.025/.05/5/20
M990D		*	2/4.5/8/20	0/.004/.01/.025/.05/5/20
M990D1	□	DC	4.5	.004
M990D2	◻	DC	4.5	.025
M990E	⬡	*	2.6/5.5/8/20	0/.004/.01/.025/.05/5/20
M990E1	△	DC	5.5	.050
M990E2	◊	DC	2.6 RETARDED	0
			5.5 NON-RET.	0

NOMINAL. MAY VARY
BY +50% -15%

4. M990E2 is only M990 fuze which can be used to initiate SNAKEYE I retarded.
5. Don't use the M990C without a MK26 safety device.
6. RF initiation allows in-flight pilot option of arming and functioning times.
7. Read all tactical and delivery restrictions and select the proper M990 accordingly.

WARNINGS

The following procedures must be observed when handling these fuzes:

Don't remove the warning tag and safety cotter pin from the fuze until the safety wire is in place.

The short arming time of 4.5 sec. for -D1 and -D2 requires special delivery tactics to escape fragments! Same with 5.5 sec.! See the appropriate NATOPS manual.

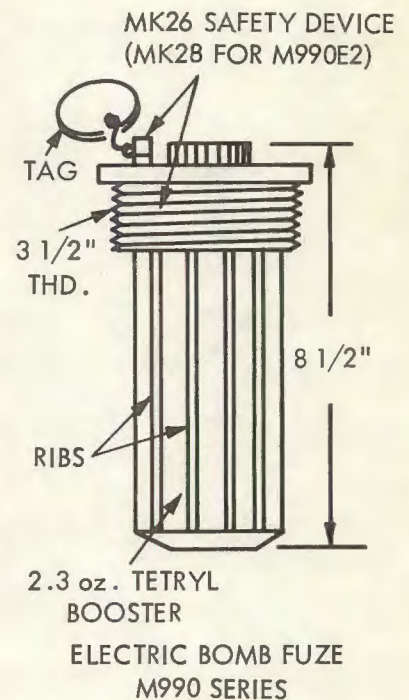
Don't use less than 5.5 sec. arming time for MK83 and MK84 bombs!

Don't ever use the 2 sec. arming time!! Don't use the 2.6 sec. time except with SNAKEYE I retarded!!

Don't use RF with -D1, -D2, -E1 or -E2! Don't use both RF and "DC-ONLY" fuzes on same ship or base!

The 300V on the AWW-1 must be within ±6 volts!

Don't use the M990C without MK26 safety device!



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2. Used with M20 or MK43 VT devices for airburst.
3. May be used with RF initiation from AWW-1 or with DC-only initiation. Those shown with asterisk below can be used with both RF and DC-only initiation.

FUZE	DECAL	ARMING TIMES SECONDS	FUNCTIONING TIMES SECONDS
M990C	*	2.4-2.8/20	0.004/.01/.025/.05/2/20
M990D	*	2.4-2.8/20	0.004/.01/.025/.05/2/20
M990D1	□	4.5	.004
M990D2	◻	4.5	.025
M990E	○	2.4-2.8/20	0.004/.01/.025/.05/2/20
M990E1	△	2.5	.020
M990E2	◇	2.5 NON-RET.	0
		2.5 RETARDED	0
		SNAKEYE	0

NOMINAL. MAY VARY BY +20% -12%

4. M990E2 is only M990 fuze which can be used to initiate SNAKEYE (retarded).
5. Don't use the M990C without a MK20 safety device.
6. RF initiation allows in-flight pilot option of arming and functioning times.
7. Read all tactical and delivery restrictions and select the proper M990 accordingly.

WARNINGS

The following procedures must be observed when handling these fuzes:

Don't remove the warning tag and safety cotter pin from the fuze until the safety wire is in place.

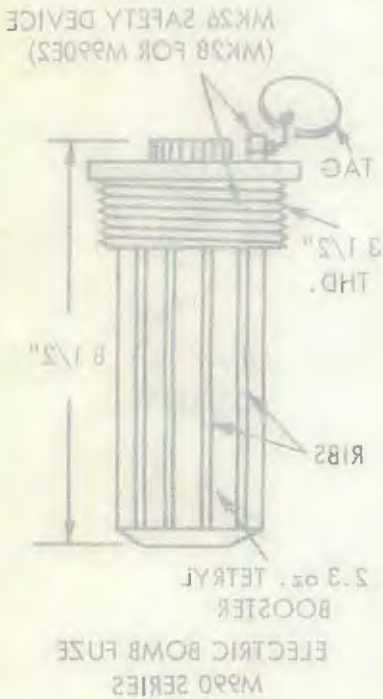
The short arming time of 4.5 sec. for -D1 and -D2 requires special delivery tactics to escape fragmentation. Same with 2.5 sec. See the appropriate NATOPS manual.

Don't use less than 2.5 sec. arming time for MK83 and MK84 bombs. Don't ever use the 2 sec. arming time! Don't use the 2.5 sec. time except with SNAKEYE (retarded)!

Don't use RF with -D1, -D2, -E1 or -E2! Don't use both RF and "DC-ONLY" fuzes on same ship or base!

The 300V on the AWW-1 must be within ±5 volts!

Don't use the M990C without MK20 safety device!



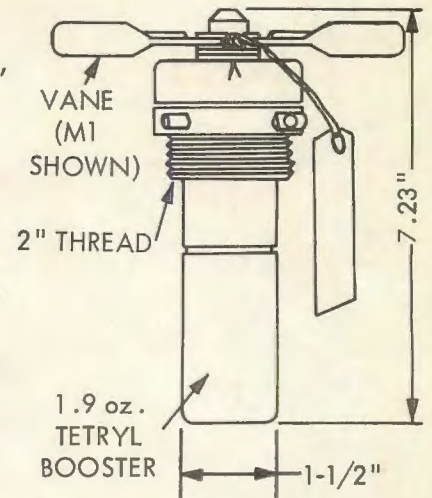
SUMMARY SHEET

Note: This sheet is issued in reproducible form to facilitate making of reproductions locally. It presents a summary of information contained in the following section, and may be used for convenient reference. It is NOT intended to replace the OP.

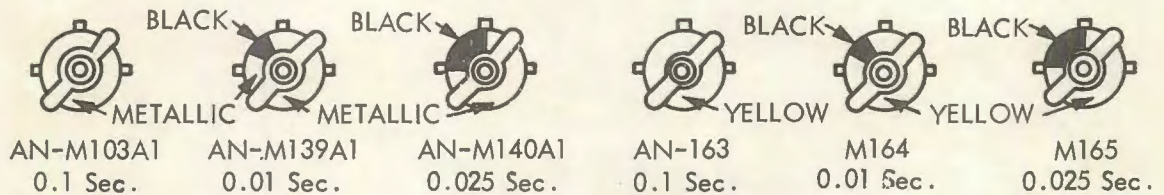
AN-M103A1/M163

KEY POINTS

1. Fuzes in this series are AN-M103A1, AN-M139A1, AN-M140A1, M163, M164, and M165.
2. UNIVERSAL MECHANICAL NOSE FUZE; FITS CURRENT HE BOMBS.
3. 2" thread - needs no adapter booster for GP(FAT) bombs - T45E4 for low drag bombs.
4. Arming vane MK6 and MK7 recommended. M1 may be used as an alternate but arming time is extremely short.
5. No special installation tools required. Unpack fuze, check as specified in OP, screw into nose well hand-tight, and affix arming vane and arming wire.
6. See text for arming delay times. Function at either instantaneous or delay.
7. Functioning delay times are as indicated below:



MECHANICAL IMPACT NOSE FUZE
AN-M103A1/M163 SERIES



8. Instantaneous setting preferred for reliability.

WARNINGS

The following safety precautions must be observed when handling these fuses:

See the text to learn to identify armed and partially armed fuses. These fuses contain a lethal amount of tetryl in the booster and can kill if they are improperly handled when armed.

Fuses can be armed by rotating the arming vane or vane strap. Always keep them secured by a cotter pin and safety wire.

Rough handling can make the fuze dangerous to all hands. Handle fuzes like eggs, not like rocks and cordwood.

Choose the proper fuze and vane for the mission. Read "Operational Characteristics".

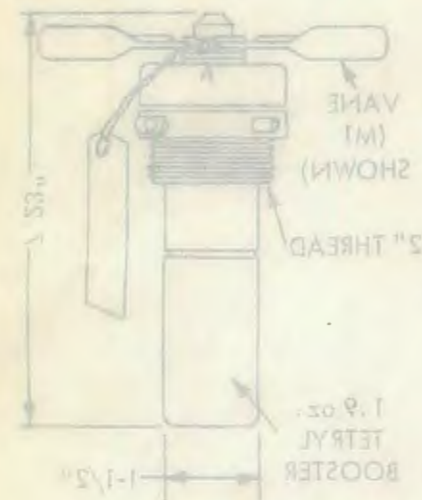
Don't ever use a damaged fuze or vane.

Note: This sheet is issued in reproducible form to facilitate making of reproductions locally. It presents a summary of information contained in the following section, and may be used for convenient reference. It is NOT intended to replace the OP.

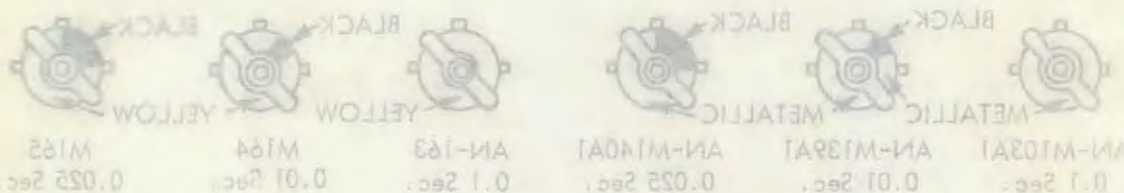
AN-M103A1/M163

KEY POINTS

1. Fuses in this series are AN-M103A1, AN-M139A1, AN-M140A1, M163, M164, and M165.
2. UNIVERSAL MECHANICAL NOSE FUZE; FITS CURRENT HE BOMBS.
3. 2" thread - needs no adapter booster for GP(AT) bombs - T4254 for low drag bombs.
4. Arming vane MK& and MK7 recommended. MI may be used as an alternate but arming time is extremely short.
5. No special installation tools required. Unpack fuze, check as specified in OP, screw into nose well hand-tight, and affix arming vane and arming wire.
6. See text for arming delay times. Function of either instantaneous or delay.
7. Functioning delay times are as indicated below:



MECHANICAL IMPACT NOSE FUZE
AN-M103A1/M163 SERIES



8. Instantaneous setting preferred for reliability.

WARNINGS

The following safety precautions must be observed when handling these fuses:

See the text to learn to identify armed and partially armed fuses. These fuses contain a lethal amount of retyl in the booster and can kill if they are improperly handled when armed.

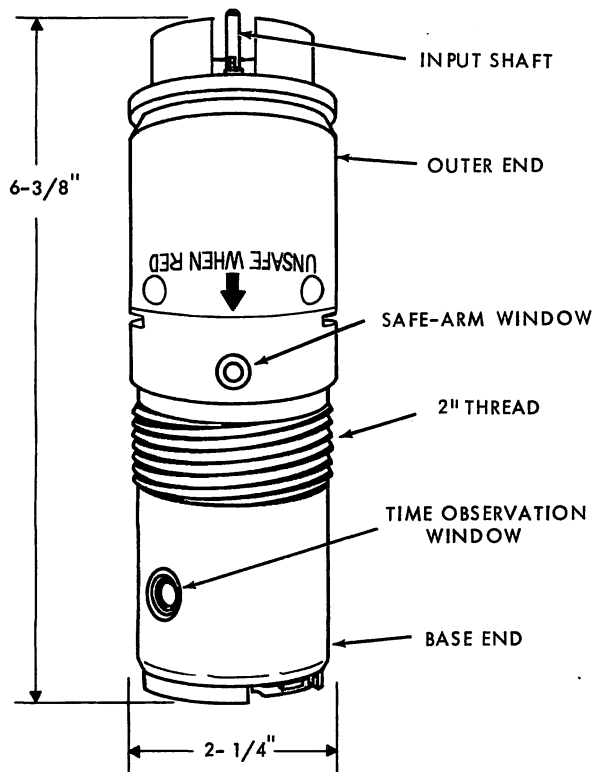
Fuses can be armed by rotating the arming vane or vane stop. Always keep them secured by a cotter pin and safety wire.

Rough handling can make the fuze dangerous to all hands. Handle fuses like eggs, not like rocks and cardboard.

Choose the proper fuze and vane for the mission. Read "Operational Characteristics".

Don't ever use a damaged fuze or vane.

SUMMARY SHEET
MK 346 MOD O MECHANICAL LONG DELAY TIME FUZE



NOTE : This material is prepared in reproducible form for convenient reference. It is not intended to replace the information in the OP.

ARMING: 1st. Stage : 1.5 to 4 sec.
nominal after release. See text

2nd. Stage : At impact.

FUNCTIONING DELAY: Classified

DETONATOR: Mk 44 Mod 1

LEAD: 148 Mg of RDX CH-6

USED WITH: Mk 81, 82, 83 low-drag and SNAKEYE I bombs

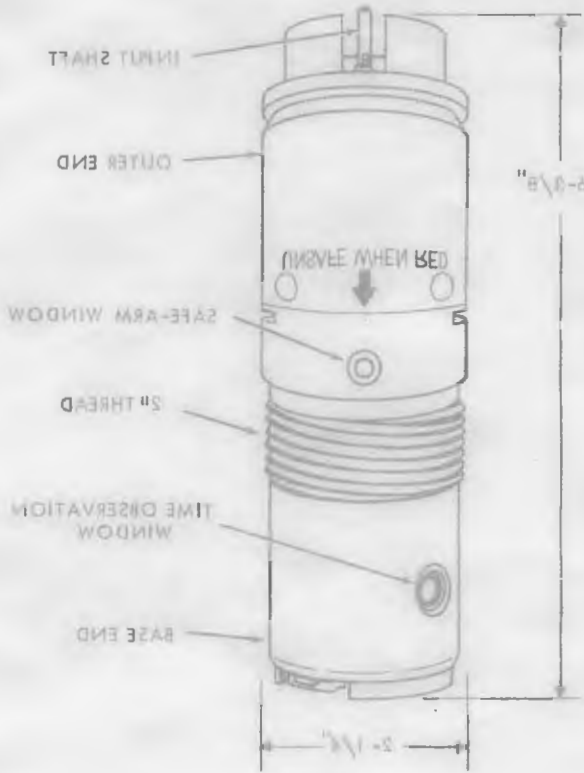
INSTALLATION IN LOW DRAG BOMB:

1. Install adapter booster, using long locking pin.
2. Install fuze all the way into the booster with no threads showing.
3. Use spanner wrench to tighten, if necessary.
4. Install Arming Assembly and tail on bomb.

KEY POINTS

1. Safer than any other long delay fuze.
2. All mechanical clockwork operation; no chemical components.
3. One fuze can give a variety of pre-selected burst times.
4. Not sensitive to temperature changes.
5. Out-of-line detonator; can be installed below flight deck.
6. Two-stage arming for inflight and delivery safety.
7. Used with: Arming Assembly Mk 4 for MK 81 Low Drag and MK 81-SNAKEYE I Bombs
Arming Assembly Mk 5 for Mk 82 Low Drag and MK 82-SNAKEYE I Bombs
Arming Assembly Mk 3 for Mk 83 Bomb
8. Requires Adapter Booster T46E4 or equivalent for tail well installation.
9. Mk 346 equipped weapons can be returned to field or carrier and reset (if desired) for future missions.
10. Fuze is locked in bomb after impact prevents enemy from defuzing bomb.

SUMMARY SHEET
 MK 346 MOD 0 MECHANICAL LONG DELAY TIME FUZE



KEY POINTS

1. Safer than any other long delay fuze.
2. All mechanical clockwork operation; no chemical components.
3. One fuze can give a variety of pre-selected burst times.
4. Not sensitive to temperature changes.
5. Out-of-line detonator can be installed below fuze.
6. Two-stage aiming for insight and delivery safety.
7. Used with: Aiming Assembly MK 4 for MK 81 Low Drag and MK 81-SHAKEEYE I Bombs; Aiming Assembly MK 5 for MK 82 Low Drag and MK 82-SHAKEEYE I Bombs; Aiming Assembly MK 3 for MK 83 Bomb.
8. Reduces Adapter Booster T&E or equivalent for tail well installation.
9. MK 346 equipped weapons can be returned to field or carrier and reset (if desired) for future missions.
10. Fuze is locked in bomb after impact..... prevents enemy from detaching bomb.

INSTALLATION IN LOW DRAG BOMBS:

1. Install adapter booster, using long locking pin.
2. Install fuze in the way into the booster with no threads showing.
3. Use spanner wrench to tighten, if necessary.
4. Install Aiming Assembly and tail on bomb.

USED WITH: MK 81, 82, 83 Low-Drag and SHAKEEYE I Bombs
 LEAD: 148 MG of BDX CH-6
 DETONATOR: MK 44 Mod 1
 FUNCTIONING DELAY: Classified
 2nd Stage: At impact.
 1st Stage: 1.2 to 4 sec. nominal after release; see text.

NOTE: This material is prepared in reproducible form for convenient reference. It is not intended to replace the information in the OP.