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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO. 1126

ARMY R&D AIRCRAFT ROCKET FUZES

4th Partial Report

FUNCTIONING TEST OF P.D. ROCKET FUZE T-2027

FINAL Report

Copy No 8

Task

Assignment Chief of Ord. TAI-2704

Classification CONFIDENTIAL
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Functioning Test of P.D. Rocket Fuze T-2027
-----PART ASYNOPSIS

1. Picatinny Arsenal was requested by Army Ordnance on 26 October 1950 to develop a mechanical fuze for the 2.75 FEAR incorporating the clockwork type of arming mechanism found in the Navy Mk 176 fuze. It was further specified that the fuze should have a baffle delay type of detonator to provide impact functioning delay for defeat of aircraft.

Static tests at Picatinny Arsenal revealed that satisfactory delay times could be obtained when the baffle plates were removed from the delay detonator and that the standard deviation was decreased when this was done. Delay times of 539 microseconds were obtained with a standard deviation of 179 microseconds.

2. The objects of these tests were:

a. To determine the minimum thickness of aluminum target and maximum angle of obliquity against which the T-2027 fuze will function.

b. To determine the impact delay time against minimum and maximum target thickness.

c. To determine the impact delay times with the fuze conditioned at high and low temperatures.

3. It is concluded that the T-2027 fuze fired for target impact at velocities of approximately 2100 ft./second will:

a. Function with reasonable consistency on

(1) .020 or heavier aluminum alloy at 60° obliquity at ambient and elevated temperature.

(2) .080 or heavier aluminum alloy at 0° obliquity at -30°F.

(3) .250 aluminum alloy or mild steel at temperatures ranging from -30°F. to 130°F.

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b. When detonating after impact on targets #125 and thinner, usually have a delay greater than 500 microseconds, but when detonating on #250 and heavier targets often have a delay less than 500 microseconds.

4. It is recommended that work be continued on the development of a delay element for the T-2027 fuze that will not (1) have its impact sensitivity reduced at low temperatures, and (2) have its delay time reduced when subjected to heavy impacts.

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Functioning Test of P.D. Rocket Fuze T-2027
-----PART BINTRODUCTION

1. AUTHORITY:

These tests were conducted in accordance with Test Program Requests Nos. 3492, 3586 and 3609 of Picatinny Arsenal, submitted as enclosures to references (a), (b) and (c) respectively. Reference (d) authorized the conduct of the tests.

2. REFERENCES:

- a. Picatinny Arsenal Conf ltr ORDBB-TE2 471.94/64-170
S. H. Rush/aom/6175 of 4 Sep 1952 with OCO Conf
1st End ORDTA O.O.471.82/1603(c) J. I. Kistle/rw/77803
of 15 Sep 1952
- b. Picatinny Arsenal Conf ltr ORDBB-TE2 471.94/64-197
S. H. Rush/gjh/617 of 29 Dec 1952 with OCO Conf
1st End ORDTA O.O.471.82/1933(c) ORDBB-TE2 471.94/64-197
E. B. Andrews/pd/77803 of 6 Jan 1953
- c. Picatinny Arsenal Conf ltr ORDBB-TE2 471.94/90-3
S. H. Rush/gjh/6175 of 25 Feb 1953 with OCO Conf
1st End ORDTA O.O.471.82/135(c) E. B. Andrews/rw/53775
of 5 Mar 1953
- d. BUORD Restr ltr S78-1(26) Re2b-DBLaP:bjn of 11 Apr 1952

3. BACKGROUND:

Picatinny Arsenal was requested by Army Ordnance on 26 October 1950 to develop a mechanical fuze for the 2.75 FFAR incorporating the clockwork type of arming mechanism found in the Navy Mk 176 fuze. It was further specified that the fuze should have a baffle delay type of detonator to provide impact functioning delay for defeat of aircraft.

Static tests at Picatinny Arsenal revealed that satisfactory delay times could be obtained when the baffle plates were removed from the delay detonator and that the standard deviation was decreased when this was done. Delay times of 539 microseconds were obtained with a standard deviation of 179 microseconds.

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4. OBJECT OF TEST:

a. To determine the minimum thickness of aluminum target and maximum angle of obliquity against which the T-2027 fuze will function.

b. To determine the impact delay time against minimum and maximum target thickness.

c. To determine the impact delay times with the fuze conditioned at high and low temperatures.

5. PERIOD OF TEST:

a. Dates Project Letters	15 Sep 1952
	6 Jan 1953
	5 Mar 1953
b. Dates Necessary Material Received	13 Oct 1952 to
	2 Mar 1953
c. Date Commenced Test	4 Nov 1952
d. Date Test Completed	20 Mar 1953

6. REPRESENTATIVES PRESENT:

Mr. S. H. Rush

Picatinny Arsenal

PART C

DETAILS OF TEST

7. DESCRIPTION OF ITEM UNDER TEST:

a. The T-2027 fuze is essentially the same as the Navy Mk 176 or EX-100 fuze, shown as Figure 1. However, the explosive loading in the rotor has been changed as shown in Figure 2. In this fuze it consists of an obturated primer and detonator with an air gap between them.

b. The firing pin has also been modified so that it now has a hemispherical tip rather than a point. The T-2027 fuzes used in this test were actually made from Mk 176 fuzes having the revisions noted above incorporated in them.

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8. DESCRIPTION OF TEST EQUIPMENT:

Heads:	2#75 Mk 1 Mod 2, HBX-1 loaded and Comp B loaded
Motors:	5#0 Mk 10 Mod 5 (2 per round)
Head to Motor Adapters:	Aluminum, Picatinny Dwg. PX-8-539
Launcher:	NPG 1050 ft.
Targets:	#016 Aluminum 52SO Alloy, #020 to #250 aluminum 24ST alloy and #250 mild steel
Camera:	35mm Fastax
Velocity Measurements:	Solenoids with oscillograph
Fuze Delay Measurements:	#005 lead foil, photo-electric cell, Tektronix oscilloscope with Land Camera

Temperature conditioning equipment.

9. PROCEDURE:

a. Fuzes required to be fired at extreme temperatures were temperature conditioned in the loaded heads for 24 hours before firing. The 2#75 heads were assembled to 5" HVAR motors through the medium of special aluminum adapters. A second 5" HVAR motor was used in tandem as a "booster" to obtain higher striking velocities and increase the acceleration period of the rounds. This fuze requires a minimum acceleration of 20 G's to be maintained for at least one (1) second or it will not arm. The 5" HVAR motors were used rather than a 2#75 motor due to the short range available with this track which does not permit a 2#75 motor to attain full velocity. The targets were positioned 250 ft. beyond the muzzle of the 1050 ft. launcher during the first two (2) increments of the test and 400 ft. for the third.

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Functioning Test of P.D. Rocket Fuze T-2027

b. Fuze delays were obtained in three (3) ways:

(1) Visually - the absence of fragment marks on the face of an expended target after a high order detonation indicated that the fuze had some delay. Cardboard placed on the ground just beyond the target provided a rough indication of the amount of the delay by the location of the fragment marks in them.

(2) High Speed Camera - the 35mm Fastax Camera film, operated at 2500 frames per second, provides a slightly more accurate measurement of the fuze delay.

(3) Photo-electric cell and oscilloscope record - measurements were made from the photographed pattern of a Tektronix Type 513-D cathode-ray oscillograph. The oscillograph sweep was triggered by the impact of the rocket on a #002 lead foil contact screen secured to the face of the target (separated from the target by an insulating sheet of paper). A photoelectric cell set up near the target detected the detonation of the head. The burst signal was applied to the vertical deflection input of the oscillograph. The time from the beginning of the trace to the detonation signal represented the functioning delay time of the fuze.

10. RESULTS:

a. Detailed results of the firing are presented in Appendix (B). Appendix (C) consists of excerpts from typical movie records of the target impacts.

b. Following is a summary of the results obtained:

All rounds fired with impact velocities between 1900-2300 ft./sec.

Summary of Results

No. Rds. Fired	Target		Fuze Funct.		Delay	
	Thickness	Obl. -30°F.	HO	Dud	Microseconds	Inches
8	#040 Al	0°	1	7	697	36"
2	#064 Al	0°	-	2	---	---
3	#080 Al	0°	2	1	700 - 840	15"-18"
1	#125 Al	0°	1	-	640	12"
1	#250 Al	0°	1	-	---	6"
4	#250 mild steel	0°	3	1	---	2"-12"

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Functioning Test of P.D. Rocket Fuze T-2027

Summary of Results (Continued)

No. Rds. Fired	Target		Fuze Funct.		Delay	
	Thickness	Obl.	HO	Dud	Microseconds	Inches
		0°F				
2	#040 Al	0°	-	2	---	--
		Ambient				
2	#016 Al	0°	-	2		--
4	#020 Al	0°	2	2	697 - 789	--
7	#020 Al	60°	7	-	743 - 771	--
10	#032 Al	0°	8	2	558 - 794	--
2	#032 Al	60°	2	-	684	--
4	#250 Al	0°	4	-	342 - 403	--
4	#250 Al	60°	4	-	441 - 529	12"-36"
		130°F.				
6	#040 Al	0°	5	1	535 - 545	12"-24"

c. At low temperatures, 0°F. and -30°F., the T-2027 fuze did not function on targets as thin as it did at higher temperatures nor with as much reliability. At low temperatures, the fuze would not function satisfactorily on targets lighter than #080 aluminum (24 ST alloy). Functioning delay times after target impact were all above 500 microseconds on the rounds detonating.

d. At ambient and elevated temperatures, the fuze provided high order functioning with reasonable consistency on targets as light as #020 aluminum at 60° obliquity. Functioning delay times were above 500 microseconds on all except those rounds fired at #250 targets. It was also noted during the low temperature firing that extremely short delays were being obtained on the #250 targets. One (1) explanation of the reduced delay time on the heavier targets may be that the detonator is shifting forward upon impact deceleration and thereby decreasing the air gap between itself and the primer (Figure 2).

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Functioning Test of P.D. Rocket Fuze T-2027
-----PART DCONCLUSIONS

11. It is concluded that the T-2027 fuze fired for target impact at velocities of approximately 2100 ft./second will:

a. Function with reasonable consistency on

- (1) #020 or heavier aluminum alloy at 60° obliquity at ambient and elevated temperature.
- (2) #080 or heavier aluminum alloy at 0° obliquity at -30°F.
- (3) #250 aluminum alloy or mild steel at temperatures ranging from -30°F. to 130°F.

b. When detonating after impact on targets #125 and thinner, usually have a delay greater than 500 microseconds, but when detonating on #250 and heavier targets often have a delay less than 500 microseconds.

PART ERECOMMENDATIONS

12. It is recommended that work be continued on the development of a delay element for the T-2027 fuze that will not (1) have its impact sensitivity reduced at low temperatures, and (2) have its delay time reduced when subjected to heavy impacts.

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Functioning Test of P.D. Rocket Fuse T-2027

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

F. W. KASDORF, Rocket Battery Officer
Rocket Battery Division
Terminal Ballistics Department

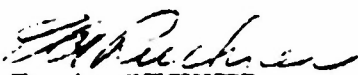
This report was prepared by:

F. W. KASDORF, Rocket Battery Officer
Rocket Battery Division
Terminal Ballistics Department

This report was reviewed by:

W. B. ROBERTSON, Lieutenant Commander, USN
Terminal Ballistics Officer
Terminal Ballistics Department
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Terminal Ballistics Department
C. C. BRAMBLE, Director of Research, Ordnance Group

APPROVED: J. F. BYRNE
Captain, USN
Commander, Naval Proving Ground


E. A. RUCKNER
Captain, USN
Ordnance Officer
By direction

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NPG REPORT NO. 1126

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Fourth Partial Report
on
Army R&D Aircraft Rocket Fuzes

Final Report
on
Functioning Test of P.D. Rocket Fuze T-2027

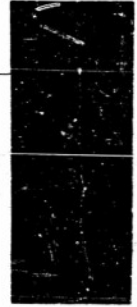
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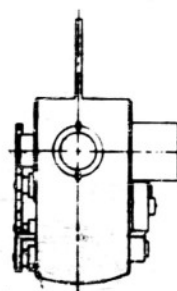
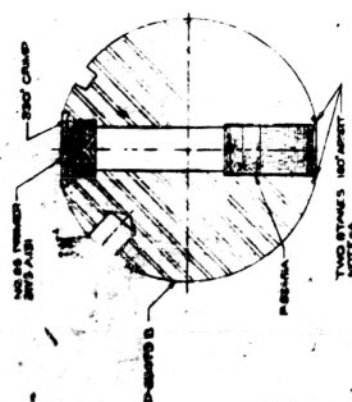
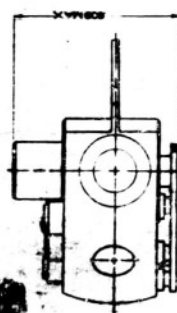
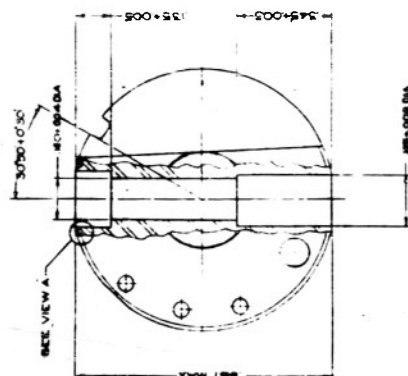
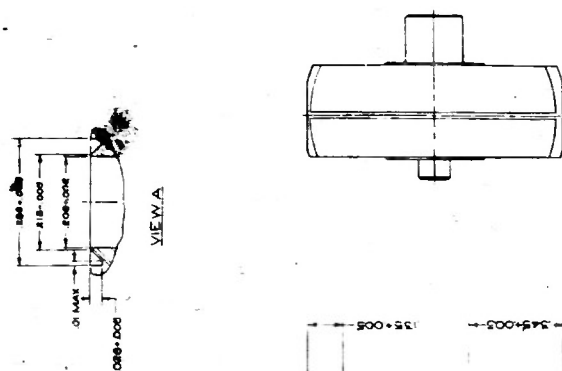
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Superior

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FOR FURTHER INFORMATION SEE
DRAWING BOARD 626821

LOADING ASSEMBLY P-83476A
FOR FURTHER INFORMATION SEE
DRAWING BUDD 457585

NOTES:
1. STAGERS MUST NOT PROTRUDE ABOVE SURFACE OF ROTOR

ON AND	LIST OF DRAWINGS	DRAWING NUMBER
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S. TRANSCORD AIRSIAL DWG
T- BUREAU OF ORIGINACE DEPT
OF THE NAVY DWG

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Figure 2

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NPG REPORT NO. 1126

Functioning Test of P.D. Rocket Fuze T-2027

TABLE ITEST PROGRAM REQUEST NO. 3492 (HBX-1 LOADED HEADS)

Firing Record of T-2027 P.D. fuze in 2475 rocket heads Mk 1-3
Fired from NPG 1050 ft. launcher with two (2) 5" HVAR Motors

Rd. No.	Date 1952	Temp. of Fuzed Head Deg. F.	Target - Al Thick Obl. Inches Deg.	Striking Velocity Ft./Sec.	Func- tioning	Delay Micro-Sec.
1	11-4	Ambient (60°)	.032 0	2009	HO	Missed
2	11-4		.016 0	2024	Dud	--
3	11-4		.032 0	2000	HO	704
4	11-4		.032 0	1979	HO	794
5	11-4		.032 0	2024	HO	575
6	11-4		.016 0	2032	Dud	--
7	11-5		.032 60	1962	HO	220
8	11-5		.032 60	1946	HO	684
9	11-5		.020 60	1984	HO	Inst.
10	11-5		.250 0	791*	--	--
11	11-5		.020 60	1982	HO	Inst.
12	11-5		.020 60	1996	HO	771
13	11-5		.250 0	N.T.	HO	394
14	11-5		.250 0	1986	HO	N.T.
15	11-5		.250 0	1976	HO	342
16	11-5		.020 60	1990	HO	Missed
17	11-5		.020 0	1996	Dud	--
18	11-7		.020 60	1946	HO	756
19	11-7		.020 0	1956	HO	789
20	11-7		.250 0	1944	HO	403
21	11-7		.020 0	1940	Dud	--
22	11-7		.020 60	1969	HO	743
23	11-7		.020 60	1969	HO	--
24	11-7		.020 0	1981	HO	697
25	11-7		.032 0	1914	Dud	--
26	11-7		.032 0	2002	Dud	--
27	11-7		.032 0	1958	HO	592
28	11-7		.032 0	1953	HO	640
29	11-7		.032 0	1973	HO	558
30	11-7		.032 0	N.T.	HO	Inst.

NOTES: Total Range to Target = 1315 Ft.

N.T. - Not Taken

Inst. - Oscilloscope Recorded Instantaneous Functioning

* Forward Motor did not burn; Malfunction

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Functioning Test of P.D. Rocket Fuze T-2027

TABLE II

TEST PROGRAM REQUEST NO. 3586 (HBX-1 LOADED HEADS)

Firing Record of T-2027 P.D. fuze in 2875 rocket heads Mk 1-3
 Fired from NPG 1050 ft. launcher with two (2) 5" HVAR Motors

Rd. No.	Date	Temp. of	Target - Al		Striking Velocity	Func-	Delay	
		Fuzed Head	Thick	Obl.			Micro-Sec.	Inches
No.	1953	Deg. F.	Inches	Deg.	Ft./Sec.	tioning		
1	1-29	Amb.	.250	60	1969	HO	Missed	36
2	1-29	Amb.	.250	60	1946	HO	529	36
3	1-29	130	.040	0	1982	HO	535	12
4	1-29	130	.040	0	1947	HO	545	12
5	1-29	130	.040	0	1951	Dud	--	--
6	1-29	130	.040	0	1938	HO	Missed	12
7	1-29	130	.040	0	1952	HO	545	12
8	1-29	Amb.	.250	60	1962	HO	441	12
9	1-29	130	.040	0	1992	HO	545	24
10	1-30	Amb.	.250	60	1917	HO	Missed	36
11	1-30	-30	.040	0	1923	Dud	--	--
12	1-30	-30	.040	0	1966	Dud	--	--
13	1-30	-30	.040	0	1927	Dud	--	--
14	1-30	-30	.040	0	2030	Dud	--	--
15	1-30	-30	.040	0	1969	HO	697	36
16	1-30	-30	.040	0	1935	Dud	--	--
17	2-6	0	.040	0	2154	Dud	--	--
18	2-6	0	.040	0	2181	Dud	--	--

NOTE: Total Range to Target = 1315 Ft.

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Functioning Test of P.D. Rocket Fuze T-2027

TABLE III

TEST PROGRAM REQUEST NO. 3609 (COMP. B LOADED HEADS)

Firing Record of T-2027 P.D. fuze in 2875 rocket heads Mk 1-3
Fired from NPG 1050 ft. launcher with two (2) 5" HVAR Motors

Rd. No.	Date	Temp. of		Target		Cbl. Deg.	Striking Velocity Ft./Sec.	Func- tioning	Delay *	
		Fuzed Head	Thick Inches	First	Second				Micro-Sec.	Inches
	1953	Deg. F.				Deg.				
1	3-19	-30	.040	.250	0		1923	HO -.250	---	6
2	3-19	-30	.040	.250*	0		2093	HO -.250	---	3
3	3-19	-30	.125	.250x	0		N.T.	HO -.125	640	12
4	3-19	-30	.080	.250x	0		2009	HO -.080	840	15
5	3-19	-30	.080	.250x	0		2304	Dud	---	--
6	3-19	-30	.064	.250x	0		2215	HO -.250	---	12
7	3-20	-30	.080	.250x	0		2239	HO -.080	700	18
8	3-20	-30	.064	.250x	0		2163	HO -.250	---	2

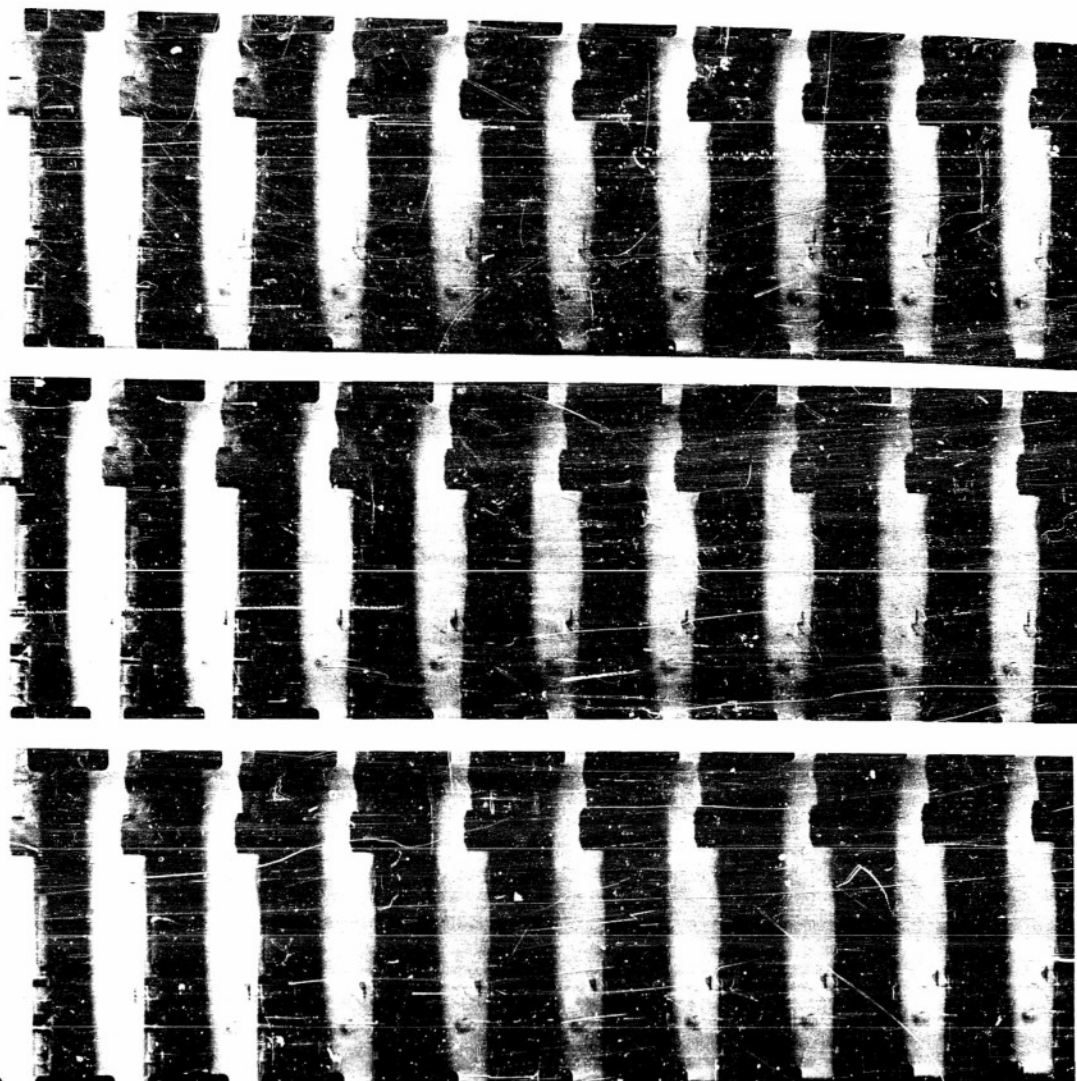
NOTE: *Photo-Electric Cell Trained on First Target Only.
When Fuze Functioned on second target no Oscillograph
Record of Delay was obtained.
x These Targets were Mild Steel Plates, all others Aluminum.

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NP 1-2027 P.D. rocket fuze in 2975 rocket head
Experimental ballistic test of T-2027 P.D. rocket fuze in 2975 rocket head
HBX-1 loaded. Fired from 1050 ft. launcher. View: Round No. 21 bn TPR 3492.
Dud operation on 4020 aluminum target at 0° obliquity at 1940 ft./sec.
Date fired: 7 November 1952. Figure 3



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P.D. rocket fuze in 9975 rocket head in
launcher. View: Round No. 19 on RPT 3492.

Obliquity at 1956 ft./sec. Fuze

November 1952

Figure 4

ballistic test of T-202
fired from 1050 ft. launcher. View: Round No. 19 on RPT 3492.

Obliquity at 1956 ft./sec. Fuze

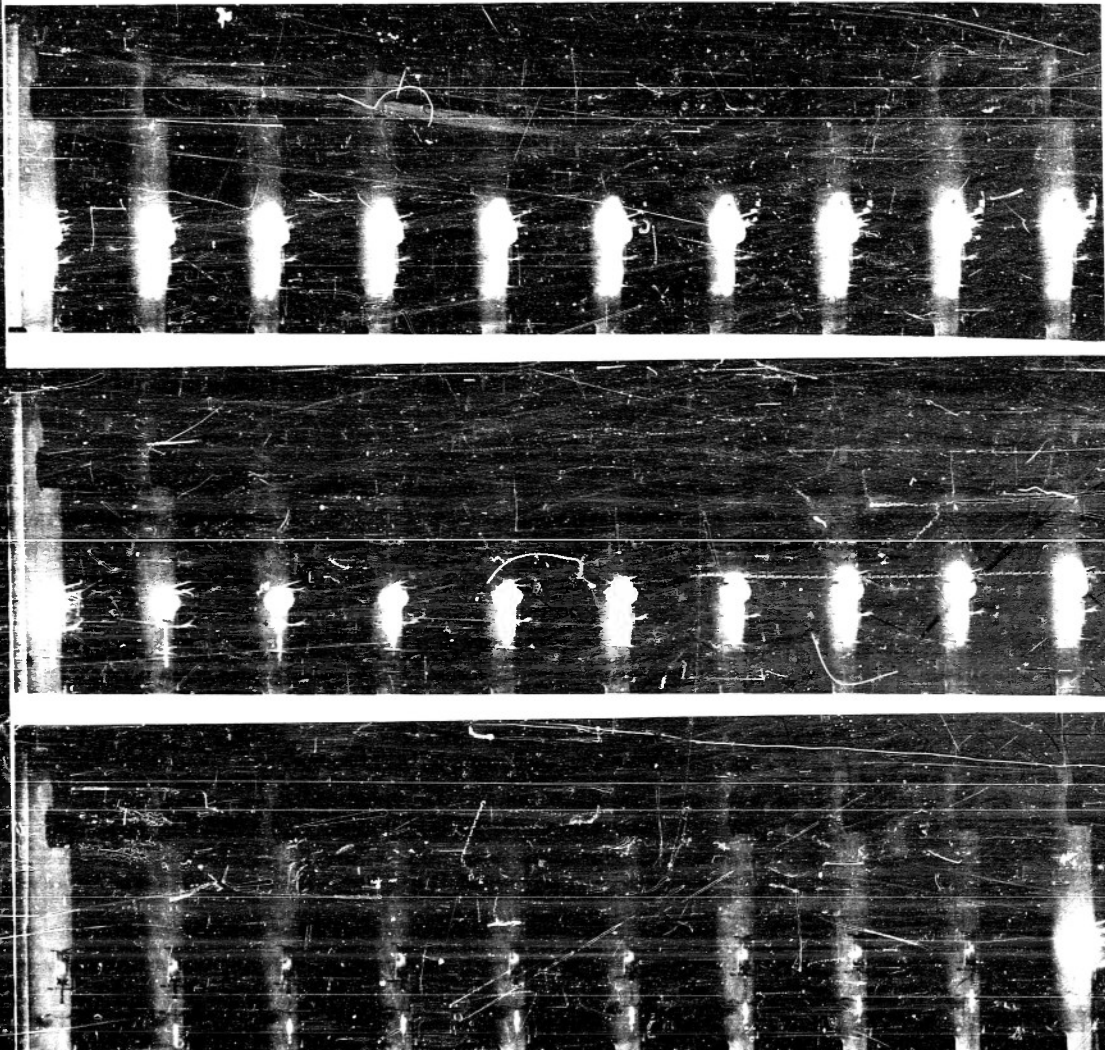
November 1952



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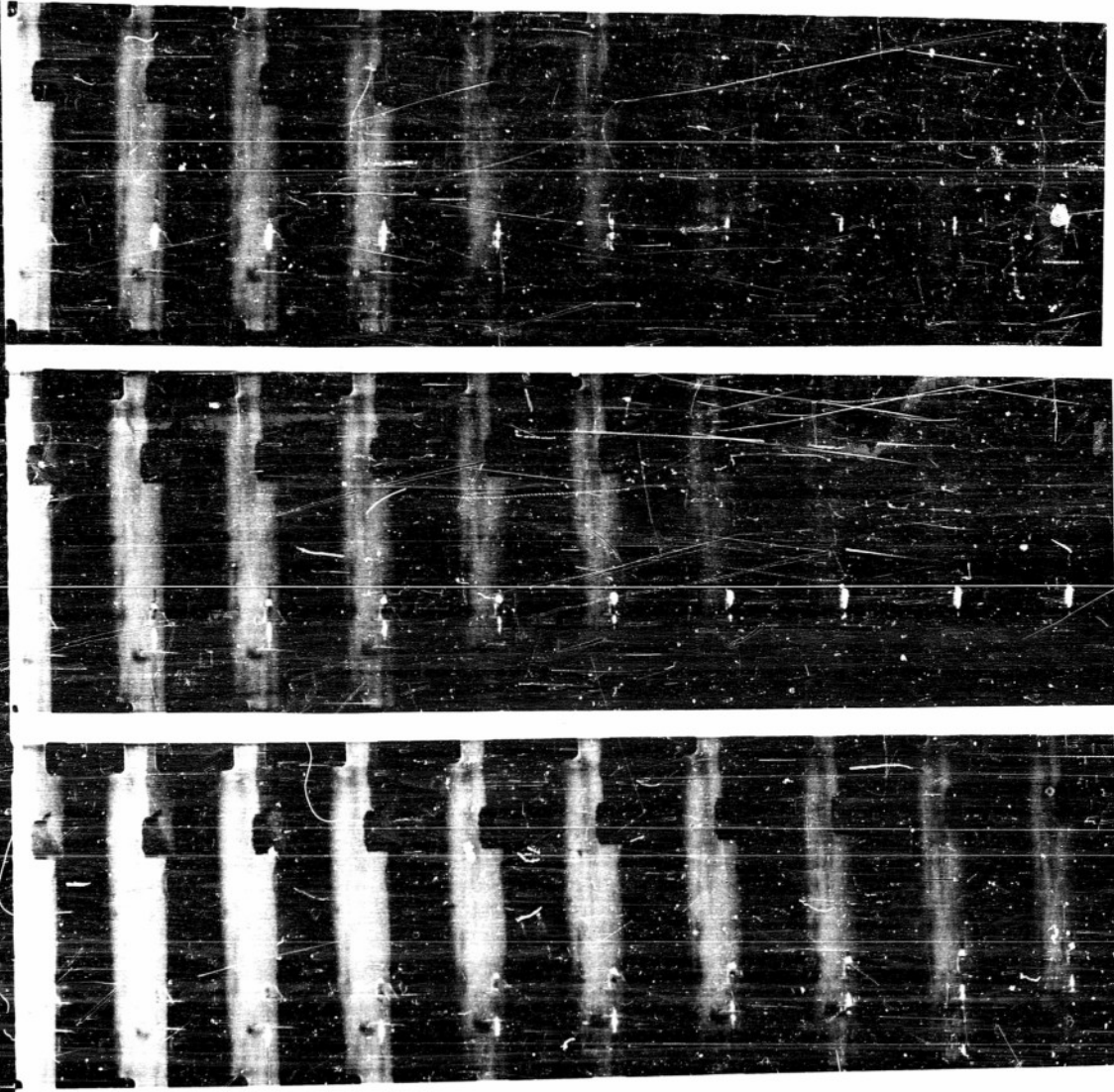
Proc. 21
Experimental ballistic test of T-2027 P.D. rocket fuze in 2075 rocket head
fired from 1050 ft. launcher. View: Round No. 1 on TPR/3402.
Operation on W020 aluminum target at 60° obliquity at 1946 ft./sec. Fuze
delay 750 micro-seconds. Date Fired: 7 November 1952

Figure 5



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NPC-6112
Experimental ballistic test of T-2027 P.D. rocket fuze in 2"75 rocket head
HBX-1 loaded. Fired from 1050 ft. launcher. View: Round No. 26 on TPR 3492.
Dut. Deviation on 1032 aluminum target at 0° obliquity at 200 ft./sec.
Date Fired: 7 November 1952

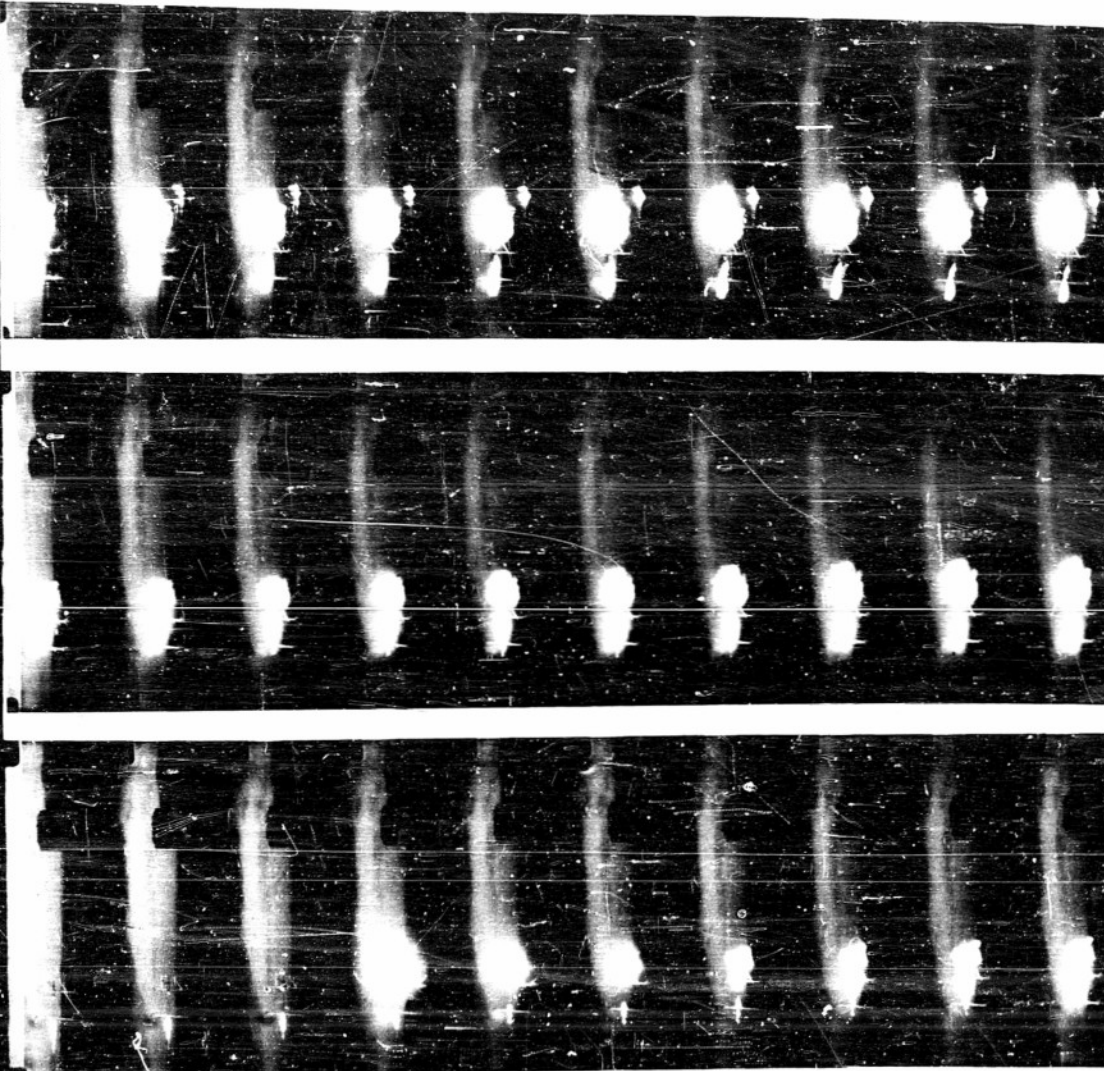


NFC-32323

Experimental ballistic test of T-2027 P.D. rocket fuze in 2W75 rocket head HBX-1 loader. Fired from 1050 ft. launcher. View: Round No. 27 on TPR 3452. HO operation on #032 aluminum target at 0° obliquity at 1958 ft./sec. Fuze delay 592 micro-seconds. Date fired: 7 November 1952 Figure 7

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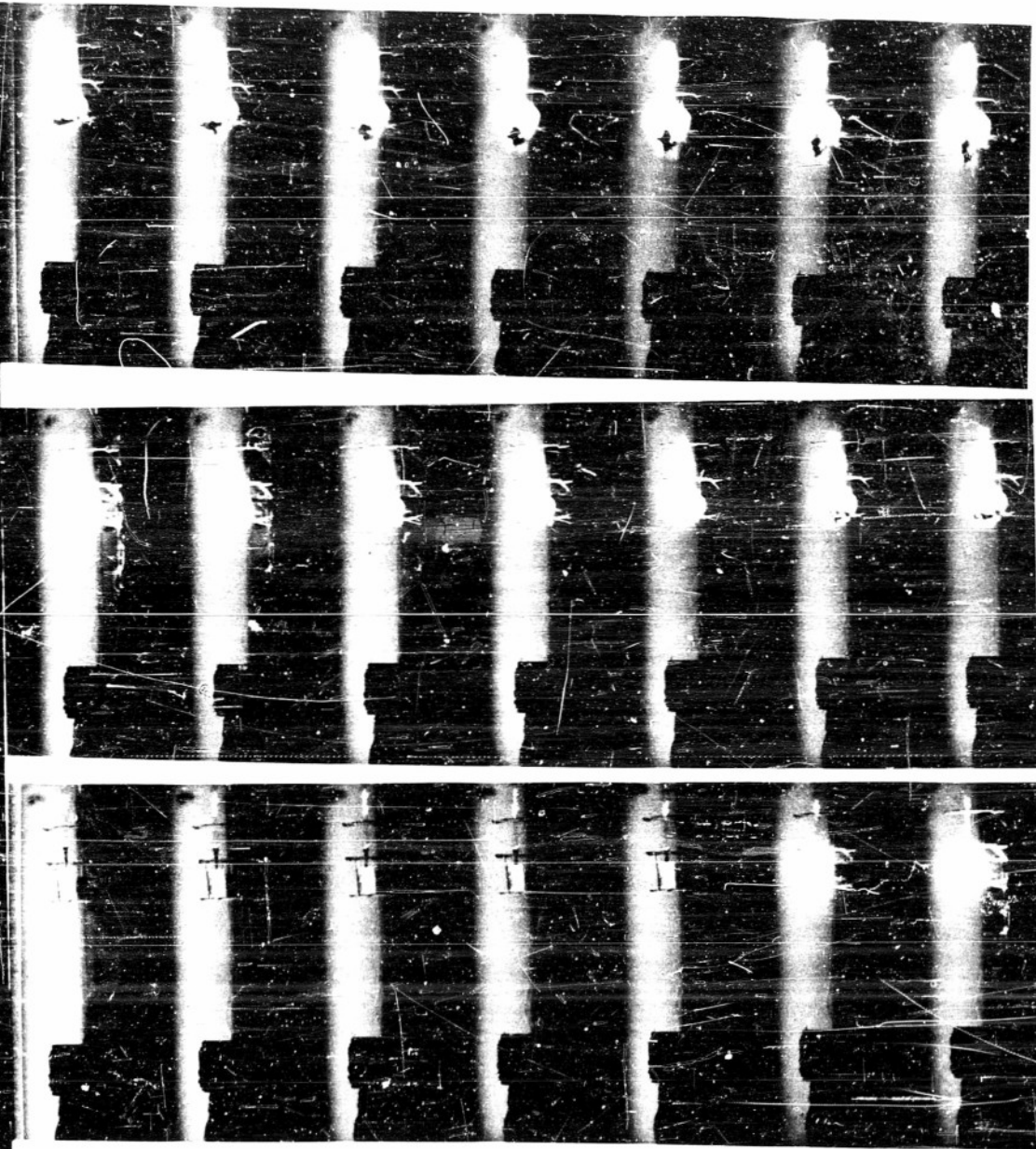
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NP9-62824
Experimental ballistic test of T-2027 P.D. rocket fuze in 2"75 rocket head.
Fired from 1050 ft. launcher. View: Round No. 8 on TPR 3492.
HMX-1 loaded.
HO operation on M032 aluminum target at 60° obliquity at 1946 ft./sec. Fuze
delay 634 micro-seconds. Date fired: 5 November 1952

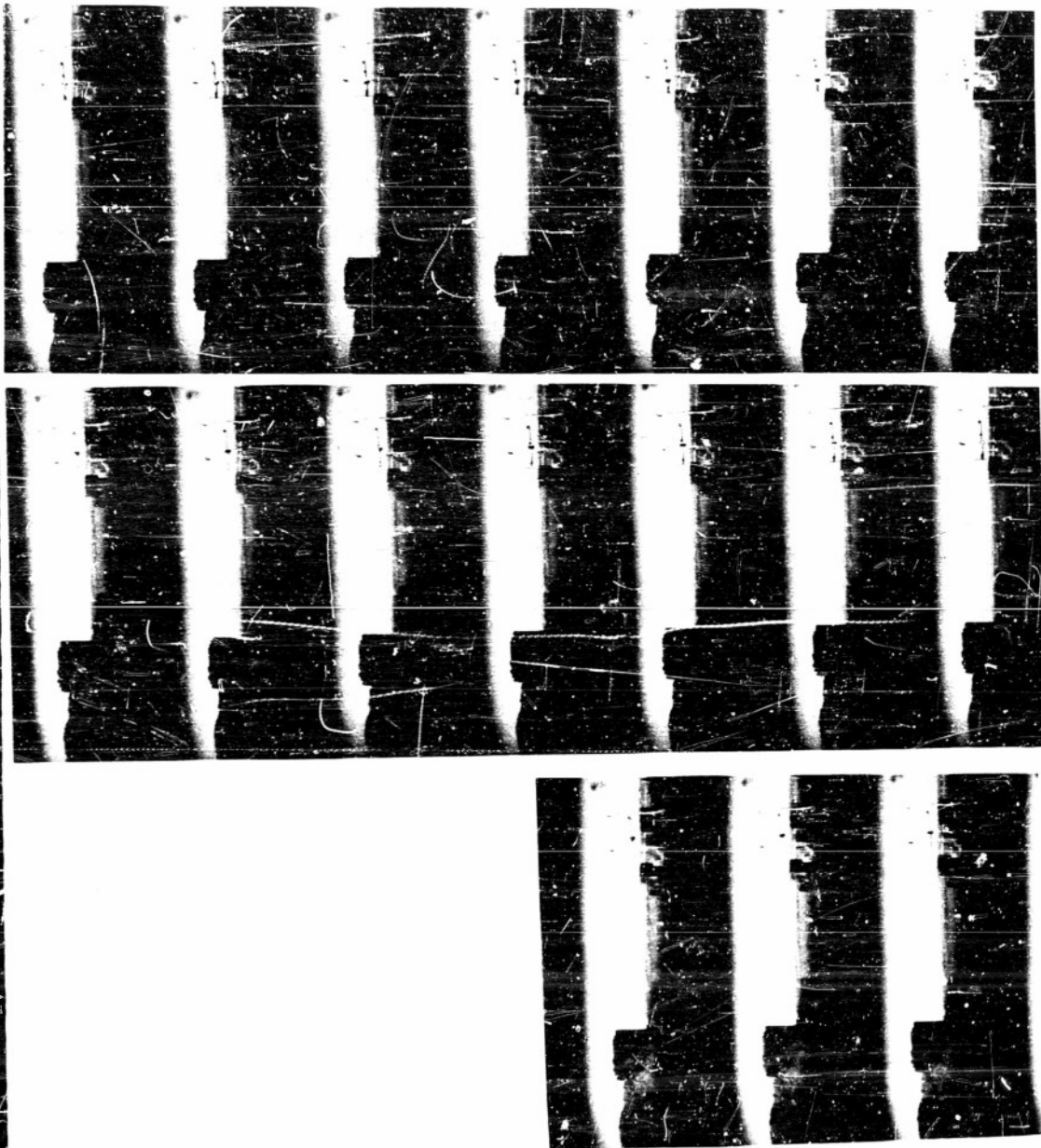
Figure 8



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NP9-52225
Experimental ballistic test of T-2027 P.D. rocket fuze in 2"75 rocket head.
HBX-1 loaded. Fired from 1050 ft. launcher. View: Round No. 10 on RPH 3492.
Dud operation on #250 aluminum target at 0° obliquity at 791 ft./second.
Forward motor did not fire so fuze did not receive sufficient acceleration to
arm. Date Fired: 5 November 1952

Figure 9



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NP9-60126
Experimental ballistic test of T-2027 P.D. rocket fuze in 2475 rocket head HEX-1 loaded. Fired from 1050 ft. launcher. View: Round No. 20 on TPR 1492. HQ operation on #250 aluminum target at 0° obliquity at 1944 ft./second. Fuze delay 403 micro-seconds. Date Fired: 7 November 1952

Figure 10

