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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO. 1180

WEAPON "A" LAUNCHER CHANGES

4th Partial Report

ROCKET LAUNCHER MARK 19 MOD 0
PROOF FIRING TEST OF PRODUCTION MODEL

FINAL Report

Copy No. _____

Task

Assignment NPG-Re5e-88-2-53

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10 November 1953

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Rocket Launcher Mark 19 Mod 0
Proof Firing Test of Production Model

PART A

SYNOPSIS

1. a. The Rocket Launcher Mark 19 Mod 0 is a sub-caliber launcher for the Anti-Submarine Rocket Launcher Mark 108. It is capable of firing, in sequence, six 4"0 sub-caliber rockets. The prototype launcher was previously test fired at the Naval Proving Ground.

b. Ballistic data had been recorded on the experimental 4"0 Sub-Caliber Rockets during firing tests of the prototype Rocket Launcher Mark 19 Mod 0 and firings conducted from an open rail type launcher. The rounds exhibited considerable yaw in flight and excessive dispersion. The Bureau of Ordnance requested that ballistic data be recorded during the present test.

2. This test was conducted to:

a. Proof test fire the production model of the Rocket Launcher Mark 19 Mod 0.

b. Collect additional ballistic data for ballistic evaluation of the experimental 4"0 Sub-Caliber Rockets.

3. It is concluded that:

a. When the Rocket Launcher Mark 19 Mod 0 is loaded in the Rocket Launcher Mark 108:

(1) Between -30° and +30° in train only one of the two Mark 108 firing pins is operative and any two adjacent rockets of a salvo can fire simultaneously.

(2) With the mount trained 35° off the centerline, both Mark 108 firing pins are operative, and the rockets will fire individually in the proper sequence.

b. The experimental 4"0 Sub-Caliber Rockets exhibit excessive yaw during burning and the dispersion is greater than is desirable.

Rocket Launcher Mark 19 Mod 0
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4. It is recommended that:

a. The Rocket Launcher Mark 108 be trained 35° off the center-line before loading the Rocket Launcher Mark 19 Mod 0 into the guide tube.

b. Prior to starting a firing program the firing pins of the Mark 108 Launcher should be checked to see that they are contacting the contact band on the spacer tube of the loaded Mark 19 Launcher.

c. The experimental 4"0 Sub-Caliber Rockets be modified to improve their flight and decrease their dispersion.

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PART B

INTRODUCTION

1. AUTHORITY:

This test was requested and authorized by reference (a) as modified by references (b) and (c), and conducted under Task Assignment NPG-Re5e-88-2-53 established by reference (d).

2. REFERENCES:

- a. BUORD Conf ltr Re5e-WJL:hts Ser 38750 of 5 May 1952
- b. BUORD Conf ltr Re5d-KEY:j1j S79-5 (1) Ser 53396 of 12 Mar 1953
- c. BUORD Conf ltr Re5d-KEY:j1j S79-5 (1) Ser 54854 of 8 Apr 1953
- d. BUORD Conf ltr Re5e-CEA:hts NP9 Ser 42212 of 17 Jul 1952
- e. O.P. 1894 (preliminary): Rocket Launcher Mark 19 Mod 0, Description and Instructions
- f. NPG Conf ltr OTR:JAN:pps All/5806-2 Ser 23090 of 11 Sep 1952
- g. NPG Conf ltr OTR:JAN:dmf All/5388-2 Ser 23793 of 13 Jan 1953
- h. NPG Conf ltr OTR:JAN:j1r All/532-9 Ser 31507 of 15 Apr 1953

3. BACKGROUND:

a. The Rocket Launcher Mark 19 Mod 0, described in reference (e), is a sub-caliber launcher for the Anti-Submarine Rocket Launcher Mark 108. It is capable of firing, in sequence, six 400 Sub-Caliber Rockets. The prototype launcher was previously test fired at the Naval Proving Ground and reported in references (f) and (g).

b. Ballistic data had been recorded on the experimental 400 Sub-Caliber Rockets during firing tests of the prototype Rocket Launcher Mark 19 Mod 0 and firings conducted from an open rail type launcher. The rounds exhibited considerable yaw in flight and excessive dispersion. The results were reported in references (f), (g) and (h). Reference (b) requested that ballistic data be recorded during the present test.

Rocket Launcher Mark 19 Mod 0
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4. OBJECT OF TEST:

This test was conducted to:

- a. Proof test fire the production model of the Rocket Launcher Mark 19 Mod 0.
- b. Collect additional ballistic data for ballistic evaluation of the experimental 4!0 Sub-Caliber Rockets.

5. PERIOD OF TEST:

- | | |
|-------------------------------------|--------------|
| a. Date of Project Letter | 14 July 1952 |
| b. Date Necessary Material Received | 2 April 1953 |
| c. Date Commenced Test | 9 April 1953 |
| d. Test Completed | 5 June 1953 |

6. REPRESENTATIVES PRESENT:

LT R. J. Rohr	Bureau of Ordnance (Re5)
LT A. L. Waxman	Bureau of Ordnance (Re5b)
Mr. K. E. Yunker	Bureau of Ordnance (Re5c)
Mr. J. A. Burke	Naval Gun Factory (Code 700)

Rocket Launcher Mark 19 Mod 0
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PART C

DETAILS OF TEST

7. DESCRIPTION OF ITEM UNDER TEST:

a. The Rocket Launcher Mark 19 Mod 0 is a sub-caliber attachment designed to adapt the Rocket Launcher Mark 108 to the firing of 4"0 Sub-Caliber Rockets in anti-submarine practice. The launcher consists of two principal components, a tube assembly and a spacer assembly, as shown in Figure 1. The complete launcher assembly is inserted in the guide tube of the Rocket Launcher Mark 108. It is sub-divided to hold six (6) 4"0 sub-caliber rockets, as shown in Figure 2. The assembled round is shown in Figure 3. When properly energized, an electrical firing mechanism (Figures 2 and 4), contained in the tube assembly, fires the rockets in sequence. The operation of the firing mechanism is explained in Appendix (C). The Rocket Launcher Mark 108 operates in a normal manner with the Mark 19 Launcher inserted in the guide tube. The director controls elevation and train and the local mount operator fires the rounds.

b. The experimental 4"0 Sub-Caliber Rockets consisted of three components:

- (1) 4"0 Rocket Head NOTS Model 101-A, BUORD Sketch 338313A.
- (2) 2"25 Rocket Motor NOTS Model 103A, Charge Mark 16 Mod 1.
- (3) Dummy Depth Charge, BUORD Sketch 321058.

A detailed description of the Rocket Launcher Mark 19 Mod 0 and the experimental 4"0 Sub-Caliber Rocket is given in reference (e).

8. DESCRIPTION OF TEST EQUIPMENT:

- a. Rocket Launcher Mark 108 Mod 2
- b. Multiple Channel Recording Oscillograph.
- c. Tray fabricated from 14 ft. length of 13 in. diameter steel pipe.
- d. Manually operated firing board.

Rocket Launcher Mark 19 Mod 0
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9. PROCEDURE:

The test was conducted in three phases:

a. Phase I

The Rocket Launcher Mark 19 Mod 0 was loaded with six rockets and hoisted into the Mark 108 guide tube. The guide tube was set at 0° train and elevation set as shown in Table I. Both the train and elevation power drives were operating. The firing circuit was operated in LOCAL with a 5 second interval between rounds. Seven salvos were fired. The Mark 19 Launcher malfunctioned at least once during each salvo, starting with the first salvo. Two rounds fired simultaneously when the firing circuit was closed to fire a single round. The malfunction will be discussed in detail later in this report. In an effort to determine the cause of the malfunction it was necessary to modify the test procedure. After each salvo the firing mechanism containing the sequential "stepper switch" was removed from the launcher tube and tested. In each case it functioned normally. On salvos 4 through 7, a recording oscillograph was employed to measure voltage and current in the firing circuit, in an effort to determine the reason for malfunctioning.

b. Phase II

It was necessary to isolate the Mark 19 Launcher from the Mark 108 Launcher in order to determine the reason why two rounds of each salvo were firing simultaneously. A trough was fabricated by cutting a 14 foot section of 13 inch diameter steel pipe in half, lengthwise. The trough was secured to a foundation at 11° elevation and the launcher secured in the trough. Figures 5 and 6 show the relation of these components. Two salvos (Numbers 8 and 9) were fired with the launcher in the trough. The firing circuit was controlled through a manually operated firing board. This completely eliminated the firing circuit of the Mark 108 launcher. Voltage and current in the firing circuit were recorded on a multiple channel recording oscillograph.

c. Phase III

The remaining salvos (Numbers 10 through 16) were fired with the Mark 19 Launcher loaded into the guide tube of the Mark 108 launcher. Control and instrumentation of the firing circuit will be discussed later in this report.

Rocket Launcher Mark 19 Mod 0
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10. RESULTS AND DISCUSSION:

The ballistic performance of the 4.0 Sub-Caliber Rockets continued to be unsatisfactory during this test.

A casualty record is shown in Table I and ballistic data in Table II.

a. Phase I

The first four salvos were fired under normal conditions. The six 4.0 rockets were loaded in the Rocket Launcher Mark 19 Mod 0. The launcher and spacer tube were hoisted into the guide tube of the Rocket Launcher Mark 108.

Salvo 1 - When the firing circuit was closed to fire round 1, rounds 1 and 2 fired together. When the firing circuit was closed for the second time there was no action. On the third, fourth, fifth and sixth closing of the firing circuit the proper rounds fired in sequence. This indicated that the stepper switch of the firing mechanism had energized two firing positions with a single closure of the firing circuit. The firing mechanism was removed from the launcher and tested. It functioned normally.

Salvo 2 - The launcher was loaded as before. Rounds 1 and 6 fired together during the first closure of the firing circuit. Rounds 2, 4, 5 and 6 fired properly in sequence. Round 3 was a misfire. It fired on the second revolution of the stepper switch (9th closing of the firing circuit). This sequence of firing indicated that the stepper switch fired round 1, stepped backward to fire round 6, and returned to the proper position to fire round 2 when the circuit was closed on the second attempt to fire. The firing mechanism was removed, tested and found to be operating satisfactorily.

Salvo 3 - The firing mechanism was set to commence firing with tube No. 3. This was done to determine whether the first two rounds would always fire together during a salvo or whether this only occurred when tube No. 1 was involved. The first five rounds fired normally. Round 6 (in tube No. 2) was a misfire. Examination showed it had moved off its firing pin. The only apparent explanation is that the round was not firmly seated and was moved forward by the gas pressure of preceding rounds.

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Salvos 4 through 7 - The cause of previous dual firing was believed to be a temporary surge or voltage drop in the firing circuit, causing the stepper switch to cycle. This would cause rounds to fire together with a single closing of the firing circuit. The firing circuit was instrumented to measure current and voltage at the instant of firing. Dual firing occurred on salvos 4 through 7 inclusive. The oscillograph records indicated that electrical instability in the firing circuit occurred concurrently with the double rounds. An explanation is provided in Appendix (C). Prior to salvo No. 7 a new firing mechanism was installed that had been thoroughly tested. Dual firing recurred.

b. Phase II

Two salvos (8 and 9) were fired with the Mark 19 Launcher secured in a metal tray (described in paragraph 9b and shown in Figures 5 and 6). This was done so that the firing circuit of the Mark 108 Launcher could be completely eliminated during firing.

Salvo 8 - Only the launcher tube was used in the tray, with the spacer tube omitted as shown in Figure 5. The stepper switch was removed from the firing mechanism. Individual firing leads controlled by knife switches were run to each firing pin and a common ground was provided. Voltage in each firing lead was recorded. The salvo fired normally. Voltage reached only the firing pin for which it was intended as each individual rocket was fired. At this point it was definitely determined that the double rounds were being fired electrically as a result of faulty stepper switch action caused by a temporary power interruption at some point in the firing circuit.

Salvo 9 - This was fired with the complete launcher in the tray, the stepper switch reinstalled and the spacer tube used, as shown in Figure 6. A firing lead, from a manually operated firing board, was securely attached to the spacer tube and a positive ground return provided. The salvo fired normally. Voltage reached the individual firing pins in the proper sequence. This indicated that all elements of the complete Mark 19 Launcher were functioning properly.

c. Phase III

Salvos 10 through 16 - Six salvos were fired with the Mark 19 Launcher loaded into the guide tube of the Mark 108 Launcher as described in Phase I.

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Salvo 10 - The firing circuit and power drives of the Mark 108 Launcher were not operated during this salvo. The firing circuit was controlled through the manually operated firing board described in Phase II. The salvo fired normally.

The results up to this point in the test indicated that the Mark 19 Launcher, fired from the guide tube of the Mark 108 Launcher, functioned normally when a positive contact was provided between the source of the firing circuit and the firing lead of the spacer tube. The firing circuit of the Mark 108 Launcher is connected to two (2) firing pins in the guide tube which transmit the voltage to the contact band of the Mark 19 spacer tube. The Mark 108 Launcher is so constructed, however, that when the guide tube is loaded between -30° and $+30^{\circ}$ in train only the upper firing pin is in contact with the contact band of the spacer tube. All previous salvos fired from the Mark 108 Launcher had been loaded at 0° train. Therefore it appeared that the rocket blast and shock were partially lifting the single firing pin causing a temporary interruption of the firing circuit and allowing the stepper switch to cycle and fire two rounds simultaneously.

Salvo 11 - The Mark 108 Launcher was trained to starboard 35° off centerline during loading. This insured that both firing pins were in contact with the contact band. The salvo fired normally.

Salvo 12 was loaded on 0° train, with only one firing pin operating to verify the results. Dual firing occurred as expected.

Salvo 13 was loaded with the Mark 108 Launcher trained to port 35° off centerline. A double shot occurred. Investigation after firing disclosed that the Mark 108 Launcher was slightly out of adjustment and that only the top firing pin was operative. Consequently a momentary firing circuit break again occurred after the first round and the stepper switch cycled of its own accord.

Salvo 14 - A jumper wire was connected between the Mark 108 firing pins and the terminal lug of the Mark 19 Launcher contact band. This jumper bypassed both firing pins and provided a positive connection between the Mark 108 firing circuit and the contact band of the spacer tube. The launcher was loaded at 0° train. The salvo fired normally.

Salvo 15 was loaded 35° off centerline and fired normally.

Salvo 16 was loaded at 0° train and two rounds fired simultaneously as expected.

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d. Dual Firing Analysis

In each case where dual firing occurred only a single firing pin was contacting the spacer tube. The dual firing encountered always occurred on rounds positioned in the same sector of the launcher tube as the firing pin. With two firing pins contacting the spacer tube one of the firing pins in the same sector as the rounds being fired may be lifted. However the other firing pin, diametrically opposite, is not affected and maintains a constant voltage supply to the firing mechanism. This assures proper functioning of the firing mechanism and fires the rounds in their proper sequence.

PART D

CONCLUSIONS

11. It is concluded that:

a. When the Rocket Launcher Mark 19 Mod 0 is loaded in the Rocket Launcher Mark 108:

(1) Between -30° and $+30^{\circ}$ in train only one of the two Mark 108 firing pins is operative and any two adjacent rockets of a salvo can fire simultaneously.

(2) With the mount trained 35° off the centerline, both Mark 108 firing pins are operative, and the rockets will fire individually in the proper sequence.

b. The experimental 4"0 Sub-Caliber Rockets exhibit excessive yaw during burning and the dispersion is greater than is desirable.

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Proof Firing Test of Production Model

PART E

RECOMMENDATIONS

12. It is recommended that:

a. The Rocket Launcher Mark 108 be trained 35° off the center-line before loading the Rocket Launcher Mark 19 Mod 0 into the guide tube.

b. Prior to starting a firing program the firing pins of the Mark 108 Launcher should be checked to see that they are contacting the contact band on the spacer tube of the loaded Mark 19 Launcher.

c. The experimental 4"0 Sub-Caliber Rockets be modified to improve their flight and decrease their dispersion.

PART F

DISPOSITION OF MATERIAL

13. The Rocket Launcher Mark 19 Mod 0 was retained at the Naval Proving Ground for future tests. The expended experimental 4"0 Sub-Caliber Rockets were scrapped.

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Proof Firing Test of Production Model

The tests upon which this report is based were conducted by:

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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Fourth Partial Report
on
Weapon "A" Launcher Changes

Final Report
on
Rocket Launcher Mark 19 Mod 0
Proof Firing Test of Production Model

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DP9-63782

Rocket launcher Mark 19 Mod 0 consisting of tube and spacer assembly. 4.0 rockets
used in launcher are shown in foreground.

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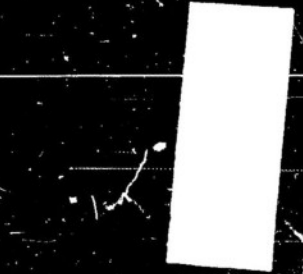
Figure 1



NP9-63783

Tube assembly of Rocket Launcher Mark 19 Mod 0 with two rounds loaded.

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NP9-63783

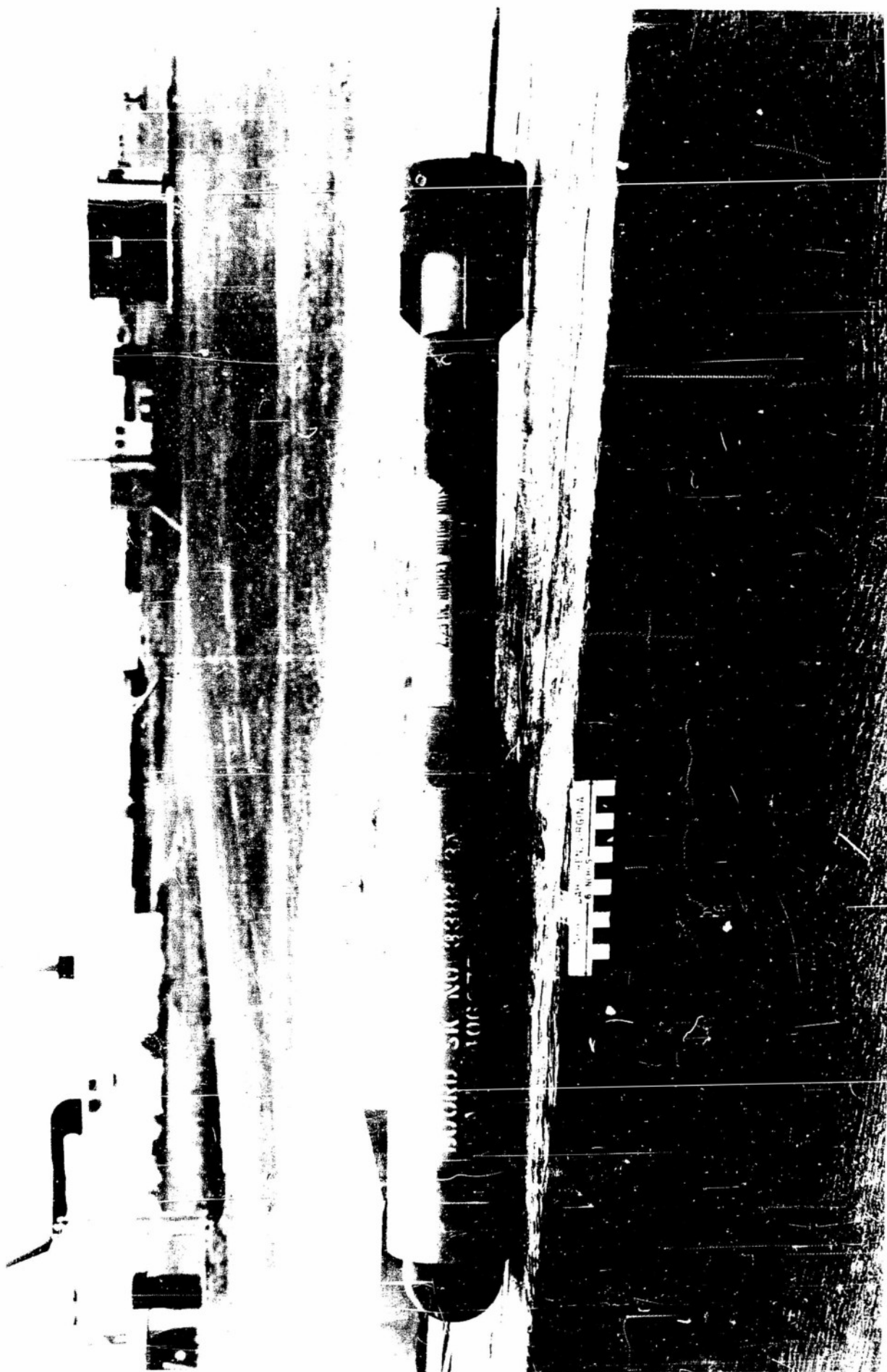
NP9-63784

470 sub-caliber rocket (experimental) for use with Rocket Launcher Mark 19 Mod 0.

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Figure 3



NP9-63737

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Firing mechanism for Rocket Launcher Mark 19 Mod 0 which fits inside Launcher Tube and contains "stepper switch". Figure 4



9-63738

Launcher Tube of Rocket Launcher Mark 19 mod 0 fired from tray.

Figure 5

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NP9-63739

Rocket Launcher Mark 19 Mod 0 fired from tray.
Figure 6

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Rocket Launcher Mark 19 Mod 0 Proof Firing Test of Production Model

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TABLE I

CASUALTY RECORD OF ROCKET LAUNCHER MARK 19 MOD 0

Date Fired 1953	Salvo No.	Angle of Elevation Degrees	Launcher Conditions	Remarks
4-9	1	49	From Mk 108 Launcher. Normal Conditions.	Rds. 1 & 2 fired together. Other rounds fired in sequence.
4-9	2	49	From Mk 108 Launcher. Normal Conditions.	Rds. 1 & 6 fired together. Rd. 3 misfired, fired on second revolution of Stepper Switch.
4-9	3	30	From Mk 108 Launcher. Firing mechanism set to fire from Mk 19 rails in following order: 3, 4, 5, 6, 1, 2.	First 5 rounds fired in sequence. Rd. 6 misfired. Moved off firing pin during firing.
4-21	4	30	From Mk 108 Launcher. Normal Conditions. Current and voltage measured in firing circuit.	Rds. 2 & 3 fired together. Other rounds fired in sequence.
4-21	5	30	From Mk 108 Launcher. Normal Conditions. New firing mechanism installed. Current and voltage measured in firing circuit.	Rds. 1 & 6 fired together. Other rounds fired in sequence.
4-28	6	49	From Mk 108 Launcher. Normal Conditions. Current and voltage measured in firing circuit.	Rds. 1 & 2 fired together. Rds. 3, 4, 6, fired in sequence. Rd. 5 misfired, fired on second revolution of Stepper Switch.
4-28	7	49	Same as Salvo 6.	Rds. 2 & 3 fired together. Other rounds fired in sequence.

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TABLE I (Continued)

Date Fired 1953	Salvo No.	Angle of Elevation Degrees	Launcher Conditions	Remarks
5-5	8	11	From tray using manually operated firing board. Stepper Switch removed. Individual lead to each firing pin. Voltage measured on each firing pin. Spacer Tube of launcher not used.	All rounds fired normally in sequence.
5-5	9	11	From tray using manually operated firing board. Stepper Switch reinstalled. Spacer Tube used. Voltage measured on individual firing pins.	All rounds fired normally in sequence.
5-12	10	31° 20'	From Mk 108 Launcher using complete Mk 19 Launcher. Manually operated firing board used bypassing individual firing pins.	All rounds fired normally in sequence.
5-12	11	49	From Mk 108 Launcher using complete Mk 19 Launcher. Mount trained 35° off centerline during loading to allow both firing pins to contact the contact band of spacer tube.	All rounds fired normally in sequence.
5-13	12	49	From Mk 108 Launcher under normal conditions. Rds. 1 & 2 fired together. Rds. 4 & 5 Loaded with Mk 108 Launcher on centerline. One firing pin in contact with contact band of spacer tube.	fired together.

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TABLE I (Continued)

Date Fired 1953	Salvo No.	Angle of Elevation Degrees	Launcher Conditions	Remarks
5-13	13	49	From Mk 108 Launcher. Mount trained 35° off centerline to port to allow both firing pins to contact the contact band. Slight misadjustment caused only one firing pin to contact the contact band of spacer tube.	Rds. 1 & 2 fired together. Other rounds fired in sequence.
5-19	14	49	From Mk 108 Launcher. Launcher firing pins bypassed by wire from Mk 108 firing circuit to contact band of spacer tube.	All rounds fired normally in sequence.
5-19	15	49	From Mk 108 Launcher. Mount trained 35° off centerline to allow both firing pins to contact the contact band of spacer tube.	All rounds fired normally in sequence.
5-19	16	49	From Mk 108 Launcher. Loaded on centerline. One firing pin contacted the contact band of spacer tube.	Rds. 1 & 2 fired together. Rds. 4 & 5 fired together.

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Rocket Launcher Mark 19 Mod 0 Proof Firing Test of Production Model

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TABLE II

DISPERSION DATA ON 4" SUB-CALIBER ROCKETS
FIRED DURING PROOF TEST OF ROCKET LAUNCHER MARK 19 MOD 0

No. Rds.	Angle of Elevation Degrees	Type of Round	Range-Feet		Deflection-Feet		Rocket Motor Lot No.
			Average	Standard Deviation	Average	Standard Deviation	
12*	49	Modified for Slow Spin	2402	±47	-3	±136	RXL049 Lot 4 of 1953
11**	30	Shimmed	2203	±203	-69	±104	RXL049 Lot 4 of 1953
4	31° 20'	Unmodified	2392	±144	-5	±125	RXY1049 Lot 4 of 1953
32	49	Unmodified	2647	±105	+31	±139	3 Salvos RXY1049 Lot 5 of 1953 5 Salvos RXY1049 lot 5 of 1953

NOTES: 1. Rounds conditioned at 70°F.

2. Impacts are uncorrected for standard conditions.

3. Impacts approximately 22 ft. below trunnion height.

4. In an effort to improve dispersion; rounds marked * were modified for slow spin by adding canted vanes in the motor nozzles, rounds marked ** were modified by wedging the depth charge inside the rocket head.

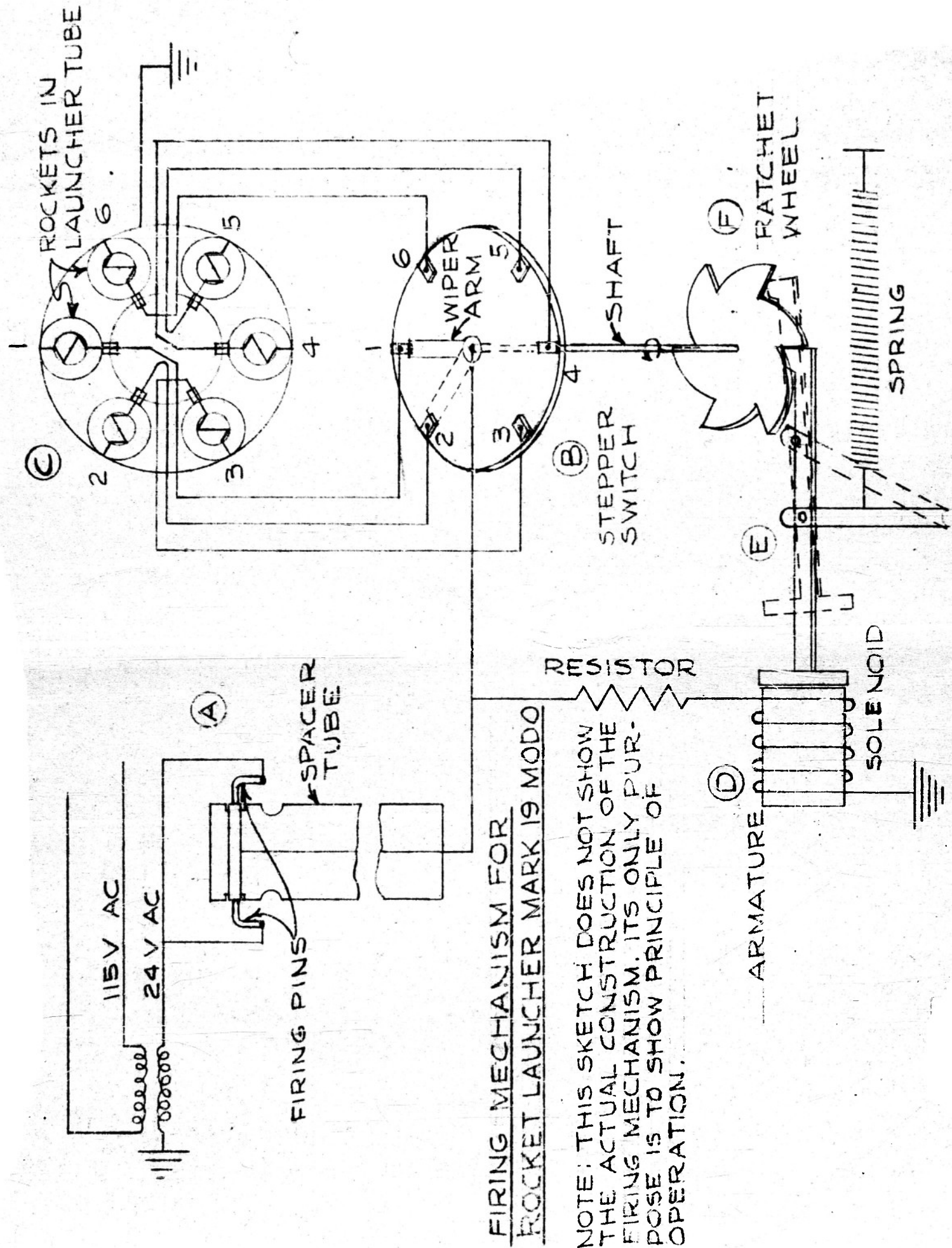
5. Dispersion was excessive. Desired dispersion should not exceed that of 12"75 Rocket which is ±60 ft. in range, ±22 ft. in deflection.

6. Rocket Motors - 2"75 Model 103A Grain Mark 16 Mod 1 (Experimental) ALN-INV.

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APPENDIX B

FIGURE 7



Rocket Launcher Mark 19 Mod 0
Proof Firing Test of Production Model

FIRING MECHANISM FOR ROCKET LAUNCHER MARK 19 MOD 0;
PRINCIPLE OF OPERATION

(Figure 7)

The firing mechanism is contained in a cylindrical tube approximately 3" in diameter and 24" long that is fitted inside the center of the Mark 19 Launcher tube at the after end. It is energized from the firing pins of the Rocket Launcher Mark 108. The six (6) firing pins of the Rocket Launcher Mark 19 are individually connected to the contacts of a "stepper switch". The "stepper switch" consists of six equally spaced contacts arranged in a circle around a wiper arm connected to the firing circuit. The wiper arm is rotated by a shaft operated by a solenoid and ratchet gear. Figure 7 shows the stepper switch set to fire round 1. When the firing circuit is closed, 20 volts AC flows through the Mark 108 firing pins to the contact band of the spacer tube (A). The spacer tube conducts the current to the firing mechanism. The current flows through the wiper arm to the No. 1 contact of the stepper switch (B), to No. 1 firing pin (C) to fire No. 1 round, and to the ground return. At the same time the current flows through a resistor and energizes solenoid (D). The solenoid attracts the armature, stretches the spring and sets up the ratchet wheel for a cycle. When the firing circuit is released by the operator the armature is released and the spring rotates the ratchet wheel (F) 1/6 of a turn moving the wiper arm to contact No. 2. When the firing circuit is closed for the second time round No. 2 is fired. Each time the firing circuit is opened and closed the cycle is repeated, firing the proper round in sequence.

At the instant of firing the firing circuit remains closed. With only one firing pin touching the contact band of the spacer tube the blast and shock lifts the pin for an instant. This interrupts the current to the solenoid causing the ratchet wheel to cycle carrying the wiper arm to the succeeding position. When the firing pin settles back in position current again flows through the stepper switch and the succeeding round is fired. Thus two adjacent rounds are fired with a single closing of the firing circuit. When both firing pins of the Mark 108 Launcher are touching the contact band of the spacer tube, at least one pin is always making contact and the firing mechanism functions properly.

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Rocket Launcher Mark 19 Mod O
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2

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APPENDIX D