AD NUMBER: AD0860898
LIMITATION CHANGES
TO: Approved for public release; distribution is unlimited.
FROM: This document is subject to special export controls; 01 Mar 1969, and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the Air Force Armament Laboratory (ATWB), Eglin AFB, Florida 32542.
AUTHORITY
ST-A AFATL LTR, 22 NOV 1976

AD 860898

AFATL-TR-69-40

ENGINEERING DEVELOPMENT FOR THE FMU-54A/B (FUZE, INERTIAL BOMB TAIL) AND FMU-70/B (FUZE, INERTIAL BOMB NOSE)

R. E. BOWERS
D. A. BRACKMAN
AVCO ORDNANCE DIVISION

TECHNICAL REPORT AFATL-TR-69-40

MARCH 1969

This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the Air Force Armament Laboratory (ATWB), Eglin AFB, Florida 32542.

AIR FORCE ARMAMENT LABORATORY

AIR FORCE SYSTEMS COMMAND • UNITED STATES AIR FORCE

EGLIN AIR FORCE BASE, FLORIDA

47

ENGINEERING DEVELOPMENT

FOR THE

FMU-54A/B

(FUZE, INERTIAL BOMB TAIL)

AND

FMU-70/B

(FUZE, INERTIAL BOMB NOSE)

R. E. Bowers
D. A. Brackman

FOREWORD

This report was prepared by Avco Ordnance Division of Richmond, Indiana, under Contract AF 08(635)-4517 with the Air Force Armament Laboratory, Eglin Air Force Base, Florida. The report covers work done during February 1966 through December 1968. Mr. E. T. Smith (ATWB) was program monitor for the Air Force.

Information in this report is embargoed under the Department of State International Traffic In Arms Regulations. This report may be released to foreign governments by departments or agencies of the U. S. Government subject to approval of the Air Force Armament Laboratory (ATWB), Eglin AFB, Florida 32542, or higher authority within the Department of the Air Force. Private individuals or firms require a Department of State export license.

This technical report has been reviewed and is approved.

John H Hobaugh

JOHN H. HOBAUGH, Colonel, USAF
Chief, Development Division

ABSTRACT

The objectives of this development program were to utilize the FMU-54/B Fuze (Inertial Bomb, Tail) design as the basis for the design of the FMU-54A/B Fuze (Inertial Bomb, Tail) and the FMU-70/B Fuze (Inertial Bomb, Nose). Both fuzes must retain all characteristics of the basic fuze and be of the same size and configuration. The FMU-54A/B Fuze must have the settable delay time increased from a maximum of 3.5 to 6.0 seconds to provide safe escape distance for the delivery aircraft and must have the added capability of an air burst upon receipt of an electrical signal from a proximity sensor. To attain these objectives, the timing mechanism was redesigned for both fuzes, the retardation sensing system for the FMU-70/B Fuze was designed to sense the lack of retardation as well as retardation, components of the FMU-54A/B Fuze were reduced in size and weight to make space for the electrical detonator as well as the impact detonator, and the lanyards were redesigned to accommodate the electrical signal for the proximity sensor and the electrical detonator. The fuzes fabricated and tested function as required and have passed all MIL-STD tests. An improvement in tactical capability could be made by the inclusion of a short explosive delay function mode.

(The reverse of this page is blank)

BLANK PAGE

TABLE OF CONTENTS

LIST OF FIGURES

SECTION I.

INTRODUCTION

The objectives of the work completed on Contract No. AF08(635)-4517 were to utilize a modification of the existing FMU-54/B Fuze to develop two new fuzes of the same type with similar characteristics. These two fuzes were designated the FMU-54A/B Tail Fuze and the FMU-70/B Nose Fuze.

The FMU-54/B Fuze is a mechanically operated retardation sensing device with a predetermined arming delay of 0.75 to 3.50 seconds, settable in 0.25 second intervals, to provide safe escape distance for the delivery aircraft. The fuze fits into the tail fuze well of M117, Mk 81, and Mk 82 type bombs intended to be equipped with high drag (retardation) fins. Detonation of the bomb occurs on impact.

The FMU-54A/B Fuze was to be of the same configuration as the FMU-54/B Fuze except that it must have a predetermined arming delay of 0.75 to 6.00 seconds, settable in 0.25 second intervals up to 3.00 seconds and settable in 0.50 second intervals from 3.00 to 6.00 seconds. In addition, the FMU-54A/B Fuze must have an air burst capability and be compatible with the Mk 43 Target Detecting Device.

The FMU-70/B Fuze also was to be of the same configuration as the FMU-54/B Fuze except that it would fit the bomb nose fuze well. This fuze would detonate on impact only, after the set time delay has elapsed.

SECTION II.

REQUIREMENTS

GENERAL

The Air Force requirement for the efforts covered by this report was a continuation of the design of a fuze to be used in retarded munitions. This effort was to continue using the FMU-54/B Fuze as a basic instrument for redesign. This redesign was to add the adaptability to accept an electrical firing signal from a nose mounted Mk 43 Target Detecting Device. In the absence of a signal from the target detecting device, the fuze must have the capability of detonating on ground impact.

Originally, effort was expended for the development of a nose fuze; however, due to the peculiar behavior of a retarded bomb when the fin fails, development effort was directed toward a tail fuze. During the Phase I modification, a requirement for the nose fuze was reinitiated with the effort to be extended toward designing the fuze to sense the fin failure and bomb tumble, while retaining all of the original FMU-54/B Fuze functional characteristics. The nose and tail fuzes, therefore, must function in the following manner.

1. Sense the bomb release from the aircraft.
2. Sense the retardation of the bomb caused by the drag device.
3. Assure that proper retardation of the bomb has occurred before arming.
4. Provide delay arming time for safe escape distance for the aircraft.
5. Arm the bomb for detonation by the target detecting device or on ground impact.

In the event that the drag device should not function or should break away from the bomb, the fuze must return to a safe condition to prevent detonation on impact or on signal from the target detecting device.

DESIGN REQUIREMENTS

The original Air Force requirement was that a mechanical fuze be designed and developed and that prototypes be fabricated for use in the 750 pound M117 demolition bomb using the MAU-91 retarder, and the 500 pound Mk 82 demolition bomb using the Mk 15 retarder. The design was to be such that the fuze could be used in other retarded munitions with a minimum of redesign.

GENERAL FUZE DESIGN REQUIREMENTS

The general fuze design requirements established by the Air Force are as follows:

1. Tail Fuze FMU-54A/B

    a. Design shall be accomplished to incorporate the necessary connections, wiring, explosive components, and safety devices into the basic fuze to permit the fuze to accept the electric firing pulse from the nose mounted Mk 43 Target Detecting Device. The electric firing signal shall initiate the firing train. The mechanical firing pin shall be retained to provide backup impact functioning if failure of the target detecting device occurs.

b. An electrical/mechanical cable and lanyard assembly shall be designed to connect the nose mounted Mk 43 Target Detecting Device to the tail mounted FMU-54A/B Fuze. This cable shall be installed in the internal conduit of the bomb. The aft portion of the cable, from the center charging well to the rear fuze well, shall consist of the required electrical wiring plus the mechanical lanyard necessary for fuze actuation.

c. The modified tail fuze shall provide ground-settable arming times of up to 6 seconds. Arming time settings of from 1 through 3 seconds shall conform to the settings available on the nose fuze. Arming time settings from 3 through 6 seconds shall be at 0.5 second intervals.

2. Nose Fuze FMU-70/B

a. Modifications to the present nose fuze design shall be accomplished when shown to be necessary by laboratory or field test results. Such modifications, if required, shall be for the purpose of correcting deficiencies or improving the performance, safety, and reliability of the nose fuze.

b. The general design requirement for the retarded bomb nose fuze system includes its use in the new series munitions which contain internal plumbing. The fuze shall possess extreme safety charateristics, ruggedness, and reliability. The fuze shall detect the proper operation of the retardation device, and, in the absence of proper retardation, shall prevent an instantaneous or short-delay impact function. The arming sequence shall be initiated mechanically by release of the munition from the aircraft. Proper operation of the retardation device shall cause the retardation sensor to actuate. A settable time delay, following completion of the retardation sensing cycle, shall occur prior to completion of the arming sequence. Bomb impact shall then cause the fuze to function. Improper operation of the retardation device, shall dud the fuze.

FUNCTIONAL FUZE SEQUENCE REQUIREMENTS

The arming sequence shall be initiated when the bomb is released from the aircraft. Proper operation of the bomb retardation device shall cause the retardation sensor to activate. The retardation sensor shall release a settable time delay which must elapse before arming the fuze. The settable delay shall permit the out-of-line explosive to move in-line and the fuze shall function upon receiving an electrical impulse from the Mk 43 Target Detecting Device. In the event of an electrical failure, the bomb shall function on impact. In the event that the retardation device should not function properly, the fuze must remain safe and fall as a dud. To accomplish this sequence of operation, certain fuze components are necessary. The requirements of each of these components are as follows:

1. Lanyard Pull Pin (Arming Initiation) Requirements

   a. The lanyard pull pin shall prevent functioning of the fuze until the pin has been pulled.

   b. To assure that the fuze is not initiated when the bomb is dropped in the safe condition, the force to initiate the pull pin shall be 10 + 3 pounds. Originally, this required force was 17 ± 2 pounds, but was changed as a result of swivel link breakage tests conducted on the FMU-54/B Fuze.

   c. For an armed drop, the lanyard pull pin shall release the fuze mechanism at bomb release from the aircraft, using the lanyard system shown in figure 1.

   d. The design of the pin shall be so that the lanyard (cable) can be easily attached to the fuze by the armorer.

   e. The lanyard (cable) shall incorporate a feature which will break the cable as close to the bomb body as possible upon release from the aircraft to insure that the Mk 43 Target Detecting Device will not receive an erraneous signal prior to the proper functioning time.

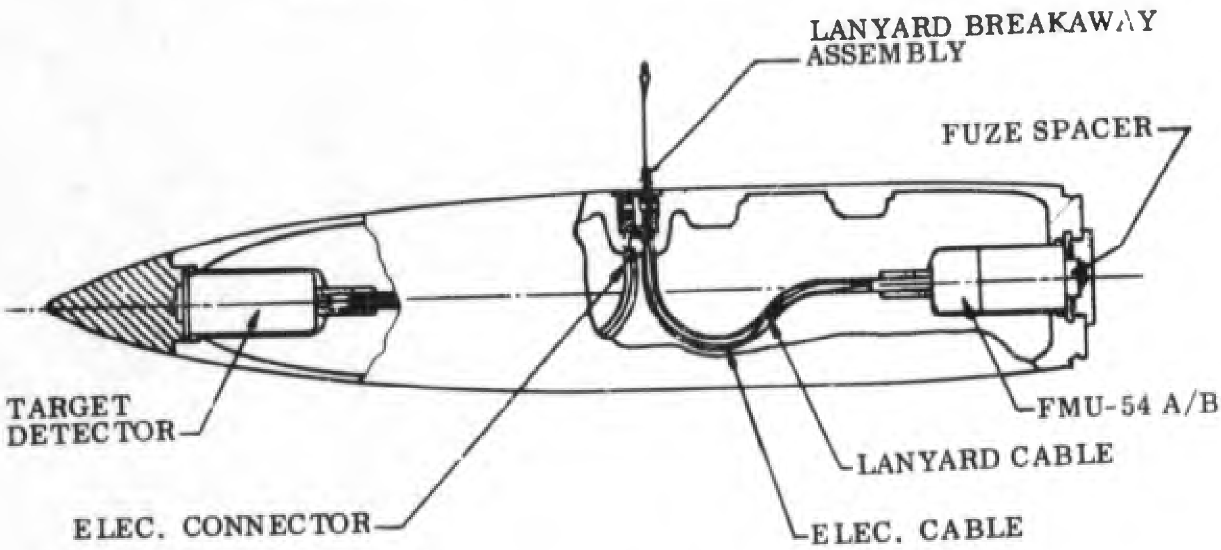


Figure 1. Lanyard System

2. Retardation Sensor Requirements

   a. Originally the retardation sensor was to be designed in accordance with the computed deceleration curves, figure 2, for the M117 Bomb using the Snakeye 1 retarder. Since these are computed curves, the design was to be flexible to permit the incorporation of specific retardation data as it became available.

b. The retardation sensor shall detect the proper functioning of the retardation device of the bomb, and if proper retardation (in accordance with the deceleration curves of figure 2) is maintained for 0.6 to ± 0.06 second, the sensor shall release the settable time delay. If the proper retardation is not maintained, the sensor must return to the safe condition, thus preventing the fuze from functioning.

c. Time delays of 0.75 through 6.00 seconds, in 0.25 second intervals through 3.00 seconds, and 0.50 second intervals from 3.00 through 6.00 seconds intervals with no greater than 5 percent tolerance, shall be provided for the tail fuze.

d. Provisions shall be made so that the delay time can never be set for less than 0.75 second.

e. The design shall be so that the armorer can set the desired delay time into the fuze prior to installation of the fuze into the bomb.

f. The setting mechanism for the timer shall have detents at each settable increment, and shall be fixed so that it can only be turned in a counterclockwise direction to prevent obtaining a false time delay setting.

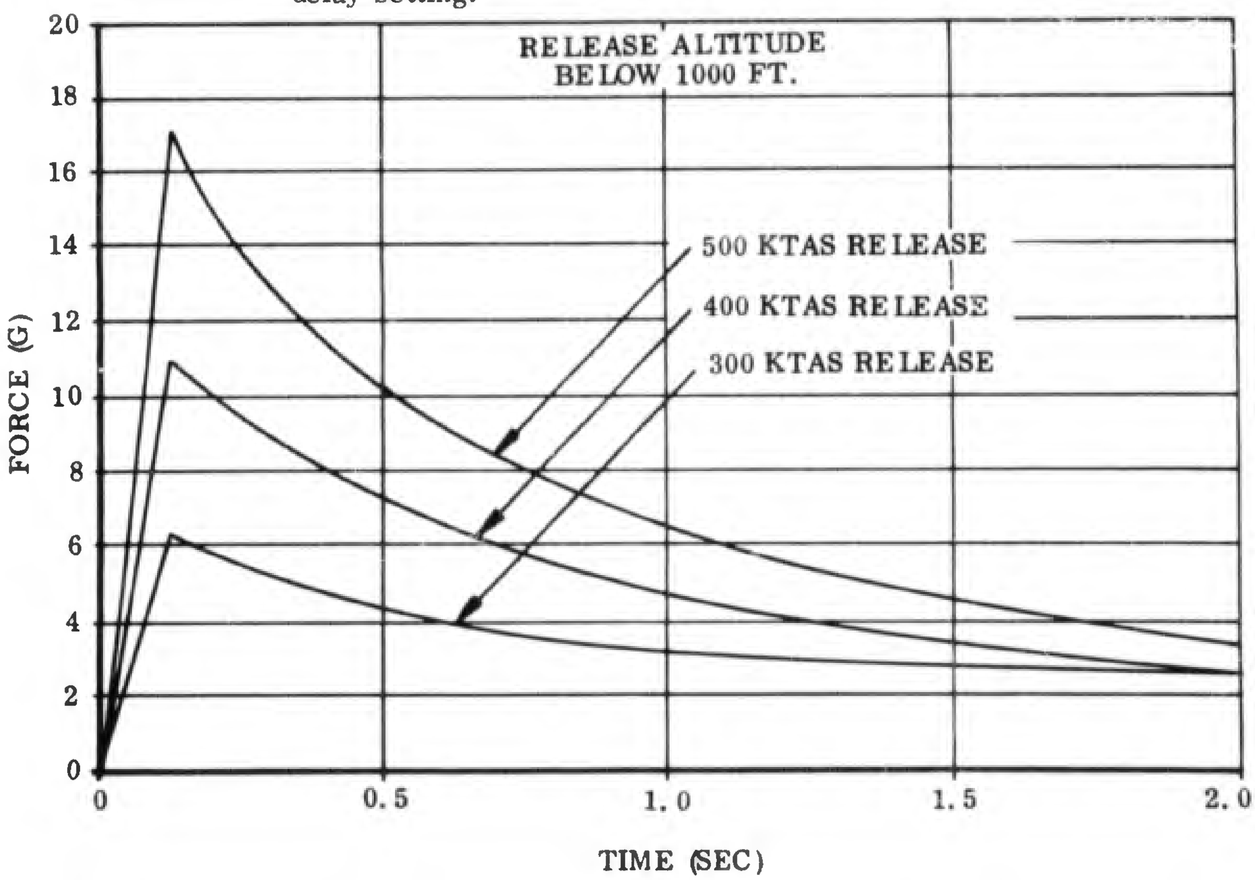


Figure 2. Retard Curves

4. Out-of-Line Explosive Train (Slider) Requirements

   a. The fuze shall contain an out-of-line explosive train. Movement of the explosive train (detonator) in-line with the firing devices and other explosive elements shall occur after completion of the selectable timing sequence.

   b. Once the explosive train is in-line, the system must be locked in this position to prevent it from moving out-of-line due to external causes.

   c. When the explosive train is out-of-line, the firing devices shall be locked or grounded to prevent functioning. As the train is moved to the in-line position, the firing devices shall be free to function properly.

5. Firing Device Requirements

   a. The electrical detonator, upon receiving a signal from the target detecting device, shall initiate the explosive train. In the event of failure of the target detecting device, the mechanical firing device shall initiate the explosive train on ground impact.

   b. The mechanical firing devices shall be sensitive enough to assure function when the bombs impact the ground at shallow angles.

6. Explosive Element Requirements

   a. The design of the fuzes shall permit installing of the explosive elements after the fuze mechanism has been completely assembled.

SECTION III.

DESIGN

GENERAL (TAIL FUZE - FMU-54A/B)

The fuze system schematically shown in figure 3, meets the requirements outlined. This system is initiated at bomb release by a pull on the lanyard pull pin, thus releasing the retardation sensor. If the retardation device of the bomb functions and the proper G level is maintained, the retardation sensor will complete its cycle and release the settable timer. The timer, which can be set from 0.75 to 6.00 seconds, will then run for the preset time and release the spring loaded slider which houses the detonators. As the slider moves in-line with the explosive elements, the electrical detonator is connected to the Mk 43 Target Detecting Device firing circuit and the mechanical firing device is unlocked.

The Fuze, Inertial Bomb Tail FMU-54A/B, which was first designed and fabricated is shown in figure 4. The fuze was designed to fit into the 2.890 inches diameter by 6.220 inches long tail fuze well of the M117 bombs and on all newer type munitions with internal plumbing.

A window has been provided in the housing cover through which the armorer can see if the fuze is in the safe or armed condition. A flag on the out-of-line detonator slider can be seen through this window and will move from a green to a red zone if the fuze should arm. A recessed pin has been provided in the housing cover to be used for removing the fuze from the fuze well. It is also in this cover that the delay timer setting mechanism has been placed. A screw type setting mechanism has been provided through which the armorer can set the timer to obtain delay times of 0.75 to 6.00 seconds.

A spring and ball detent have been used to detent the mechanism at each timer setting.

The fuze is installed in the fuze well together with a lanyard assembly and fuze spacer (figure 5). The 0.062 inch stainless steel lanyard (cable) and the Mk 43 Target Detecting Device connector wires are threaded through the plumbing of the bomb (figure 1). A safety wire coiled around the body of the fuze prevents the lanyard pull pin from moving during transportation and handling. Since the safety wire is around the outside body of the fuze, the armorer must remove the safety wire before the fuze will slide into the fuze well. This prevents the fuze from being installed with the safety wire in place.

Since the fuze is shorter than the fuze well, the rubber cushion is required to hold the fuze in place (figure 5).

The overall resultant design change accomplished in Phase II of the program is indicated in figures 6 and 7. The new slider, the production frame modified, and the production retardation sensor is shown.

DETAIL DESIGN

The major components which make up the fuze are the lanyard assembly, pull pin and safety release system, retardation sensor, timer, firing devices, and

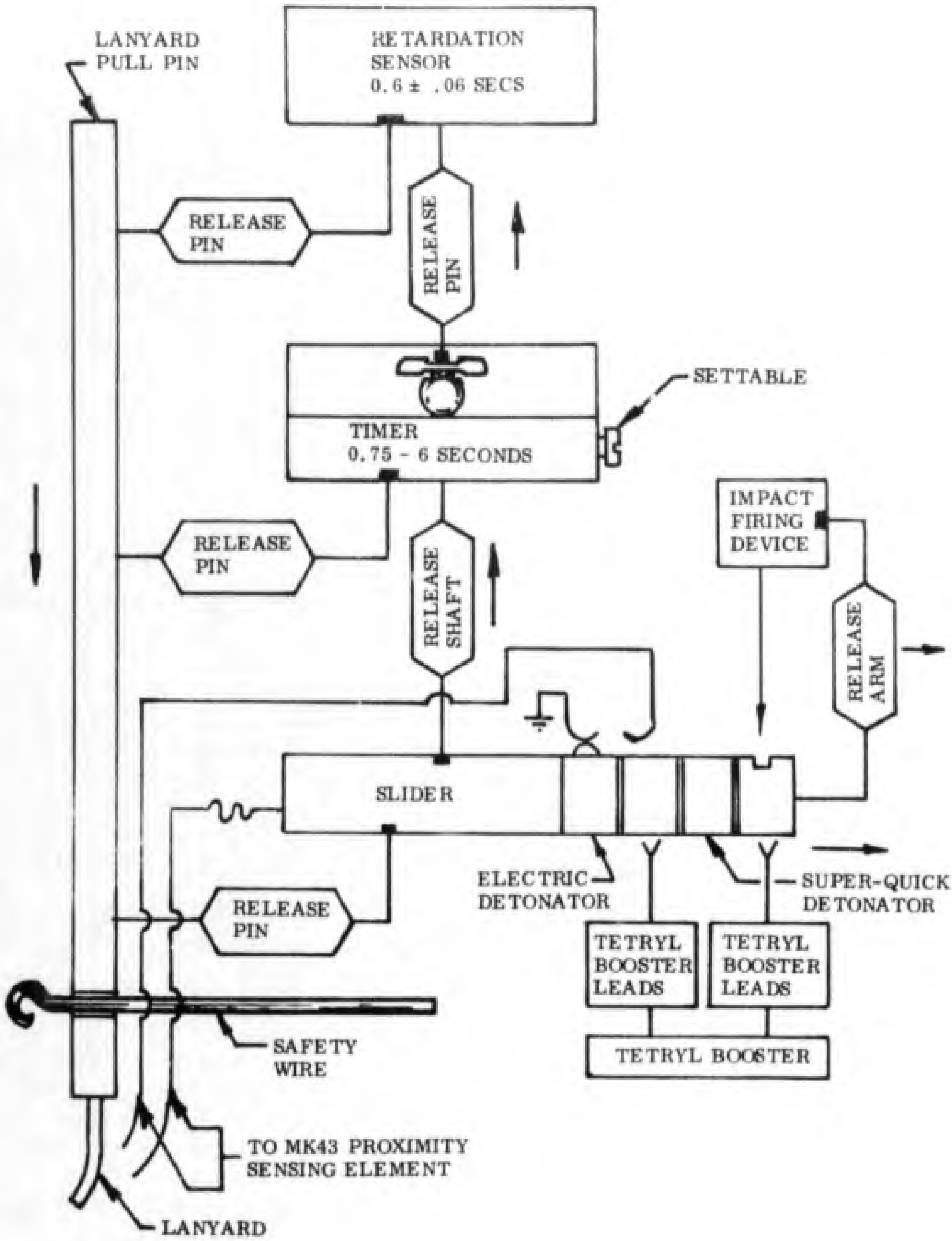


Figure 3. Modified Tail Fuze Block Diagram

explosive train. The following is a description of the design of each of these components. The descriptions are given first for the Phase I units, followed by a change in design, where applicable, as applied in the Phase II units.

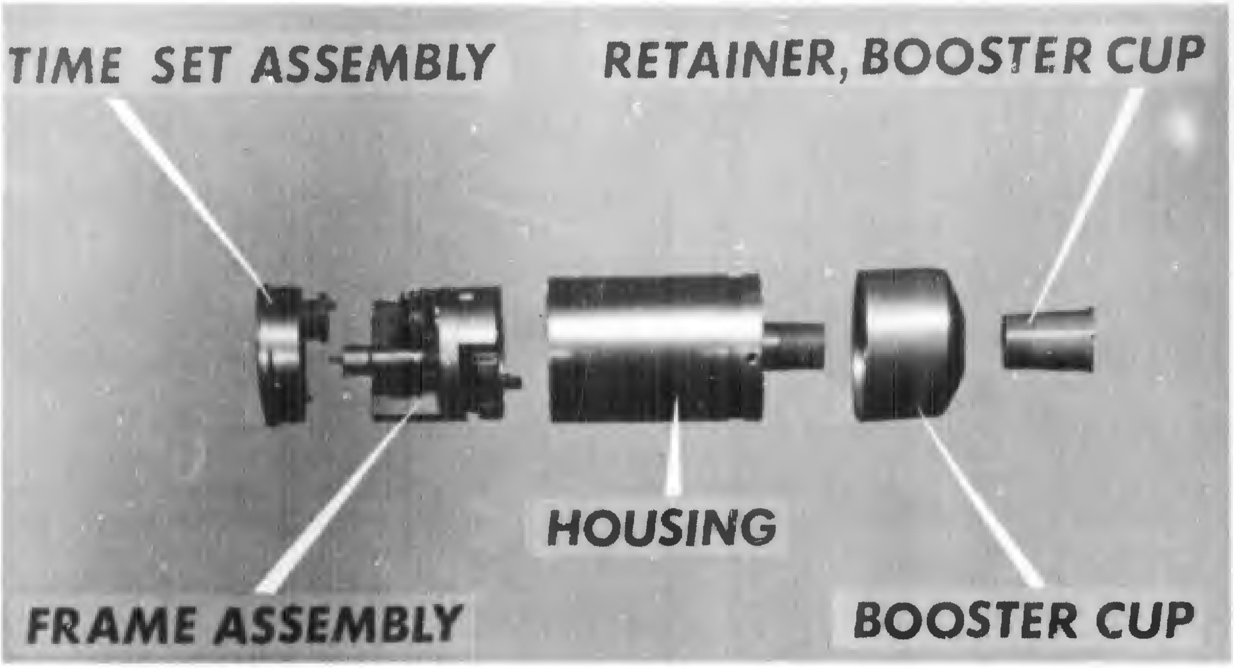


Figure 4. FMU-54A/B Fuze Exploded View

Figure 5. Lanyard Assembly, Fuze Housing Assembly, and Fuze Spacer

Lanyard and Safety Release System

The lanyard system shown in figure 6 is a safety device which prevents the arming cycle of the fuze from beginning until the unlocking pin has been pulled. This pin releases the sensing weight of the retardation sensor, thus permitting the fuze to begin its arming cycle if proper retardation is experienced. As shown in figure 3, the safety wire passes through the pin body, preventing the lanyard pull pin from being accidently released during transportation and handling. When the safety wire is removed, the lanyard pull pin can be initiated if a force of 10 + 3 pounds is exerted upon the lanyard. The restraining force is produced by three detent balls.

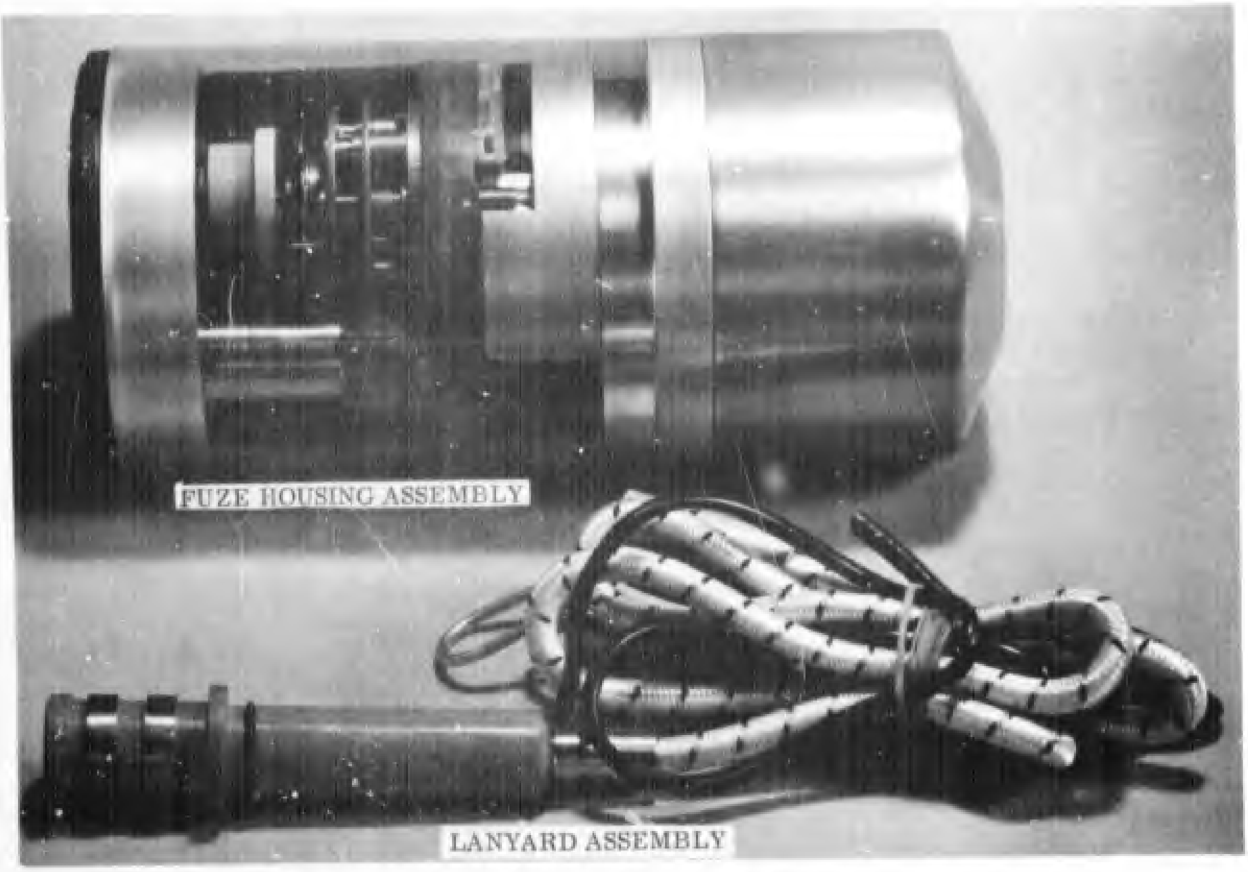


Figure 6. Fuze Housing Assembly and Lanyard Assembly (Phase II)

The original breakaway system (figure 8) was designed to break the steel lanyard cable as close to the bomb body as possible. This is required since the cable length, pulled out of the conduit on bomb release, would interfere with the target detecting device and could detonate the bomb at the instant the arming cycle was complete.

This entire component was redesigned in the Phase II effort to accomplish three objectives:

1. Replace the steel cable with bunji cord to more effectively safe the fuze during fuzed bomb handling because of its retraction into the bomb plumbing.

2. Eliminate the assembly problem of attaching the contacts by putting contact rings on the lanyard and leaf type contacts in the fuze.

3. Simplify and reduce the cost of the overall component through redesign of the engagement method.

The resultant lanyard assembly delivered with the Phase II units is shown in figure 9. The lanyard housing is of plastic construction with the contacts and wires molded in. A plastic spring collet is used to grasp the engagement shaft of the fuze. A cross sectional view of the housing and lanyard assembly is shown in figure 10.

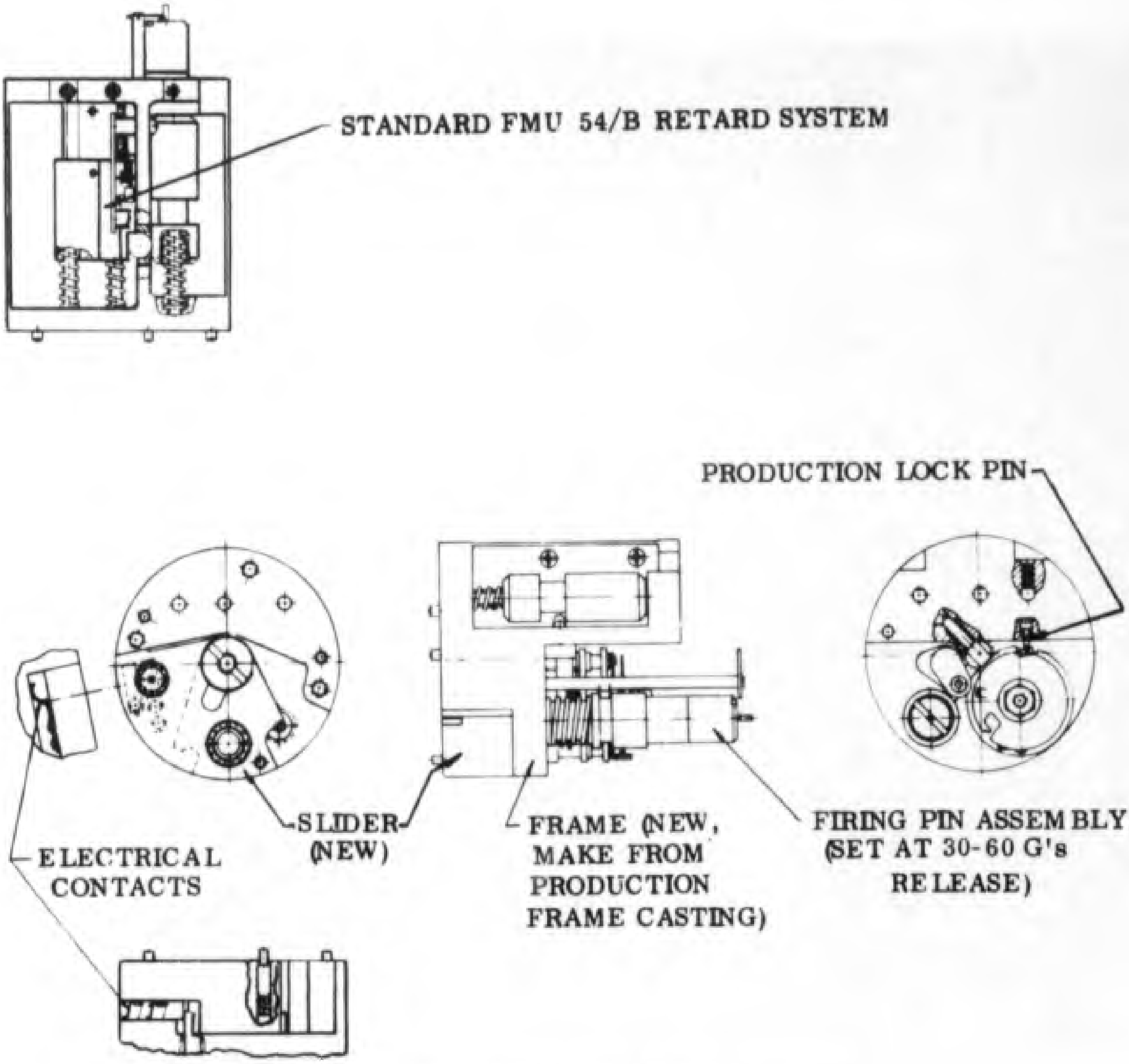


Figure 7. FMU-54A/B Fuze Frame Assembly

Retardation Sensor

The retardation sensor (figure 11) is a safety device which prevents arming by keeping the timer locked until a prescribed deceleration signature has been attained.

The retardation sensing system was first greatly reduced in size over that used in the FMU-54/B Fuze, due to the volume required for the addition of the electrical firing system.

Upon the proper bomb retardation, the sensing weight compresses its spring until the ball interlock, which is forced against the sensing weight by the corner of the G weight, can move into the cutaway area of the sensing weight. At that instant, the previously restrained G weight is slammed downward by the inertial force acting upon it.

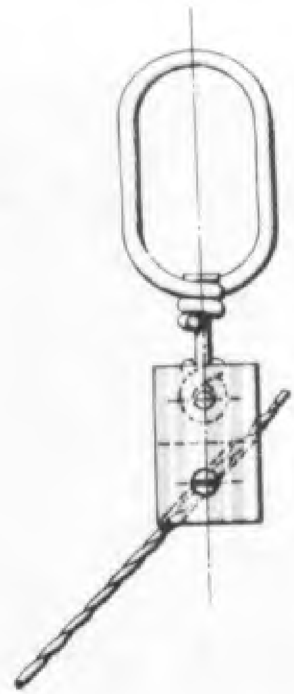


Figure 8. Lanyard Breakaway System

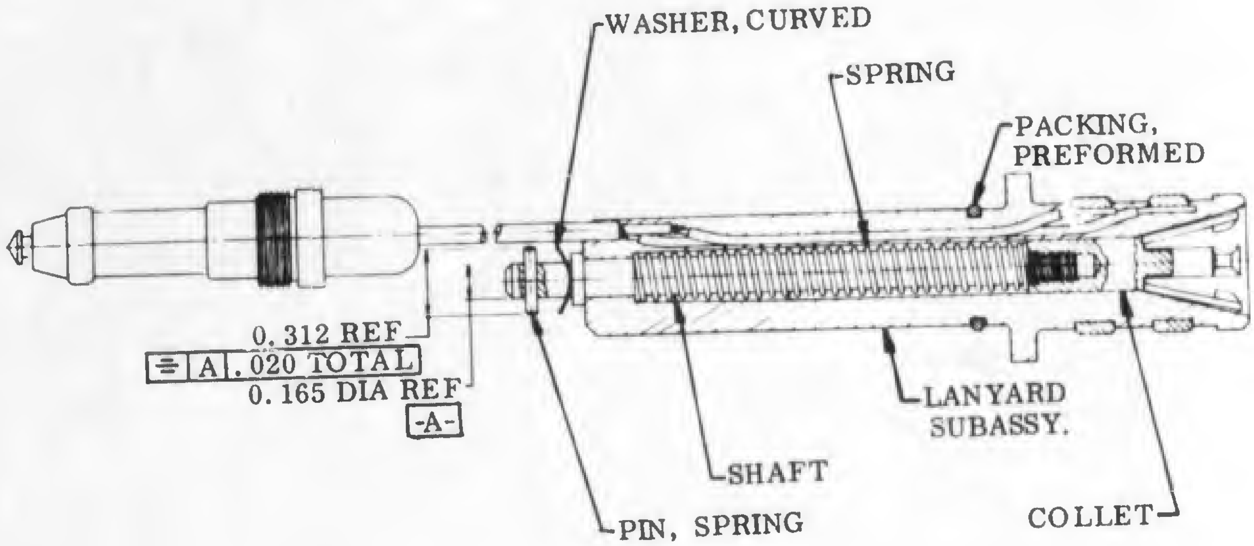


Figure 9. Lanyard Assembly

Because the timing block is restrained by the verge escapement, the connector spring, which connects the timing block and G weight together, is momentarily fully extended. The connector spring then provides the force to pull the timing block (whose motion is resisted by its delay mechanism) toward the G weight. At the end of its full travel, the timing block is locked down by the pin that also serves to unlock the escapement of the timer. The G weight springs resist the forward movement of the G weight and when the deceleration forces are removed, return the G weight and timing block to their initial positions. Hence, while enough inertial force is maintained upon the G weight to overcome these compression springs, the timing block is

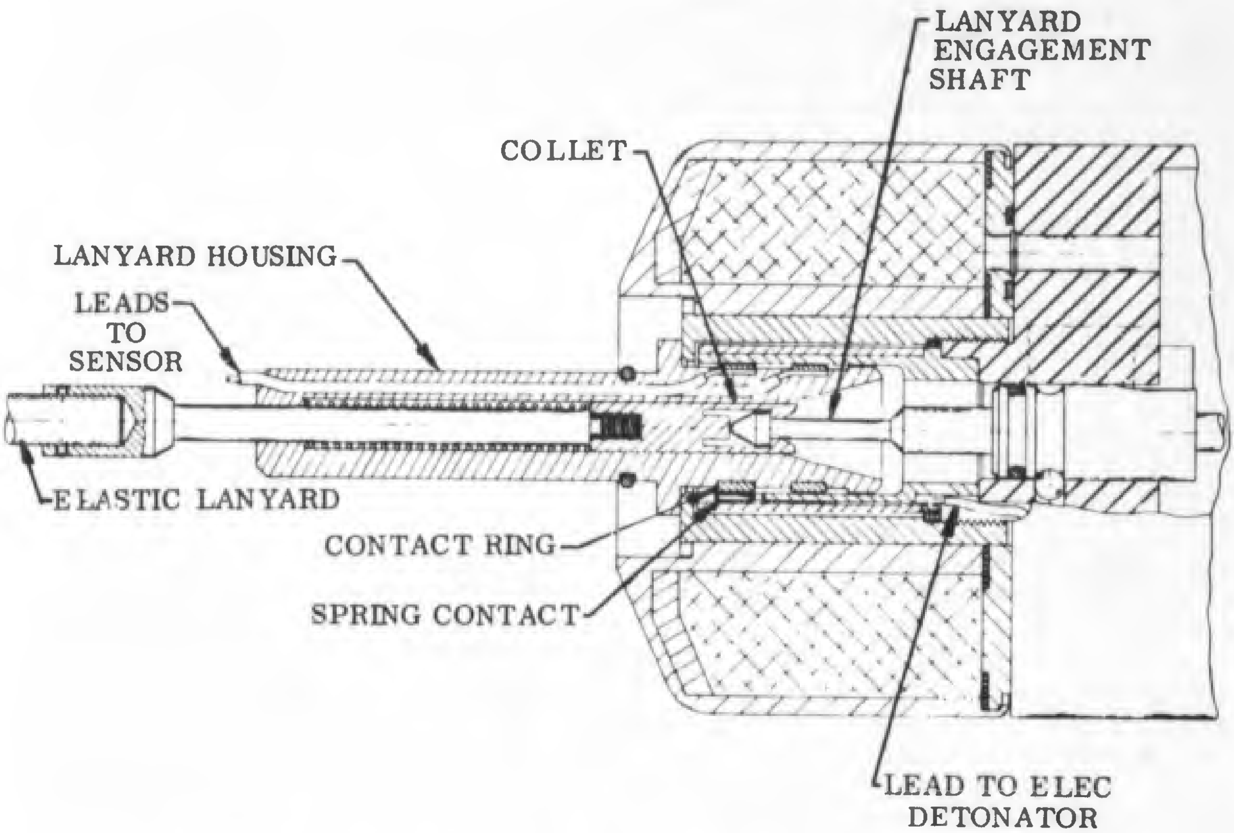


Figure 10. FMU-54A/B Fuze Housing and Lanyard Assembly

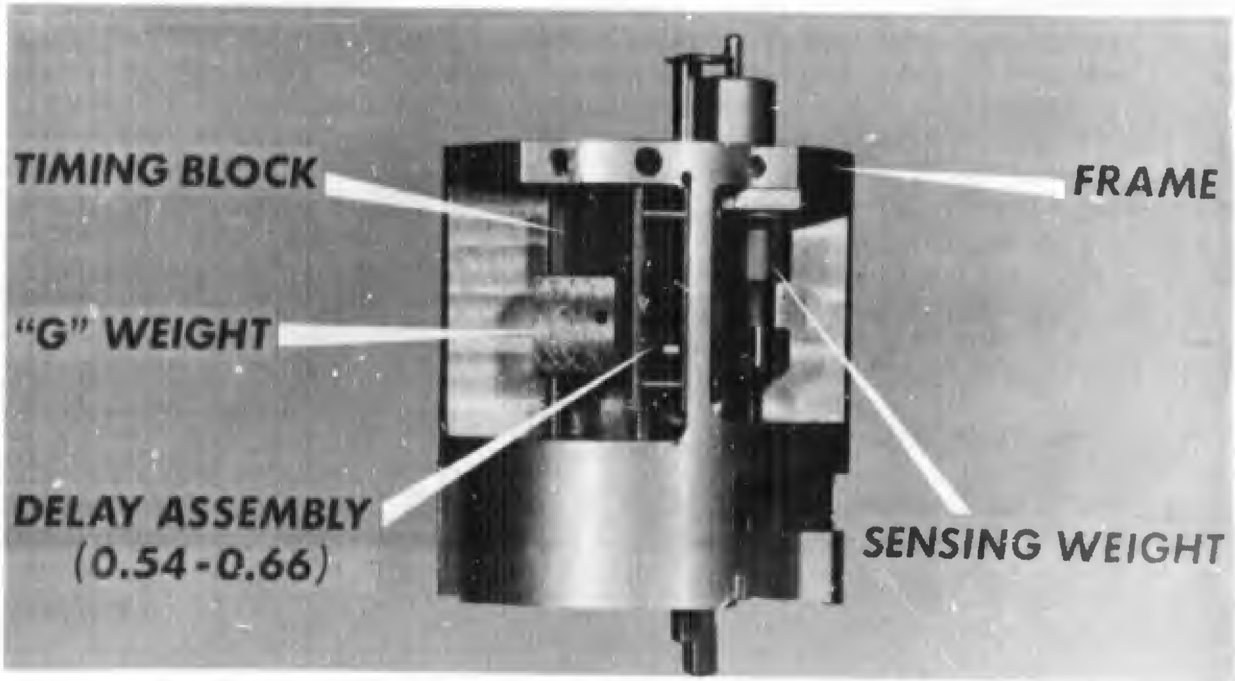


Figure 11. FMU-54A/B Fuze Frame Assembly Showing Retard System

pulled downward by the connecting spring. At any point during the downward excursion of the timing block, should the inertial force acting upon the G weight drop to a value less than that required to maintain the G weight at its forward position, the G weight will move back thus preventing the full travel of the timing block. The force required to maintain the G weight at its bottom position steadily decreases as the timing block approaches the G weight. In this way the reset point, that is, the retardation level below which the retardation sensing function cannot go to completion, follows closely to the retardation function of the drag device.

Figure 7 shows the retardation sensing system used in the 20 Phase II units. This is identical to the system used in the production FMU-54/B Fuze. By re-evaluation of space utilization, and slight modification of the production frame, it was found possible to use these parts. The result is a simplified spring mass balance and cost reduction of the fuze. The functional specifications remain the same.

Timer

The timer, as shown in figures 12 through 15, is powered by a Sandvik steel spring delivering up to 8.0 inch ounces of torque to a center gear of 41 teeth. This gear drives an 8 tooth pinion which turns gear number 2 which has 31 teeth, this gear drives an 8 tooth pinion which turns gear number 3 which also has 31 teeth. This drives the 8 tooth pinion which powers the 22 tooth star wheel which oscillates the verge. The beat rate is, therefore, 22 x 41/8 x 31/8 x 31/8 or 1686 beats per revolution of the center shaft. The timing disc turns 270 degrees in 6 seconds or 45 degrees per second; the beat rate should be tuned to 1686/8 or 210.75 beats per second. The center shaft turns the timing disc through a friction clutch and the release arm rides on the timing disc. The timing disc has a notch cut in it into which the release arm falls. This rotates the release arm which permits the slider to move to the armed or in-line position. This timer is started by the removal of the pin from the verge. This is a pin released by the timing block in the retardation sensor. The verge escapement is self starting and need not receive vibration from other levers to start. Setting is accomplished by rotating the timing disc by means of the timer setting slot on the front of the fuze. A safety disc is attached directly to the center shaft. Consequently, it prevents the release arm from falling in the timing disc slot when the timing disc is rotated through zero. The disc can be rotated in one direction only (that corresponding to decreasing time) but can be rotated through zero.

The timer is wound at the factory and there is no provision for rewinding the mainspring since the fuze is intended for one time use.

This timer has been made essentially of brass, the mainspring is of life time materials, and the tolerances of the assemblies have been made to limits which will enable it to perform over a range of temperatures specified. No changes were made on the timer in the second effort.

Firing Device (Mechanical)

The firing device is shown in figure 16. The firing device is identical to the mechanism now being used on the FMU-54/B Fuze. The firing device G weight is locked by the firing device lock arm which is attached to the slider. When the slider moves to the armed position, the lock is removed and the firing device is ready to operate upon ground impact. Upon hitting the target, and sensing a minimum G force

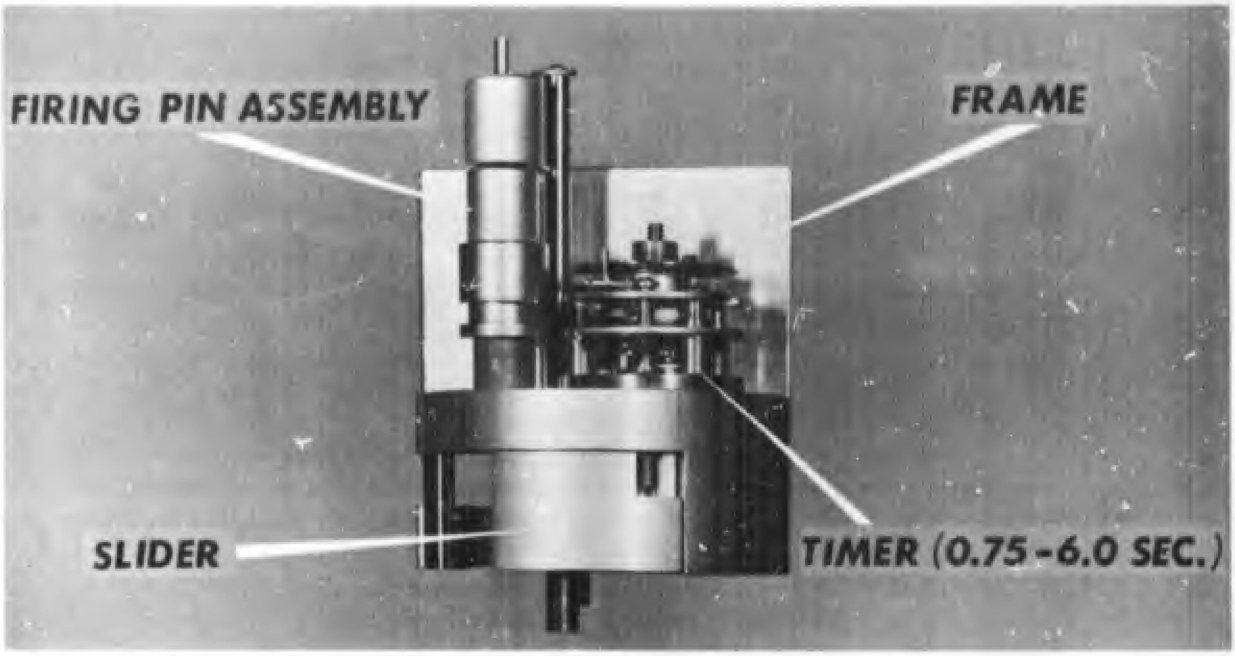


Figure 12. FMU-54A/B Fuze Frame Assembly Side View

of 30 G's, the G weight moves forward against the firing pin spring force being transmitted to the G weight through the cam balls. With the ball lock uncaged, the firing pin cams the balls out of the way and the spring drives the firing pin into the detonator.

Firing System (Electrical)

The firing system, as shown in figures 17 and 18, is a slider holding both the electric detonator and stab detonator, and a printed circuit board for transmittal of the electrical impulse from the Mk 43 Target Detecting Device to the electric detonator (T75). The electric detonator is held in the unarmed position by the slider so that its input leads are grounded and there is no danger of the detonator being activated by static charges. After the bomb has been released, the retarder executes a satisfactory bomb retardation, and the timer is cycled through its set time. Then, the slider is released and the electric detonator is aligned over its respective lead, while at the same time, the electric contact would be switched from ground to the firing lead of the Mk 43 Target Detecting Device.

In the 20 Phase II units the circuit board, the slider, and the contacts were redesigned for better space utilization, more economical manufacture, and to make a more reliable contact. The final design is shown in figure 19.

Explosive Trains

The explosive trains are shown in figure 18. The detonator contained in the slider is the most sensitive component in the train and is situated so that it is out-of-line with the next explosive element. The timer releases the slider and it is brought into the in-line position by a torsion spring and held in the in-line position by a spring loaded detent. Upon receiving an electrical impulse or on impact, the detonator is detonated, which in turn initiates the action of the detonating elements of the explosive train. The final charge (the booster pellet) in turn causes the detonation of the bomb bursting charge.

Figure 13. FMU-54A/B Fuze Timer Assembly - Top View

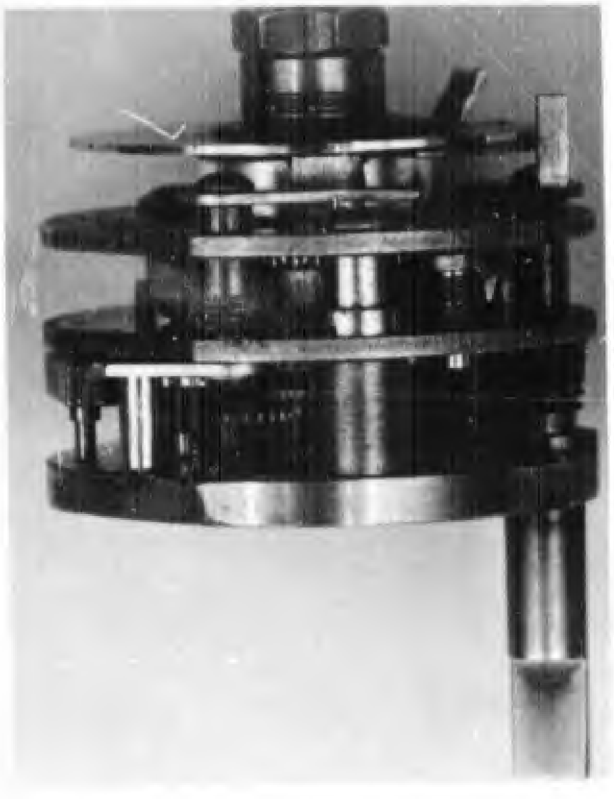


Figure 14. FMU-54A/B Fuze Timer Assembly - Side View

The fuze is arranged so that the booster which contains the dangerous quantity of explosive can be kept separated from the sensitive components and assembled to the fuze prior to use. The detonators can be inserted or removed from the slider by access through the detonator cover plug and unscrewing the detonator retaining screws.

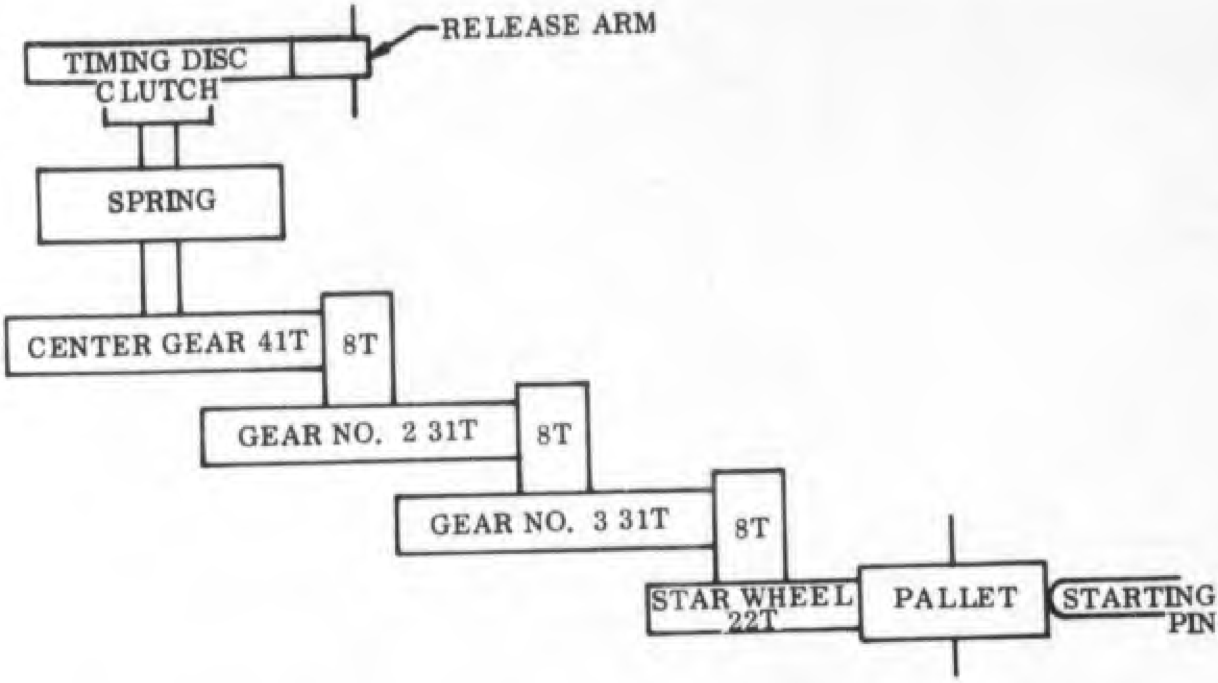


Figure 15. FMU-54A/B Fuze Timer Gear Schematic Diagram

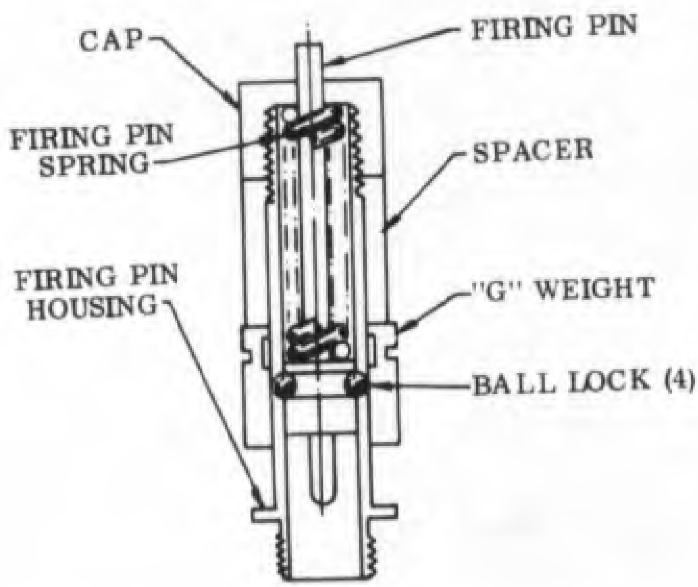


Figure 16. Mechanical Firing Device

Lanyard - Fuze Interface

Figure 10 shows the method of interface between the lanyard assembly and the fuze. In the first group of units, the fuze had ring contacts and the lanyard had blades. This was redesigned as described under "lanyard" and the leaf spring contacts are now housed in the fuze. Here they are protected against bending or other damage. Wires from these contacts are routed through the base and sealed with RTV sealant. Another change made in the twenty units involved elimination of connectors between the wells.

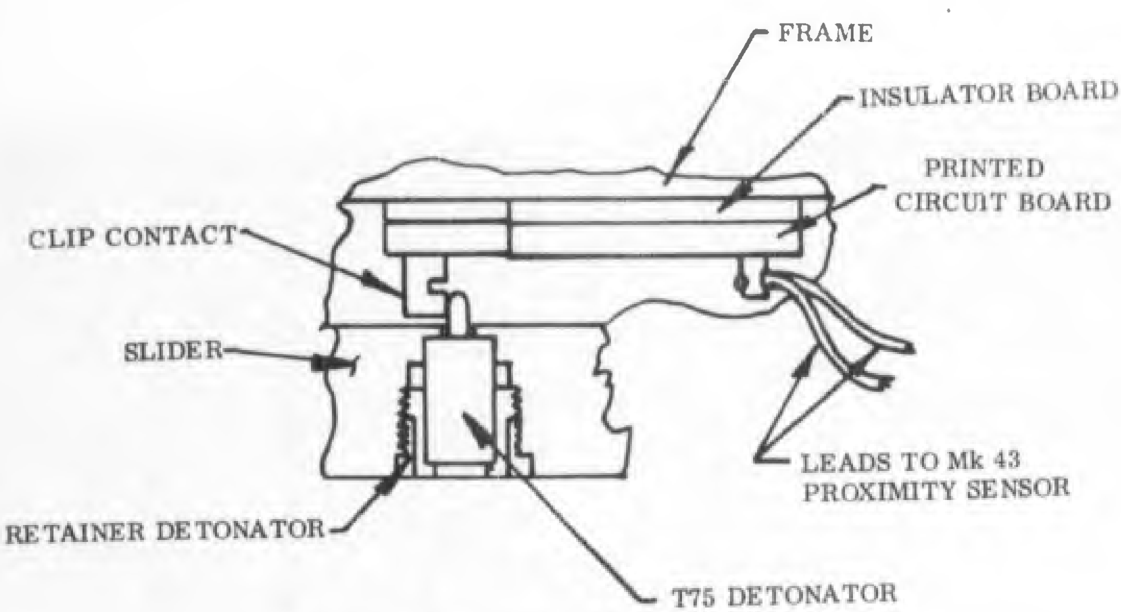


Figure 17. Electrical Firing Device

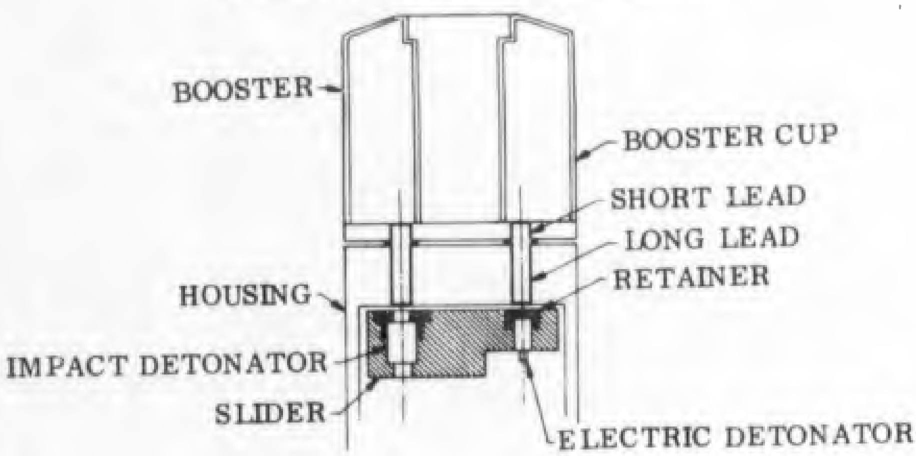


Figure 18. Explosive Trains

The interfacing was redesigned to be a continuous cable to be threaded through the bomb plumbing to the nose fuze well. One end of the cable is attached to the initiator, the other end is attached to an electrical plug which mates with the sensor. Approximately half the length of the cable is elastic silicone wire which will simplify installation and automatically retract to insure that the cable is snug and all slack is removed.

Telemetering Switches

To monitor the operation of the fuze during its flight from the aircraft to the earth, the Air Force elected to place a radio link between the bomb and the ground. This link would be capable of carrying the intelligence about the performance of the fuze. The fuze had to provide this intelligence. It was decided to do this with switches. Microswitches were incorporated in the design of 40 of the fuzes. These switches were to monitor the following functions:

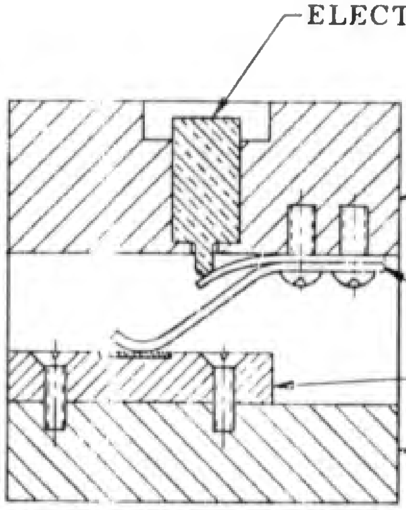


Figure 19. Fuze Electrical Contacts

Switches	Function
1	Lanyard Pull
2	Retardation Sensor Commit
3	Timer Start
4	Slider in Armed Position
5	Firing of T75 Detonator
6	Firing Pin (Mechanical)

The wiring diagram and color code for the switches is shown in figure 20.

The wires to these switches were brought out through the booster cup. No connector was provided as this would have prevented the threading of the wires back to the telemetering unit. The telemetering equipment and its installation is to be the responsibility of the Air Force.

These circuits in the fuze were checked for shorts to the fuze housing and for low resistance on switch closure.

Midway through the test program at Eglin AFB it was decided to increase the number of live drop tests. Sixteen of these units were returned to Avco Ordnance Division and the switches were removed. The fuzes were then sealed, loaded, and returned to Eglin AFB for test.

GENERAL (NOSE FUZE - FMU-70/B)

The nose fuze design, outlined here, is shown in figure 21. The primary objective of this effort, as described previously, was to improve the reliability of the original nose fuze which included the tumble sensor. The end result was elimination of the tumble sensor and redesign of the retardation sensing system to sense lack of retardation as well as retardation.

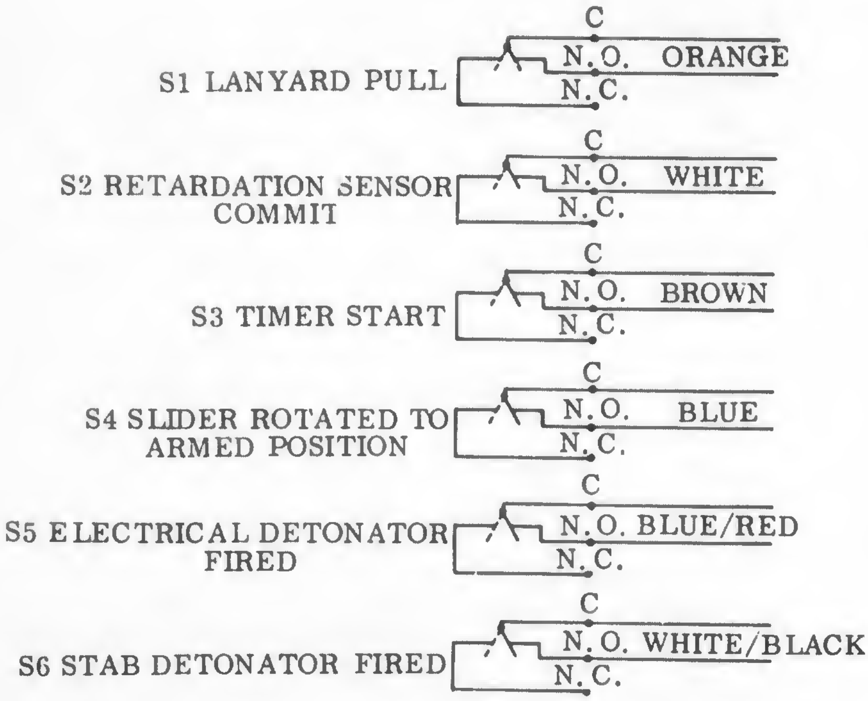


Figure 20. Telemetering Switch Schematic Diagram

Figure 21. FMU-70/B Fuze Exploded View

In all respects, the FMU-70/B Nose Fuze functions exactly as the FMU-54/B Tail Fuze presently in production. The design problem here entails how to make it not function in the event of retarder loss, bomb instability and tumble, and the eventual build up of forces due to rotation which would duplicate those of retardation, thus arming the bomb in an undesirable environment. This problem does not apply to the tail fuze where tumble tends to reset the mass system. The FMU-70/B has exactly the same physical shape and outward appearance as the FMU-54/B. Many parts are common to the FMU-54/B including the settable timer from 0.75 to 3.5 seconds. The major differences are the inversion of the mass system to function in the opposite direction along the axis of the bomb and the inclusion of the features to sense retarder loss. The discussion of the design in the following paragraphs concerns itself with these special features which dud the fuze.

The fuze provides a basic three-mass sensing system, which in this case, is a "retardation sensing system". This mechanism will allow the bomb to become armed only after a minimum established rate of deceleration has been sensed for a minimum specified length of time.

The basic three-mass concept includes the following items:

1. A sensing weight.

2. A G weight.

3. A timing block operating in conjunction with a runaway escapement delay.

The three masses are spring loaded as shown in figure 22. Referencing specifically the sensing weight, it will move in the direction of motion when the specified deceleration is sensed. With the sensing weight in its forward position, the ball detent holding the G weight now effects its release and it is free to move forward to bottom on the frame. The G weight is controlled by two compression and one extension spring, and the combination spring load is adjusted to be of such a magnitude that the G weight can only move if the deceleration is above the threshold G level (deceleration). In the application described herewith, this action will occur very quickly after the fins have opened.

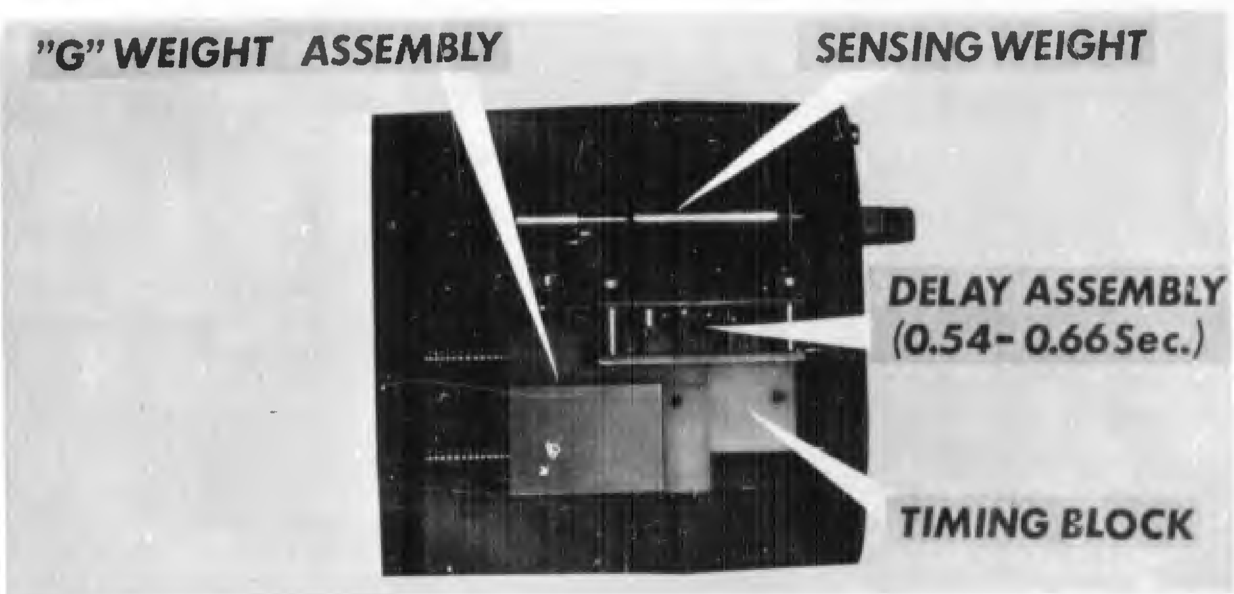


Figure 22. FMU-70/B Fuze Retard Sensor Initial Position

Figure 22 indicates that the timing block is not set up to start from the extreme of its travel. This feature is called a "floating delay". It was conceived to meet the possible condition in the Nose Fuze where the fins would separate (breakaway) from the bomb, making it unstable, without imparting a retardation force to trigger a breakaway device, which would function when subjected to a high drag spike.

In this case, there would be only one force, due to radial acceleration, slowly applied as the bomb began to tumble. This force might arm the bomb without accomplishing the desired safe escape. In the illustration, figure 22, it is seen that the two masses in the system, the G weight and Timing Block, in the initial position, are floating between two limiting surfaces. The rack engaging the runaway escapement is set so that it can run either direction. Immediately upon initiation, the only force working against the mass system is that of the compression springs. These start pushing against the escapement, toward the frame as indicated. The time to move to the frame is controlled by the rate of the springs and the size of the pallet. If no retardation force is sensed to overcome the compression springs, and the mass system moves to the stop, it will become locked there by a pin. (See figure 23.)

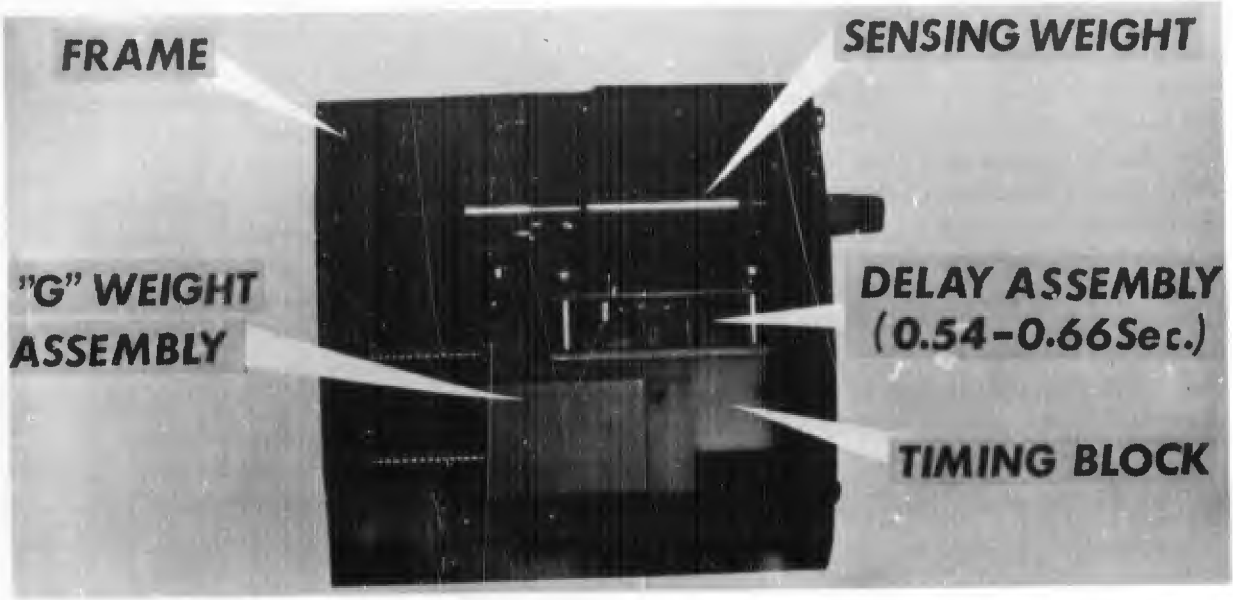


Figure 23. FMU-70/B Fuze Retard Sensor Locked - No Retard

The time required to dud the bomb is set longer than the longest expected time to fin opening. Then, if the fins fall away without imparting a retardation force, the fuze will be dudded before centrifugal force builds up to cause arming.

The illustrations show that the runaway escapement is mounted in slotted holes. This gives added adjustment in the balancing of spring rates, travel, and pallet size to permit proper timing in both directions.

Assuming the retarder opens and supplies a spike force, immediately after reaching the "commit" level, the retardation sensing system will be aligned with the extension spring fully extended.

The relatively light timing block is fitted with a rack which in turn engages the runaway escapement. Due to its relatively low mass, it is affected very little by the forces of deceleration. It is, however, pulled by the extension spring but its movement is resisted by the escapement mechanism. Therefore, as long as the deceleration forces remain above the spring forces acting on the G weight, it will be held in the point of its farthest travel down and the timing block will continue its forward motion until the predetermined "delay" time, as controlled by the escapement mechanism, has expired. The system then releases the remaining fuze functions as the timing block locks down against the G weight and the fuze is armed. (See figure 24.)

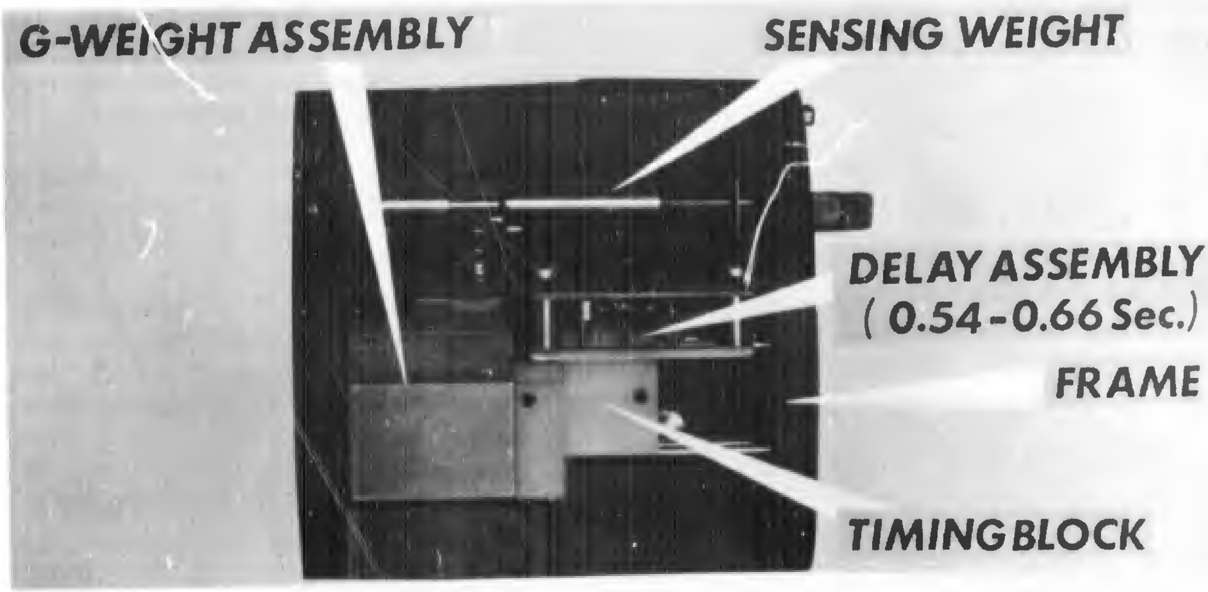


Figure 24. FMU-70/B Fuze Retard Sensor Functioned

The foregoing description covers proper function under proper retardation, in accordance with the arming requirements. However, in the event of a retarder failure (breakaway), retardation will not be continuous and effective and, in consequence, arming of the fuze must be prevented.

When the retarders breakaway from the bomb, the retardation drops off radically and, in addition, the bomb becomes unstable and spins or tumbles as it falls. Acting on a nose fuze, the centrifugal force, resulting from the spin, may replace the effect of deceleration and arm the bomb.

The three-mass system requires that the G weight is a heavy part arranged to sense deceleration in such a manner that it will stay forward and pull the timing block for its full travel. The device proposed herein has for its purpose, to sense when a break-away of the retarder occurs and to use this information to alter the fuze so that arming cannot occur. The device is called a break-away G weight. Upon any loss of retardation after "commit", the device will separate the heavy mass from the spring system exerting force on the timing block. The system sensitivity is thereby eliminated and the G level required to pull the timing block is increased far beyond that which occurs in any bomb flight.

Figure 22 shows the original G weight and how it is modified. It has been divided into a heavy block, strapped to a much lighter carrier. The carrier piece supports all the load of the compression and extension springs, and the heavy portion is attached to the carrier by a latch like finger which acts also as a cantilever spring. At the end of the latch is a plate which can be made to act as a cam in one direction of travel.

As the fins open and retardation is sensed, the system functions as previously described with the carrier and heavy mass acting as a unit. As the assembly, in normal manner, moves forward, a spring loaded pin moves out behind the latch plate. In the event of loss of retardation, as the springs return the G weight to its original position, the spring load button will cause the latch to be cammed open, releasing the heavy mass from the carrier. Now, as the tumble develops and centrifugal force acts, the heavy mass will move forward unrestricted without exerting any force on the spring system. This leaves the light carrier and timing block to act against the heavy springs calibrated to work with the heavy mass, and in consequence, the fuze cannot arm itself. (See figure 25.)

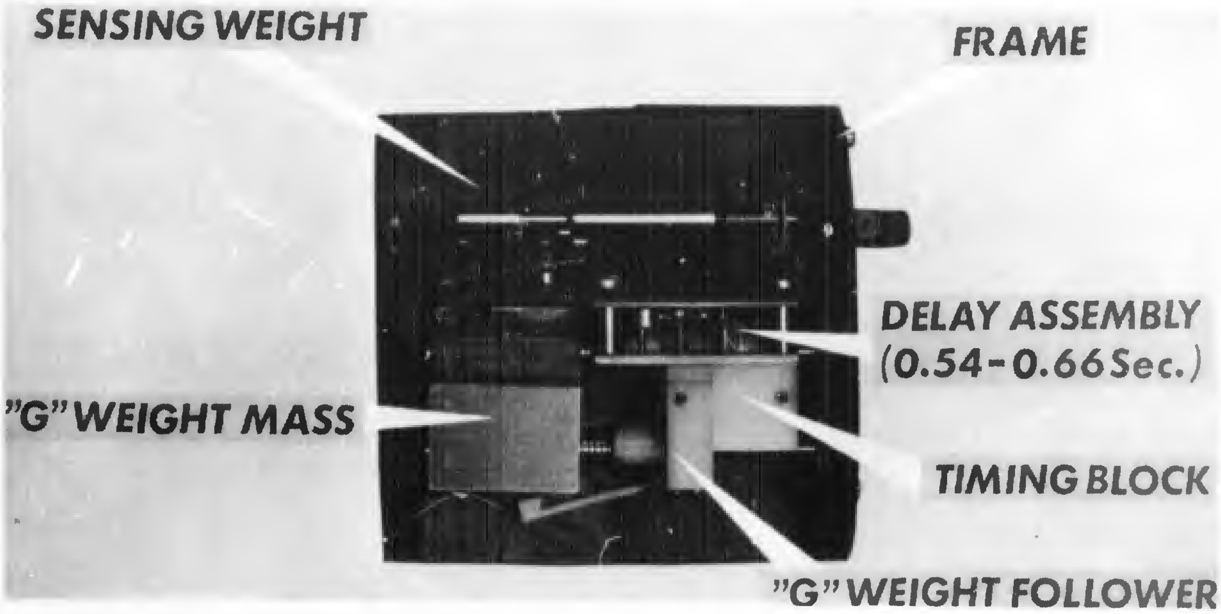


Figure 25. FMU-70/B Fuze Retard Sensor Breakaway Functioned

Aside from the previous description, the components in this fuze are the same as those in either the FMU-54/B or FMU-54A/B, or both. The lanyard and safety release system, the firing device, and the explosive train are as related for the mechanical portion of the FMU-54A/B described in this report. Telemetering switches have been installed in all 20 items as described for the FMU-54A/B.

SECTION IV.

TESTING

TEST SUMMARY

Table I outlines the fuze test plan. The test program for the fuze was developed to cover four areas of interest.

1. The functional tests, wherein the deceleration of the bomb was simulated and the performance of the fuze was recorded.

2. The safety test,which insured that the fuze could be transported and handled by the ground support units with no danger to themselves,and the aircraft safety tests to insure safe operation with aircraft.

3. The environmental testing,to insure that the fuze did not deteriorate due to environmental conditions during its storage and use.

4. Actual drop testing,with unloaded bombs and telemetered performance. (As of this report, no tests have been conducted.)

The Phase I tests listed in table I were all performed satisfactorily with the exception of the Aircraft Vibration and Temperature and Humidity. These tests indicate a problem in sealing against moisture over the 28 day cycle. A ball lock problem between the G weight and sensing weight caused the failures in the Aircraft Vibration tests.

For the second group of 20 FMU-54A/B Fuzes, with the new lanyard design, it was necessary to perform a special test program on the bunji cord and collet to establish specifications and prove structural capability.

FMU-54A/B TESTS

TIMER TEST

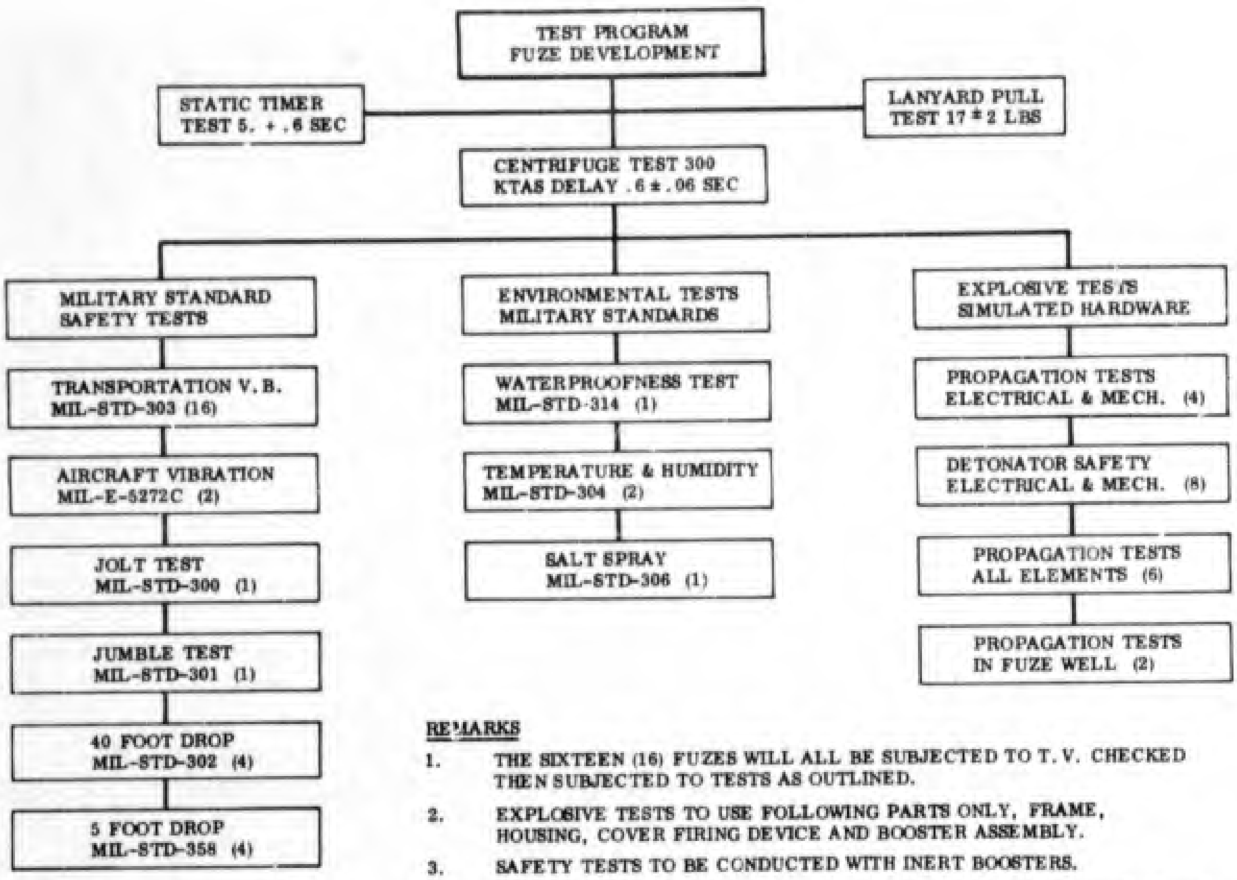
The timer should operate over a range of 0.75 to 6.0 seconds with an accuracy of 5 percent. The elapse time, from initiation of the timer until operation of the release arm, was compared with the laboratory standard oscillator and counter. The counter was gated by switches on the input and output members of the timer. All timers were within the specified performance.

LANYARD PULL TESTS

The lanyard pull force was set at 10 + 3 pounds, this corresponds to the setting of the production FMU-54/B Fuze. The apparatus shown in figure 26 was used in setting the value for the force to move the lanyard pull pin.

Adjustment of this force is made by three screws in the base of the housing. Each turn of the set screws (three screws must each be turned an equal amount) changes the pull force in accordance with direction the screws are turned.

TABLE I. FUZE TEST PLAN



REMARKS

1. THE SIXTEEN (16) FUZES WILL ALL BE SUBJECTED TO T. V. CHECKED THEN SUBJECTED TO TESTS AS OUTLINED.
2. EXPLOSIVE TESTS TO USE FOLLOWING PARTS ONLY, FRAME, HOUSING, COVER FIRING DEVICE AND BOOSTER ASSEMBLY.
3. SAFETY TESTS TO BE CONDUCTED WITH INERT BOOSTERS.
4. ENVIRONMENTAL TESTS TO BE CONDUCTED WITH ALL EXPLOSIVES INERT.
5. UNITS REQUIRED FOR ADDITIONAL SAFETY TESTS BY AIR FORCE COULD COME ABOVE TEST FUZES.
6. FUZES FROM JOLT, JUMBLE, 5 FOOT AND 40 FOOT DROP WILL BE USED IN EXPLOSIVE TESTING.

SIMULATED PERFORMANCE TESTS - (FUNCTIONAL TEST)

Figure 27 shows the centrifuge used in testing the fuze for deceleration performance. This centrifuge has a 42 inch radius arm and can provide acceleration in the range needed for this purpose. Figure 28 shows the G versus time curve used for simulation by the centrifuge. The following three tests were performed on the centrifuge.

Test No. 1

This test on the sensor determines proper reset if retardation is not sufficient to maintain the force on the G weight required to pull the timing block to the lock out or time start position.

Test No. 2

This test was conducted to determine the commit point of the sensor. The centrifuge was programmed to produce forces in accordance with the curve shown

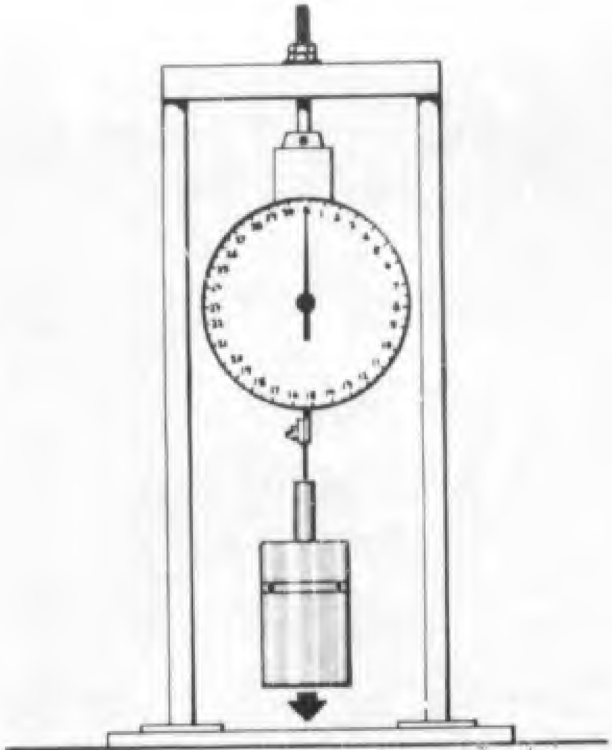


Figure 26. Lanyard Pull Test Set-up

in figure 28. When the forces reached the level between 3 and 4 G's, the sensing weight movement was monitored by a microswitch located at the start of the G weight movement. This signal then showed on the curve as a broken line representing the true commit point.

Test No. 3

This test was a continuation of test No. 2 wherein the centrifuge continued through the programmed curve to determine the retardation relay time, or the total elapsed time from commit to armed position of the explosive element.

EXPLOSIVE PROPAGATION TEST (SIMULATED)

In-line and out-of-line tests were conducted using the T75 electric detonator. No tests were conducted using the mechanical detonator, since no difference exists between this fuze and the FMU-54/B Fuze (previously tested).

Figures 29 and 30 show the test setup and the firing control box. The firing control duplicates the output of the Mk 43 Target Detecting Device.

Figure 31 shows the results of the simulated tests conducted. When firing in the out-of-line condition, the leads were not initiated nor were they burned in any way. The in-line tests initiated the leads high order. This was substantiated in further tests using the actual fuze with boosters.

Figure 27. Centrifuge

EXPLOSIVE PROPAGATION TEST (ACTUAL UNIT)

Tests were conducted on the FMU-54A/B Fuze using the T75 electric detonator with leads only. Two fuzes were detonated through the booster pellet to check explosive train continuity. All functioned high order. Figure 32 shows the results through explosive leads only. Figure 33 shows the results through the complete explosive train.

JOLT TEST

This test was conducted in accordance with MIL-STD-300, and was made with inert parts. The results indicated that the fuze was still in the safe position.

This was a destructive test and the unit was to remain safe throughout the test.

JUMBLE TEST

This test was conducted in accordance with MIL-STD-301, and was made with inert parts. The results show the fuze still in the safe position. Approximately 110 degrees of crimped edge, which holds the time set assembly in the housing, was torn loose. This was a destructive test and the unit was to remain safe throughout the test.

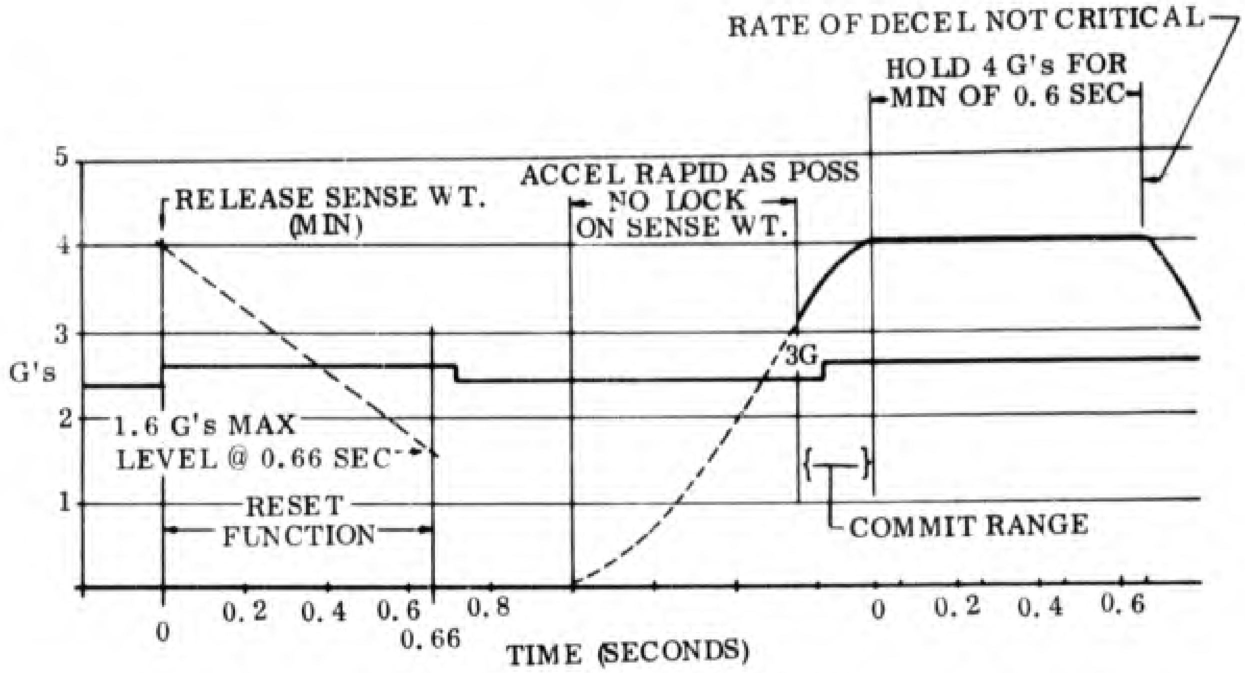


Figure 28. Deceleration Curves

40-FOOT DROP TEST

The 40-foot drop test is a safety test. The unit is to remain safe after the drop; however, it need not be operable. This test was conducted in accordance with MIL-STD-302.

Results

a. Nose Down - Exterior satisfactory, visual inspection; slider showed green. Slider detonator plug removed, slider in safe position.

b. Nose Up - Exterior satisfactory, visual inspection; slider showed green. Slider detonator plug removed, slider in safe position. Fuze still operable.

c. Horizontal - Exterior satisfactory, visual inspection; slider showed green. Slider detonator plug removed, slider in safe position. Fuze still operable.

d. 45 Degrees Nose Down - Exterior satisfactory, visual inspection; slider showed green. Slider detonator plug removed, slider in safe position.

In general, since the fuzes do not have to be operable after the 40-foot drop tests, and since they are safe to dispose of, the fuzes have successfully passed the MIL-STD safety tests.

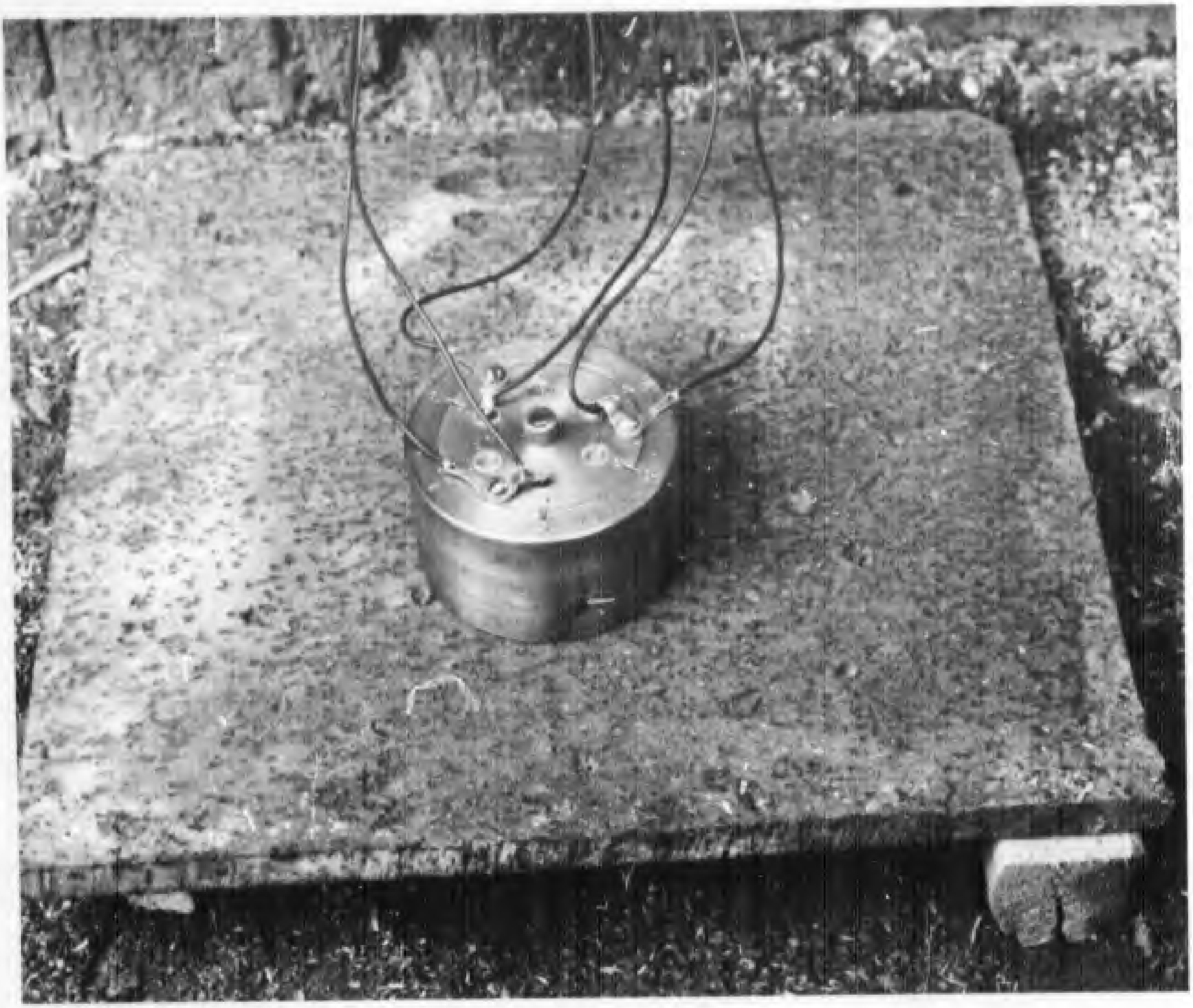


Figure 29. Explosive Test Set-up (Electrical Detonation)

5-FOOT DROP TEST

The 5-foot drop test was conducted in accordance with MIL-STD-358. The unit is to remain safe and operable after testing. Fuzes were dropped in the same plane as the 40-foot drop. All fuzes were safe and operable after tests.

TRANSPORTATION VIBRATION

Two fuzes were tested in accordance with MIL-STD-303. One fuze operated through the slider and armed properly. One fuze operated through the timer; however, the release arm did not release the slider. Failure was attributed to the release arm spring. The spring end contacted the inside of the housing, resulting in less spring torque. The length of the spring tab has been reduced to eliminate this problem.

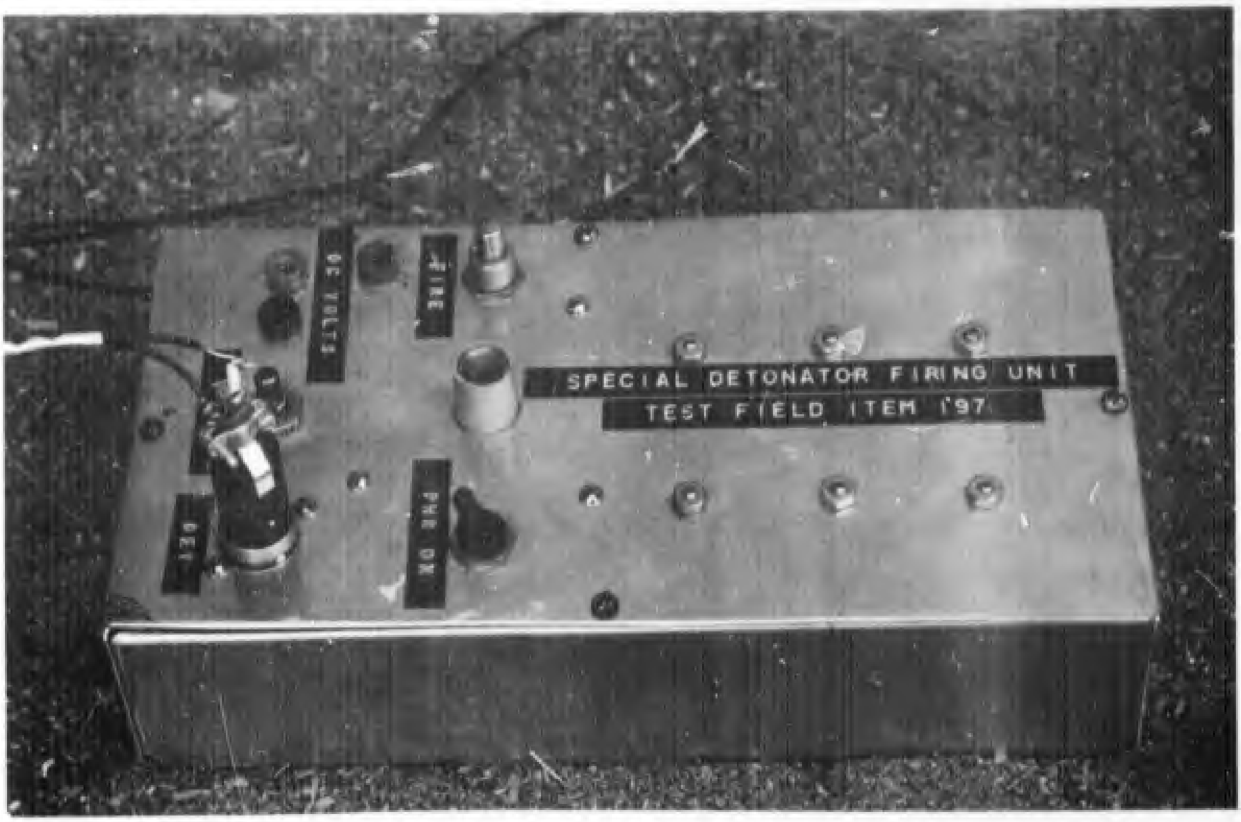


Figure 30. Firing Control Box (Electrical Detonation)

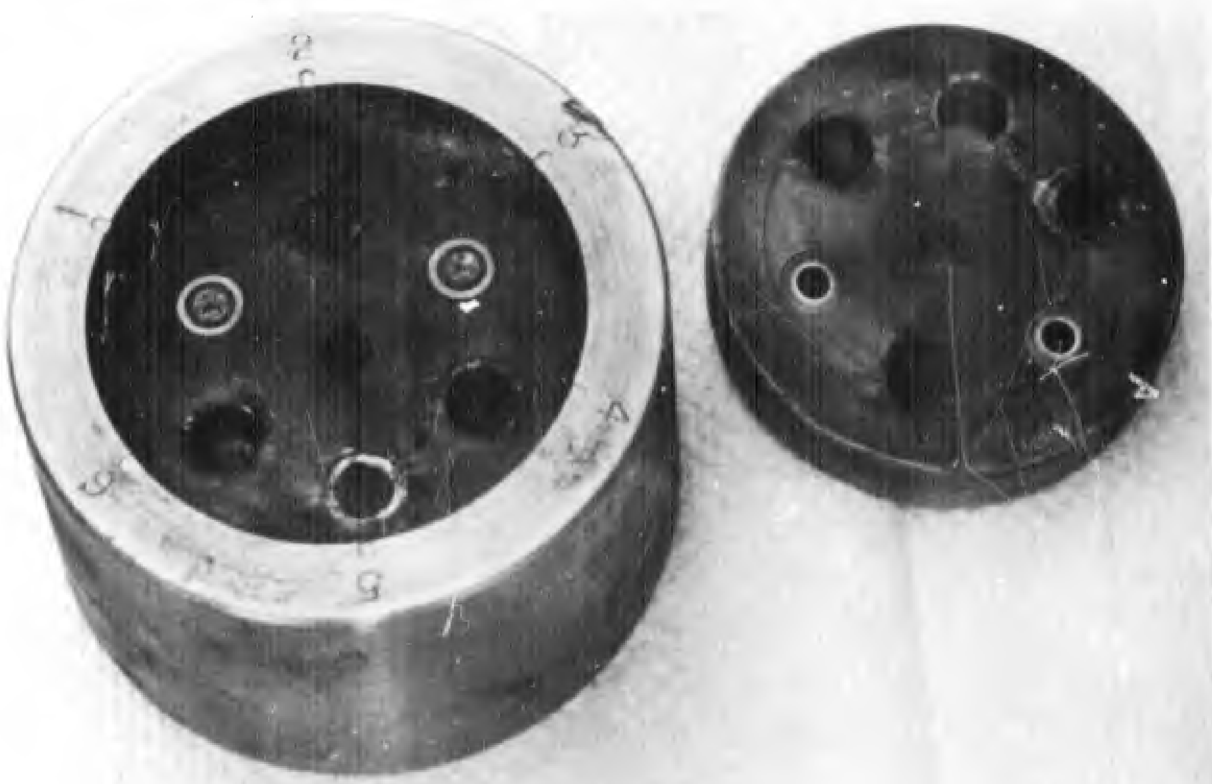


Figure 31. Test Results (Electrical Detonation)

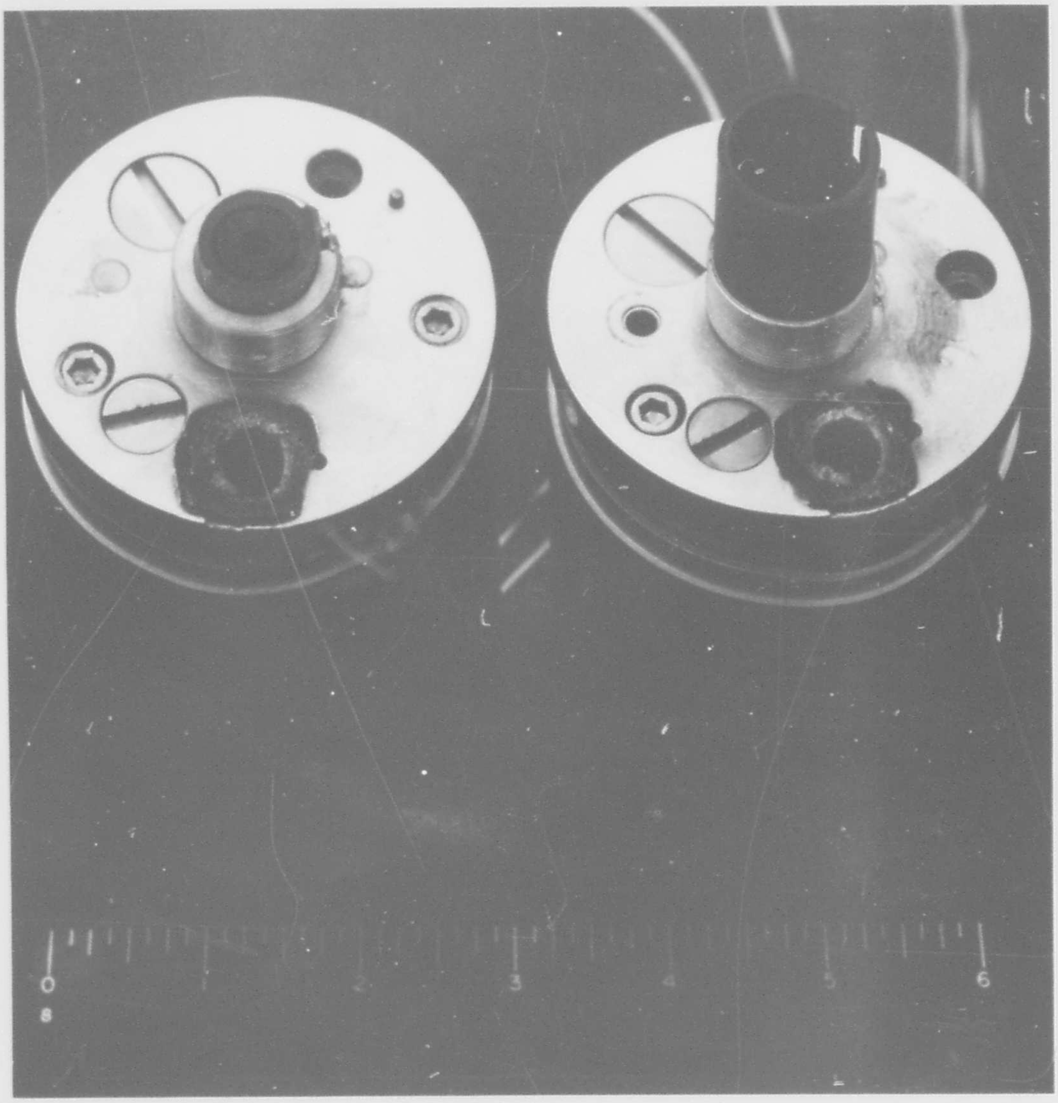


Figure 32. Test Results (Explosive Lead Only)

AIRCRAFT VIBRATION

Two fuzes of each group were tested in accordance with MIL-E-5272C. Of the Phase I group, one fuze operated through the slider and armed properly. One fuze did not operate. Examination showed that the G weight was held by the ball lock. Once freed, the fuze operated several times. This can be corrected on the next fabrication by the use of a "nylatron GS" guide bushing.

The two Phase II units both functioned properly after completion of this test.

Figure 33. Test Results Through Booster

TEMPERATURE AND HUMIDITY

Two fuzes of each group were tested in accordance with MIL-STD-304. Phase I fuzes failed this test, due to fuzes not being sealed properly. Both Phase II units passed the test without leaks.

WATERPROOFNESS

One fuze was subjected to a Waterproofness test, MIL-STD-314. This fuze passed the test in accordance with test specifications.

SALT SPRAY

One fuze was to be subjected to the Salt Spray test, MIL-STD-306. This fuze passed the test in accordance with test specifications.

NEW LANYARD DEVELOPMENT TESTS

The design and test actually breaks down into two parts, the stretchable lanyard assembly and the initiator. All metal parts are designed as die castings. A breakaway, or controlled failure, swivel is used with the lanyard. A quick disconnect for cord interchangeability is included. Twenty sets of parts were fabricated and used as follows:

1. Collet Integrity - Static Pull (Component)
2. Static Pull - Complete System (2 sets)
3. Impact Pull - (Simulated Ejection) (2 sets)
4. Temperature and Humidity - 28 day cycling
   Checks for function at -65° and +165 ° made (5 sets)
5. Salt Spray - 48 hours (3 sets)
   MIL-STD requires operation
6. Transportation Vibration
   All parts assembled with simulated hookup under tension

The delrin collets were assembled into a simulated fuze assembly and pull tests were made to insure that the fingers are strong enough to reliably initiate every fuze. Loads above 50 pounds were applied with no collet failures. This represents a 150 percent safety factor for a 20 pound pull setting in the fuze unlocking shaft. Actual failures occur above 100 pounds.

Static Pull - Lanyard Assembly

For this test all parts from the swivel to the lanyard engagement shaft inclusive were assembled in a test fixture and a steady load was applied. In both cases the swivels failed at 110 pounds with no damage to lanyard adapters, stretchable cord connections, the lanyard housings, or the collets. Pull without the swivel failed the collet at 130 pounds.

Impact Pull - Simulated Ejection

Complete assemblies were engaged with a fuze in a standard fuze well and plumbing. The plumbing was mounted on a drop fixture table in the environmental test laboratory. The swivel was affixed to a stationary member and the table was dropped 36 inches. In two tests the fuze was initiated and again the swivel broke as intended. In one case the collet fingers broke, but only after initiating the fuze. That same drop broke the stop pin off of the unlocking shaft.

Transportation Vibration

A simulated installation was made on a special fixture including all parts from the swivel assembly to the lanyard engagement shaft. This was mounted and exposed to the MIL-STD Transportation Vibration test in one plane for four hours. No problems or failures were encountered.

Temperature and Humidity

Five initiator assemblies were placed in the temperature and humidity chamber 27 September 1968. Function checks were made at both temperature extremes with no problems. One fuze assembly, installed in a well and plumbing with the stretchable cord assembly, was placed in the chamber and checked for fuze initiation at both temperature extremes. The fuze was initiated both cold and hot with no difficulty.

Salt Spray

Three initiator assemblies were exposed to the MIL-STD-331 procedure. Parts were operable after 48 hours exposure.

FMU-70/B TESTS

Under this contract, the tests prescribed for the nose fuze were limited as the environmental tests were met by the FMU-54/B Fuze designed on this contract. There were 20 fuzes contracted for and all were committed for functional test at Eglin Air Force Base. Therefore, only non-destructive functional tests were made, with the exception of a few applicable tests, to check components where a new material had been introduced. These were made on a prototype fuze as described in the following paragraphs.

The following tests were made:

1. Commit Point
2. Delay Time - Normal Retard
3. Delay Time - No Retard
4. Total Time
5. Reset - Breakaway Function
6. Lanyard Pull Load
7. Aircraft Vibration and Temperature Extremes - One Unit

COMMIT POINT

The specified commit point, or G level, at which the sensing weight releases the ball lock on the G weight, for the retarded bomb fuze, is 3.5 ±0.5 G's. This release level is tested in a simulated function test for a centrifuge by accelerating through 4 G's. (See function test - FMU-54A/B, figure 28.) All of the FMU-70/B fuzes functioned about the mean, prior to installation of telemetry switches. However, after switches were installed, some were higher than four G's. This was due to the drag of the switch button and could not be prevented without reducing too much of the spring load to make the commit point reliable. Therefore, they were shipped with this deviation from the specification.

DELAY TIME - NORMAL RETARD

The specified delay time is 0.6 ±0.06 second. This is the time for which good retardation must be sensed. This time is checked both statically on a bench test with oscillator and counter, and dynamically in the centrifuge test. To have as little effect on delay time as possible, with the reverse delay feature as described previously, all fuzes were set as close to the minimum delay as possible. Average forward delay time was 0.575 second.

DELAY TIME - NO RETARD (REVERSE)

The time designed for in this function mode is 0.200 to 0.300 second. This is extremely short and difficult to measure since there were no readily accessible pick up points for counter switches. Figure 34 shows a high speed camera setup which was used to time this function. Figure 35 shows a fuze mounted on the test fixture. The solenoid was wired through a timing device with the camera circuit. It was energized after the camera obtained a high speed. The action was recorded and time read out from the resultant film.

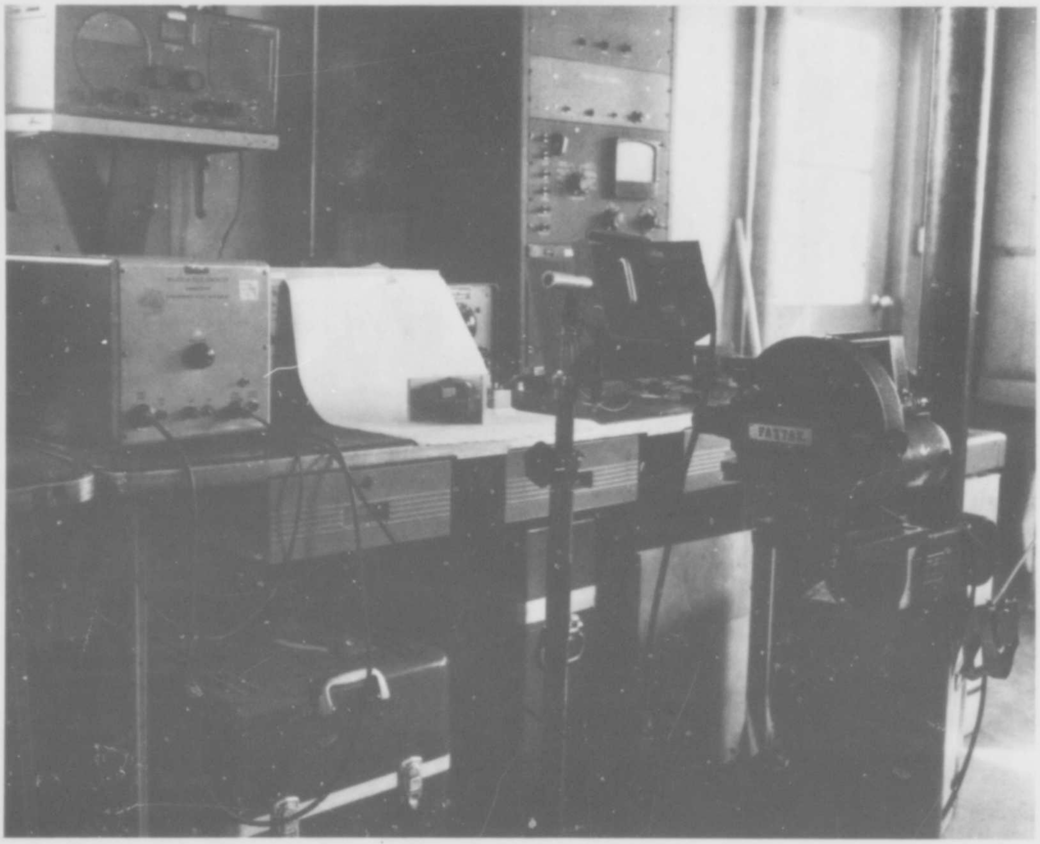


Figure 34. Retard System Camera Set-up

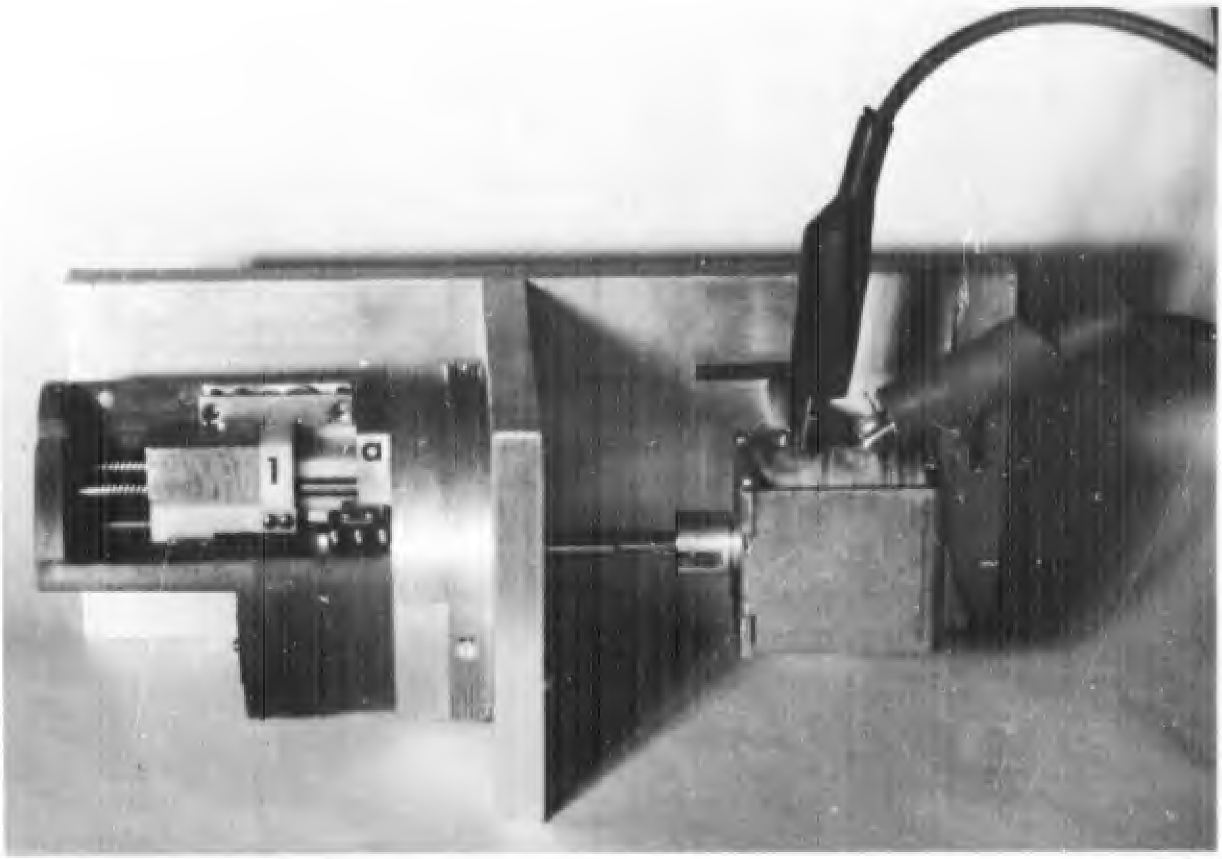


Figure 35. Retard System - Fuze Test Set-up

TOTAL TIME

The timer should function over a range of 0.75 second to 3.5 seconds with an accuracy of ±5 percent. Timers used in these fuzes were first tested at a static test station. Then, in assembly with the delay, total fuze arming time was statically measured on the laboratory oscillator and counter through the telemetry switches. All units were within specified limits.

RESET - BREAKAWAY FUNCTION

The breakaway design of the fuze was tested on the centrifuge by running a reset curve. In this test, the fuze is rotated at more than 4 G's, the brake applied to the centrifuge, and the unit allowed to commit at approximately 4 G's. At commit, the G weight slams forward but fails to remain there since the centrifuge is decelerating. On this test, all breakaway G weights functioned properly.

LANYARD PULL LOAD

The lanyard pull force was set at 10 to 13 pounds, corresponding to present production and the FMU-54A/B Fuze. The test setup and procedure is the same as that described in the FMU-54A/B Fuze section of this report.

AIRCRAFT VIBRATION AND TEMPERATURE EXTREMES - ONE UNIT

In an effort to improve bearing characteristics in the retardation system of this design, plastic replaced aluminum in the timing block and was used for the light carrier of the G weight assembly. Due to this change and the frail appearance of some parts, it was believed that the subject tests should be performed to confirm that these extreme conditions would not cause failure. A prototype unit, used to originally demonstrate design and function, was first submitted to aircraft vibration test.

There was no effect whatsoever on appearance or function of any portion of the fuze. The same assembly was then submitted to the standard temperature cycle from -65 degrees to +165 degrees F. It was tested as a frame assembly, with no package, to achieve worst conditions on the interior parts, specifically the plastic. Because this was the first prototype, one hole through the carrier had been machined to early production tolerance and had only 0.001 inch clearance on the guide rod. With the hole undersize and contraction of the material due to the -65 degrees F, the carrier fused to the rod. The other hole, with more reasonable clearance, was free as was the timing block.

SECTION V.

CONCLUSIONS & RECOMMENDATIONS

The fuzes fabricated and assembled, as described in this report, meet all of the requirements set forth. Preliminary test results indicate satisfactory function with all MIL-STD tests having been passed. Some potential improvements have already been indicated, as is normally the case in actual qualification and use, but the concepts involved appear to be totally feasible.

One remaining area of potential improvement of tactical capability is the inclusion of a short delay function mode. This is currently being added to the basic FMU-54/B Fuze currently in production.

Pending completion of Air Force tests, and continued success, both the FMU-54A/B and FMU-70/B Fuzes should be fabricated and tested in larger quantities, with indicated design improvements and production considerations applied. The eventual inclusion of both fuzes in the inventory will improve logistics, safety, reliability, and tactical capability of retarded bomb fuzing.

(The reverse of this page is blank)

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Avco Ordnance Division Richmond, Indiana	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP

3. REPORT TITLE

ENGINEERING DEVELOPMENT FOR THE FMU-54A/B (FUZE, INERTIAL BOMB TAIL) AND FMU-70/B (FUZE, INERTIAL BOMB NOSE)

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Final Report. 2 February 1966 through December 1968

5. AUTHOR(S) (First name, middle initial, last name)

Russel E. Bowers
Donald A. Brackman

6. REPORT DATE March 1969	7a. TOTAL NO. OF PAGES 46	7b. NO. OF REFS
8a. CONTRACT OR GRANT NO. AF 08(635)-4517 b. PROJECT NO. c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) AFATL-TR-69-40	

10. DISTRIBUTION STATEMENT This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the Air Force Armament Laboratory (ATWB), Eglin AFB, Florida 32542.

11. SUPPLEMENTARY NOTES Available in DDC	12. SPONSORING MILITARY ACTIVITY Air Force Armament Laboratory Air Force Systems Command Eglin Air Force Base, Florida

13. ABSTRACT

The objectives of this development program were to utilize the FMU-54/B Fuze (Inertial Bomb, Tail) design as the basis for the design of the FMU-54A/B Fuze (Inertial Bomb, Tail) and the FMU-70/B Fuze (Inertial Bomb, Nose). Both fuzes must retain all characteristics of the basic fuze and be of the same size and configuration. The FMU-54A/B Fuze must have the settable delay time increased from a maximum of 3.5 to 6.0 seconds to provide safe escape distance for the delivery aircraft and must have the added capability of an air burst upon receipt of an electrical signal from a proximity sensor. To attain these objectives, the timing mechanism was redesigned for both fuzes, the retardation sensing system for the FMU-70/B Fuze was designed to sense the lack of retardation as well as retardation, components of the FMU-54A/B Fuze were reduced in size and weight to make space for the electrical detonator as well as the impact detonator, and the lanyards were redesigned to accommodate the electrical signal for the proximity sensor and the electrical detonator. The fuzes fabricated and tested function as required and have passed all MIL-STD tests. An improvement in tactical capability could be made by the inclusion of a short explosive delay function mode.

DD FORM 1 NOV 65 1473

UNCLASSIFIED

Security Classification

UNCLASSIFIED

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Mechanical Timer						
Inertia Sensor						
Bomb Fuze Lanyard Assembly						
High Drag Air Burst Fuzing						
Electrically Initiated Fuze						
Drag Device Failure Sensor						

UNCLASSIFIED

Security Classification