UNCLASSIFIED

AD NUMBER
AD905236
LIMITATION CHANGES
TO: **Approved for public release; distribution is unlimited.**
FROM: **Distribution authorized to U.S. Gov't. agencies only; Test and Evaluation; MAY 1972. Other requests shall be referred to Air Force Armament Lab., Eglin AFB, FL.**
AUTHORITY
AFATL ltr 14 Mar 1979

THIS PAGE IS UNCLASSIFIED

AFATL-TR-72-91

IMPROVED FMU-68/B FUZE

KDI POLY-TECHNIC DIVISION
KDI PRECISION PRODUCTS, INC.

TECHNICAL REPORT AFATL-TR-72-91

MAY 1972

Distribution limited to U. S. Government agencies only; this report documents test and evaluation; distribution limitation applied May 1972. Other requests for this document must be referred to the Air Force Armament Laboratory (DLJF), Eglin Air Force Base, Florida 32542.

AIR FORCE ARMAMENT LABORATORY
AIR FORCE SYSTEMS COMMAND • UNITED STATES AIR FORCE
EGLIN AIR FORCE BASE, FLORIDA

Improved FMU-68/B Fuze

Richard C. Carter

FOREWORD

This effort was conducted by KDI Poly-Technic Division, KDI Precision Products, Inc., 10540 Chester Road, Cincinnati, Ohio 45215 under Contract F08635-71-C-0098 with the Air Force Armament Laboratory, Eglin Air Force Base, Florida during the period from February 1971 to May 1972. Mr. Earl S. Suters, Jr. (DLJF) monitored the program for the Armament Laboratory.

This technical report has been reviewed and is approved.

Charles Petrikas

for NORMAN S. DRAKE, Colonel, USAF
Chief, Bombs and Fuzes Division

ABSTRACT

An improved FMU-68/B mechanical fuze, designated as FMU-68A/B modified fuze, was designed and tested during a twelve-month period. The design objective was to provide additional safety features to the fuze which eliminate hazards encountered during upload and download of fuzed bombs. The fuze fits into the well of an AN-M23A1 igniter which is compatible with BLU-27B/B and BLU-32A/B firebombs. The fuze has a built-in timer with a predetermined arming delay of 0.30 to 0.50 second which provides safe separation from the aircraft. The uploaded FMU-68A/B modified fuze can be restored to preflight condition by replacement of the safety cap and installation of a new safety wire if the arming wire (lanyard) has not been extracted from the fuze during the flight. Environmental tests were performed and test results formulated. One hundred twenty-five FMU-68A/B modified fuzes were shipped to Eglin Air Force Base for evaluation. It was concluded from the program effort that the FMU-68A/B modified fuze represents a significant increase in safety over the FMU-68/B fuze and that the improved fuze functions well within specifications.

(The reverse of this page is blank)

TABLE OF CONTENTS

TABLE OF CONTENTS (Concluded)

LIST OF FIGURES

(The reverse of this page is blank)

SECTION I

INTRODUCTION

This final report reviews the work performed in the design, development, and testing of the FMU-68 A/B modified fuze. The contractual requirement was to develop an improved FMU-68/B fuze having a selectable 0.4-or a 2.0-second arming delay with enhanced safety. The improved fuze was to be interchangeable with the FMU-68/B and to be able to discriminate between the M23A1 or the BBU-1/B igniters while automatically selecting the proper arming delay without manual selection of the arming delay, external attachments, or auxiliary timers.

During the course of the program the objectives were changed to limit the time delay capability of the improved fuze to 0.4-second nominal and to limit the fuze application to the M23A1 igniter. The objective of maximizing the safety features of the improved FMU-68/B fuze remained unchanged.

The development and testing of the FMU-68A/B modified fuze is discussed in this report.

SECTION II

CHRONOLOGICAL PROGRAM HISTORY

The design effort for the improved FMU-68/B fuze was initiated early in February 1971. A meeting was held on 8 March 1971 with the Eglin Program Manager to review the effort to be pursued.

During March and April, 1971, Form III drawings were completed and two prototype fuzes were tested at ambient temperatures. The prototype timers performed well except that the timer mechanism would not run in a 40-g force field. Modifications to both the verge and starwheel bearing journals resulted in satisfactory operation at 40 g's.

The design review was held in May 1971. Minor documentation changes were introduced to enlarge the arming wire holes in the arming collar and arming pin to make insertion or removal of the arming wire easier. Form III drawing package was delivered to the Air Force, and fabrication of 80 sets of parts was authorized.

During June 1971 twenty-five fuzes were prepared for conducting igniter tests at Aerospace Research, Roanoke, Virginia, during July 1971.

During July 1971 twelve FMU-68A/B fuzes (loaded with detonator only) were shipped to Eglin AFB for captive flight tests.

Igniter tests were conducted at Roanoke, Virginia, and the results demonstrated that the FMU-68A/B fuze modifications did not degrade the explosive performance as compared to the standard FMU-68/B fuze.

During August 1971 a lot of twenty fuzes was subjected to environmental tests. The fuzes successfully passed the tests with the one exception. Five units of a sample of seven subjected to aircraft vibration tests failed to function after test. Subsequent investigation revealed that the pitch radius of the center gear was slightly oversize and the vydax lubricant used in the gear mechanism was applied too heavily. The problems on this lot were corrected, employing new gear stampings and revised lubrication procedures, and the lot was again subjected to additional vibration tests. The improved lot performed within specification after vibration.

During September 1971 the Initial Design Complete review was held at KDI Poly-Technic. At this time thirty-eight FMU-68A/B fuzes were loaded with M-55 detonators only and shipped to Eglin AFB for evaluation.

During October 1971 the design program was redirected to delete the dual time capability from the fuze and to delete the shear cap in favor of a replaceable safety cap. The replaceable safety cap would permit resafing the fuze in the event that the fuze was returned from the field in an undropped munition.

In November 1971 the revised Form III drawings were completed, and four prototypes of the FMU-68A/B modified fuze were tested at ambient conditions.

In December 1971 thirty fuzes for engineering evaluation of the FMU-68A/B modified design were assembled for environmental tests. These test fuzes were submitted to environmental tests in January 1972. A problem was encountered in the waterproofness test. The fuze leaked around the large O-ring seal between the case and arming collar assembly and the housing. A new O-ring design was introduced, and test results were satisfactory on the revised hardware tests. Form I drawings were submitted to the Air Force for approval in January 1972. One hundred forty-five additional fuzes for evaluation and environmental test loaded with detonator only were assembled in January 1972. Twenty of these were successfully submitted to lot tests at KDI, and the remaining one hundred twenty-five were shipped to Eglin AFB in February 1972.

The Eglin Program Manager observed the loading operations on the fuzes to be shipped to the Air Force. Drafts of all of the data items except for the final report were submitted for Air Force approval. The FMU-68 A/B modified fuze design is defined by Air Force drawing number 716374 and subsequent drawings called out thereon.

SECTION III

TECHNICAL DISCUSSION

1. BACKGROUND

The FMU-68/B Mechanical Impact Fuze is used on the BLU-27 and BLU-32 series firebombs to provide in-flight safety and safe separation from the aircraft.

At the time this contract was conceived and implemented, either of two igniters were being considered for use with the BLU-27 and BLU-32 series firebombs to satisfy two modes of firebomb delivery. Standard firebomb techniques (generally low level drops) employ the AN-M23A1 white phosphorous igniter. Only 0.4-second fuze delay is required to insure safe separation of the armed bomb and aircraft. For tactical reasons the BBU-1/B high explosive igniter was developed which required a longer delay time to provide increased separation distance and to minimize the igniter explosive hazard to the aircraft. Thus, the BBU-1/B igniter required a nominal 2.3-second fuze delay time.

The improved FMU-68/B mechanical fuze was designed to be used with either of the previously mentioned igniters. By automatically detecting the difference of the fuze well depth in the two igniters, the improved fuze would select the required delay time for each corresponding igniter.

In addition to providing dual time capability to the improved FMU-68/B fuze, it was desired to increase the safety features. The increased safety features were as follows:

- Design of a metal shear cap which replaced three parts and simplified uploading procedures.

- Replacement of the arming pin assembly made up of three parts with a single piece arming pin which extends through the rotor into the housing.

- Design of a device which physically prevents reinsertion of the arming pin once it has been ejected from the fuze.

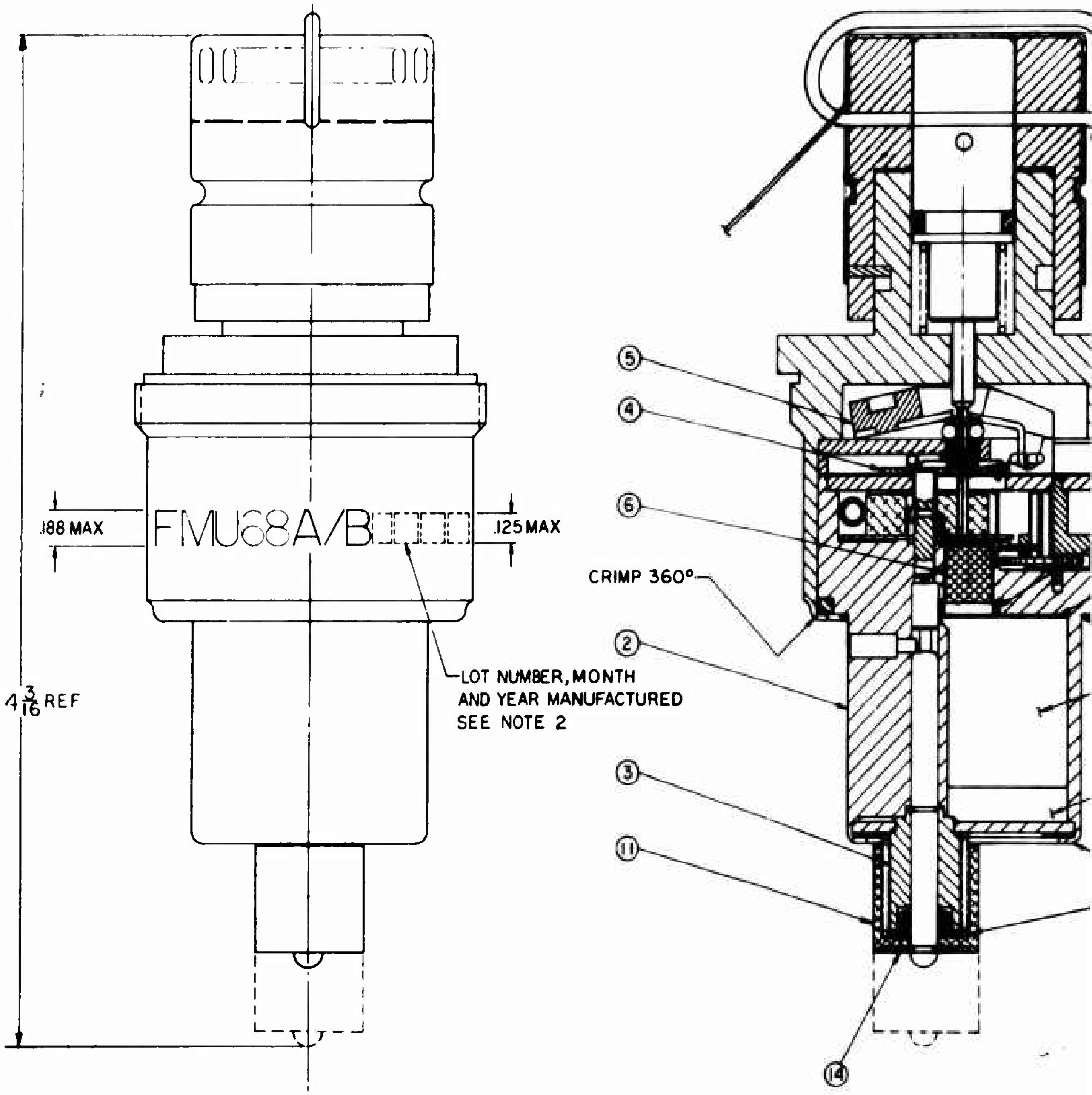
2. DUAL TIME FUZE DESIGN

a. Fuze Description

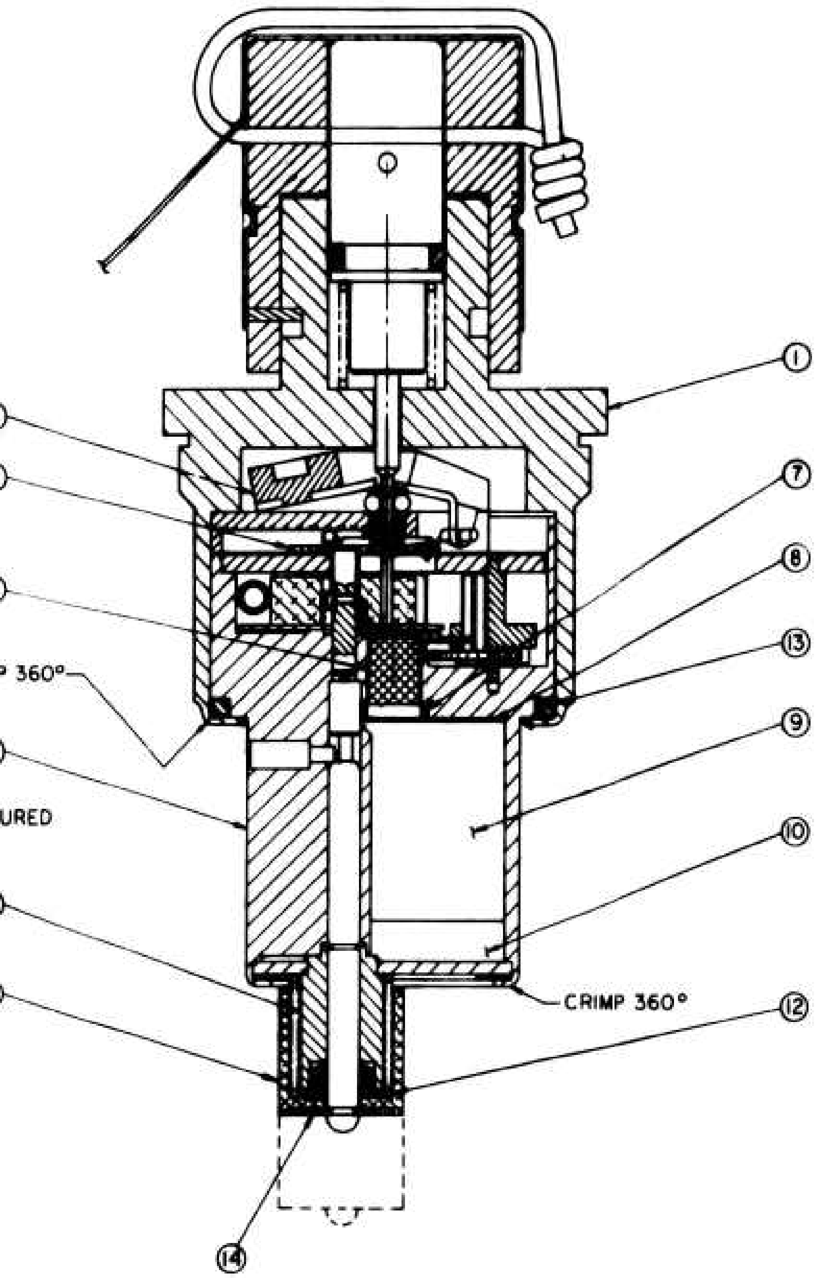
The improved FMU-68/B was designated as the FMU-68A/B fuze and is shown in Figure 1 and 2. The characteristics are given in Table I.

Figure 1. Cutaway View of FMU-68 A/B Fuze.

(The reverse of this page is blank)



FMU68A/B
.188 MAX
.125 MAX
$4\frac{3}{16}$ REF
LOT NUMBER, MONTH AND YEAR MANUFACTURED SEE NOTE 2
CRIMP 360°
5
4
6
2
3
11
14



1. CASE AND ARMING COLLAR ASSEMBLY
2. HOUSING AND GEAR ASSEMBLY
3. CLOSING DISC ASSEMBLY
4. FIRING PIN AND SPRING ASSEMBLY
5. CENTER PLATE ASSEMBLY
6. LEAD CUP ASSEMBLY
7. SLEEVE
8. SEAL FUZE
9. PELLET, BURSTER
10. PAD, BURSTER
11. SPRING, CAP
12. SPRING, PROBE
13. "O" RING
14. RING, RETAINING

Figure 2. FMU-68 A/B Fuze

(The reverse of this page is blank.)

TABLE I - CHARACTERISTICS OF THE FMU-68A/B MECHANICAL FUZE

Function: Automatically provide 0.4-second or 2.3-second arming delay and function upon impact.

Timer:

a. Type: Mechanical

b. Escapement: Runaway

c. Accuracy:

Setting	±Tolerance
0.4 Second	0.1 Second
2.3 Second	0.3 Second

d. Start: Arming Wire pull

Size and Weight:

a. External Dimensions: Cylindrically shaped of 3 basic diameters, the top and bottom sections approximately one-inch diameters, the center section 1.625 inches in diameter. The overall height is four and one-quarter inches maximum.

b. Unit Weight: 0.34 lb.

Environments:

a. Temperature: -65°F to +160°F

b. MIL-STD-331, MIL-STD-810B

Explosives: 9.8 grams tetryl, Grade 1, Class A.

Mounting: Screws directly into igniter with 1-1/2-24 NS-2A threads.

Safety:

a. Fuze is safe when safety wire is in place.

b. Fuze is safe when safety cap is in place.

c. Fuze is safe when arming pin is in place.

The new features which were added to the FMU-68/B fuze in order to make up the FMU-68A/B were as follows:

- An escapement which allows a 2.3-second delay.

- Ability to automatically select either 0.4-second or 2.3-second delay, depending upon applicable igniter.

- External probe which discriminates between alternate igniter fuze wells.

- Timer plates and adapter case of the FMU-68/B design were eliminated in favor of a one-piece die casting.

- One-piece arming pin which extends through the rotor into the timer housing.

- Aluminum shear cap safety device which simplified uploading and reduced number of parts.

- Device to physically prevent re-insertion of arming pin into fuze.

The FMU-68/B fuze accomplishes the selectable delay time with two center gear segments in the escapement gear train, as shown in Figures 3 and 4. The selection is between two delay arming times. The safety and arming device consists of a spring-loaded rotor containing a detonator which is held out of line by an arming pin (see Figure 3). The fuze becomes armed when the rotor is released by the arming pin and rotated by the rotor spring into a position aligning the detonator to the explosive lead. The rotor is delayed because it is forced to dissipate energy through an escapement by segment gears attached to the rotor. The rotor gear segment integral to the rotor will delay rotor arming 0.4 second (average) after the rotor is released. Alternately, the rotor will be delayed in arming 2.3 seconds when keyed with the concentric center gear segment. The two center gear segments have the identical pitch diameter and tooth configuration, and both are engaged similiarly in the gear train. The delay time is determined by the mode of the selection device. The selection mechanism can allow the rotor to rotate with the 0.4-second rotor segment or the device can engage the 2.3-second center gear segment to rotate with the rotor.

The selection mechanism consists of a probe assembly (shown in Figures 2 and 5) acting parallel to the center axis of the proposed fuze and concentric with the rotor.

The selection is accomplished by means of a key integral with the shaft common to the rotor and the hub of the center gear segment assembly.

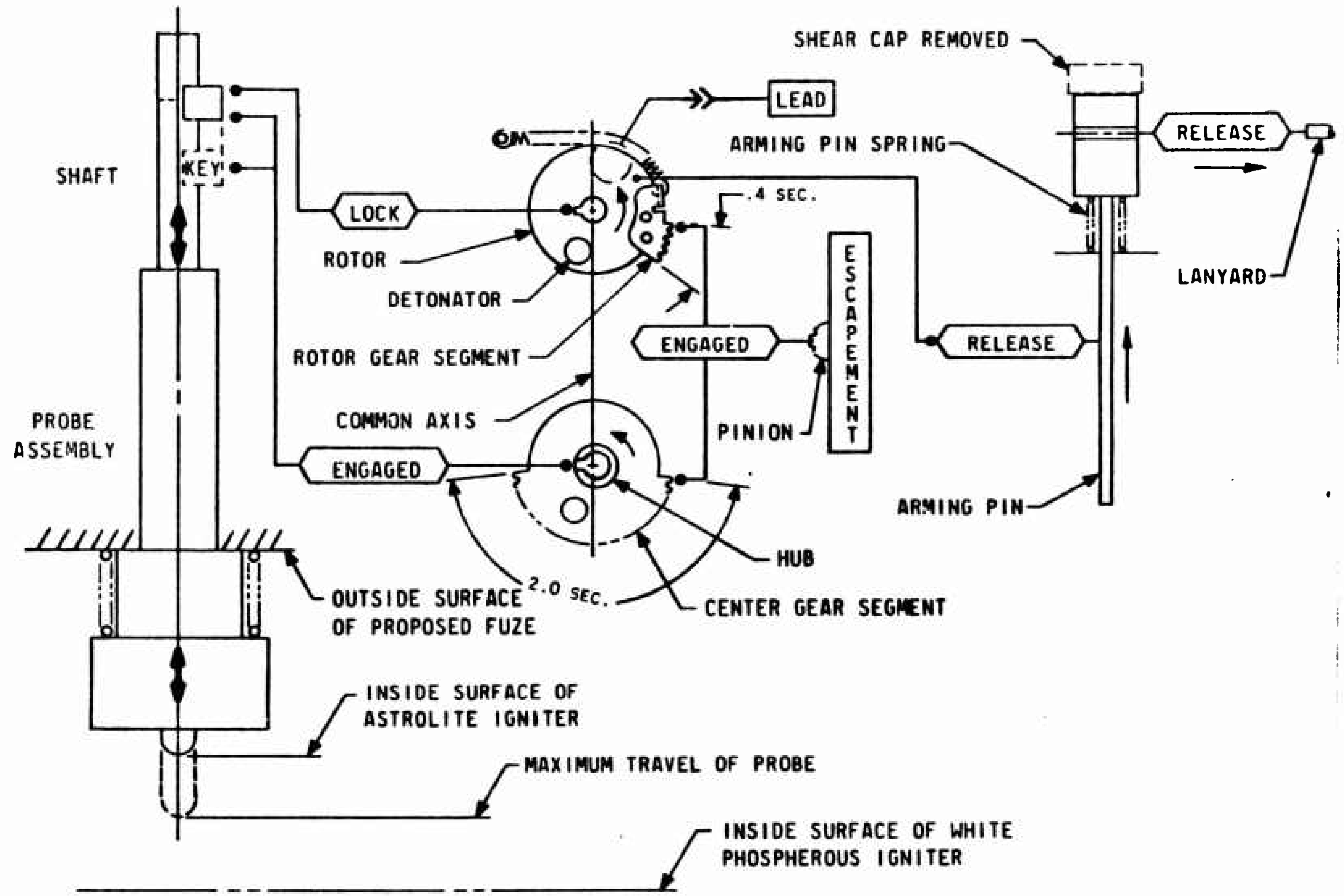


Figure 3. Schematic Diagram of FMU-68 A/B Fuze

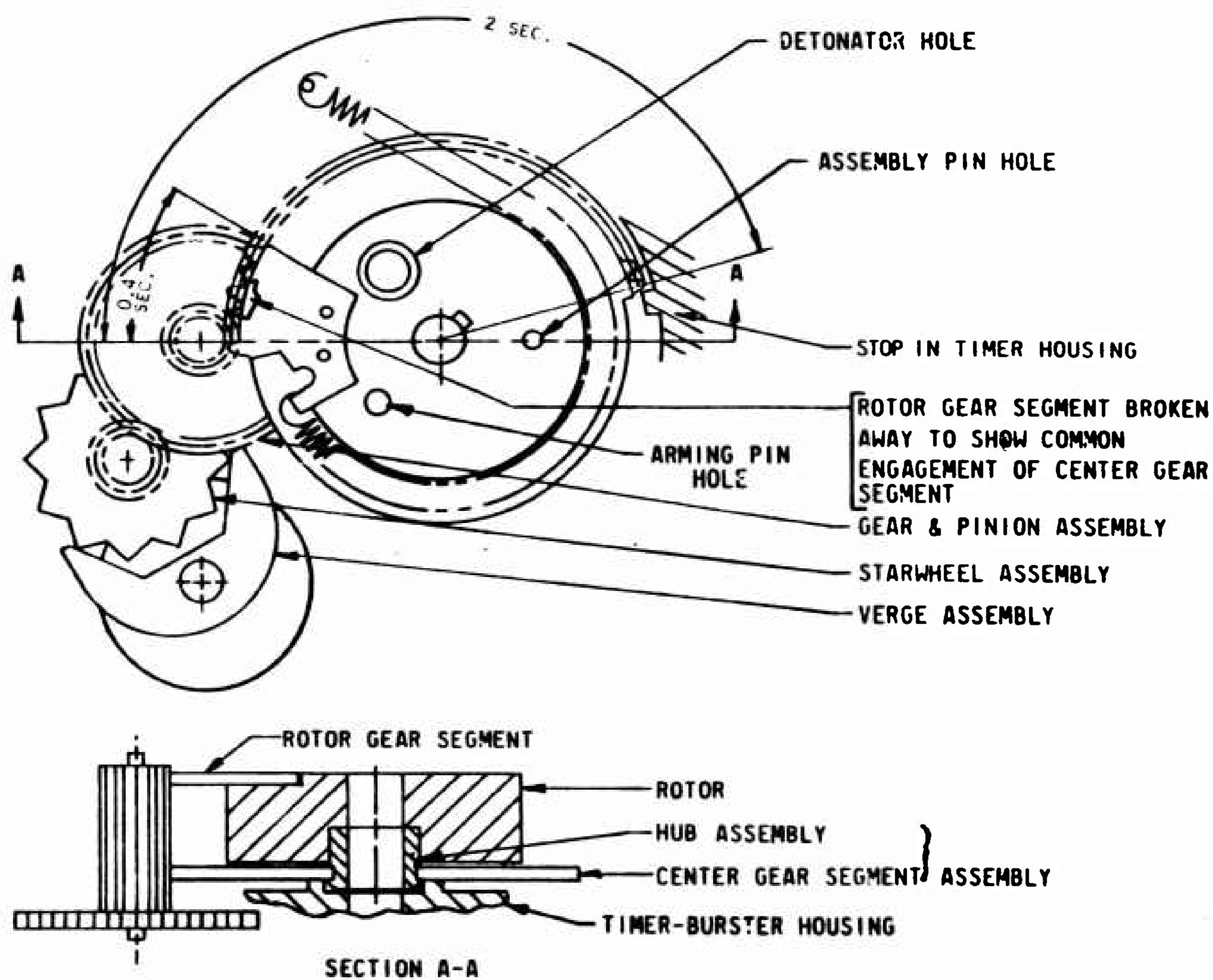


Figure 4. Schematic Diagram of Dual Center Gears

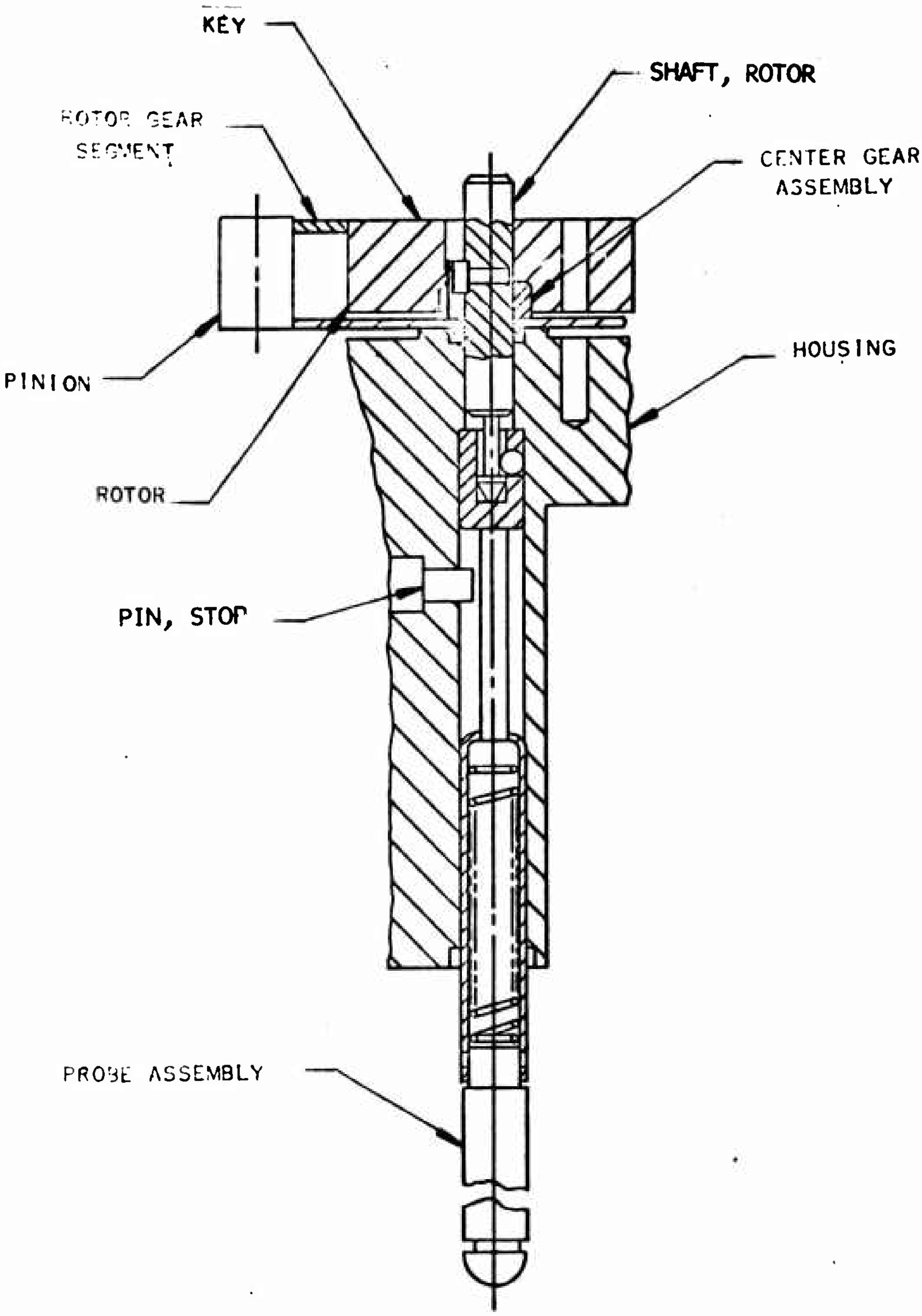


Figure 5. Selection Mechanism for the FMU-68A/B Fuze

A keyway is provided in the center hole of the rotor and hub. The mode of the selection device will position the key such that it will either (a) engage the hub of the center gear segment assembly (2.3-second gear segment), to restrain the rotor or (b) disengage the hub so that rotation of the rotor is restrained by the rotor gear segment (0.4-second gear segment). The probe assembly will detect the well depth of a BBU-1B igniter and select the proper 2.3-second delay time. The probe will not contact the bottom surface of the fuze well when assembled into the M23A1 Igniter. In that event the probe will not be forced upward into the fuze from its free position; consequently, the key will not then engage the rotor. Therefore, either delay time for the igniters used with the fuze will automatically be selected by the internal mechanism. The probe assembly reverses to the long delay position by the bias of the probe springs in the event that the fuze is unscrewed from the igniter. The fuze was particularly designed so that when the fuze is screwed into the BBU-1/B igniter (Astrolite) the 2.3-second timing mode will be affected before the first thread engagement is completed. This feature prevents a timing error due to improper threading of the fuze into the igniter. The selection mechanism is reversible and does not load the timing escapement in any way.

(1) The Housing

In order to accommodate the internal design changes, a new die-cast housing was designed. The upper shaft plate, the upper spacer plate, the rotor plate, the lower spacer plate, the lower shaft plate, and the adapter case of the FMU-68/B mechanical fuze were combined into one housing, as shown in Figure 6. All required functions of the timer-housing assembly and the adapter case are incorporated into the new housing. This change eliminates the 3 long spring pins and substitues 3 short spring pins, of which only two are used in assembly location of the top plate to the housing. The third is used to hold one end of the rotor spring inside the new housing. Six parts were combined into one die casting, thereby reducing the production cost relative to the FMU-68/B.

(2) Arming Pin Anti-Reinsertion Feature

The FMU-68A/B fuze incorporated a safety device which physically prevents reinsertion of the arming pin back into the fuze. This action was necessary from a hazard and safety standpoint because, once the arming pin is ejected for any reason, the fuze is armed and attempts at reinsertion of the arming pin might cause detonation of the fuze. Figure 7 shows the device, and Figure 8 shows the operation of the device.

b. Igniter Compatibility of Fuze

The addition of the time selection mechanism required that a portion of the existing burster pellet be removed in order to accommodate the probe mechanism. This removal caused a corresponding weight reduction

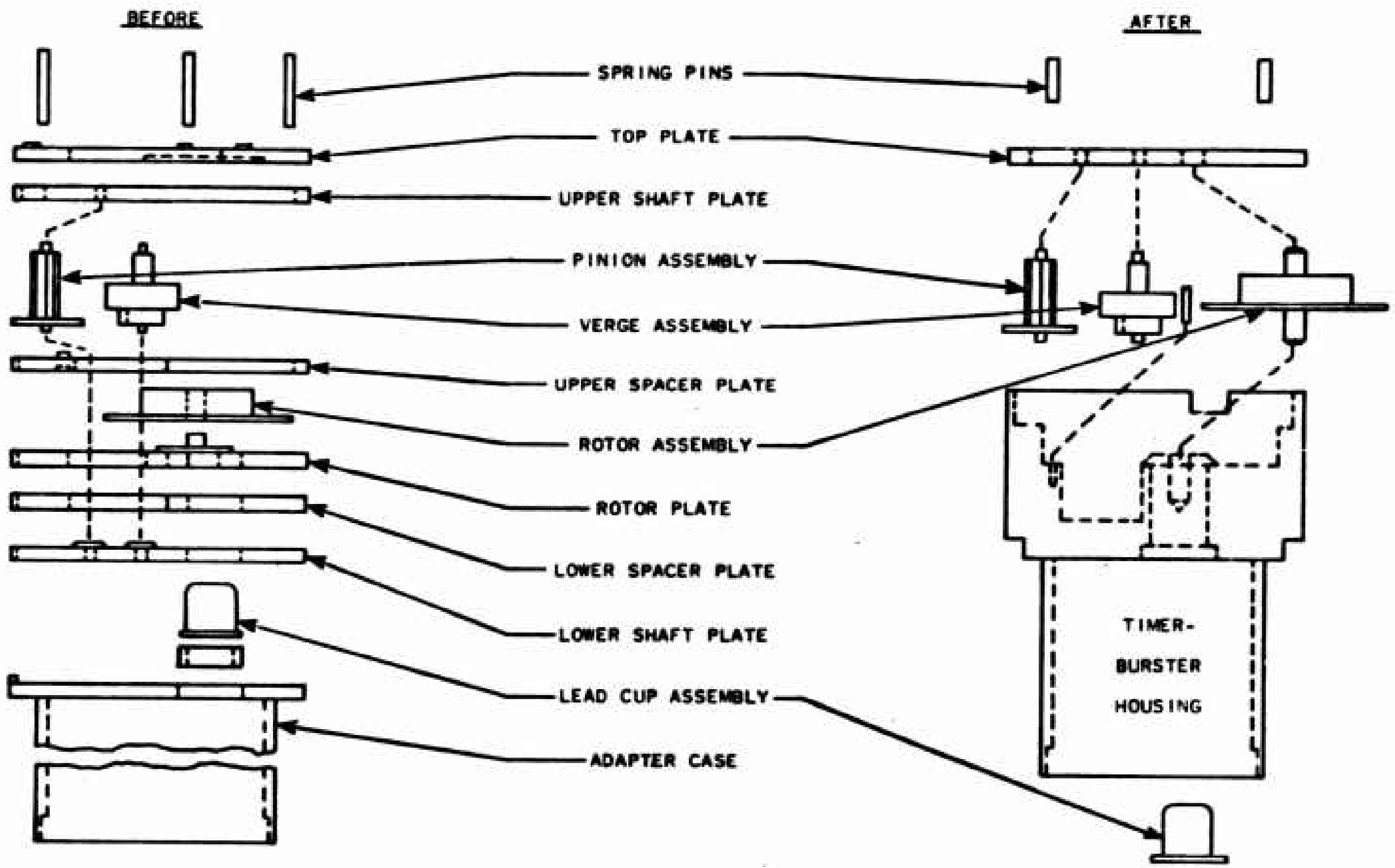


Figure 6. Timer-Burster Housing for FMU-68A/B Fuze: Before and After Modification

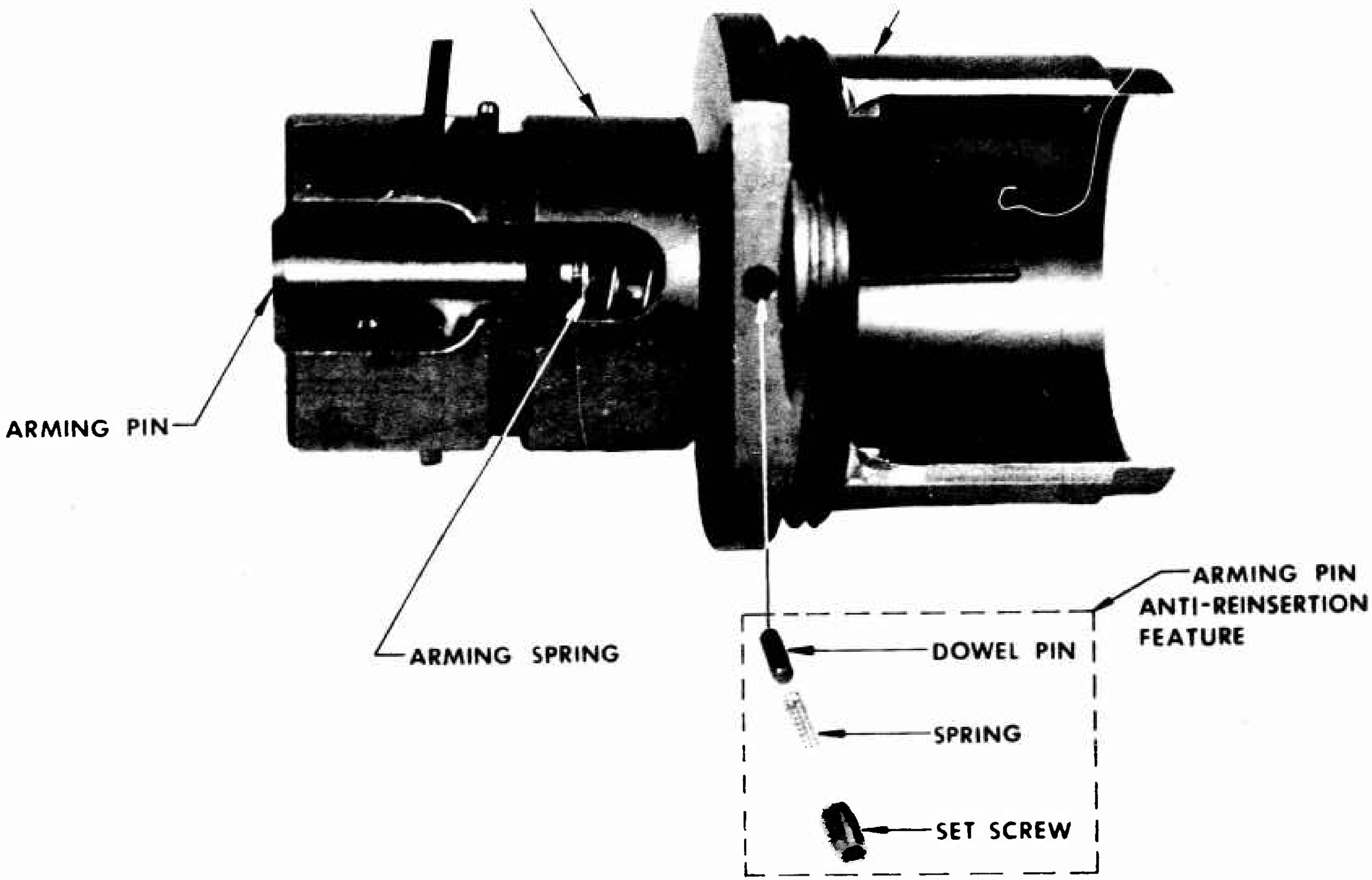


Figure 7. Cutaway View of Case and Arming Collar Assembly.

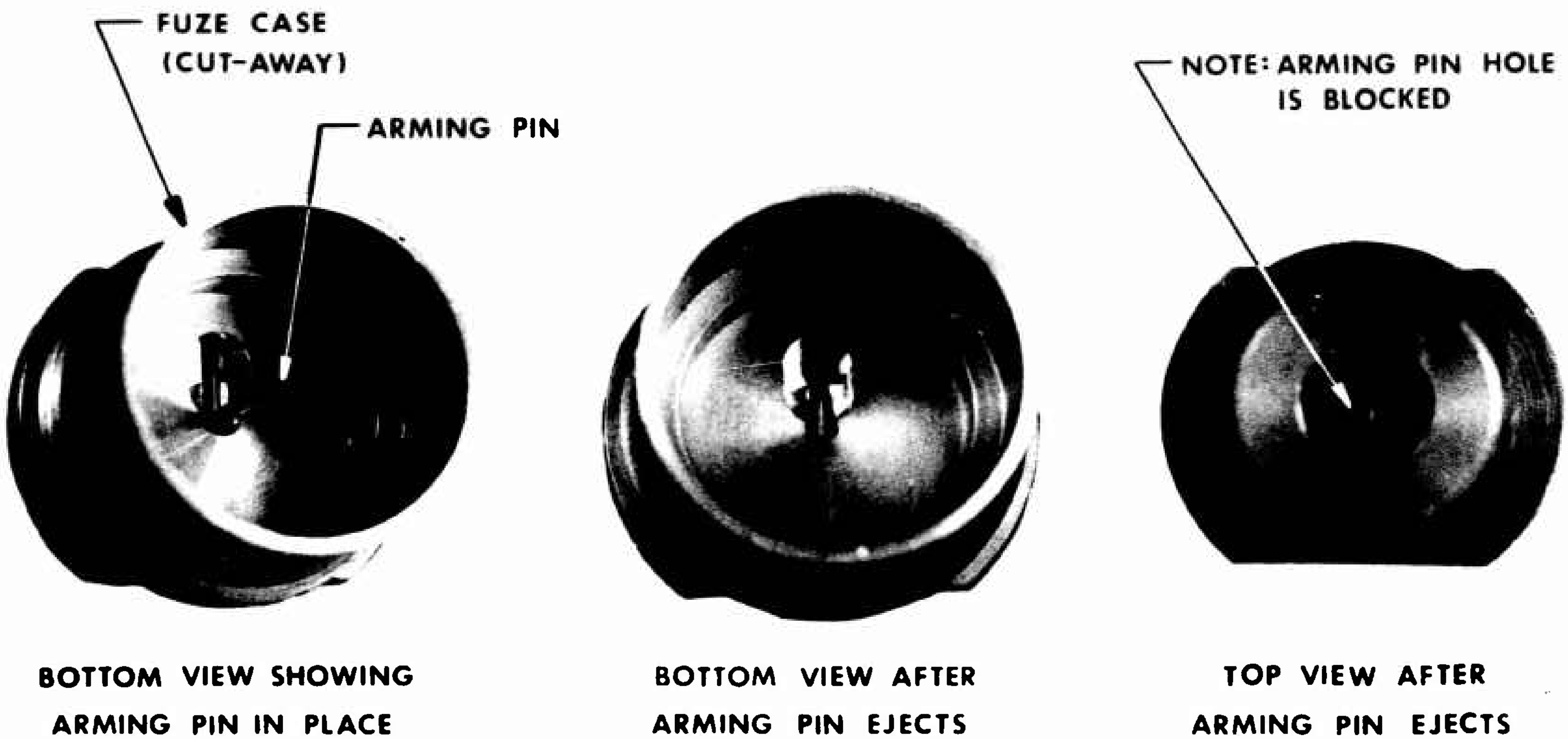


Figure 8. Cutaway View Showing Operation of Arming Pin Anti-Reinsertion Feature.

of the burster pellet from 11.9 grams to 9.8 grams for the new burster pellet. Explosive tests were conducted which proved that the new burster pellet configuration was compatible with both the AN-M23A1 and the BBU-1/B igniters. Appendix I contains the modified burster test plan and the test report.

c. Fuze Evaluation

Environmental tests were conducted on 32 fuzes to prove the integrity of the design and to check the ability of the fuze to perform with accuracy and safety under adverse conditions. The tests were performed in accordance with the Contractor's Development Test Procedure in Appendix II.

(1) Timing (Ambient), Units 001 through 032

The timers were completely assembled except for the M-55 detonator. The time recorded was the time interval from release of the rotor until the rotor reached the in-line position. The test fixture displayed the time on a digital readout, and the times were recorded on the data sheet in Appendix II. All units were within specifications.

(2) Guided Drop No-Function Test, Units 001 through 020

This test was performed to assure that the fuze would not function if impact occurred prior to the completion of the arming delay time. The case and arming collar was not crimped in this test so that the fuzes could be used for subsequent tests. No fuze functioned as a result of this test, thus satisfying the requirement.

(3) Extreme Temperature, Units 001 through 020

The timers were subjected to this test to assure that they would time properly under extreme temperatures. The data sheet reveals that all the units timed within specifications at both -65°F and +160°F for the 0.4-second mode. However, several of the units tested tended to exceed the 2.6-second limit by as much as 0.3 second at -65°F. Test results indicate that at -65°F the tolerance should be increased from +0.3 to +0.5 in the 2.3-second mode for the lubricant (vydax) used in the fuze. The dual time capability was abandoned before any decision was made on this matter. Further lubrication and low temperature tests were conducted; the results are reported in subsection d (3).

(4) Seal Leakage, Units 013, 014, and 016 through 019

The units were completely assembled with simulated burster and lead charge. In accordance with the test plan the fuzes were evacuated through the No. 4-40 threaded hole in the case and arming collar asssembly, and the leak rate was checked prior to and after vibration tests on a mass-spectrometer. The results are given in Table II.

TABLE II - LEAK TEST RESULTS

FUZE SERIAL NO.	SEAL LEAK RATE, 1.0×10^{-5} cc/sec Maximum	
	PREVIBRATION	POST VIBRATION
013	0.2×10^{-8}	0.6×10^{-8}
014	0.2×10^{-8}	0.3×10^{-8}
016	0.3×10^{-8}	0.4×10^{-8}
017	0.5×10^{-8}	2.0×10^{-8}
018	0.3×10^{-8}	0.4×10^{-8}
019	0.3×10^{-8}	0.4×10^{-8}
020	0.3×10^{-8}	0.4×10^{-8}

It was concluded that the fuze seals were satisfactory since the units which were subjected to the vibration environment did not exceed the prescribed leak rate (1.0×10^{-5} cc/second) after the vibration.

(5) Transportation Vibration, Units 013, 014, 016, 019 and 020

The fuzes were tested in accordance with test number 5 in the test plan (Appendix II). The results are given on the test data sheet in Appendix II. Units 016 and 020 were subjected only to transportation vibration and failed to function in the subsequent guided drop test. These failures were found to have been caused by an oversize condition on the center gear. Additional test units were fitted with new center gears and successfully passed the transportation vibration test, thus satisfying the requirement. The problem and solution are more completely discussed in subsection d.

(6) Aircraft Vibration, Units 013, 014, 017, 018, and 019.

The fuzes were tested in accordance with test number 6 in Appendix II and the results are shown in the test data sheet. Several of the units did not function in the subsequent guided drop test, and failures were traced to the rotor center gear. New vibration test fuzes were equipped with new center gears, and these units successfully passed the aircraft vibration tests. The test results are more fully discussed in subsection d.

(7) Five Foot Drop, Units 010, 011 and 012

The fuzes were dropped in accordance with test number 7 in the test plan (Appendix II). The units remained safe and functioned properly when tested in the subsequent guided function drop test.

(8) Captive Flight, Units 021 through 032

These fuzes were subjected by the Air Force to 20 hours of actual flight environment. The fuzes remained safe to handle, but 9 of 12 failed to function in the subsequent guided function tests. The failures were traced to the rotor center gear. New test units were equipped with new center gears and were vibrated for 3 hours/axis at 10 g's. It was concluded that these new vibration units would have passed a captive flight test since the new vibration environment was more severe than that of captive flight. This conclusion was reached by comparing the wear on the gear pivots and bearing seats after the captive flight test with that which occurred during the second vibration environment. The corrected fuzes performed within specification after vibration tests, thus satisfying the requirement.

(9) Guided Function, Units 008, 010, through 020 and Units 021 through 032

The fuzes, after experiencing some or all of the preceding tests, were tested at ambient temperature per test number 9 in the test plan (Appendix II). The results are shown on the test data sheet in Appendix II. The failure of the fuzes to operate properly after vibration could not be attributed to the guided drop fixture or test method. However, the guided drop function test completely distorts and/or destroys the internal parts of the fuze, thereby precluding analysis in case of failure. The corrected fuzes discussed under tests number 5, 6, and 8, above, were tested in the following manner:

- The fuzes were completely assembled with simulated burster, lead, and detonator and were then vibrated. This inert condition of the fuzes reduced the hazard of handling and of opening the units for post-vibration examination.

- The fuze arming time after vibration was monitored with a microphone, and the signal was recorded on a visicorder. Since all fuzes completed the arming cycle, it was concluded that they would function if dropped. It was felt that this procedure gave more meaningful results for development tests.

(10) Aircraft Acceleration, Units 002, 003, 004

The fuzes, when tested per test number 10 of the test plan in Appendix II, remained safe to handle and armed within specified time while experiencing 40 g's acceleration. The armed fuzes were functioned by dropping them (in a plastic pipe for a guide) for a distance of four feet. The fuze functioned properly, thus satisfying the requirement.

(11) Jolt, Units 005, 006, and 007

The fuzes were subjected to test number 11 of the test plan in Appendix II. The detonator did not explode, there were no loose parts, and the fuze was safe to handle after the test. This test proved the integrity of the fuze relative to jolt.

(12) Jumble, Units 006, 007

The fuzes were subjected to test number 12 of the test plan in Appendix II. The fuzes did not explode, there were no loose parts, and the fuze was safe to handle after the test. This test proved the integrity of the fuze relative to jumble.

(13) Detonator Safety, Units 001, 009

The fuzes were subjected to test number 13 of the test plan in Appendix II to prove that they are safe to store and handle. The lead in each fuze was not charred nor did it explode when the detonator was exploded in the out-of-line position. This test proved the integrity of the fuze relative to detonator safety.

d. Problem Solutions

Thirty-two FMU-68A/B fuzes were tested in accordance with the test plan (Appendix II). Twenty fuzes were environmentally tested, and twelve were captive flight tested. The tests revealed certain problem areas inherent in the test units. The following is a discussion of these problems and the solutions.

(1) Twenty Fuzes Subjected to Environmental Tests

Twenty fuzes were assembled and environmentally tested in a series of tests, including timing, extreme temperature, 40-g acceleration, jolt and jumble, leakproofness, transportation and aircraft vibration, 5-foot drop, detonator safety, and function tests. These tests are discussed in subsection c. The fuze successfully passed these tests with the following exception: Five units from a sample of seven which were subjected to vibration tests failed to function after vibration. Subsequent investigation revealed that the timers did not start or, in some cases, did not completely arm. The pivot holes in the housings contained a mixture of wear particles and vydax lubricant, MIL-L-60326 Type III. This was the lubricant used in the FMU-68/B fuze program. In addition, the pitch radius of the center gear was .0025 larger than print requirements (a factor which, under ordinary circumstances, is not detrimental since the gears have a minimum of .004 clearance).

In order to isolate the problem, 16 additional new vibration units were fabricated. All 16 units utilized new center gears with reduced pitch radius within print tolerance. Four units were lubricated with CRC-3-36 lubricant (MIL-C-23411 Type II) instead of vydax. Four units were lubricated with vydax and equipped with steel pivot inserts in the housing (only) to reduce wear at this location during vibration. Four units were lubricated with vydax and built up with all pivot hole diameters opened up to .0415 (.001 oversize) to evaluate the effect of increased clearance in the gear train bearings. Four units were built up with standard hardware and vydax lubricant. Therefore, 12 of the 16 units were lubricated with vydax, MIL-L-60326, Type III. The purpose of these tests was to reveal whether the problem was caused by lubricant failure, excessive center gear pitch radius, pivot hole wear, or a combination of these problems.

The sixteen new units were evaluated after vibration environmental tests. The vibration environment was purposely made more severe than specified in the test plan (Curve P, Figure 514-3, MIL-STD-810B, 9 hours). Of the 16 units, 14 armed properly and 2 failed to be recorded in a time trace on the visicorder tape. Upon opening the two units with no trace, one was armed and the gear train was free which indicated an instrumentation problem, and the second had failed to arm. The rotor of the failed unit had moved approximately 2 gear teeth. Vibration had made a burr in the top plate around the No. 1 pinion shoulder, thereby preventing the gear train from functioning properly. The gear train was free after deburring the pinion hole. These tests showed that the center gear had contributed to the lock-up of gear trains after vibration environment and that the new gear was a good fix.

(2) Twelve Fuzes Subjected To Captive Flight

The 12 captive flight units were returned to KDI from Eglin after twenty hours of actual flight experience. Timing tests were run on these units and 9 of 12 failed to time. Examination of these units revealed the same failure pattern as previous units (i.e., center gear out of specification). Eleven of these units were cleaned, relubricated, and reassembled with new center gears. Transportation and aircraft vibration tests were performed on the rebuilt units (Curve C and Curve P, Figure 514-3 MIL-STD-810B). Of these 11 units, 10 timed within specifications while one timed in 3.6 seconds. The verge seemed to be sluggish on this unit, and after cleaning the verge pivot hole in both the housing and the top plate, the unit timed properly. A lubricant development specialist from the Du Pont Company (developer and manufacturer of vydax) informed KDI that the lubricant film should be very thin in applications such as on fuze timers.

The solution to the timing problem was to correct the center gear problem and to apply the vydax lubricant in a very thin coating. The lubricant callout on the drawings in MIL-L-60326 Type III which, if properly applied, is a very thin coating (almost invisible). Up to the time of resolution of this problem, the vydax lubricant was applied with a clearly visible coating.

(3) Additional Lubrication Tests

While experimenting with the fuze timing problem, it was noted that a fuze would arm faster (up to 0.5 second in the 2.3-second mode) if it had been lubricated with vydax and then lubricated additionally with CRC 3-36. Five units were built up for addtional lubrication tests. Table III gives the results of the test. The recorded time readings are in seconds and are the average of 3 runs. The tests showed that the vydax and CRC 3-36 together caused the units to run approximately 0.3 second faster. The results with unit number 5 showed that temperature cycling was not a factor. This data is in agreement with that obtained in previous experiments with the fuze prototypes.

TABLE III. LUBRICATION TEST USING VYDAX AND CRC 3-36

UNIT	VYDAX	VYDAX AND CRC 3-36 WITH HEAT CYCLE (1)	VYDAX AND CRC 3-36 (NO HEAT CYCLE)	ULTRASONICALLY CLEANED AND RE-VYDAXED (NO CRC 3-36)
1	2.23	1.92		
2	2.11	1.87		2.01
3	2.18	1.84		2.09
4	2.38	2.24		
5	2.41		2.15	2.38

(1) Units were heated to 160°F and stabilized for 1 hour and then cooled to -65°F and stabilized for 1 hour.

(4) Timing Data For Fuzes Shipped to Eglin AFB

Thirty-eight fuzes were shipped to ADTC, Eglin AFB for environmental tests. These fuzes were equipped with correct center gears, [see paragraph (3)] and were lubricated with lubricant MIL-L-60326 Type III. The timing data is given in Appendix III. Note that five of the thirty-two fuzes tested in the 2.3-second mode exceeded the upper time limit of 2.6 seconds at -65°F.

In a discussion with the Air Force Program Manager, it was recommended that, for vydax-lubricated fuzes, the timing specification should be $2.3 \, ^{+0.5}_{-0.3}$ seconds. This problem was never resolved because the program was redirected, as discussed in the next section.

3. FINAL DESIGN

a. Fuze Features

The requirement for the fuze dual time capability was cancelled by the Air Force, and the program was redirected to incorporate the FMU-68A/B safety features into the FMU-68/B design. The resulting improved fuze was called the FMU-68A/B modified (see Figure 9). The FMU-68A/B modified fuze has the following features:

- An escapement which allows a 0.4-second delay.
- Compatibility with the AN-M23A1 igniter.
- One-piece die casting for timer housing.
- Visual indication of safe or armed condition.
- Arming pin is one-piece construction and passes through the rotor into housing.
- Arming pin cannot be physically reinserted once ejected.
- Replaceable safety cap, i.e., removal after upload and replace before download.
- Replacement of new safety wire (MS20995F47) restores fuze to as-built condition at download.

The characteristics of the FMU-68A/B modified fuze are given in Table IV. The major internal components are shown in Figure 10.

b. Fuze Description

The FMU-68A/B modified fuze is cylindrically shaped of three basic diameters; the top and bottom sections are approximately one inch in diameter and the center section is 1.625 inches in diameter. The overall height is 3-13/32 inches maximum. This cylindrical body contains the functional components of the fuze. A safety wire is formed around the outside of the fuze and extends through the fuze body. A removeable safety cap is used in addition to the safety wire to prevent arming of the fuze. The fuze has a built-in timer with a predetermined arming delay of 0.30 to 0.50 second. This timer provides safe separation from the aircraft.

Upon release of the bomb from the aircraft, the arming wire withdraws from the fuze allowing a spring-loaded arming pin to be ejected from the fuze. (See Figure 11.) This will start the timer, initiating the fuze

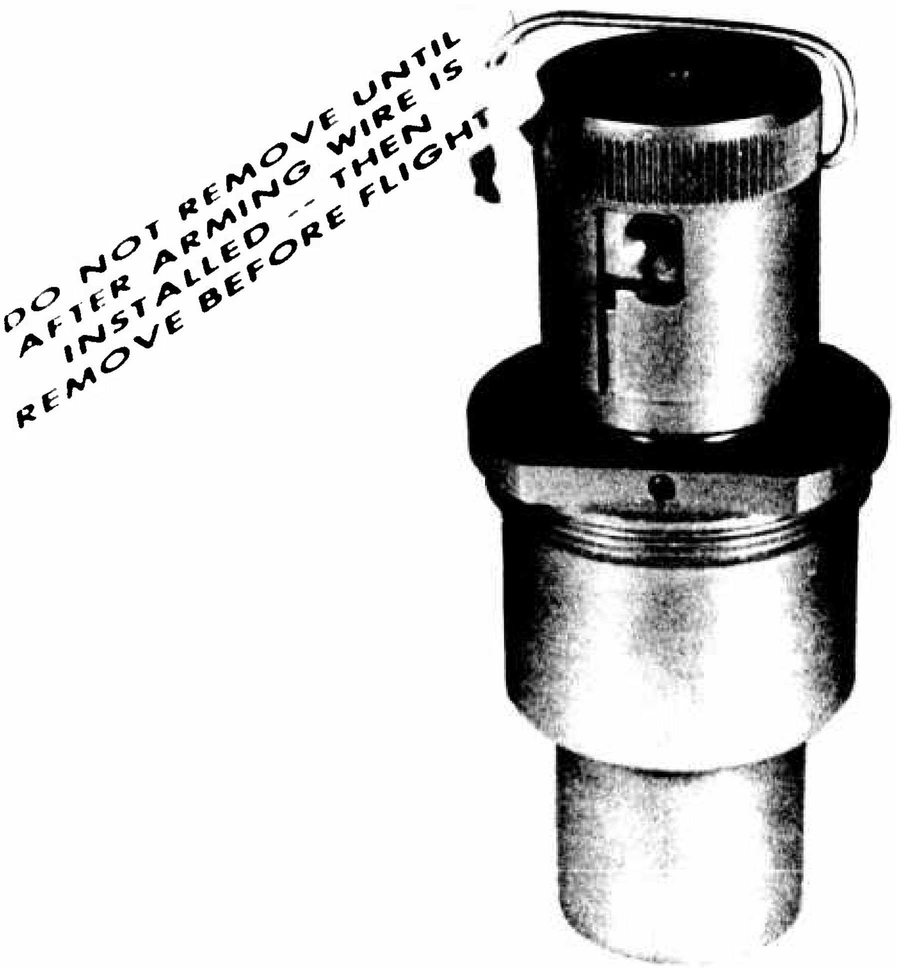


Figure 9. FMU-68 A/B Modified Fuze.

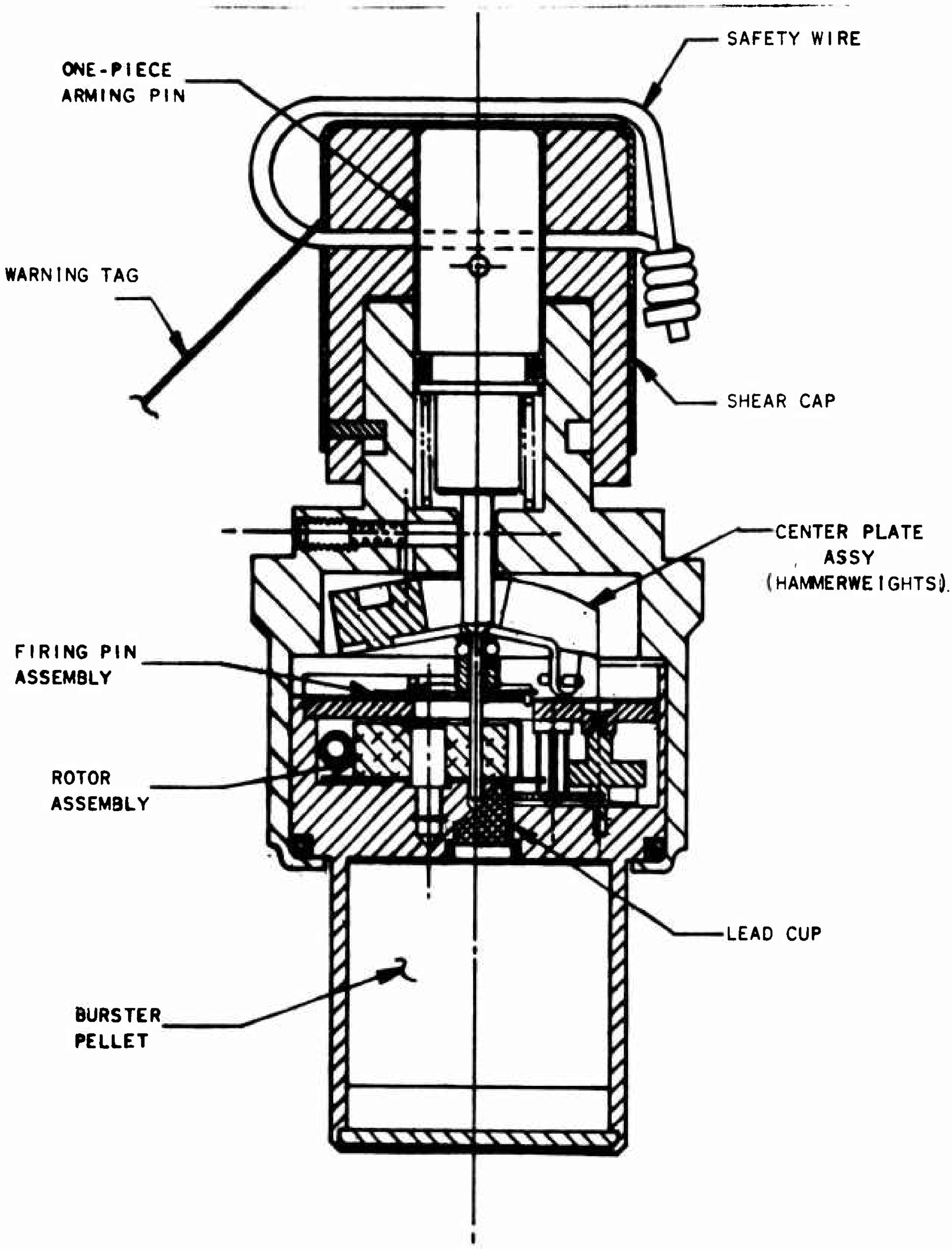


Figure 10. Major Internal Components of FMU-68A/B Modified Fuze

TABLE IV. CHARACTERISTICS OF THE FMU-68A/B MODIFIED FUZE

Function: provides 0.4-second arming delay and function upon impact.

Timer:

a. Type: Mechanical
b. Escapement: Runaway
c. Accuracy: 0.4 second ± 0.1 second
d. Start: Arming Wire pull

Size and Weight:

a. External Dimensions: Cylindrically shaped of three basic diameters, the top and bottom sections approximately one-inch diameter, the center section 1.625 inches in diameter. The overall height is 3-13/32 inches maximum.
b. Unit Weight .29 lb.

Environments:

a. Temperature: -65°F to +160°F
b. MIL-STD-331, MIL-STD-810B

Explosive: 11.9 grams tetryl, Grade 1, Class A.

Mounting: Screws directly into igniter with 1-1/2-24NS-2A threads.

Safety:

a. Fuze is safe when safety wire is in place.
b. Fuze is safe when safety cap is in place.
c. Fuze is safe when arming pin is in place.

arming cycle. The fuze timer is a mechanism with a predetermined arming delay of 0.30 to 0.50 second. The timer is driven by the energy stored in the spring-loaded rotor. Upon release of the rotor by removal of the arming pin, the rotor will dissipate its energy through the timing escapement by means of a segment gear attached to the rotor. At the end of the arming delay the rotor assembly rotates against a stop. In this position the detonator is in line with the firing pin in the impact firing device and the explosive lead in the timer housing. When the rotor assembly is in line, the fuze is armed. Upon fuze impact the momentum of the hammerweights will, through a spring-loaded linkage, drive the firing pin into the detonator, which, in turn, detonates the lead cup and burster pellet, functioning the fuze.

c. Safety Considerations

The safety features developed for the FMU-68A/B fuze were retained in the FMU-68A/B modified fuze. The one-piece arming pin and the arming pin anti-reinsertion feature (see Figures 7 and 8) have been previously discussed. However, a new safety feature was added to the FMU-68A/B modified fuze, namely a replaceable safety cap. The safety cap blocks withdrawal of the arming pin from the fuze. In addition to performing a safety back-up to the safety wire, the safety cap permits restoration of the fuze to as-built condition when downloading of the fuze is required.

Figures 12 through 15 illustrate the role of the safety pin during uploading and downloading.

- Figure 12 shows the fuze installed in the igniter. Note that the condition of the fuze may be determined visually by observing the presence of the arming pin through the inspection port in the safety cap. The end of the arming pin is painted green (color number 38901 of Federal Standard 595).

- Figure 13 shows the progressive removal of the safety wire and safety cap.

- Figure 14 shows the uploaded fuze as it would appear prior to attachment of the bomb fairing.

- Figure 15 shows, in progressive steps, the replacement of the safety cap and safety wire if downloading of the fuze becomes necessary. The advantage that the replaceable safety cap provides is that the fuze does not have to be destroyed after it is downloaded. The downloaded fuze may be reusable.

d. Fuze Evaluation

Environmental tests were conducted on thirty FMU-68A/B modified fuzes to prove the integrity of the design and to check the ability of the fuze to perform with accuracy and safety under adverse conditions. The tests were

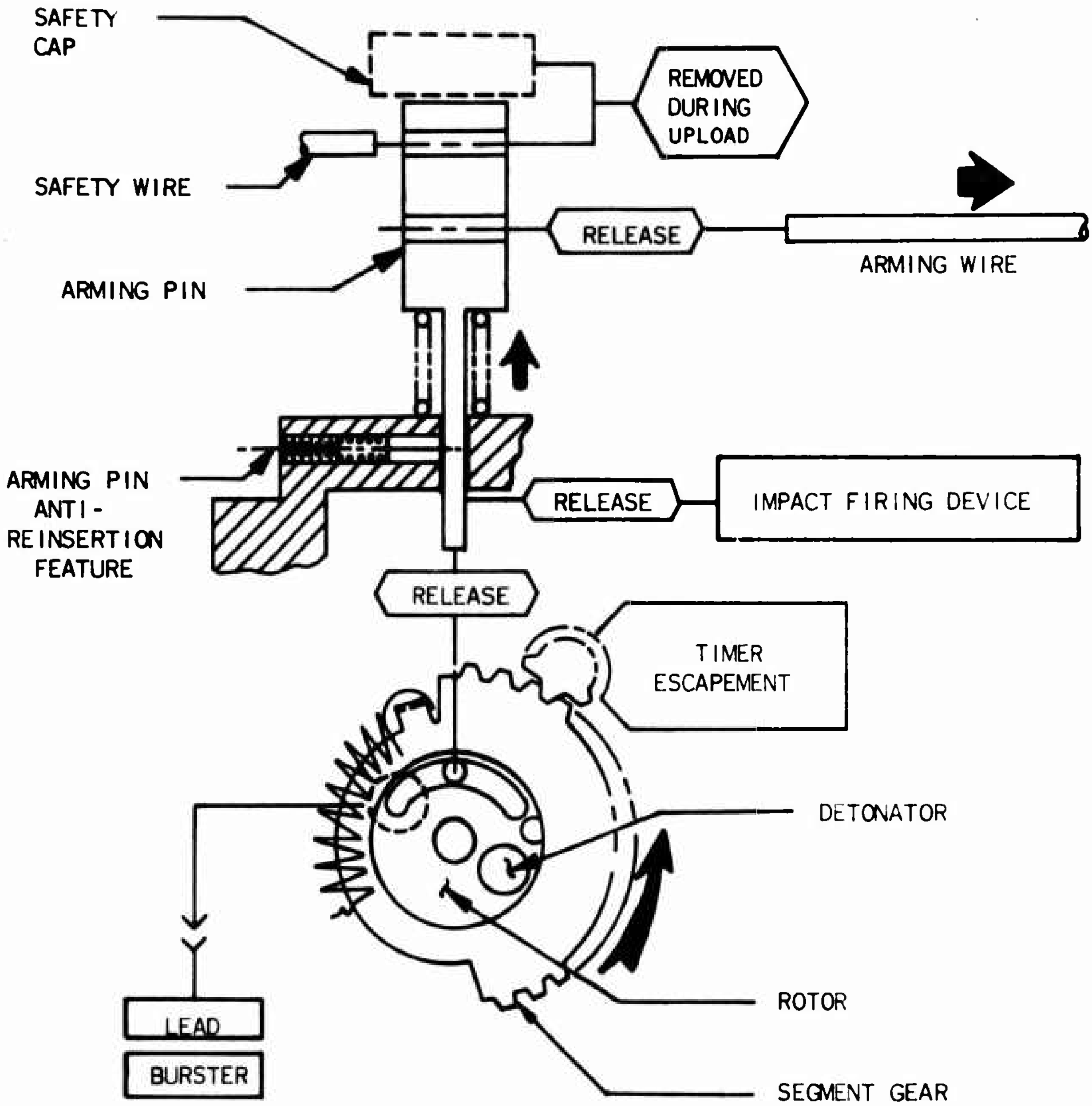


Figure 11. Functional Diagram of FMU-68 A/B Modified Fuze

(1) THREAD FUZE INTO IGNITER

(2) INSERT ARMING WIRE

(3) ATTACH CONNY CLIP

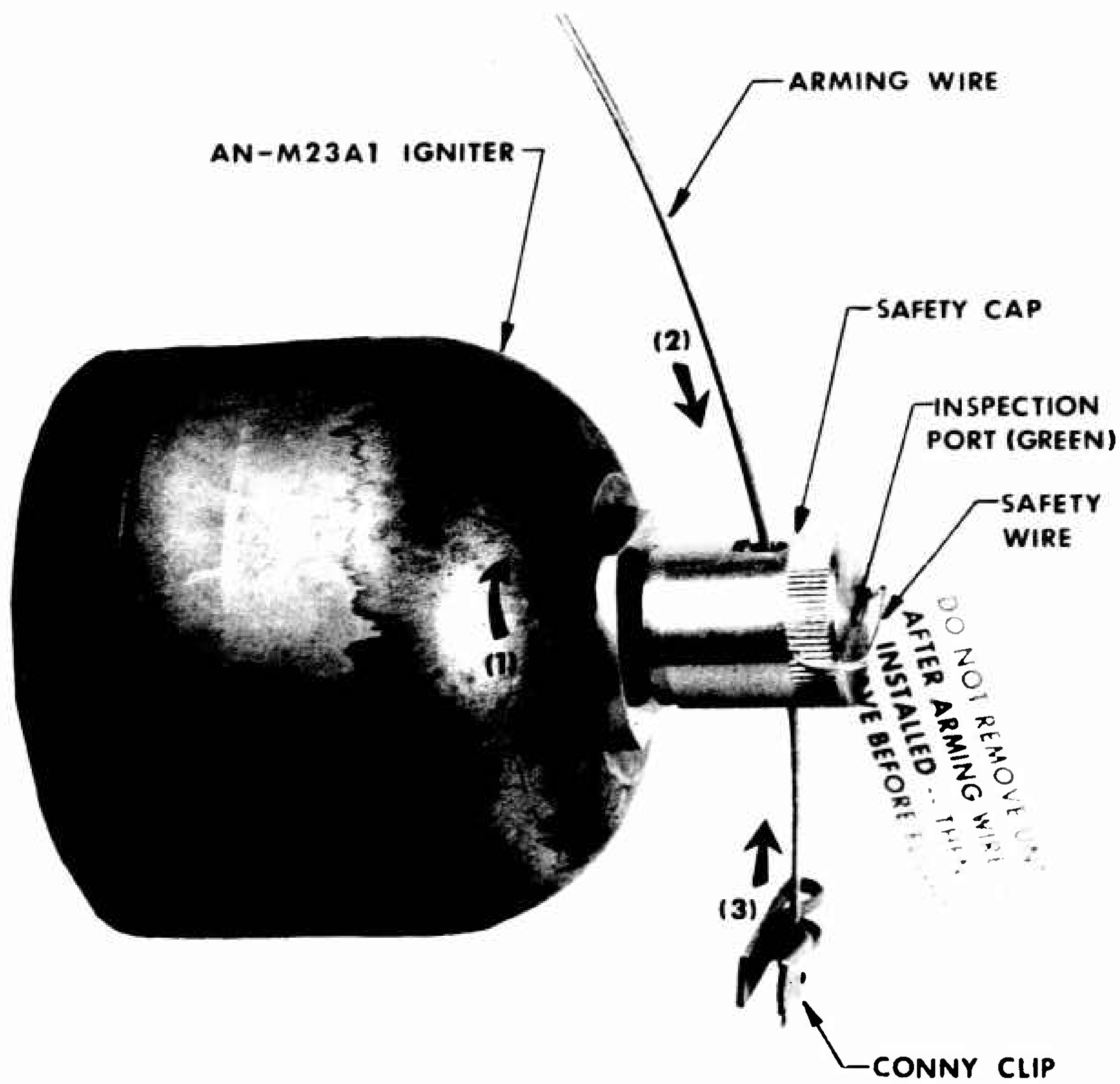


Figure 12. Upload Procedure for FMU-68 A/B Modified Fuze.

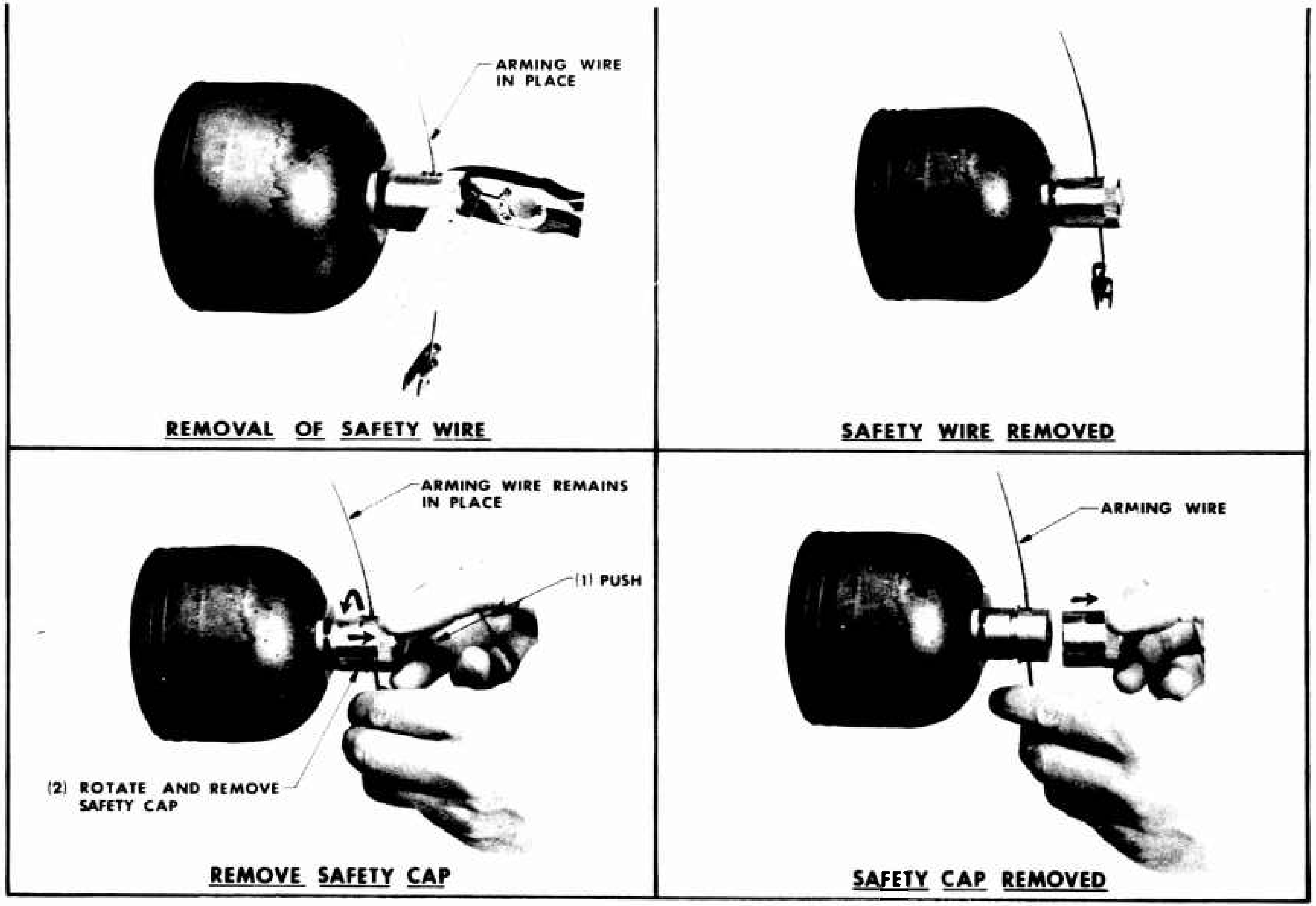


Figure 13. Removal of Safety Cup from FMU-68 A/B Modified Fuze.

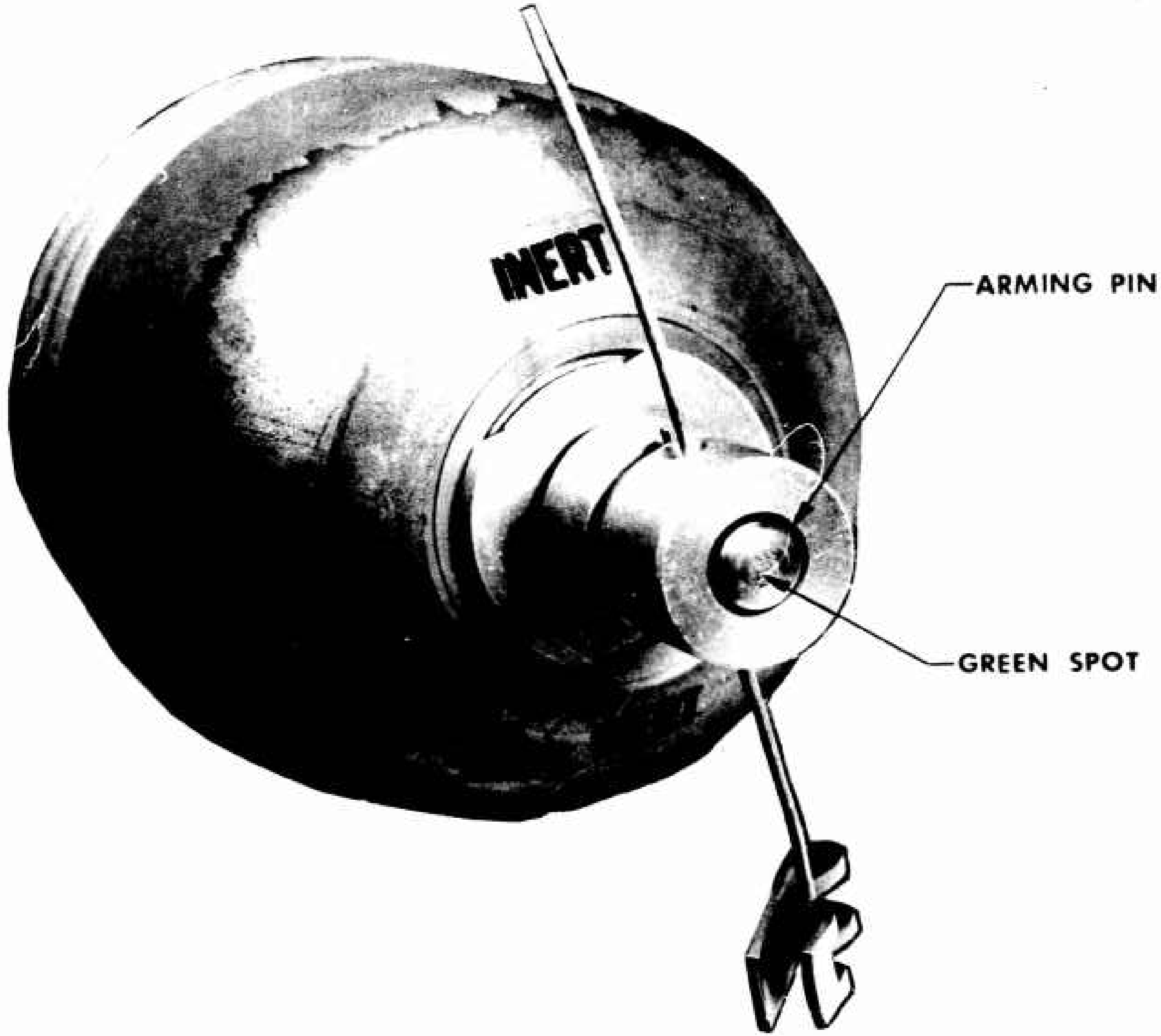


Figure 14. FMU-68 A/B Modified Fuze Upload Complete.

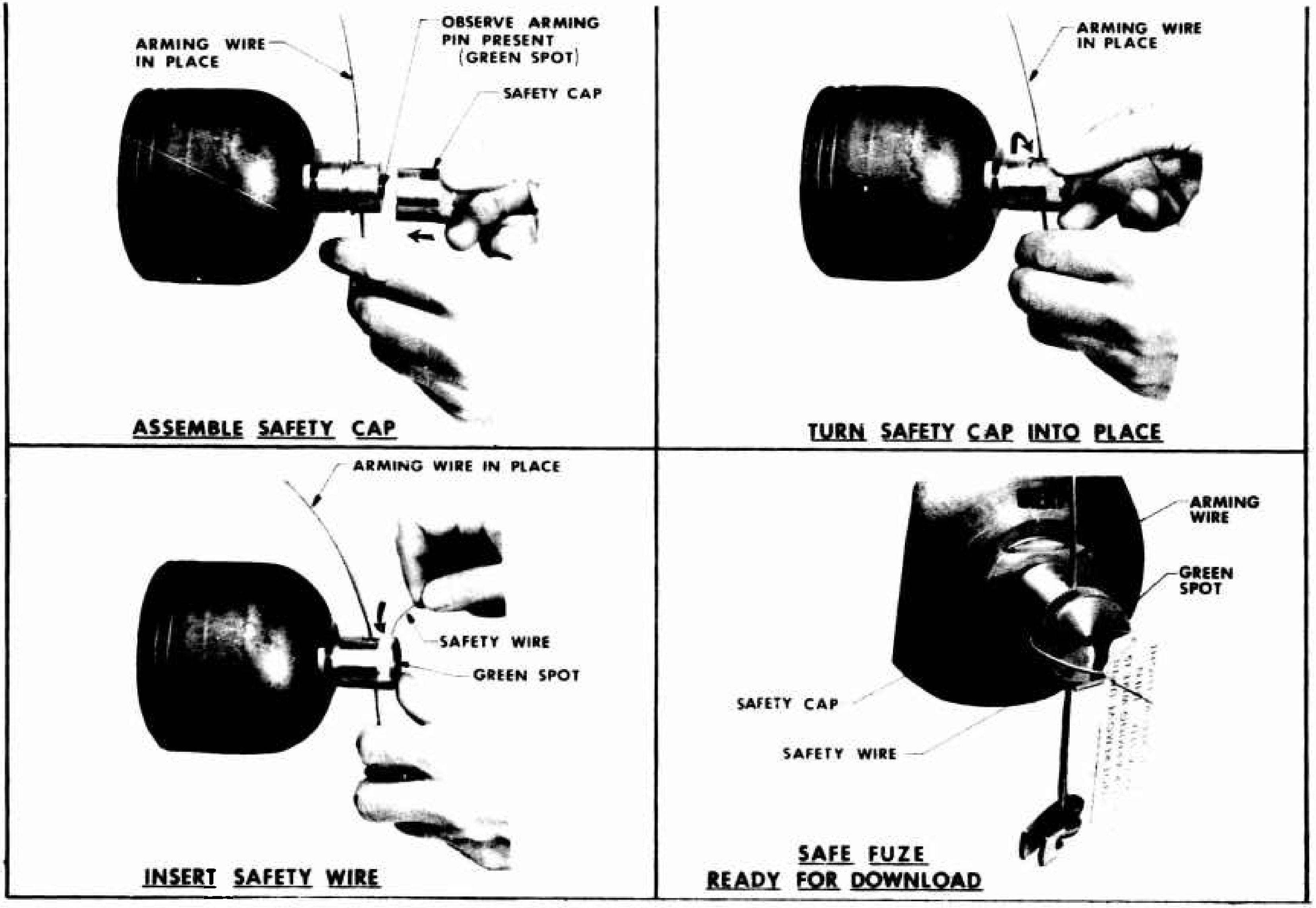


Figure 15. Replacement of Safety Cap on FMU-68 A/B Modified Fuze.

performed in accordance with the Contractor's Test Plan in Appendix IV.

(1) Timing(Ambient), Serial Numbers 001 through 030

The timers were completely assembled except for the M-55 detonator. The time recorded was the timer interval from release of the rotor until the rotor reached the in-line position. The test fixture employing photo-electric techniques displayed the time on a digital readout. A record of timing data is presented in Appendix IV. All units were within specification. Note that the recorded times are skewed toward the lower limit. The rotor spring, which produces this phenomenon, was purposely designed for the FMU-68/B production contract in order to provide maximum arming torque for the rotor during the 40-g centrifugal test. The same rotor spring design was used throughout this program.

(2) Extreme Temperature, Serial Numbers 001 through 030

The timers were tested to assure that they would time properly under extreme temperatures. The results are shown in the data sheet in Appendix IV. Note that all units performed within specifications at 160°F, and twenty-eight were within specifications at -65°F. Fuze serial numbers 003 and 013 were listed as no test at -65°F because of operator error in switching on the recorder in a timely manner. Both fuzes were observed to arm at -65°F, and they were within specification when later checked at ambient condition. Thus, it was concluded that the design met the test requirement.

(3) Transportation Vibration, Serial Numbers 009 through 019

Eleven fuzes were subjected to test number 014 of MIL-STD-331 (test 3 in Appendix IV). The results are recorded in Appendix IV. Units 009 and 010 armed within specifications when checked after transportation vibration. The remaining units were evaluated after being subjected to additional environments. No damage was observed in the transportation vibration units. From the results achieved from subsequent tests, it was concluded that the design was compatible with transportation vibration.

(4) Aircraft Vibration, Serial Numbers 011 through 021

Eleven fuzes were tested per MIL-STD-810B Procedure II, Method 514, Curve 1-C and 3-P (test number 4, Appendix IV). The test data is presented in Appendix IV. The seven fuzes armed within specifications after vibration. No arming time was recorded for the four units which were subsequently tested for waterproofness. It was concluded that the design is not adversely affected by aircraft vibration.

(5) Five-Foot Drop, Serial Numbers 006, 007, 008

Three unprotected fuzes were tested in accordance with test 111 of MIL-STD-331 (test number 5, Appendix IV). The units remained safe to handle after the test. The fuzes were armed statically in the centrifuge and the arming time was recorded. Each fuze functioned when dropped on a concrete floor from a distance of three feet. This test indicated that the fuze will arm within time specification and function properly after being subjected to five-foot drop (unprotected).

(6) Seal Leakage, Serial Numbers 013 through 016 and 022 through 025

Eight units were subjected to leak test number 108 of MIL-STD-331 (test number 6, Appendix IV). These eight fuzes leaked around the large O-ring seal. In order to isolate the problem and implement a solution, a test was conducted using various seals at the housing and fuze case interfaces. (These test results are recorded on sheet 2 of the data sheet under test number 1.) Four additional test units were tested using the selected larger O-ring configuration, and the test results are recorded under test number 2. An additional twelve fuzes were tested using the larger O-ring interface, and these fuzes did not leak when leak tested. The fuze documentation was changed to incorporate the new O-ring, and the deliverable hardware was changed to include the revised seal. It was concluded that the modified design met the waterproofness requirements.

(7) Aircraft Acceleration, Serial Numbers 026 through 030

Five fuzes were subjected to aircraft acceleration on a centrifuge (test number 7, Appendix IV). They armed within the specified time while experiencing 40 g's acceleration. The armed fuzes were functioned by dropping them (through a plastic pipe for a guide) a distance of four feet onto a concrete floor. The fuzes functioned properly, thus satisfying the requirement.

(8) Jolt, Serial Numbers 001, 002, 003

Three fuzes were subjected to jolt test number 101 of MIL-STD-310 (test number 8, Appendix IV). The detonator did not explode, there were no loose parts, and the fuzes were safe to handle after the test. The test proved the integrity of the fuze relative to jolt.

(9) Jumble, Serial Numbers 004 and 005

Two fuzes subjected to jumble test number 102 of MIL-STD-331 (test number 9, Appendix IV). The fuzes did not explode, there were no loose parts, and the fuzes were safe to handle after the test. The test proved the integrity of the fuze relative to jumble.

(10) Timing, Serial Numbers 006 through 025

Seventeen fuzes were tested for arming time (test number 10, Appendix IV). The arming time was not recorded for the units subjected to waterproofness tests. The fuzes timed within specifications after environmental tests, thus satisfying the test requirements.

(11) Bench Function, Serial Numbers 009 through 012, 017 through 021, and 026 through 030

Seventeen fuzes were armed after having been tested per test number 7 and 10. The fuzes were functioned by dropping them nose down (through a plastic pipe for a guide) a distance of four feet onto a concrete floor. The fuzes functioned properly, thus satisfying the requirement.

e. Air Force Evaluation Fuzes

Following the successful completion of the development tests, a lot of 145 FMU-68A/B modified fuzes were completed for delivery to the Air Force for evaluation. This lot incorporated all changes defined during the Contractor evaluations. Twenty of these fuzes were lot tested at the contractor facility in jolt, jumble, extreme temperature, vibration, and 40 g's acceleration tests (see Appendix V). No performance problems were encountered. The fuzes successfully passed the lot test.

One hundred twenty-five fuzes shipped to the Air Force for evaluation were loaded with M-55 detonators only.

SECTION IV

PROGRAM CONCLUSIONS

The test results show the integrity of the FMU-68A/B modified fuze to accurately and safely provide the fuzing function under adverse conditions. The fuze has been demonstrated to be safe for personnel and equipment and compatible with the AN-M23A1 igniter. The design provides increased safety and reduced handling complexity and reduced unit cost relative to the FMU-68/B fuze.

(The reverse of this page is blank)

APPENDIX I

TEST PLAN

FOR

MODIFIED BURSTER USED IN

IMPROVED FMU-68/B MECHANICAL FUZE

(The reverse of this page is blank)

TEST PLAN

FOR

MODIFIED BURSTER USED IN

IMPROVED FMU-68/B MECHANICAL FUZE

Prepared Under Contract No. F08635-71-C-0098

For

Air Force Armament Laboratory

Eglin Air Force Base, Florida 32542

KDI No. 1093

Date: April 9, 1971

Revised: April 21, 1971

PROCEDURE FOR CONDUCTING IGNITER TESTS

I. Background

In order to conduct the igniter tests with safety without creating undue fire hazard to surrounding wooded areas and to properly contain fragments, it will be necessary to explode the white phosphorous igniters in a pit. The pit can be constructed economically by bulldozing a rectangular trench approximately 6 feet deep by 14 feet wide and as long as required for maneuvering the bulldozer. Figure I-1 depicts generally how the pit would be constructed. The igniters would be exploded near the floor of the pit, and the conduit shown would be used to guide the arming wire and act as an aid in the extraction thereof. The backfill will act as a barricade to shield the operator from the igniter while the arming wire is pulled. The electric detonator would be energized from a point more remote from the explosion. (See Figure I-2.)

Figure I-3 shows a typical FMU-68/B fuze modified for the igniter tests. The arming pin assembly has been changed so that an electric squib can be inserted at the test site in the assembly as shown. The fuze contains all the required S&A parts except for the centerplate assembly which has been replaced by a special push pin required to activate the firing pin when the electric squib is fired.

The modified fuze operates as follows.

The rotor is held in the out-of-line position by the arming pin which is, in turn, secured by the arming wire. When the arming wire is pulled, the arming pin is forced upward and pulled out of the rotor by the arming spring. The arming pin assembly cannot come out of the fuze because of the restraint imposed by the collar. The rotor is free to rotate to the in-line position to arm the fuze. The detonation of the electric squib causes the arming pin to be blown downward into the fuze. The push pin is forced ahead of the arming pin and contacts the firing pin, thereby functioning the fuze.

The top view of Figure I-3 shows the two special lock pins which are inserted in the arming wire holes to permit removal of the safety wire for insertion of the physically shorted electric squib. The pins are restrained by a hose clamp as shown. After the electric squib is inserted and secured, the safety wire is replaced. The hose clamp is then removed which permits access to the arming wire hole in the arming collar. This arrangement will permit handling of the fuze in complete safety.

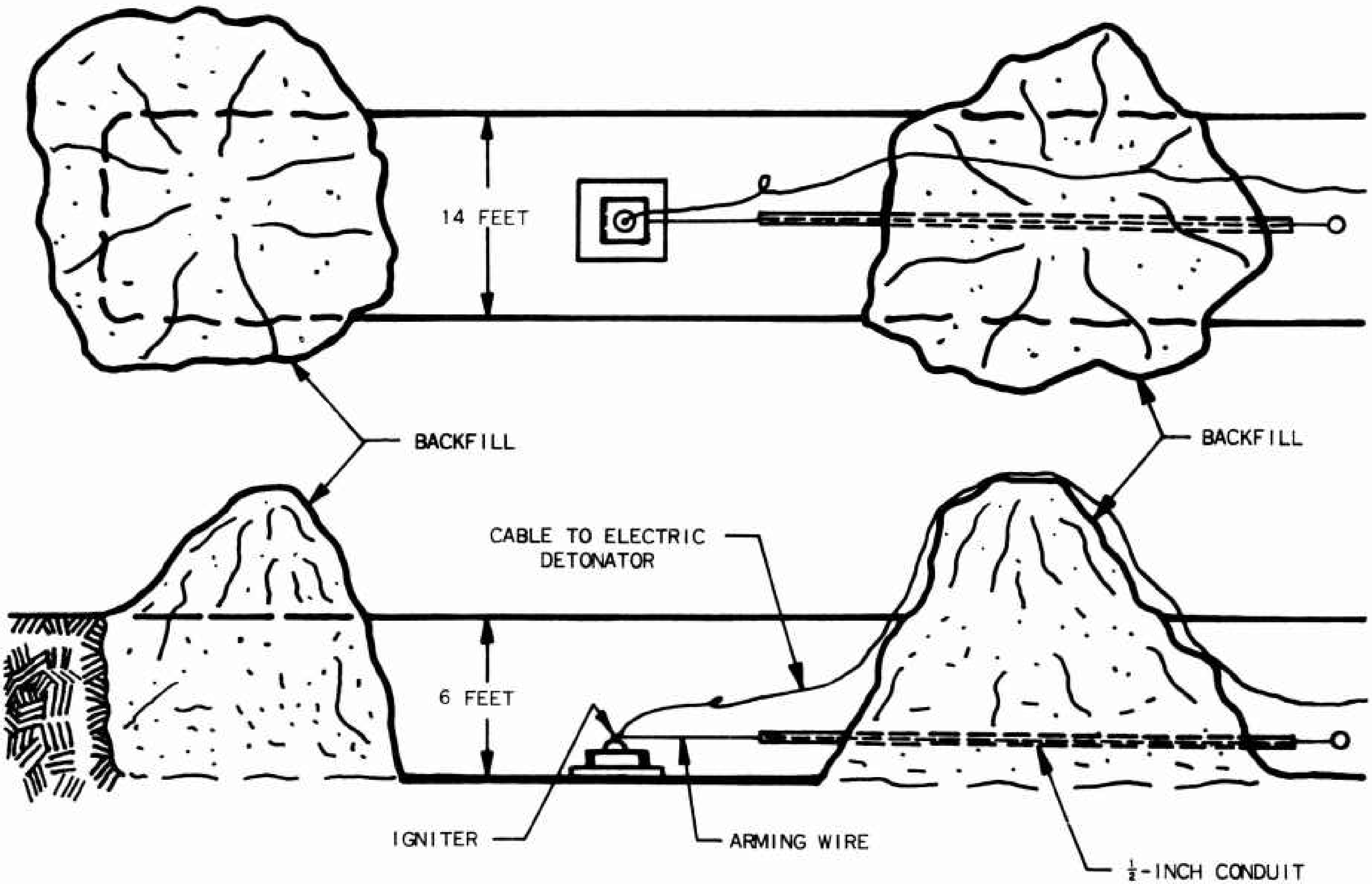


Figure I-1. Explosive Test Pit

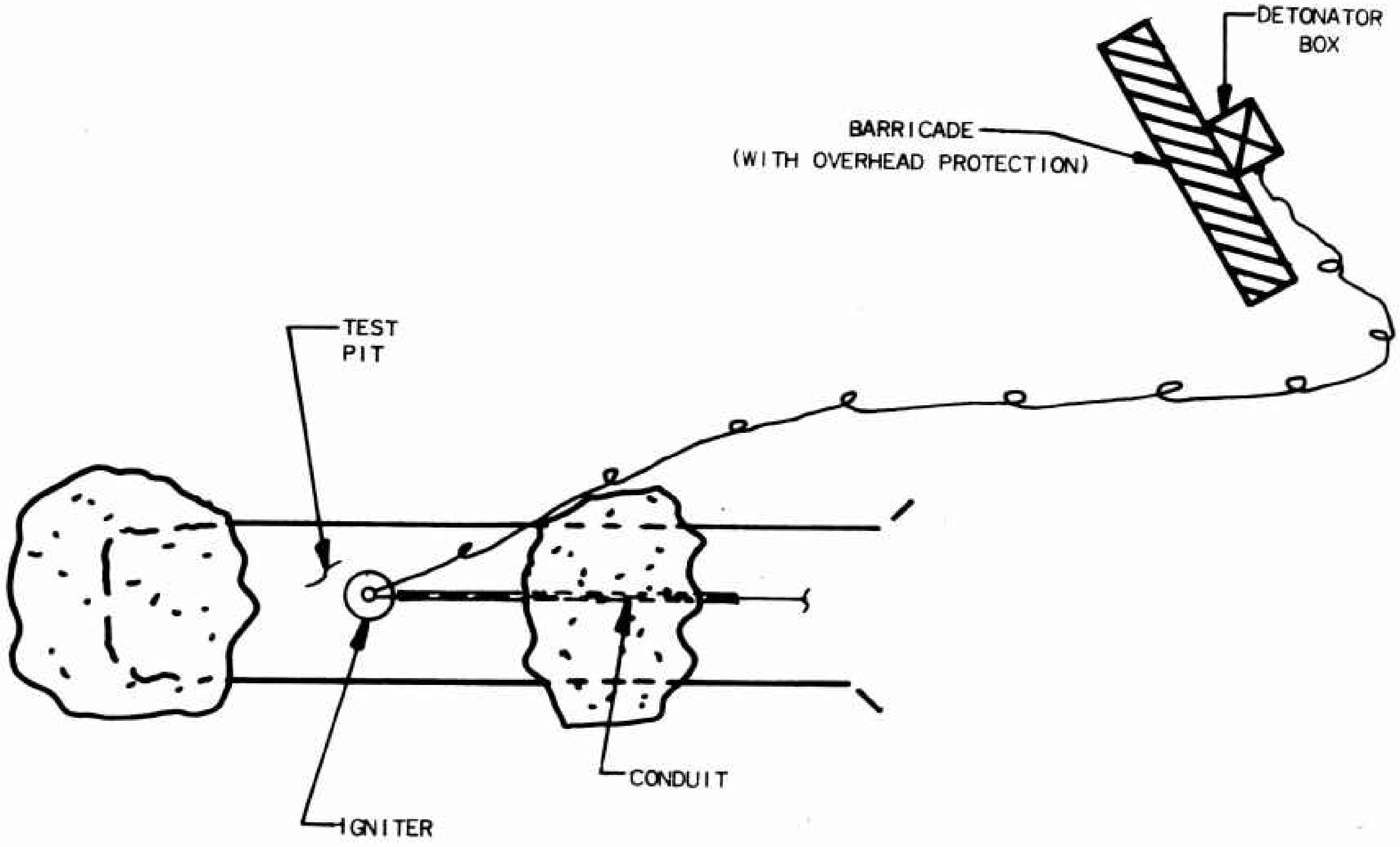


Figure I-2. Explosive Test Site

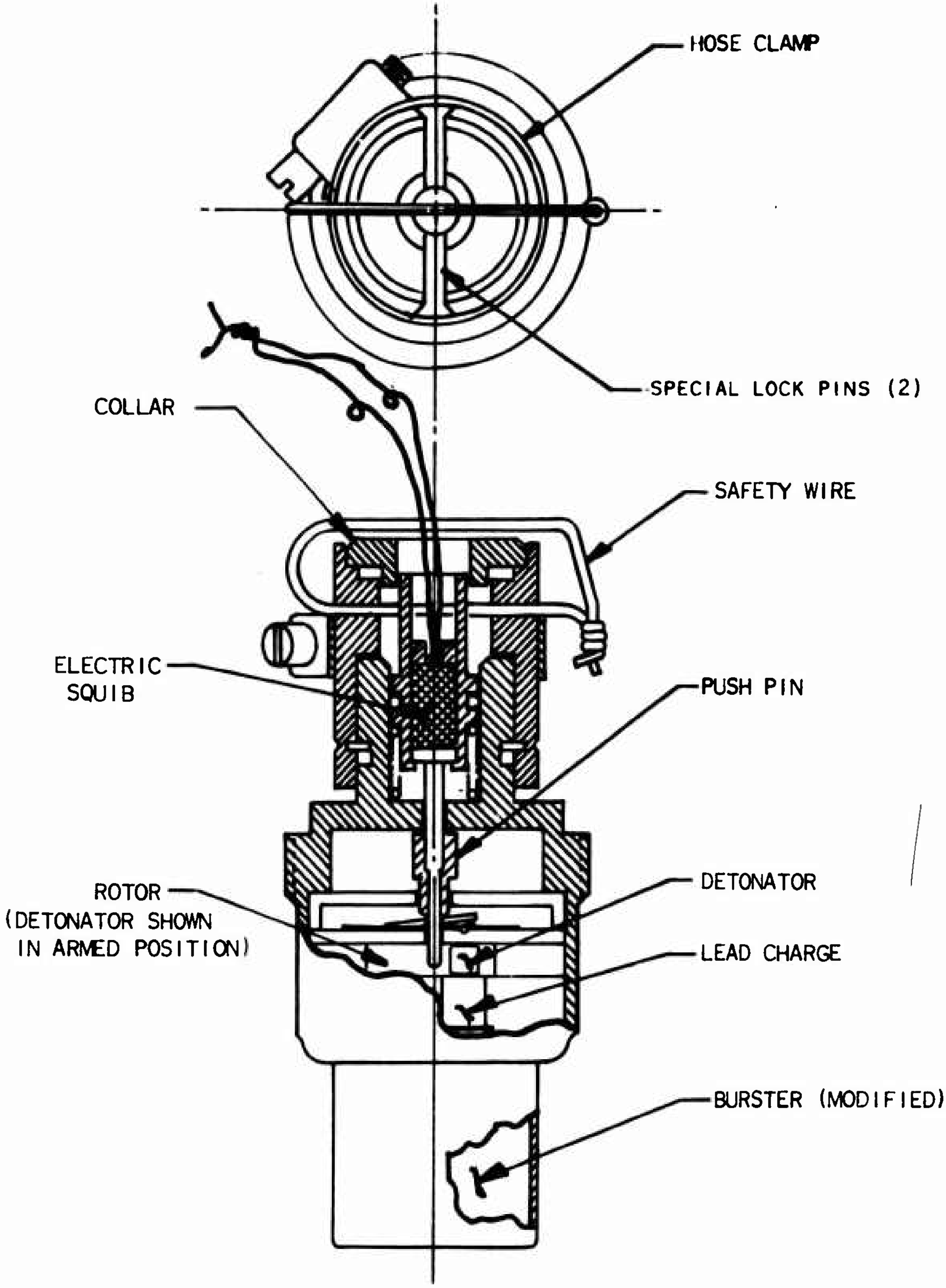


Figure I-3. FMU-68A/B Fuze Showing Addition of Electric Detonator

II. Operating Procedure (See Figure I-4.)

1. Cut safety wire from fuze to permit installation of physically shorted electric squib.

2. Insert shorted electric squib into hole in arming pin assembly and secure with back-up ring.

3. Insert new safety wire and tie securely.

4. Remove hose clamp and special safety pins which will permit access to arming wire holes.

5. Insert arming wire into fuze and secure with Fahnstock clip.

6. Locate igniter in hold-down fixture.

7. Clear area of all personnel except operators.

8. Screw FMU-68 /B fuze into igniter.

9. Attach arming wire from conduit onto arming wire at the fuze.

10. Connect shorted electric cable to electric squib wires. Note: Physically shorted termination of electric cable to be in a locked box behind barricade with only the operator having a key.

11. Remove safety wire from fuze.

12. Operator go behind back-fill barricade and pull arming wire out of fuze.

13. Operator check that area is cleared of personnel. Then unlock firing box and give three audible signals.

14. From behind protective barricade remove physical short and detonate the electric squib which, in turn, sets off the igniter.

15. Evaluate results according to instructions in next section.

16. In the event that no detonation occurs, then repeat audible signals and firing procedure two times.

17. In the event that no detonation occurs after three attempts, then replace short at the firing box and wait 30 minutes before visual inspection of the test specimen.

Under No Circumstances Shall a Dud Be Approached Without the Consent of the Test Officer!

18. Duds shall be destroyed in place with explosive charge.

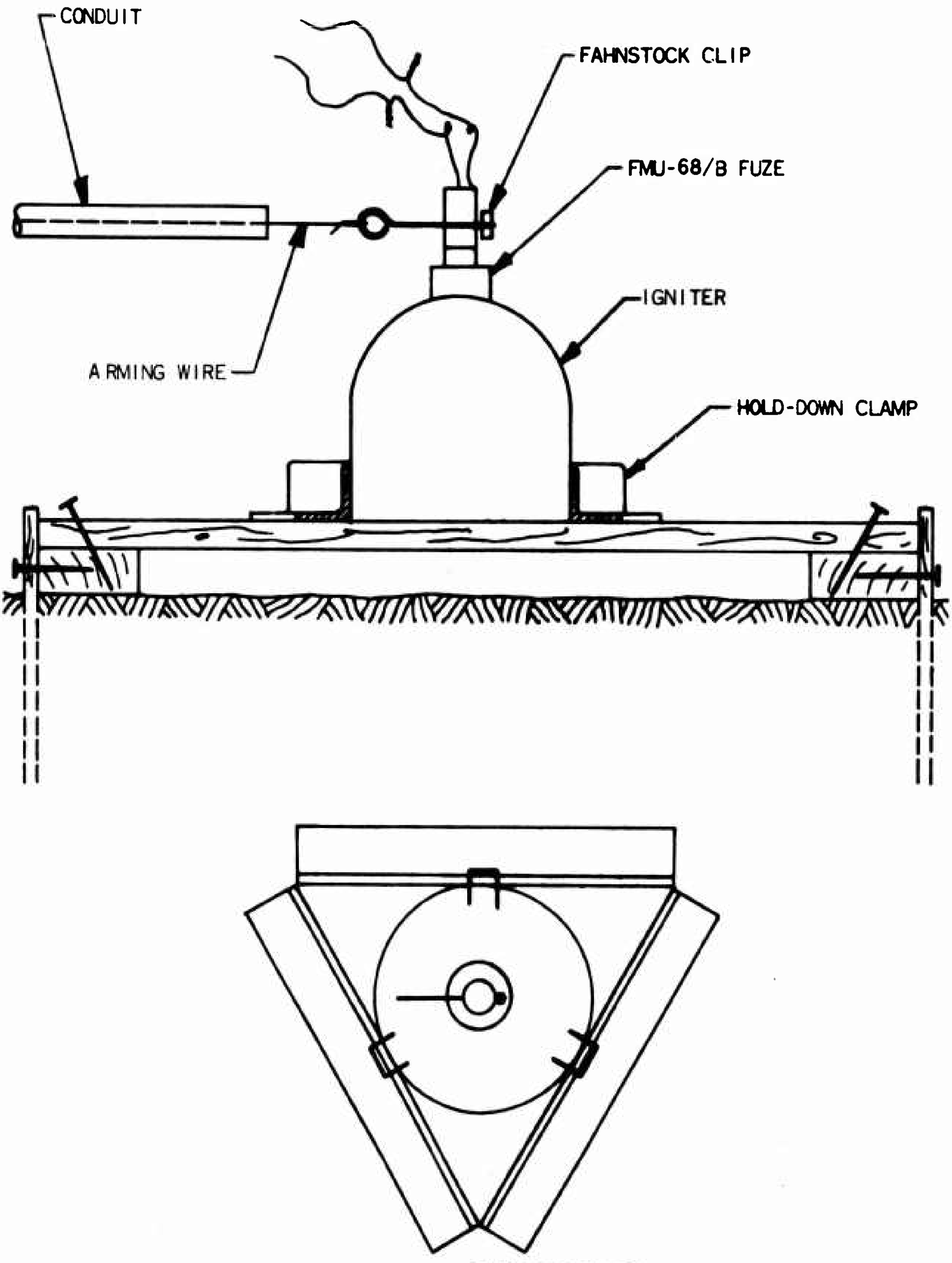


Figure I-4. Typical Test Set-up

III. Criteria for Acceptance of Burster Test Results

In order to demonstrate that the contractor has successfully modified the improved FMU-68/B fuze, it will be necessary to explode a test series of the BBU-1 Igniter (Astrolite) and the M23A1 Igniter (White Phosphorous) using models of the improved FMU-68/B fuze. The acceptance tests will be conducted as follows:

Test Series I (Astrolite Igniters)

High order explosion of the Astrolite igniter will have been demonstrated successfully if there is a complete absence of tetryl and Astrolite material after the igniter explodes. This test series will be initiated by exploding one or more BBU-1 Igniters utilizing the standard FMU-68/B fuze and then following up with a series of igniter explosions (up to 10) utilizing the improved FMU-68/B fuze. Each test of an igniter will be examined for the degree of consumption of tetryl and astrolite explosives. Case fragmentation of the igniters can be qualitatively compared between the standard and improved fuze tests. (See Table I-1.)

Test Series II (White Phosphorous Igniters)

In order to demonstrate the performance of the White Phosphorous igniter, erect a suitable enclosure around the igniter in a manner similar to Figure I-5. The celotex panels will provide a qualitative measure of the effectiveness of the dispersion of the White Phosphorous by the igniter explosion. A standard FMU-68/B fuze would be used to initiate an igniter, and then a check would be made of the charred pattern in the celotex panels to assess the flame pattern and pressure damage caused by the explosion. A new set of panels will be substituted for each igniter explosion. The success of the improved fuze would be determined by (1) comparison of the dispersion and damage pattern of the witness panels and (2) comparison of the igniter case fragmentation between explosion of igniters with a standard FMU-68/B fuze and an improved FMU-68/B fuze. (See Table I-2.)

Data Photograph typical test site and specimen before detonation. Photograph all recovered hardware. Photograph all celotex panels after each M23A1 white phosphorous test with the panels laid in sequence 1, 2, 3, 4, 5, 6, 7, 8.

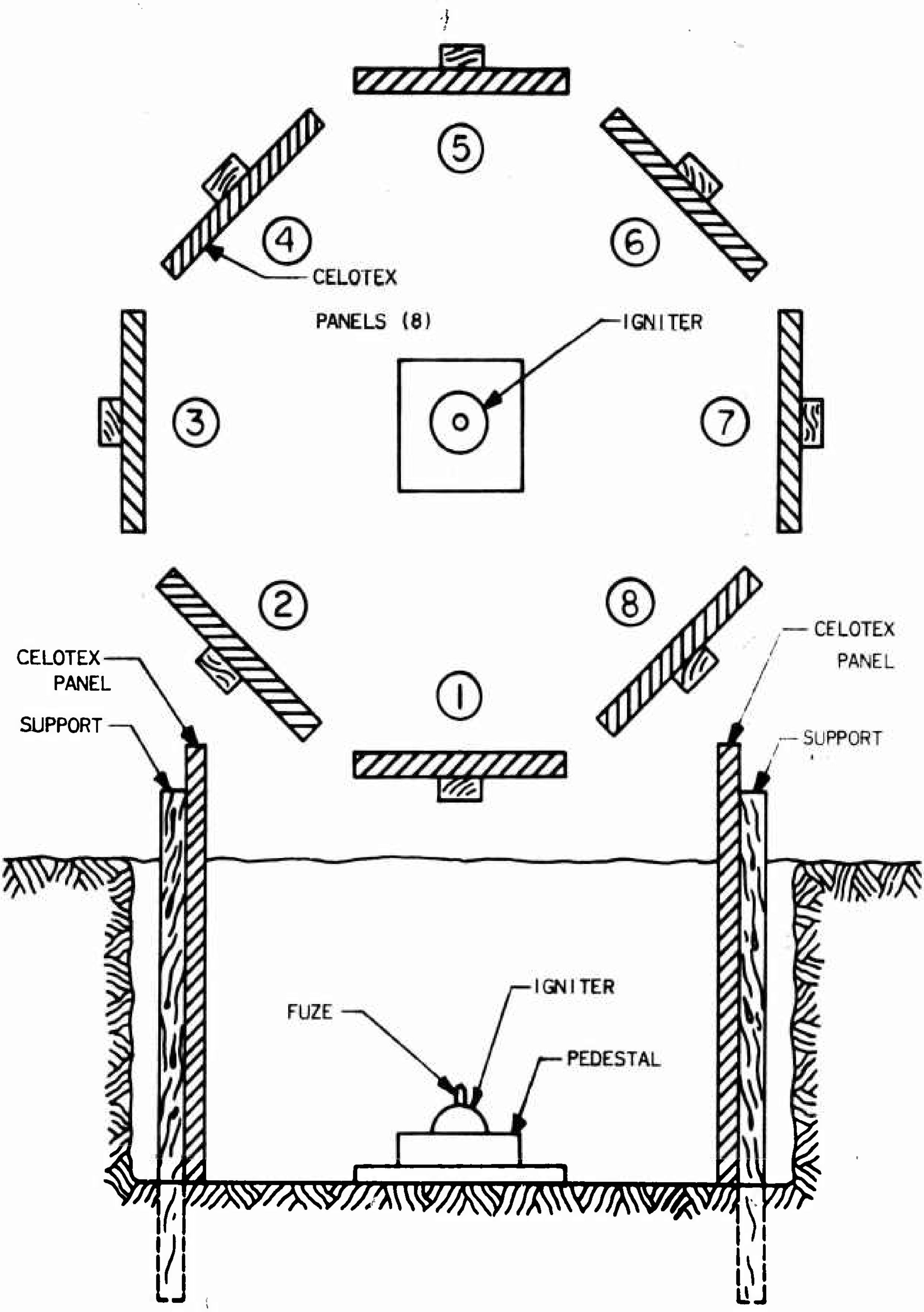


Figure I-5. Fuze Test Pit

TABLE I-1. BBU-1 IGNITER (ASTROLITE) TEST SERIES

Test Serial No.	Fuze	Remarks
1	Standard FMU-68/B	Examine residue of igniter for evidence of unexploded tetryl or astrolite. Check degree of case fragmentation.
2	Standard FMU-68/B	Same as Test 1
3	Improved FMU-68/B	Examine residue of igniter for evidence of unexploded tetryl or astrolite. Compare with results obtained in tests 1 and 2.
4		
5		
6		
7		
8		
9*		
10*		
11*		
12*	Improved FMU-68/B	

*Optional as required by Contractor Test Engineer.

TABLE I-2. M23A1 IGNITER (WHITE PHOSPOROUS) TEST SERIES

Test Serial No.	Fuze	Remarks
1	Standard FMU-68/B	Examine witness panels for evidence of dispersion of White Phosphorous. Examine igniter case for degree of fracture.
2	Standard FMU-68/B	Same as 1
3	Improved FMU-68/B	Examine witness panels for evidence of dispersion of White Phosphorous. Examine igniter case for degree of fracture, compare results with tests 1 and 2.
4		
5		
6		
7		
8		
9		
10*		
11*		
12*		

*Optional as required by Contractor Test Engineer.

DATA SHEET

TEST LOCATION ______________ DATE ______________

TEST NO.

IGNITER TYPE

SERIAL NO. ______________

M23A1 ☐

BBU-1 ☐

FUZE TYPE

SERIAL NO. ______________

FMU-68/B ☐

IMPROVED FMU-68/B ☐

TEST RESULTS	YES	NO	REMARKS
IGNITER CASE FRACTURE	☐	☐	
HIGH ORDER EXPLOSION	☐	☐	

CELOTEX WITNESS PANEL (M23A1 ONLY)		SATISFACTORY COMPARISON WITH STANDARD BURSTER	
PANEL NO.	REMARKS	YES	NO
1			
2			
3			
4			
5			
6			
7			
8			

WHITE PHOSPHORUS DISPERSION PATTERN

PANEL NUMBER (SEE FIGURE I-5, TEST PLAN)

1	2	3	4

5	6	7	8

PHOTOGRAPHIC RECORD YES ☐ NO ☐

WITNESSES

KDI ____________________

USAF ____________________

ARL ____________________

APPENDIX II

TEST REPORT

OF IGNITER EFFECTIVENESS EMPLOYING THE FMU-68A/B

MECHANICAL TIME FUZE

The contractor conducted tests on 26, 27, 28, and 29 July 1971 at Aerospace Research Inc., Roanoke, Virginia for the purpose of demonstrating the effectiveness of the FMU-68A/B mechanical time fuze in producing satisfactory performance of the AN-M23A1 and BBU-1/B igniters. The tests were required under contractual obligations due to the 2.1-gm reduction in the tetryl burster of the FMU-68A/B from the previously proven 11.9-gram tetryl burster of the FMU-68/B. The tests were observed by the Air Force Program Manager for the FMU-68A/B development and contractor representatives.

The criteria of acceptable fuze performance was similarity based on relative comparison of brisance with the BBU-1/B igniter and the splatter pattern of white phosphorous from the AN-M23A1 igniter when both the FMU-68/B and FMU-68A/B fuzes were functioned. The approved test procedure (Test Plan For Modified Burster Used In Improved FMU-68/B Mechanical Fuze revised April 21, 1971) was followed except as modified in this report.

The electric squib provided to initiate the test fuzes was not effective in initiating the fuzes. Therefore, the test method was improvised employing a No. 8 electric blasting cap and a short length of pipe. The No. 8 blasting cap was suspended above the collar of the fuze supported by the short length of pipe inserted over the fuze arming collar. The force of the blasting cap effectively forced the special arming pin into the fuze firing pin and successfully caused detonation of the fuze explosive train.

A photographic record and data sheets accompany this report.

Test Series I Brisance Tests

Of the initial ten tests, nine were performed to demonstrate the relative brisance of the BBU-1/B igniter initiated by the FMU-68/B and FMU-68A/B fuzes and one demonstrated the performance of the FMU-68A/B in opening an inert unfilled AN-M23A1 igniter. Two of the BBU-1/B igniter tests employed an FMU-68/B fuze, and the remaining seven BBU-1/B tests employed the FMU-68A/B fuzes.

Figure II-1 shows the damage done to 24 inches square and 1/2-inch thick plywood witness boards by the explosive brisance of BBU-1/B igniters in test numbers 1, 2, 3, and 4. Test numbers 1 and 2 employed FMU-68/B fuzes, and test numbers 3 and 4 employed FMU-68A/B fuzes.

Figure II-2 shows witness boards from test numbers 5, 6, 7, and 8 employing FMU-68A/B fuzes and BBU-1/B igniters. Figure II-3 shows the witness boards for test numbers 9 and 10.

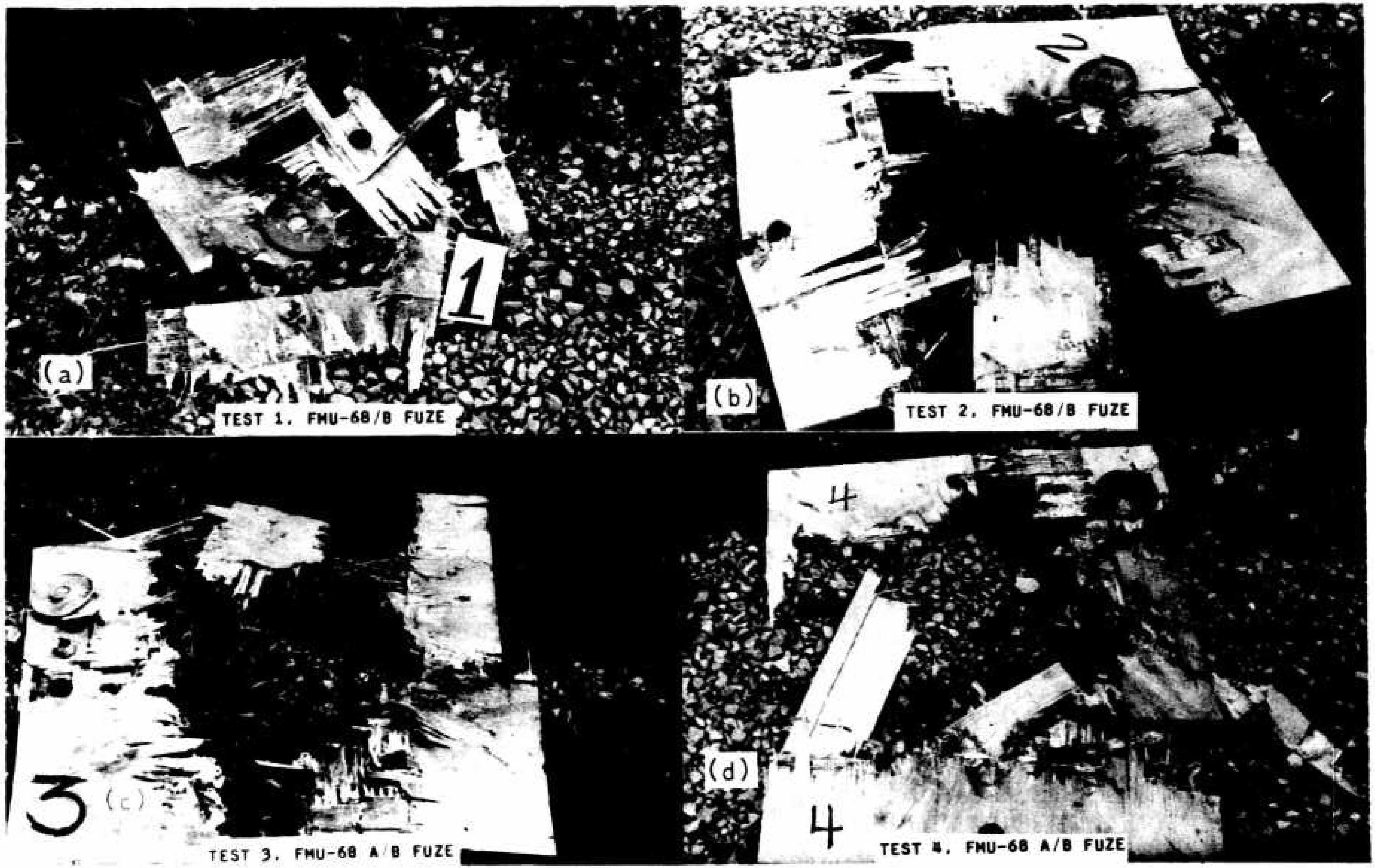


Figure II-1. Witness Boards from Test of BBU-1/B Igniters with Fuze.

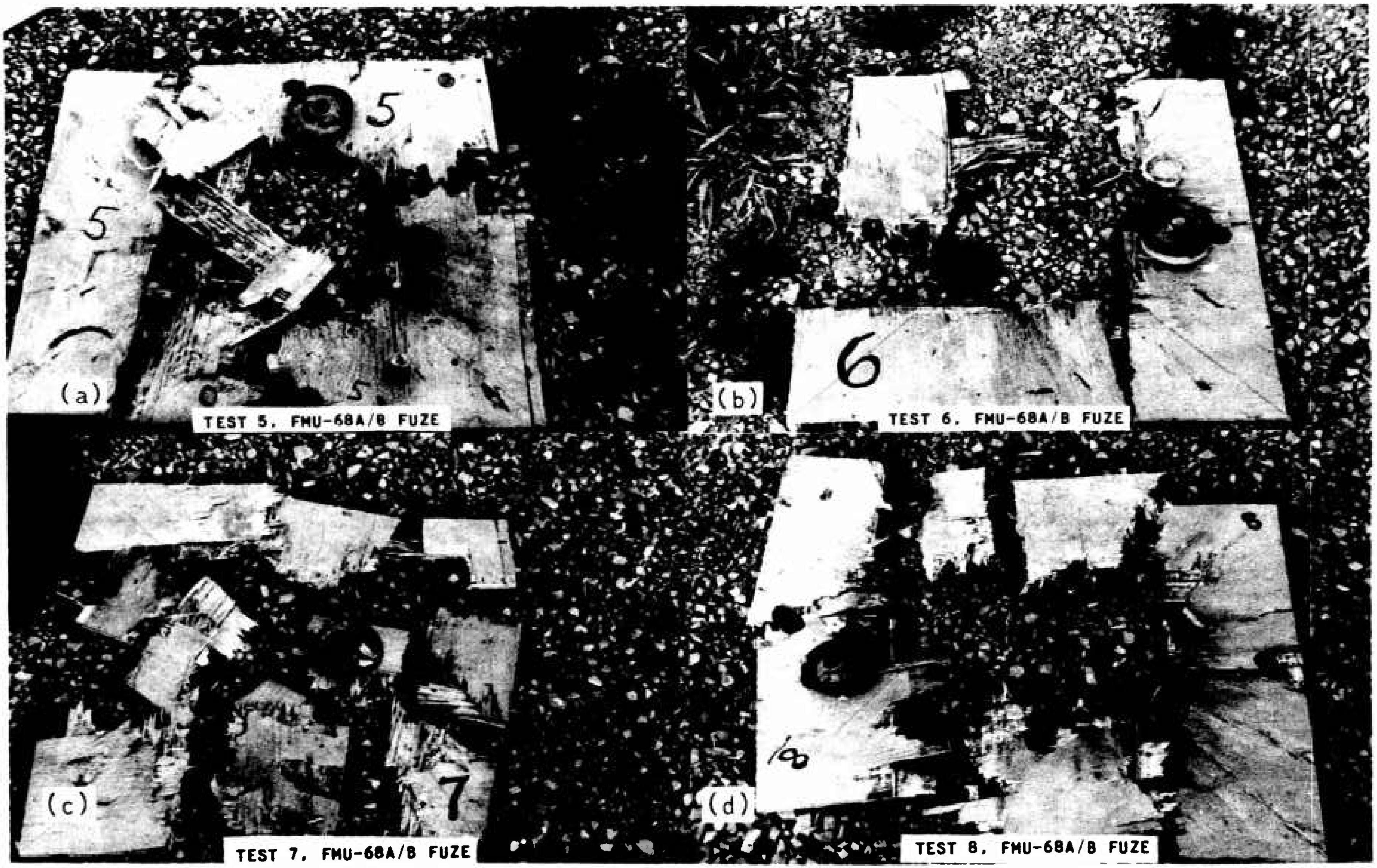


Figure II-2. Witness Boards from Tests of BBU-1/B Igniters with Fuze.

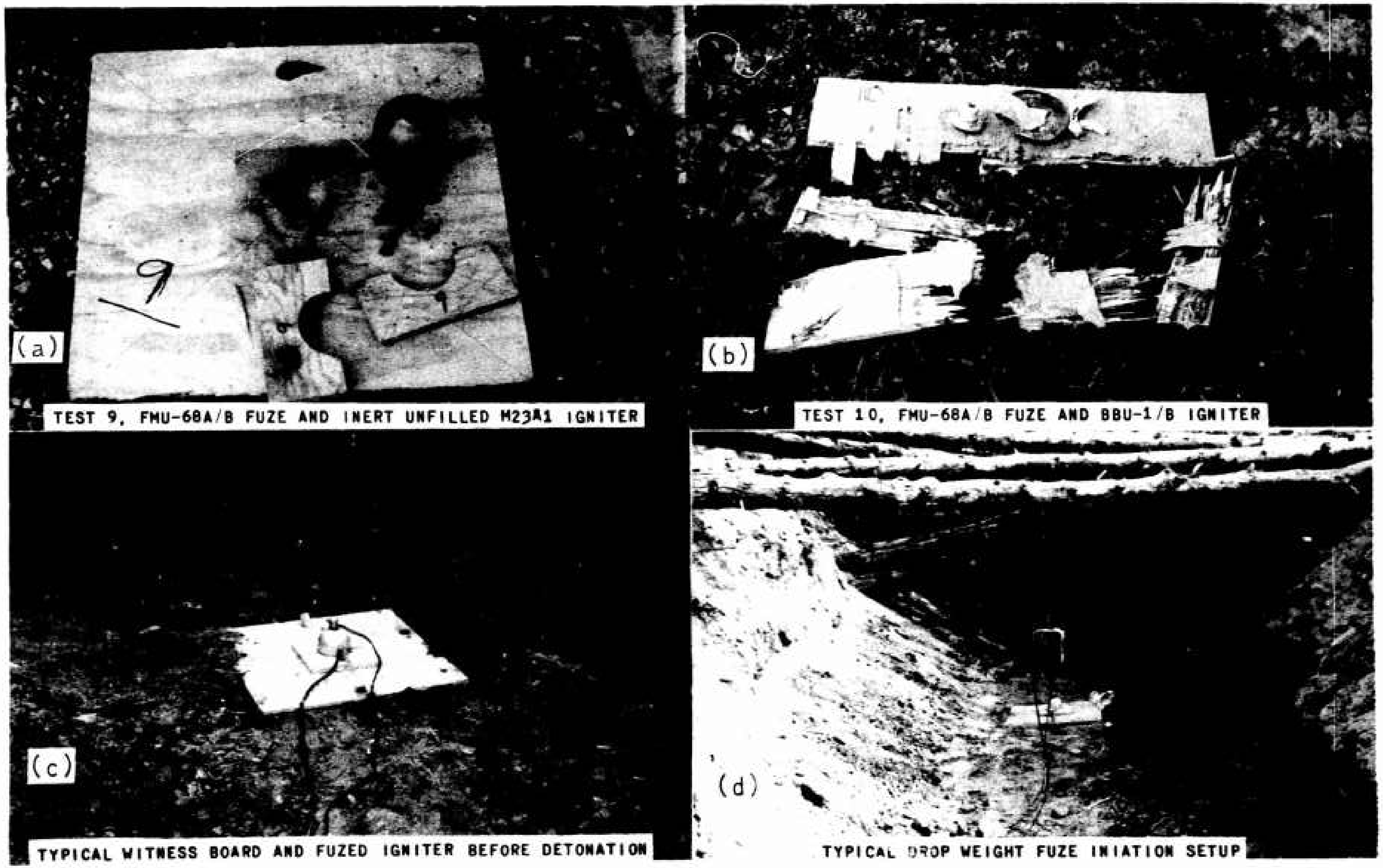


Figure II-3. Witness Boards and Typical Tests Setups.

In test numbers 9 and 10 an alternate fuze initiation technique was employed. In order to be assured that the No. 8 blasting cap was not contributing to the brisance of the fuze and igniter, a suspended weight (half a 16-inch cinder block) was caused to fall on the special arming pin, thereby forcing the firing pin. The typical test setup of the witness board and igniter are shown in Figure II-3(C). The typical suspended weight setup (with weight lowered from four feet) is shown in Figure II-3(D). Test number 9 [Figure II-3(A)], employing an FMU-68A/B fuze and an inert unfilled AN-M23A1 igniter was performed to (a) demonstrate the ability of the FMU-68A/B fuze to rupture the AN-M23A1 casing and (b) to serve as a practice run for the drop weight test of the BBU-1/B (test number 10). Figure II-3(B) shows the witness boards from Test 10 in which an FMU-68A/B fuze was initiated by the drop weight method and detonation of a BBU-1/B igniter was accomplished.

Test Series II White Phosphorous Splatter Tests

Six tests (numbers 11 through 16) were performed to demonstrate satisfactory dispersion of white phosphorous from the AN-M23A1 igniter by the brisance of the FMU-68A/B fuze. The criteria of satisfactory performance was the comparative splatter patterns of the phosphorous on witness panels after tests employing both the FMU-68/B and FMU-68A/B fuzes. Two witness panels spaced ten feet from the igniter were employed in each test. The north panel consisted of two 4-feet by 8-feet sheets of celotex placed side by side to form a panel 8 feet horizontal and 8 feet vertical. The south panel consisted of a single celotex sheet trimmed to 7-1/2 feet horizontal and 4 feet vertical. The south panel was completely contained within a log-covered earthen pit. The north panel was placed at the opening to the pit.

Figures II-4, II-5, and II-6 show the splatter patterns obtained in the tests. It was observed that the splash pattern varied from test to test for both fuzes and that the splash density can be influenced by shaking the igniter before the test. The mixing action introduced by shaking resulted in the increased splatter of test numbers 15 and 16. It is suspected that the igniter of test number 12 was also shaken. Individual variations are also attributed to the breakup characteristics of individual igniters. Each AN-M23A1 igniter opened by separation of the base from the domed tubular wall. The fuze well was disintegrated.

Figure II-7 shows a witness board and a spent AN-M23A1 igniter after a typical test in this series.

Conclusions

The FMU-68A/B was demonstrated to cause satisfactory high order detonation of the BBU-1/B igniter and to accomplish satisfactory opening of the AN-M23A1 igniter and dispersion of phosphorous. The explosive performance of the FMU-68A/B fuze gave no measurable difference when compared to the explosive performance of the FMU-68/B fuze, as indicated by the brisance and splatter

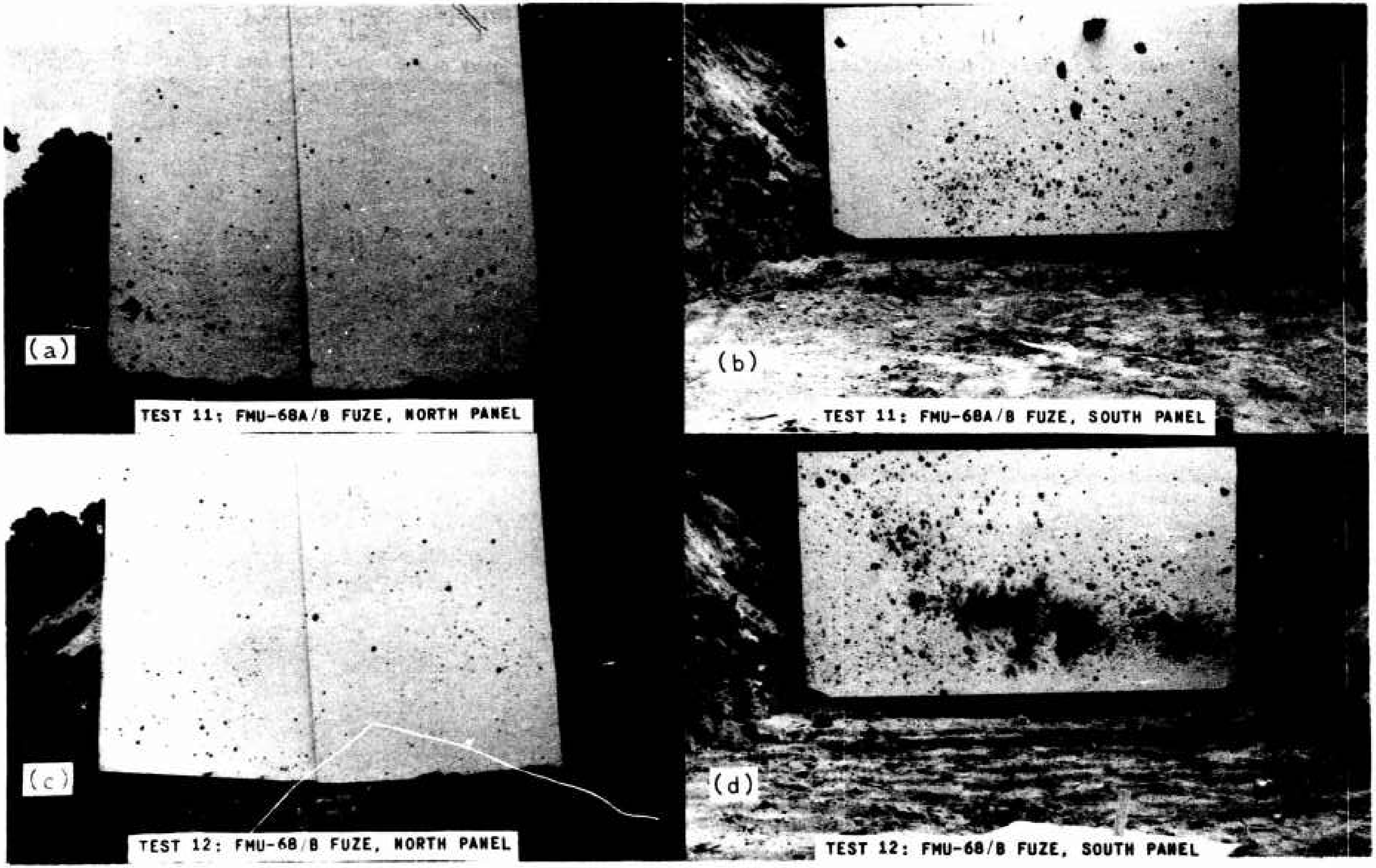


Figure II-4. Splatter Pattern of White Phosphorous from M23A1 on Witness Panels at 10 Feet.

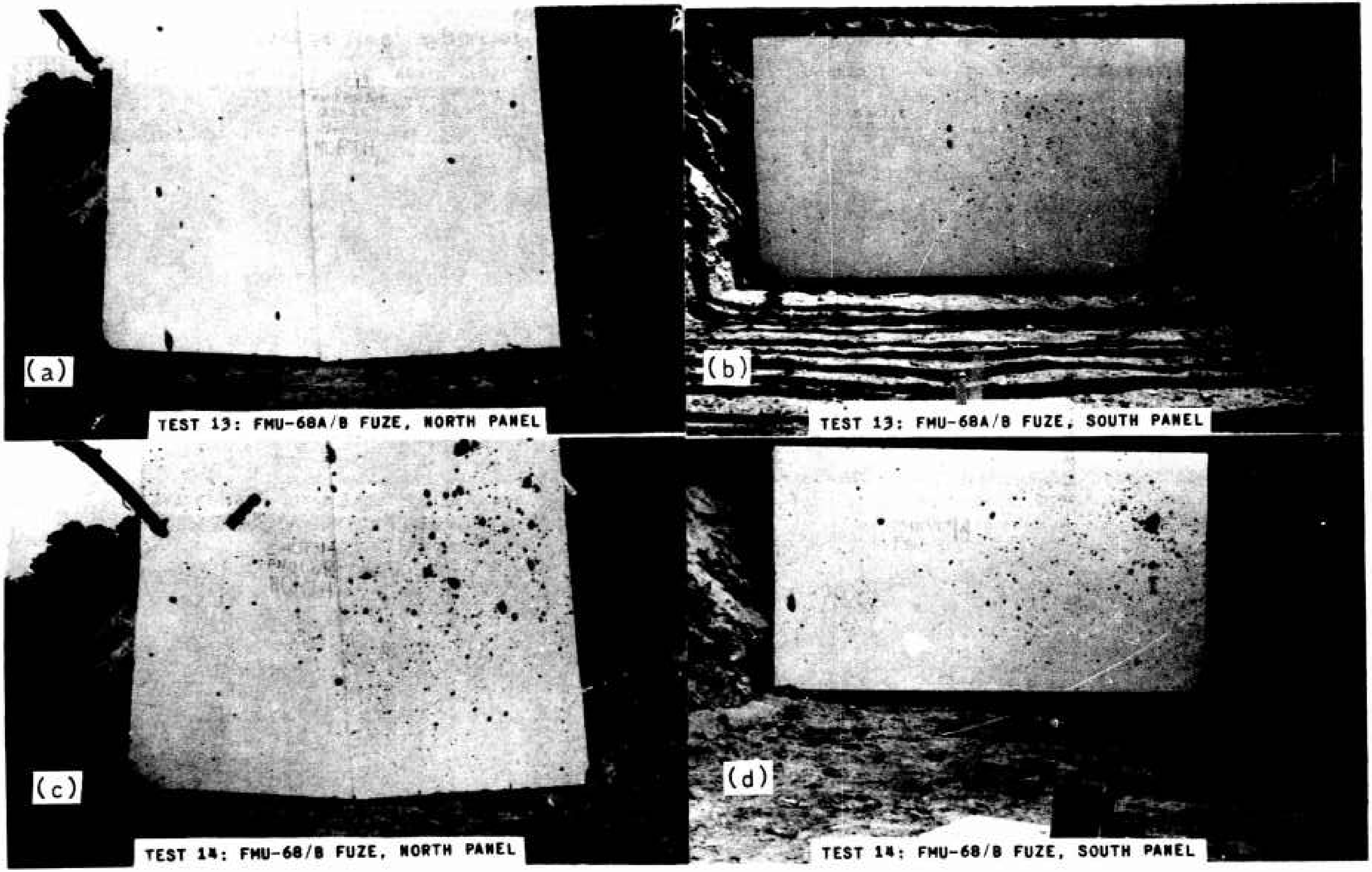


Figure II-5. Splatter Pattern of White Phosphorous from M23A1 on Witness Panels at 10 Feet.

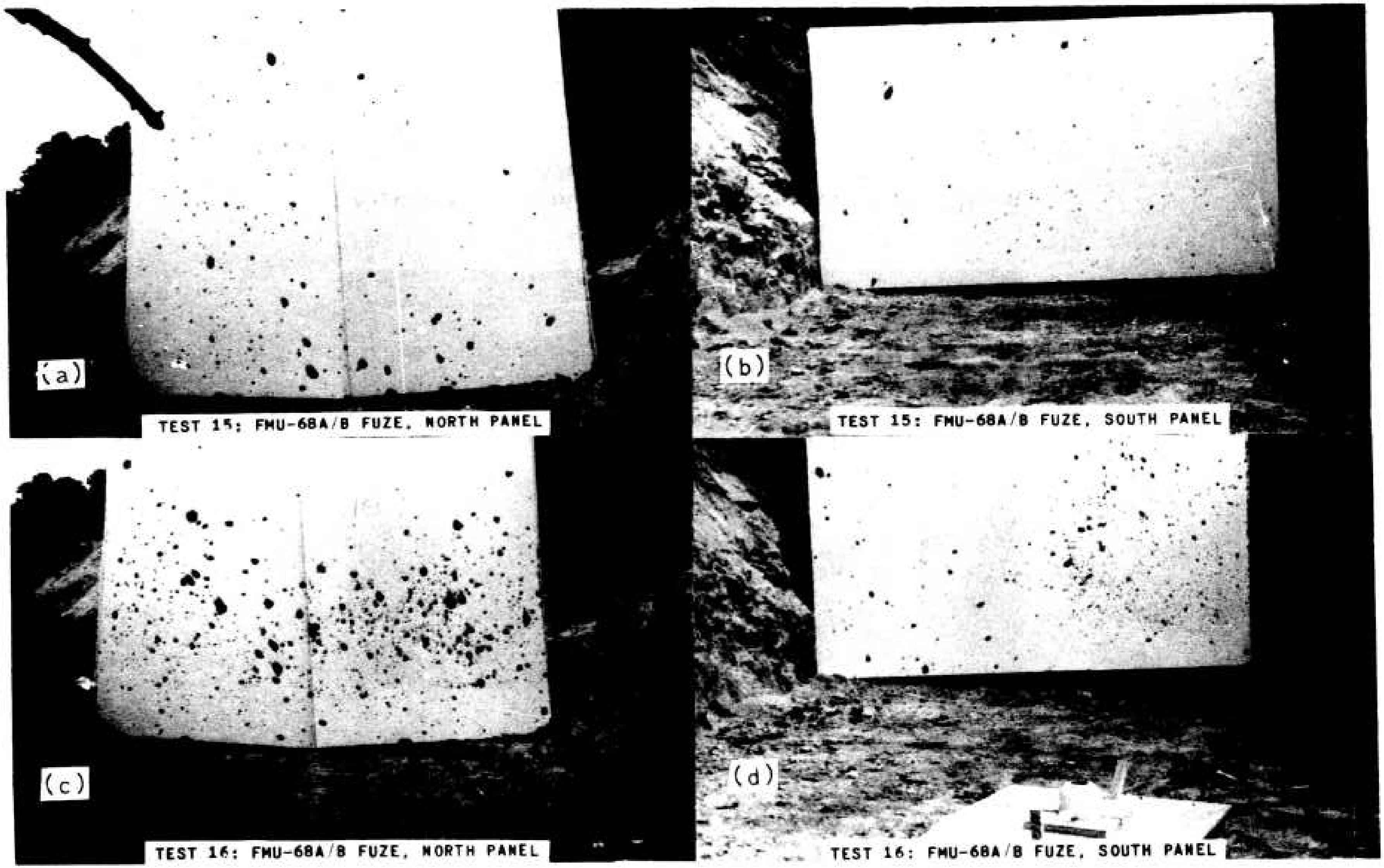


Figure II-6. Splatter Pattern of White Phosphorous from M23A1 on Witness Panels at 10 Feet.

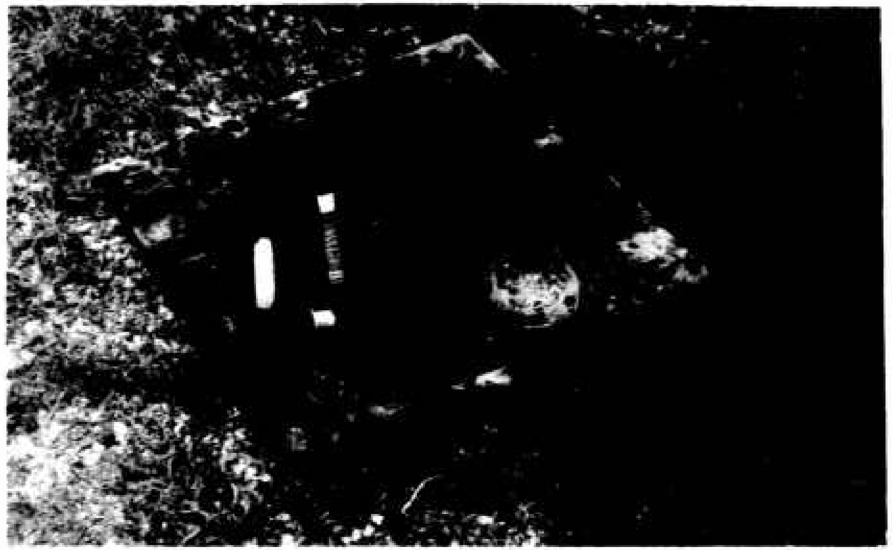


Figure II-7. Typical M23A1 Igniter and Fuze Pieces After Deterioration patterns. On the basis of these tests it is concluded that the AN-M23A1 and BBU-1/B igniters should produce the same firebomb performance when either the FMU-68/B or FMU-68A/B fuze is employed. By similarity, the FMU-100/B shall also give satisfactory performance.

APPENDIX III

DEVELOPMENT TEST PROCEDURE

FOR

FMU-68A/B MECHANICAL FUZE

Development Test Procedure

For

FMU-68A/B MECHANICAL FUZE

Prepared Under Contract No. F08635-71-C-0098

For

Air Force Armament Laboratory

Eglin Air Force Base, Florida 32542

By

KDI Poly-Technic

Cincinnati, Ohio 45215

File No. 1093

Prepared By: Richard C. Carter

Date: May 24, 1971

R C Carter

KDI Engineering Approval

KDI Quality Control Approval

FMU-68 A/B DEVELOPMENT TEST PROCEDURE

Contract No.: F08635-71-C-0098 Date: May 24, 1971

Revision:

Notes:

1. Thirty-two units shall be subjected to these tests.
2. The tests shall be conducted in the sequence listed below.
3. Test data shall be recorded on the data sheet for permanent records.

Test No. 1, Timing (ambient) - Serial Numbers 001 through 032.

Requirements: The unit shall time between .300 and .500 second with the probe extended and 2.0 - 2.6 seconds with the probe depressed.

Test Method: The explosive detonator shall not be assembled in the unit. Place the unit in a test fixture and measure the travel time interval from release of rotor in the in-line position. The test shall be conducted in the 0.4-second mode and the 2.0-second mode.

Test No. 2, Guided - No Function - Serial Numbers 001 through 020.

Requirement: The detonator shall not fire at impact.

Test Method: (0.4-second mode) Serial Numbers 001 through 010. The fuze, less lead and shear cap and with a burster charge simulant for weight, shall be loaded with major axis horizontal into a drop test fixture which provides for release of the fuze arming pin after the first one foot of fixture fall. The fixtured fuze shall be guided to fall approximately an additional 1.0 foot onto a smooth concrete floor or onto a 1/2-inch steel plate of not less than 100 pounds weight. The time of fuze free fall is to be .25 + .03 second after release of the arming pin.

Test Method: (2.0-second mode) Serial Numbers 011 through 020. The fuze, less lead and shear cap and with a burster charge simulant for weight, shall be tested to an identical test as in the 0.4-second mode except that the 2-second timing function (probe) shall be just engaged, the arming pin may be released before drop and at least the last .25 + .03 second of 1.96 seconds from release of arming pin shall be in the guided drop.

Test No. 3, Extreme Temperature - Serial Numbers 001 through 020.

Requirement: The units shall time within the limits of .4 $\pm$ 0.1 second and of 2.0 + 0.6 second.

Test Method: The housing and gearing assembly, 1093D059, shall be placed in a chamber and soaked for 4 hours at $-65^{\circ}F \pm 4^{\circ}F$. The units shall be placed on the timing fixture, and the escape time for units 001 through 066 and 019 and 020 shall be measured in the 0.4-second mode while for units 007 through 018 it shall be measured in the 2.0-second mode. At the conclusion of this test the units shall be reset and placed in an oven at $160 \pm 4^{\circ}F$ for 4 hours. The escape time for units 001 through 006 and 019 and 020 shall be measured in the 0.4-second mode, and for units 007 through 018 it shall be measured in the 2.0-second mode.

Test No. 4, Seal Leakage - Serial Numbers 001 through 020.

Requirement: The units shall not leak at a rate greater than 1×10^{-5} cc/sec at standard conditions for each pound per square inch of differential pressure existing between the inside and outside of the fuze.

Test Method: Each fuze shall be leak-checked utilizing a mass spectrometer that meets a basic sensitivity of $.1 \times 10^{-7}$ cc/sec of helium gas. The unit shall be evacuated until an absolute pressure of 0.5 inch of mercury is obtained and then shall have the seals and joints exposed to helium gas. The leakage rate shall meet the above requirements.

For this test, the fuze shall be evacuated through the #4-40 threaded hole provided for the anti-reinsertion pin, which is located in the fuze case.

Test No. 5, Transportation Vibration - Serial Numbers 013, 014, 016, 019, and 020.

Requirement: The fuze shall be safe and operable following the test. Verification shall follow the sequence of tests listed in Table I-1 of the test plan.

Test Method: The complete fuze, less lead charge and with a simulated burster, shall be subjected to MIL-STD-331, Test 104, Procedure II.

Test No. 6, Aircraft Vibration - Serial Numbers 013, 014, 017, 018, and 019.

Requirement: The unit shall be safe and operable following the test.

Test Method: The complete fuze less lead charge and with a simulated burster shall be subjected to MIL-STD-810B, Procedure II Method 514, 1-C and Procedure II Method 514, 3-P.

Test No. 7, Five-Foot Drop - Serial Numbers 010, 011, and 012.

Requirement: The fuze shall be safe and operable following test.

Test Method: The bare fuze shall be dropped in this test. The complete fuze, less lead charge and with a simulated burster, shall be subjected to MIL-STD-331, Test 111.

Test No. 8, Captive Flight - Serial Numbers 021 through 032.

Test Requirement: The units shall be safe and operable following this test.

Test Method: The complete unit, less lead and with a simulated burster, shall be supplied to the Air Force for captive flight to subject the fuze to actual environmental condition existing in flight.

Test No. 9, Guided Function - Serial Numbers 008, 010 through 020 and 021 through 032 (24 units).

Requirement: The detonator shall fire on the first impact of the fuze.

Test Method: (0.4-Second Function Test) Serial Numbers 008, 013, 015, 016, and 021 through 026. The fuze, less lead, shear cap and with a simulated burster, shall be dropped in such a way that the arming wire is pulled from the fuze at the beginning of a guided drop. Equal quantities of fuzes shall be dropped in the following orientation: major axis horizontal, major axis vertical with arming collar down. The fuzes shall fall onto a smooth concrete floor or onto a steel plate of not less than 1/2-inch thickness weighing at least 100 pounds. Time of fall shall be adjusted to be not more than 0.65 second nor less than 0.55 second after release of the rotor by the arming pin.

Test Method: (2.0-Second Function Test) Serial Numbers 010, 011, 012, 014, 016, 022, and 027 through 032. The fuze, less shear cap, lead, and with a simulated burster, shall be subject to an identical function test except that 2.0-second timing function shall be engaged, the arming pin may be released before drop, and at least the last 0.55 to 0.65 second of the 2.6 seconds shall be in the guided drop.

Test No. 10, Aircraft Acceleration - Serial Numbers 002, 003, and 004.

Requirement: The fuze shall be safe and operable following test.

Test Method: The fuzes, less lead and with a simulated burster, shall be subjected to MIL-STD-810B, Method 513, Procedure II. The units shall be bench functioned after test.

Test No. 11, Jolt - Serial Numbers 005, 006, and 007.

Requirement: The detonator shall not explode, and the fuze shall be safe to remove from the machine.

Test Method: The fuze, less lead charge and with a simulated burster, shall be subjected to MIL-STD-331, Test 101.

Test No. 12, Jumble - Serial Numbers 006 and 007.

Requirement: The detonator shall not explode, and the fuze shall be safe to remove from the machine.

Test Method: The fuze, less lead and with a simulated burster, shall be subjected to MIL-STD-331, Test 102.

Test No. 13, Detonator Safety - Serial Numbers 001 and 009.

Requirement: The lead shall not explode when the detonator is exploded out-of-line.

Test Method: The fuze with lead and simulated burster shall have the detonator initiated in an out-of-line condition. MIL-STD-331 Test 115 shall be used as a guide to determine acceptance.

TABLE III - 1. SEQUENCE OF CONTRACTOR DEVELOPMENT TESTS

UNIT SERIAL NUMBER (32 UNITS)

TEST	SPECIFICATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21-32	NOTE
TIMING (AMBIENT)		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
GUIDED NO-FUNCTION	RELIABILITY DATA	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2		1
EXTREME TEMPERATURE	4 HOUR SOAK	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		2
TRANSPORTATION VIBRATION	MIL-STD-331 (104), PROC. II													4	4		4				4		2
AIRCRAFT VIBRATION	MIL-STD-810B PROC II, 514-1C PROC II, 514-3P													5	5			4	4	4			2
5 FOOT DROP	MIL-STD-331 (111)										4	4	4										2
SEAL LEAKAGE	MASS SPECTROMETER													6	6		5	5	5	5			4
CAPTIVE FLIGHT	RELIABILITY DATA																					2	2
GUIDED FUNCTION	RELIABILITY DATA								4		5	5	5	7	7	4	6	6	6	6	5	3	
AIRCRAFT ACCELERATION	MIL-STD-810B, 513-II		4	4	4																		2
BENCH FUNCTION	RELIABILITY DATA		5	5	5																		
JOLT	MIL-STD-331 (101)					4	4	4															1
JUMBLE	MIL-STD-331 (102)						5	5															1
DETONATOR SAFETY		4								4													3
IGNITER	BURSTER PERFORMANCE		TEN M23A1								TEN BBU-1/B												

NOTES: 1-THE DETONATOR SHALL NOT EXPLODE AND UNIT SHALL BE SAFE TO REMOVE. 2-THE UNIT SHALL BE SAFE AND OPERABLE FOLLOWING TEST. 3-THE LEAD SHALL NOT EXPLODE WHEN DETONATOR IS EXPLODED OUT OF LINE. 4-LEAKAGE RATE SHALL NOT EXCEED 1 X 10^{-5} CC/SECOND.

TABLE III - 2. DEVELOPMENT TEST DATA

FUZE SERIAL NO.	TIME, SECONDS (AMBIENT)		GUIDED DROP NO FUNCTION TEST MAJOR AXIS HORIZONTAL		EXTREME TEMPERATURE TEST				SEAL LEAKAGE CC/SEC X 10^{-5}	TRANSPORTAT. VIBRATION	AIRCRAFT VIBRATION	FIVE FOOT DROP	SEAL LEAKAGE CC/SEC X 10^{-5}	AIRCRAFT
					-65° F		160° F							
	.300-.500	2.0-2.6	.300-.500	2.0-2.6	.300-.500	2.0-2.6	.300-.500	2.0-2.6						
1	.403	2.295	X		.420		.420							
2	.410	2.387	X		.460		.410							X
3	.408	2.423	X		.450		.390							X
4	.415	2.365	X		.480		.405							X
5	.389	2.169	X		.435		.400							
6	.383	2.155	X		.420		.410							
7	.450	2.356	X			2.72		2.35						
8	.419	2.338	X			2.85		2.35						
9	.374	2.126	X			2.50		2.09						
10	.368	2.156	X			2.32		2.28	X			X	X	
11	.423	2.128		X		2.46		2.20	X			X	X	
12	.374	2.163		X		2.64		2.25	X			X	X	
13	.430	2.180		X		2.60		2.36	X	X	X		X	
14	.408	2.107		X		2.98		2.16	X	X	X		X	
15	.401	2.118		X		2.77		2.23	X				X	
16	.424	2.158		X		3.06		2.16	X	X			X	
17	.406	2.138		X		2.84		2.23	X		X		X	
18	.4[illegible]6	2.162		X		2.29		2.27	X		X		X	
19	.408	2.174		X	.450		.420		X	X	X		X	
20	.408	2.109		X	.450		.440		X	X			X	
13						2.24		2.12						
14						2.74		2.15						
15						2.30		2.31						
16						2.54		2.22						
17						2.47		2.18						
18						2.26		2.22						
19						2.49		2.20						
20						2.49		2.29						
	IGNITER TESTS							(10 M23A1)						

VELOPMENT TEST DATA FOR FMU-68A/B FUZE

VIBRATION	AIRCRAFT VIBRATION	FIVE FOOT DROP	SEAL LEAKAGE CC/SEC X 10^{-5}	AIRCRAFT ACCELERATION	JOLT	JUMBLE	FORTY FOOT DROP	DETONATOR SAFETY	CAPTIVE FLIGHT TEST	GUIDED FUNCTION TEST						REMARKS
										MAJOR AXIS HORIZONTAL		VERTICAL NOSE DOWN		VERTICAL NOSE UP		
										0.4	2.3	0.4	2.3			
								X								Lead did not Explode
				X												Bench Functioned
				X												Bench Functioned
				X												Bench Functioned
					X											Unit Safe After Test
					X	X										Unit Safe After Test
					X	X										Unit Safe After Test
										X						Unit Functioned OK
								X								Lead did not Explode
		X	X								X					Unit Functioned OK
		X	X								X					Unit Functioned OK
		X	X										X			Unit Functioned OK
X	X		X									X				Unit Failed to Functio
X	X		X										X			Unit Failed to Functio
			X							X						Unit Functioned OK
X			X										X			Unit Failed to Functio
	X		X									X				Unit Functioned OK
	X		X								X					Unit Failed to Functio
X	X		X								X					Unit Functioned OK
X			X										X			Unit Failed to Functio
							(10 BBU-1/B)									

(The reverse of this page is blank)

2

APPENDIX IV

FMU-68A/B MECHANICAL FUZE DATA SHEET

FMU-68 A/B MECHANICAL FUZE DATA SHEET

TIMING TESTS

PART NO. 1093F001 REV None

DATE: 9-13-71

Eglin Environmental Test Units
Serial Numbers 33 through 70 (38 Units)

UNIT SERIAL NO.	TIME, SECONDS (AMBIENT)		TIME, SECONDS		REMARKS
	.300-.500	2.0-2.6	160°F	-65°F	
33	.423	2.21	2.25	2.60	
34	.431	2.25	2.26	2.54	
35	.447	2.28	2.27	2.60	
36	.424	2.13	2.20	2.40	
37	.424	2.14	2.14	2.40	
38	.428	2.10	2.08	2.60	
39	.458	2.19	2.25	2.60	
40	.418	2.19	2.22	2.57	
41	.438	2.14	.470	.490	
42	.441	2.23	.450	.425	
43	.418	2.23	2.24	2.80	
44	.408	2.19	2.14	2.67	
45	.438	2.14	2.07	2.70	
46	.418	2.29	2.22	2.74	
47	.408	2.09	2.08	2.73	
48	.434	2.28	2.32	2.64	
49	.458	2.29	.420	.490	
50	.418	2.23	2.15	2.40	
51	.414	2.03	2.21	2.38	
52	.401	2.28	2.27	2.50	
53	.468	2.11	2.19	2.48	
54	.426	2.09	.430	2.35	
55	.425	2.07	2.15	2.57	
56	.460	2.27	.420	.475	
57	.415	2.11	2.04	2.27	
58	.414	2.09	2.18	2.53	
59	.458	2.25	2.36	2.60	
60	.426	2.14	2.16	2.60	
61	.459	2.35	2.38	2.82	
62	.427	2.16	2.18	2.54	

FMU-68 A/B MECHANICAL FUZE DATA SHEET

TIMING TESTS

PART NO. 1093F001 REV None

Eglin Environmental Test Units
Serial Numbers 33 Through 70 (38 Units)

DATE: 9-13-71

UNIT SERIAL NO.	TIME, SECONDS (AMBIENT)		TIME, SECONDS		REMARKS
	.300-.500	2.0-2.6	160°F	-65°F	
63	.414	2.25	.410	.470	
64	.441	2.25	2.25	2.28	
65	.411	2.26	2.26	2.70	
66	.438	2.19	2.18	2.70	
67	.434	2.09	2.22	2.65	
68	.444	2.32	2.41	2.56	
69	.426	2.32	2.27	2.42	
70	.420	2.16	.450	.470	

APPENDIX V

DEVELOPMENT TEST PROCEDURE

FOR

FMU-68A/B MODIFIED MECHANICAL FUZE

DEVELOPMENT TEST PROCEDURE

FOR

FMU68A/B MODIFIED MECHANICAL FUZE

Prepared Under Contract No. F08635-71-C-0098

For

Air Force Armament Laboratory

Eglin Air Force Base, Florida 32542

By

KDI Poly-Technic

Cincinnati, Ohio 45215

File No. 1093-4

Prepared By:

Date: November 19, 1971

R C Carter

KDI Engineering Approval

E E Jones

KDI Quality Control Approval

FMU-68A/B DEVELOPMENT TEST PROCEDURE

Contract No.: F08635-71-C-0098 Date: Nov. 19, 1971

Revision:

Notes:

1. Thirty units shall be subjected to these tests.

2. The tests shall be conducted in the sequence listed below.

3. Test data shall be recorded on the data sheet for permanent records.

Test No. 1 - Timing (Ambient) - Serial Nos. 001 through 030

Requirements: The unit shall time between .300 and .500 second.

Test Method: The explosive detonator shall not be assembled in the unit. Place the unit in a test fixture and measure the travel time interval from release of the rotor to the in-line position.

Test No. 2 - Extreme Temperature - Serial Nos. 001 through 010

Requirement: The units shall time within the limits of 0.4 $\pm$ 0.1 second.

Test Method: The housing and gearing assembly, 1093D459 shall be placed in a chamber and soaked for 4 hours at -65°F $\pm$ 4°F. The units shall be placed on the timing fixture and the escape time for the units shall be measured. At the conclusion of this test the units shall be reset and placed in an oven at 160 $\pm$ 4°F for 4 hours. The escape time for the units shall be measured.

Test No. 3 - Transportation Vibration - Serial Nos. 009 through 019

Requirement: The fuze shall be safe and operable following the test.

Test Method: The complete fuze, less lead charge and with a simulated burster, shall be subjected to MIL-STD-331, Test 104, Procedure II.

Test No. 4 - Aircraft Vibration - Serial Nos. 011 through 021

Requirement: The unit shall be safe and operable following the test.

Test Method: The complete fuze less lead charge and with a simulated burster shall be subjected to MIL-STD-810B, Procedure II, Method 514, 1-C, Procedure II, Method 514, 3-P.

Test No. 5 - Five-Foot Drop - Serial Nos. 006, 007, 008

Requirement: The fuze shall be safe and operable following test.

Test Method: The bare fuze shall be dropped in this test. The complete fuze less lead charge and with a simulated burster shall be subjected to MIL-STD-331, Test 111.

Test No. 6 - Seal Leakage - Serial Nos. 013 through 016 and 022 through 025

Requirement: The unit shall be safe and operable following the test.

Test Method: The complete fuze less lead charge and with a simulated burster shall be subjected to MIL-STD-331, Test 108.

Test No. 7 - Aircraft Acceleration - Serial Nos. 026 through 030

Requirement: The fuze shall be safe and operable following test.

Test Method: The fuzes, less lead and with a simulated burster, shall be subjected to MIL-STD-810B, Method 513, Procedure II. The units shall be bench functioned after the test by dropping the bare fuze onto a concrete surface from a distance of 4 feet.

Test No. 8 - Jolt - Serial Nos. 001, 002 and 003

Requirement: The detonator shall not explode and the fuze shall be safe to remove from the machine.

Test Method: The fuze, less lead charge and with a simulated burster shall be subjected to MIL-STD-331, Test 101.

Test No. 9 - Jumble - Serial Nos. 004, 005

Requirement: The detonator shall not explode and the fuze shall be safe to remove from the machine.

Test Method: The fuze, less lead and with a simulated burster, shall be subjected to MIL-STD-331, Test 102.

<u>Test No. 10 - Timing</u> - Serial Nos. 006 through 025

Requirement: The fuze shall time between .300 and .500 second.

Test Method: Measure the fuze arming time by utilizing a microphone and a visicorder.

<u>Test No. 11 - Bench Function</u> - Serial Nos. 009, 010, 011, 012, 017, 018, 019, 020, 021

Requirement: The fuze shall function when dropped from a distance of 4 feet onto a concrete surface.

FUZE SERIAL NO.	TIME, SECONDS (AMBIENT) .300-.500		EXTREME TEMPERATURE TEST -65° F .300-.500	EXTREME TEMPERATURE TEST +160° F .300-.500		TRANSPORTAT. VIBRATION	AIRCRAFT VIBRATION	FIVE FOOT DROP	WATERPROOF-NESS	AIRCRAFT ACCELERATION	JOLT
1	.330		.360	.330							X
2	.310		.335	.305							X
3	.330		No Test	.320							X
4	.345		.355	.325							
5	.314		.335	.310							
6	.329		.335	.330				X			
7	.343		.335	.330				X			
8	.317		.335	.315				X			
9	.337		.340	.325		X					
10	.353		.380	.345		X					
11	.307		.320	.300		X	X				
12	.304		.315	.305		X	X				
13	.324		No Test	.330		X	X		X		
14	.321		.340	.315		X	X		X		
15	.333		.355	.340		X	X		X		
16	.347		.390	[illegible]		X	X		X		
17	.347		.365	[illegible]		X	X				
18	.322		.350	.320		X	X				
19	.340		.375	.320		X	X				
20	.315		.350	.320			X				
21	.341		.375	.340			X				
22	.334		.375	.350					X		
23	.315		.340	.335					X		
24	.310		.335	.310					X		
25	.314		.350	.330					X		
26	.316		.370	.340						X	
27	.337		.365	.340						X	
28	.313		.345	.320						X	
29	.344		.365	.340						X	
30	.312		.350	.310						X	

FUZE DEVELOPMENT TEST DATA

Date: January 6, 1972

WATERPROOFNESS	AIRCRAFT ACCELERATION	JOLT	JUMBLE	POST TEST TIME, SEC.			GUIDED FUNCTION TEST		REMARKS
							MAJOR AXIS HORIZONTAL	VERTICAL NOSE DOWN	
		X		-					Fuze Safe
		X		-					Fuze Safe
		X		-					Fuze Safe
			X	-					Fuze Safe
			X	-					Fuze Safe
				.370					Fuze Functioned by Guided Drop
				.380					
				.335					
				.360					
				.415					
				.340					
				.370					
X				-					Fuze Leaked (see sheet 2)
X				-					Fuze Leaked
X				-					Fuze Leaked
X				-					Fuze Leaked
				.410					Fuze Functioned by Guided Drop
				.365					
				.380					
				.370					
				.310					
X				-					Fuze Leaked
X				-					Fuze Leaked
X				-					Fuze Did Not Leak
X				-					Fuze Leaked
				.340					Fuze Functioned by Guided Drop
				.342					
				.337					
				.408					
				.330					Fuze Functioned By Guided Drop

(The reverse of this page is blank)

2

DEVELOPMENT TEST DATA
FMU-68 A/B FUZE

In order to solve the leak problem the following 8 fuzes were tested per MIL-STD-331, Test 108.

TEST I

SER. NO.	CONFIGURATION	RESULT WHEN TESTED
T-1	*MS-29561-024 "O" Ring with film of RTV-732 Silastic	Did not Leak
T-2	MS-29561-121 "O" Ring only	Did not Leak
T-3	Seal made with RTV-732 only	Did not Leak
T-4	MS-29561-024 "O" Ring only	Leaked
T-5	MS-29561-024 "O" Ring with film of RTV-732 Silastic	Did not Leak
T-6	MS-29561-121 "O" Ring only	Did not Leak
T-7	MS-29561-024 "O" Ring with film of MIL-S-8802 Class A-2 Rubber Sealing Compound	Did not Leak
T-8	MS-29561-121 "O" Ring only	Did not Leak

* This was the "O" Ring used to seal the fuzes listed on Sheet 1.

TEST II

The following test was conducted on the selected configuration which did not leak in Test I.

SER. NO.	CONFIGURATION	RESULT
T-9, T-10 T-11, T-12	MS-29561-121 "O" Ring only	Did not Leak

APPENDIX VI

FMU-68A/B MODIFIED

MECHANICAL FUZE

TEST DATA AND AS-BUILT DATA LIST

FMU-68A/B MODIFIED

MECHANICAL FUZE

TEST DATA AND AS-BUILT DATA LIST

LOT NUMBER

KP 2-1

Serial Number 103 through 232 (20 pcs.)

Prepared Under Contract No. F08635-71-C-0098

For

Armament Development and Test Center

Eglin Air Force Base, Florida 32542

KDI No. 1093-4

Prepared By RCCarter

Approved By E. E. Jones

LOT TEST DATA REPORT

FMU-68A/B MODIFIED MECHANICAL FUZE

Twenty (20) fuzes were selected from the lot of 145 fuzes fabricated for delivery to the Air Force. The fuzes were subjected to the tests listed on the attached data sheet. The fuzes armed within specifications during ambient and extreme temperatures and after vibration tests. The fuzes subjected to 40 g's acceleration also armed within the specified time range while experiencing the 40 g's.

It was concluded that the test results of the 20 fuzes were satisfactory and that the lot should be accepted.

FMU-68A/B FUZE - LOT TES

FUZE SERIAL NO.	TIME, SECONDS (AMBIENT)		EXTREME TEMPERATURE TEST			TRANSPORTAT. VIBRATION	AIRCRAFT VIBRATION			AIRCRAFT ACCELERATION 40 G'S	JOLT
			-65° F	+160° F							
	.300-.500		.300-.500	.300-.500							
103	.353		.370	.350							X
110	.325		.345	.320							X
116	.313		.340	.308							X
122	.307		.335	.300							
128	.322		.335	.315							
136	.335					X					
144	.335					X					
152	.337					X	X				
160	.351					X	X				
168	.312					X	X				
175	.344					X	X				
179	.333					X	X				
190	.312					X	X				
192	.306					X	X			X	
195	.326					X	X			X	
207	.324						X				
211	.368						X				
222	.316									X	
223	.308									X	
232	.325									X	

/

[illegible] - LOT TEST DATA

		AIRCRAFT ACCELERATION 40 G S	JOLT	JUMBLE	POST TEST TIME, SEC.			GUIDED FUNCTION TEST		REMARKS
									VERTICAL NOSE DOWN	
			X		-					Safe, No Broken or Loose Parts
			X		-					Safe, No Broken or Loose Parts
			X		-					Safe, No Broken or Loose Parts
				X	-					Safe, No Broken or Loose Parts
				X	-					Safe, No Broken or Loose Parts
					.360				X	Functioned Upon Impact
					.360				X	
					.400				X	
					.390				X	
					.375				X	
					.385				X	
					.380				X	
					.380				X	
		X			.340				X	
		X			.370				X	
					.380				X	
					.430				X	
		X			.350				X	
		X			.390				X	
		X			.340				X	

(The reverse of this page is blank)

2

KDI PRECISION PRODUCTS

CINCINNATI, OHIO

AS-BUILT DATA LIST

PROGRAM	DATE
FMU-68 A/B MODIFIED MECHANICAL FUZE	Feb. 10, 1972

CONTRACT	SERIAL NO 103 THRU 232	LOT NO
F08635-71-C-0098	(20 pcs)	KD 2-1

SPECIFICATION OR DRAWING NO.	TITLE	REVISION LEVEL	DEIATION OR WAIVER NO.
7056	Hammerweight	A	
7057	Bracket, Hammerweight	A	
1093D062	Center Plate Assembly	-	
1093C114	Case, Fuze	-	
1093B116	Spring, Safety	-	
1093B137	Pin, Hammerweight	-	
1093B402	Rotor Pin	-	
1093D403	Rotor Assembly	-	
1093C409	Arming Pin	-	
1093D425	Housing	A	
1093C428	Collar, Arming Pin	-	
1093C429	Shear Cap	-	
1093D433	Plate, Top	-	
1093D459	Housing&Gearing Assy.	-	
1093F401	Fuze, Mechanical FMU-68A/B	A	
MS29561-121	"O" Ring	-	
MS16555-601	Dowel Pin	-	
MS1021-10	Setscrew, Cup Point	-	
Mil-Std-22473	Sealing Compound	-	
Mil-G-4343	Lubricant	-	
Mil-A-46050	Adhesive	-	
Mil-L-60326	Lubricant (Vydax)	-	
Mil-A-46106	Adhesive (RTV-732)	-	
MS16562-191	Pin, Spring	-	
MS16562-193	Pin, Spring	-	
MS51923-130	Pin, Spring	-	

KDI PRECISION PRODUCTS
CINCINNATI, OHIO

AS-BUILT DATA LIST

PROGRAM	DATE
FMU-68 A/B MODIFIED MECHANICAL FUZE	Feb. 10, 1972

CONTRACT	SERIAL NO	LOT NO
F08635-71-C-0098	103 THRU 232 (20 pcs)	KP 2-1

SPECIFICATION OR DRAWING NO.	TITLE	REVISION LEVEL	DEIATION OR WAIVER NO.
7004	Tag, Warning	A	
7009 SP	Pellet, Burster(Simulated)	-	
7010	Pad, Burster	-	
7013	Seal, Fuze	-	
7016	Spring, Arming	-	
7017	"O" Ring	-	
7018	Wire, Safety	-	
7023	Firing Pin&Spring Assy.	D	
7024	Spring, Firing Pin	-	
7025	Pin, Firing	-	
7026	Arm, Firing Pin	C	
7028	Detonator Assembly	J	
7037	Spring, Rotor	A	
7038	Verge Assembly	C	
7039	Weight, Verge	B	
7040	Verge, Fuze, Housing	E	
7042	Pinion Assembly	B	
7043	Pinion, Fuze Housing	F	
7044	Wheel, Star	F	
7046	Gear, Rotor	A	
7047	Rotor	C	
7049	Spring, Hammerweight	A	
7051	Center Plate	C	
7052	Push Pin Assembly	A	
7053	Ball	-	
7054	Pin, Push	A	
7055	Hammerweight Assy.	-	

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) KDI Poly-Technic Division KDI Precision Products, Inc. 10540 Chester Rd., Cincinnati, Ohio 45215	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP

3. REPORT TITLE

IMPROVED FMU-68/B FUZE

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

Final Report - February 1971 to March 1972

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

Richard C. Carter

6. REPORT DATE May 1972	7a. TOTAL NO. OF PAGES 94	7b. NO. OF REFS
8a. CONTRACT OR GRANT NO. F08635-71-C-0098 b. PROJECT NO. 3783 c. Task No. 03 d. Work Unit No. 000	9a. ORIGINATOR'S REPORT NUMBER(S) 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) AFATL-TR-72-91	

10. DISTRIBUTION STATEMENT

Distribution limited to U. S. Government agencies only; this report documents test and evaluation; distribution limitation applied May 1972. Other requests for this document must be referred to the Air Force Armament Laboratory (DLJF), Eglin Air Force Base, 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 32542

13. ABSTRACT

An improved FMU-68/B mechanical fuze, designated as FMU-68A/B modified fuze, was designed and tested during a twelve-month period. The design objective was to provide additional safety features to the fuze which eliminate hazards encountered during upload and download of fuzed bombs. The fuze fits into the well of an AN-M23A1 igniter which is compatible with BLU-27B/B and BLU-32A/B firebombs. The fuze has a built-in timer with a predetermined arming delay of 0.30 to 0.50 second which provides safe separation from the aircraft. The uploaded FMU-68A/B modified fuze can be restored to preflight condition by replacement of the safety cap and installation of a new safety wire if the arming wire (lanyard) has not been extracted from the fuze during the flight. Environmental tests were performed and test results formulated. One hundred twenty-five FMU-68A/B modified fuzes were shipped to Eglin Air Force Base for evaluation. It was concluded from the program effort that the FMU-68A/B modified fuze represents a significant increase in safety over the FMU-68/B fuze and that the improved fuze functions well within specification.

DD FORM 1 NOV 65 1473

UNCLASSIFIED
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
FMU-68/B fuze						
FMU-68A/B fuze						
Timer						
AN-M23A1 Igniter (white phosphorous)						
Arming wire						
Arming pin						
Safety and arming						
BLU-27/B firebomb						
BLU-32A/B firebomb						
BBU-1/B igniter (astrolite)						