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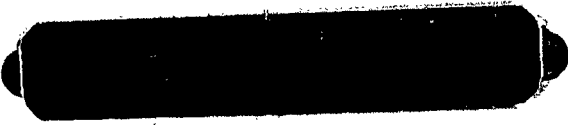
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U S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO. 1156

ARMY R&D AIRCRAFT ROCKET FUZES

5th Partial Report

DEVELOPMENT TEST OF P.D. ROCKET FUZE T-2025E2

FINAL Report Task
Assignment Chief of Ord. TA1-2704

Copy No. 5 Classification CONFIDENTIAL
SECURITY INFORMATION

Development Test of P.D. Rocket Fuze T-2025E2
-----PART ASYNOPSIS

1. The first design of the T-2025 fuze, which incorporated an electric detonator, proved to be unsatisfactory from the standpoint of impact sensitivity and delay time after impact. The fuze was then redesigned, with a stab-type detonator in lieu of the electric detonator. This was designated as the T2025E1 fuze. The plate firing tests of the T-2025E1 fuze conducted at the Naval Proving Ground indicated erratic functioning on 24ST aluminum alloy targets ranging in thickness from #032 to #500. Since the Navy Mk 176 fuze for the 2#75 FFAR Rocket essentially meets all the requirements of the T-2025E1 fuze, it was decided to terminate the development of the T-2025E1 fuze and apply all effort toward the development of the T-2025E2 fuze which contains a self destruction feature. The Magnavox Co. of Fort Wayne, Indiana, are the designers and manufacturers of this fuze.

2. The present series of tests was conducted on the T-2025E2 fuze to determine:

- a. Sensitivity
- b. Delay in detonation on target impact
- c. Functioning ability when subjected to oblique impacts

3. It is concluded that the T-2025E2 fuze:

- a. Will function on 24ST aluminum alloy targets as light as #032 in thickness.
- b. Functioned on #500 aluminum alloy targets with a delay time of approximately 300 microseconds.
- c. Will function on a light aluminum target (#032) at 60° obliquity.

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Development Test of P.D. Rocket Fuze T-2025E2

Because of the small number of rounds fired, the results of this test should not be considered as significant until further performance data can be compiled. Steel head-to-motor adapters, rather than aluminum, should be used in future tests of this type versus 1/4" and heavier metal targets to prevent adapter and motor breakup.

4. In view of the limited data appearing to be available, it is recommended that a test program be set up to determine the maximum penetration ability of the 2.75 rocket head Mk 1 versus steel and aluminum targets at all obliquities.

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Development Test of P.D. Rocket Fuze T-2025E2

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Development Test of P.D. Rocket Fuze T-2025E2
-----PART BINTRODUCTION

1. AUTHORITY:

This test was conducted in accordance with Picatinny Arsenal Test Program Request No. 3578 enclosed with reference (b). Authorization for the test was granted by reference (a).

2. REFERENCES:

- a. BUORD rest ltr S78-1(26) Re2b-DBL:ap of 11 Apr 1952
- b. DA, ORD 0 ltr to NAVPROV, ORDTA O.O. 471.82/1907(c)
E. B. ANDREWS/pd/77803 of 22 Dec 1952
- c. NPG Report No. 1023 of 2 Sep 1952
- d. NPG Report No. 1081 of 28 Jan 1952
- e. ORDTA Dispatch to NAVPROV 272000Z of Jan 1953

3. BACKGROUND:

The first design of the T-2025 fuze, which incorporated an electric detonator, proved to be unsatisfactory from the standpoint of impact sensitivity and delay time after impact (reference (c)). The fuze was then redesigned, with a stab-type detonator in lieu of the electric detonator. This was designated as the T-2025E1 fuze. The T-2025E1 plate firing tests conducted at the Naval Proving Ground indicated erratic functioning on 24ST aluminum alloy targets ranging in thickness from #032 to #500 (reference (d)). Since the Navy Mk 176 fuze for the 2475 FPAR Rocket essentially meets all the requirements of the T-2025E1 fuze, it was decided to terminate the development of the T-2025E1 fuze and apply all effort toward the development of the T-2025E2 fuze which contains a self destruction feature. The Magnavox Co. of Fort Wayne, Indiana, are the designers and manufacturers of this fuze.

4. OBJECT OF TEST:

The object of this test was to determine the sensitivity, delay in detonation on target, and functioning at high obliquities of the T-2025E2 fuze.

Development Test of P.D. Rocket Fuze T-2025E2

5. PERIOD OF TEST:

a. Date Project Letter	22 Dec 1952
b. Date Necessary Material Received	14 Jan 1953
c. Date Commenced Test	22 Jan 1953
d. Date Test Completed	8 May 1953

6. REPRESENTATIVE PRESENT:

C. L. Hardwick	Magnavox Company
----------------	------------------

PART CDETAILS OF TEST

7. DESCRIPTION OF ITEM UNDER TEST:

The fifteen P.D. T-2025E2 fuzes received for this test from Picatinny Arsenal were modified so that they could be armed prior to firing. This was believed necessary since launcher vibration might interfere with the arming mechanism normally employed. The removal of a small pin from the side of the fuze body permitted the spring loaded rotor to move to the in-line position. This operation was done remotely after the round was in the launcher. A drawing of the launcher armed fuze with a description of operation may be found in Figure 1. Figure 2 shows a cut-away view of the fuze. The fuzes used in this test did not contain the self destruction feature.

Development Test of P.D. Rocket Fuze T-2025E2

8. DESCRIPTION OF TEST EQUIPMENT:

Equipment used in the fuze functioning test consisted of:

NPG 1050 ft. rocket launcher

- 9 - 2#75 rocket heads Mk 1, modified for and loaded with black powder spotting charges
- 6 - 2#75 rocket heads Mk 1, HBX-1 loaded
- 15 - 2#75 head to 5" HVAR motor adapters, Dwg. PX-8-539
- 15 - 5" HVAR motors (Temp. 70°F)
- !032, !375, and !500 24ST aluminum alloy targets
- 1 - 35mm Fastax motion picture camera

Electronic equipment for measurement of fuze functioning delay

9. PROCEDURE:

a. The 2#75 rocket heads Mk 1 containing the T-2025E2 fuzes were assembled to 5" HVAR motors by means of special adapters and fired from the NPG 1050 ft. launcher. Various thicknesses of 24ST aluminum alloy targets were placed 265 feet from the muzzle end of the launcher. The first three rounds fired contained 3 ounces of black powder in the head as a spotting charge, designed to test the safety of the fuze on the guided launcher. The remaining rocket heads were to be loaded with 1.4 lbs. of HBX-1 explosive. However, the ninth round prematurely detonated on the launcher causing extensive damage. Therefore, when the test was resumed in April, the remaining six fuzes were tested in smoke-puff loaded heads.

Development Test of P.D. Rocket Fuze T-2025E2

b. After the round was placed on the launcher it was prearmed by withdrawing the safety arming pin by means of a lanyard pulled from an adjacent steel shelter. Fuze functioning times were measured with a unit containing an oscilloscope and photo-electric detector by measuring the time from the contact of the nose of the fuze with the plate to the detonation of the head. The contact of the nose with the plate was sensed by means of a contact screen consisting of a sheet of 0.002 lead foil over the striking area of the target. The foil was insulated from the plate by means of a sheet of paper. Circuit closure triggered the sweep of the cathode ray oscilloscope. The flash of the detonation was then detected by the photo-electric cell and applied to the vertical deflection input of the oscilloscope. The time from the beginning of the trace to the burst signal represented the functioning time of the fuze. Striking velocities were obtained by firing through solenoids and recording the impulses on an oscillograph record. A 35mm Fastax Camera, operating at approximately 3000 frames/second, recorded all impacts to determine fuze action.

10. RESULTS AND DISCUSSION:

a. The results of the T-2025E2 fuze functioning test against 24ST aluminum are summarized below:

HBX-1 Loaded Heads

<u>No. of Rds.</u>	<u>Target Thickness</u>	<u>Obliquity</u>	<u>Fuze Action</u>
2	!500	0°	2 HO
3	!375	0°	1 HO, 2 Duds
1	!032	0°	HO on launcher

Black Powder Loaded Heads

<u>No. of Rds.</u>	<u>Target Thickness</u>	<u>Obliquity</u>	<u>Fuze Action</u>
4	!032	0°	3 HO, 1 Dud
1	!032	60°	HO
2	!375	60°	2 HO
2	!375	0°	1 HO*, 1 Dud

* No film record but visually observed as a HO.

Development Test of P.D. Rocket Fuze T-2025E2

b. On the ninth round there was a premature detonation on the guided launcher after approximately 1000 ft. of rocket travel. Figure 3 shows the damage that resulted. It is believed that launcher vibration caused the firing pin detent to move sufficiently to free the firing pin and fire the fuze. The test was temporarily discontinued at this time.

c. The HBX-1 loaded heads fired against the #375 and #500 targets displayed a yellow-white smoke upon detonation indicating a possible low order. By reference (e) three of the 2#75 rocket heads Mk 1 were statically detonated without fuzes to compare the detonation characteristics with those fired off the launcher. Photographs and fragment velocity measurements of the static detonations indicated that these three rounds fired high order (Figure 8). The statically detonated rounds produced a grayish black smoke differing in appearance from the launcher fired rounds.

d. Film records of the smoke-puff loaded rounds also gave some evidence that the 2#75 rocket head Mk 1 might have deflagrated on impact with #375 aluminum at 0° and 60° obliquity. Fuze action on round 13 had visually been determined as high order at the time of the test, however, photographs show that the black powder actually had spilled from the head and partially ignited and no fuze action was present (Figure 12). Four inert heads were then given a penetration test with the following results:

<u>Rd. No.</u>	<u>24ST A1 Thickness</u>	<u>Obliquity</u>	<u>Velocity (ft/sec)</u>	<u>Penetration</u>	<u>Results</u>
1	#375	60°	1814	Complete	See below
2	#375	60°	1773	Complete	See below
3	#375	60°	Missed	Complete	See below
4	#375	60°	1783	Complete	See below

All heads were assembled to 5" HVAR motors by aluminum adapters and fired from the NPG 1050 ft. launcher. The heads were inert loaded to a point 4" below the forward face of the head. The head used on round 2 had four 5/8" holes drilled through the side wall approximately 3-1/2" from the forward face to permit emission of a smoke-puff. The other three heads were not drilled. A steel nose plug was used in place of the fuze. The condition of the heads after penetration was determined by photographs from a ballistic synchro and 35mm Fastax camera behind the target. Camera results (Figures 14-17) clearly indicate the aluminum head-to-motor adapter

Development Test of P.D. Rocket Fuze T-2025E2

has shattered resulting in a break up of the motor tube. No conclusions can be reached from the photographs as to the condition of the head. Additional penetration data should be obtained on the ability of the 2#75 Mk 1 head to penetrate targets heavier than 1/4" aluminum at high obliquities. Little data appear to exist on the penetration ability of the head at the present time. Table I gives the results of the fuze functioning test by rounds and Figures 4-7 and 9-13 show the action as recorded by a 35mm Fastax Camera.

PART DCONCLUSIONS

11. It is concluded that the T-2025E2 fuze:

- a. Will function on 24ST aluminum alloy targets as light as #032 in thickness.
- b. Functioned on #500 aluminum alloy targets with a delay time of approximately 300 microseconds.
- c. Will function on a light aluminum target (#032) at a 60° obliquity.

Because of the small number of rounds fired, the results of this test should not be considered as significant until further performance data can be compiled. Steel head-to-motor adapters, rather than aluminum, should be used in further tests of this type versus 1/4" and heavier metal targets to prevent adapter and motor break up.

PART ERECOMMENDATIONS

12. In view of the limited data appearing to be available, it is recommended that a test program be set up to determine the maximum penetration ability of the 2#75 rocket head Mk 1 versus steel and aluminum targets at all obliquities.

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Development Test of P.D. Rocket Fuze T-2025E2

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

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Rocket Battery Division
Terminal Ballistics Department

This report was prepared by:

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Rocket Battery Division
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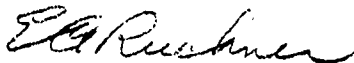
This report was reviewed by:

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NPG REPORT NO. 1156

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Fifth Partial Report

on

Army R&D Aircraft Rocket Fuzes

Final Report

on

Development Test of P.D. Rocket Fuze T-2025E2

Project No.: Chief of Ord. TA1-2704
Copy No.: 5
No. of Pages: 10

Date: **AUG 24 1953**

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TABLE I

**IMPACT FUNCTIONING RESULTS OF T-2025E2 FUZE
IN 2.75 ROCKET HEAD MK 1**

Dates Fired: 22 Jan 1953
28 Apr 1953

Rd. No.	Fuze No.	Head Loading	24ST Al Thickness	Obliquity	Striking Velocity (ft/sec)	Fuze Action	Fuze Delay Microseconds
1	13	Black Powder	.032	0°	Missed	HO	---
2	14	Black Powder	.032	60°	1743	HO	---
3	15	Black Powder	.032	0°	1714	HO	---
4	1	HBX-1	.500	0°	Missed	HO	300 ± 40
5	2	HBX-1	.500	0°	Missed	HO	290 ± 40
6	3	HBX-1	.375	0°	1680	HO	Missed
7	4	HBX-1	.375	0°	1680	Dud	---
8	5	HBX-1	.375	0°	1684	Dud	---
9	6	HBX-1	.032	0°	--	HO on launcher	---
10	11	Black Powder	.032	0°	Missed	HO	---
11	12	Black Powder	.032	0°	Missed	Dud (HO on water)	---
12	9	Black Powder	.375	60°	1783	HO	---
13	7	Black Powder	.375	0°	1780	Dud	---
14	8	Black Powder	.375	60°	1762	HO	---
15	10	Black Powder	.375	0°	Missed	*HO	---

NOTE: All rounds fired from NPG 1050 ft. launcher with single 5" HVAR motor Mk 10 Mod 6 at ambient temperature (70°F) with aluminum head-to-motor adapters.

Due to insufficient light given off by the detonation of the black powder loaded heads, delay time measurements were not taken on these rounds.

* No film record but visually observed as HO.

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NP9-63113

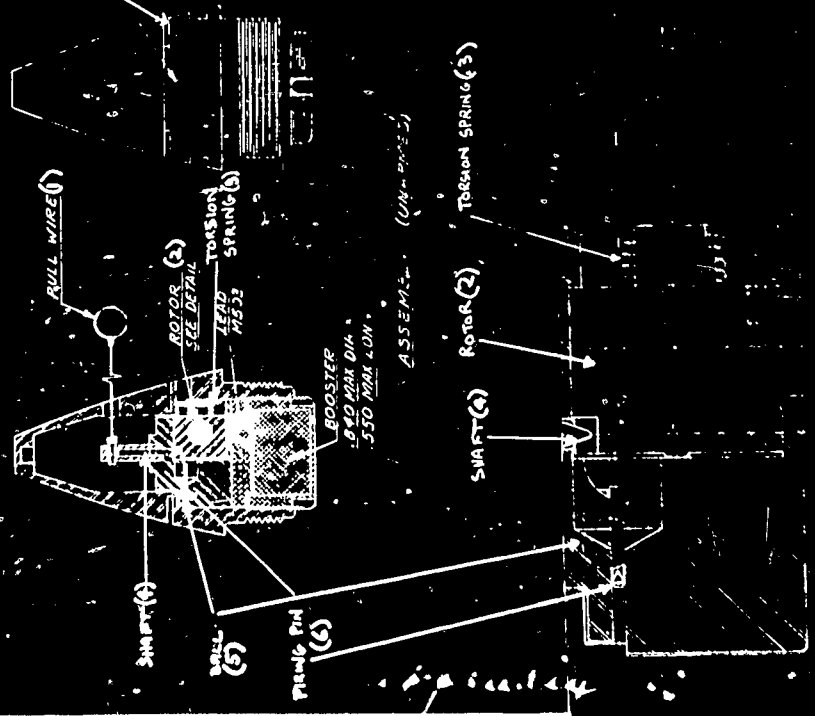
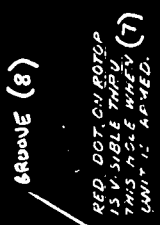
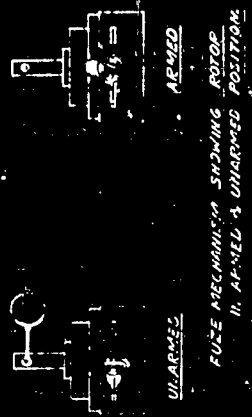
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NP9-63113

MECHANISM OF OPERATION

The fuse operates in the following manner: removal of the pull wire (1) permits the rotor (2) to move to the in-line position. This is accomplished by the coiled spring (3) acting through a series of curved pivots (4) to move forward. When the rotor (2) moves forward, the positive ending of the tube in the rotor (2) is vertical through the hole (7) in the primer. Upon striking a target, the groove (8) causes collapse of the nose section of the fuse, in turn causing the rotor (2) to be swept below the firing pin (6), thus releasing the firing pin. The firing pin is a continuation of the torsion spring (9) and delay on target (6-20") is obtained by the time necessary for the firing pin to move and strike the I26 primer.

DIMENSIONS IN INCHES



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SCALE: ACTUAL SIZE

MATERIAL	PART OR GROUPING	REFERENCE	PART	DESCRIPTION
ON 8				
LAUNCHER-ARMED FUZE				
FIRST MADE FOR THE U.S. ARMY				
DRAWN BY 1-2-4-27 17-2-4 CHECKED				
THE MACHAVOX COMPANY				
FORT WAYNE, INDIANA, U.S.A.				
1912072				

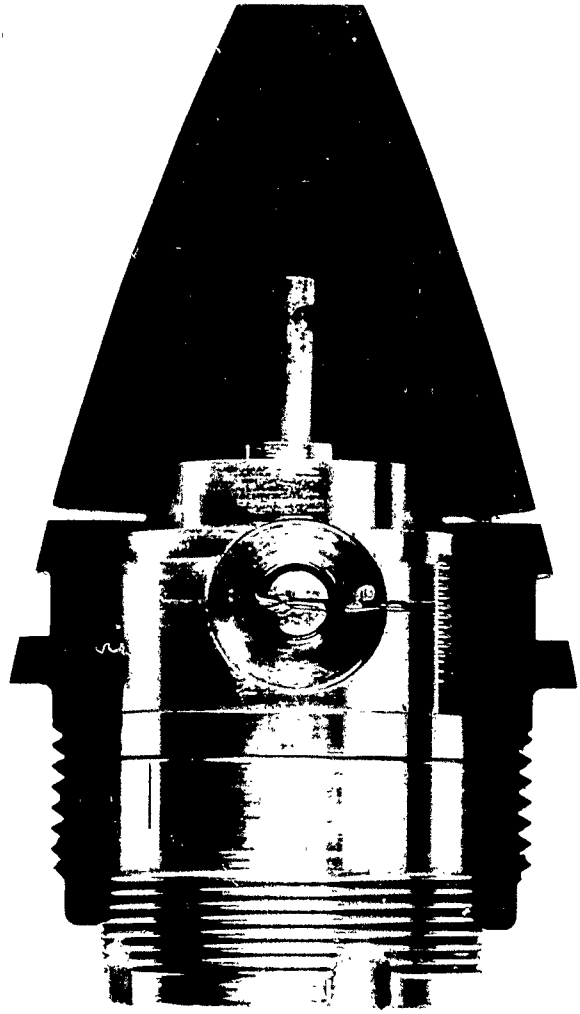
FIGURE 1

ENLARGED VIEW OF ROTOR AND FIRING PIN ARRANGEMENT

B

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NP9-63114 22 January 1953
View of partially sectioned T-2025E2 P.D. fuze for 2.75 rocket.
Figure 2



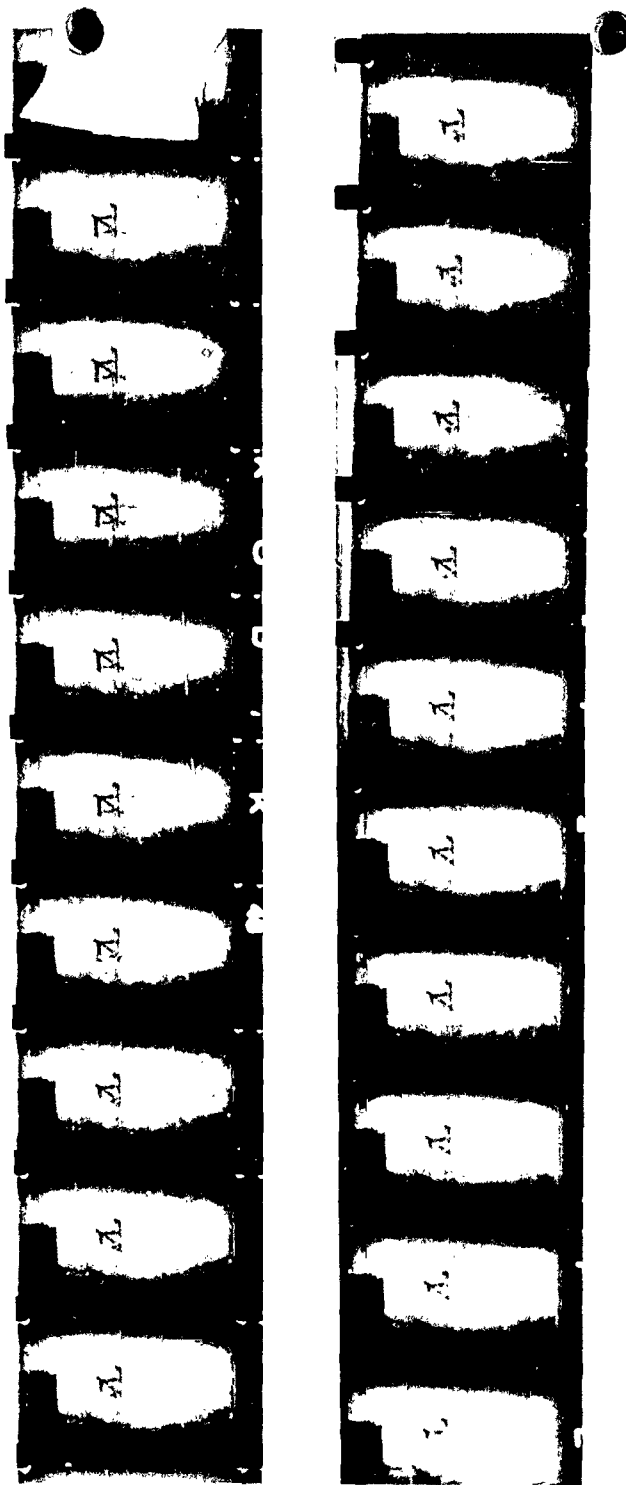
Appendix B

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NP9-52123 22 January 1953 rocket launcher on 22 January 1953 during test of T-2025E2
Casualty to NPG 1050 ft. rocket launcher on 22 January 1953 during test of T-2025E2
P.D. fuze in 2175 rocket head HBX-1 loaded. View: South side of launcher in 1016 ft.
region showing damage in direction of rocket travel.
Figure 3

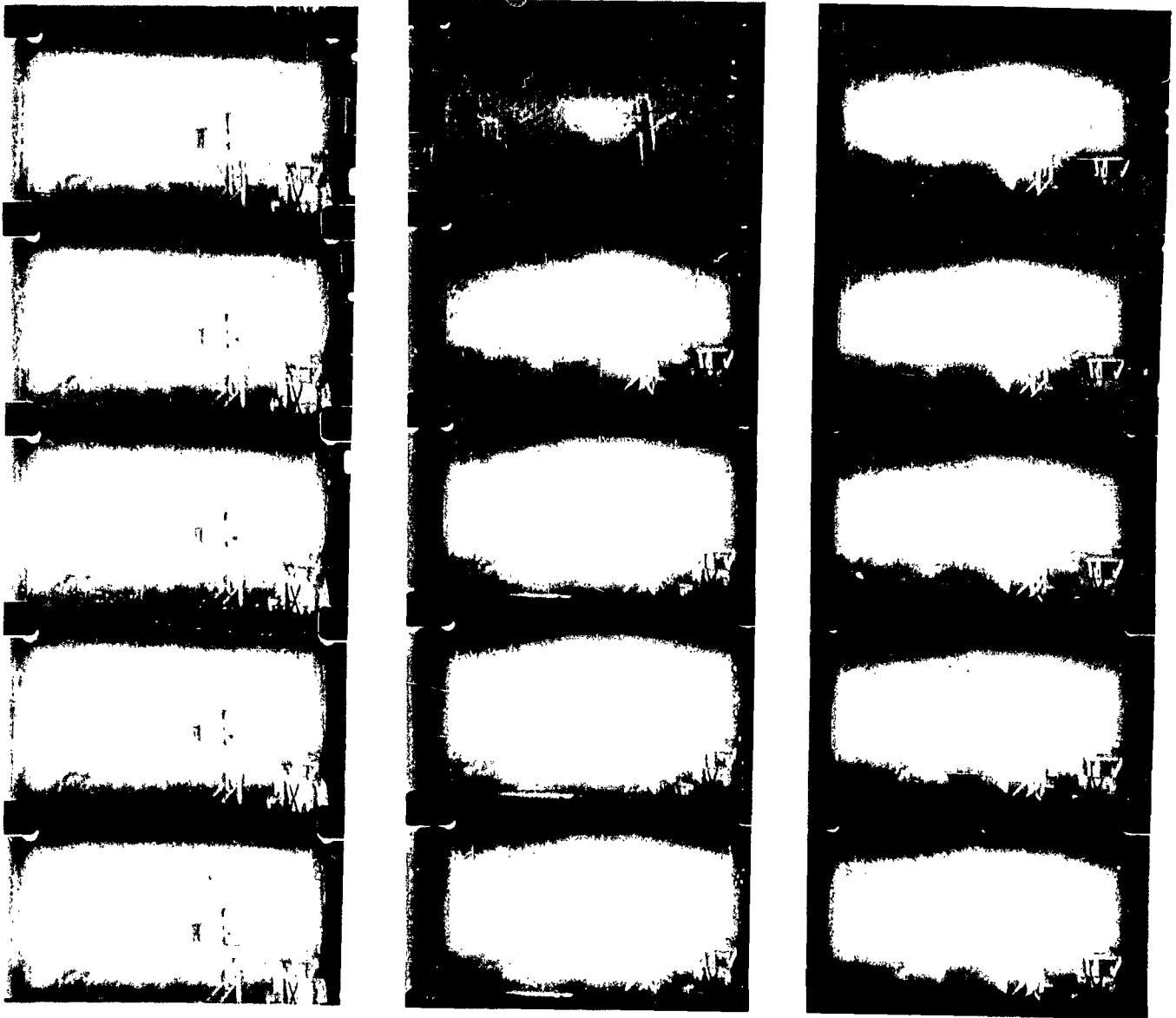


APPENDIX B



NP9-63115 22 January 1953 CONFIDENTIAL
Functioning Test of T2025E2 P.D. fuze for 2"75 rocket. Fired SECURITY INFORMATION
from NPG 1050 ft. launcher with 5" HVAR motor. View: Rd. 3 -
Impact of rocket on 7032 aluminum, 24ST alloy at 0° obliquity.
Striking Velocity: 1714 ft/sec. Fuze Action: HO (Black powder
loaded head). Figure 4

APPENDIX B

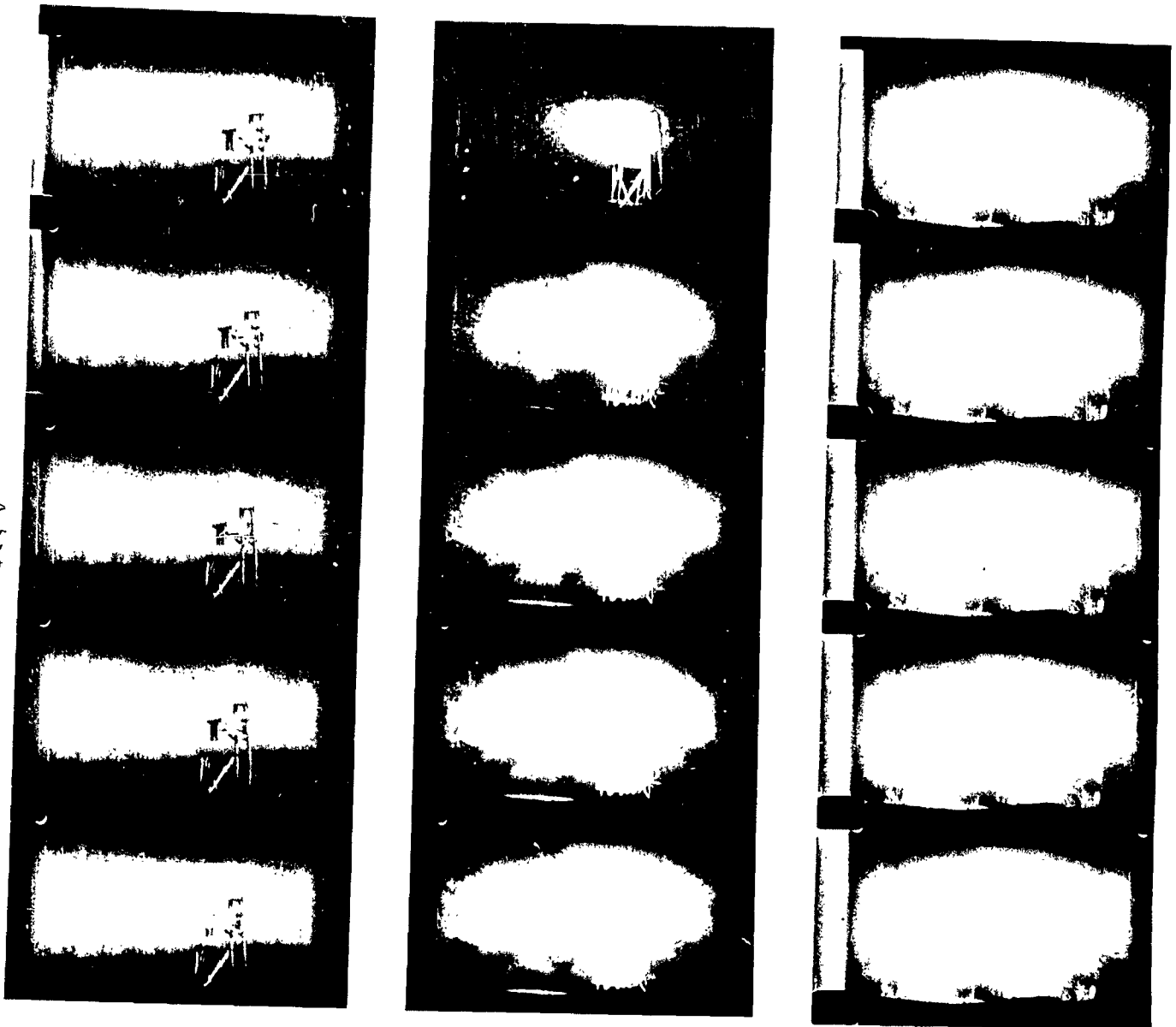


NP9-63116 22 January 1953
Functioning Test of T2025E2 P.D. fuze for 2"75 rocket. Fired
from NPG 1050 ft. launcher with 5" HVAR motor. View: Rd. 4 -
Impact of rocket on #500 aluminum, 24ST alloy at 0° obliquity.
Striking Velocity: Approximately 1700 ft/sec. Fuze Action: HO
(HBX-1 loaded). Fuze Delay: 300±40 microseconds.

Figure 5

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APPENDIX B



NP9-63117 22 January 1953
Functioning Test of T2025E2 P.D. fuze for 2"75 rocket. Fired
from NPG 1050 ft. launcher with 5" HVAR motor. View: Rd. 5 -
Impact of rocket on #500 aluminum, 24ST alloy at 0° obliquity.
Striking Velocity: Approximately 1700 ft/sec. Fuze Action: HO
(HBX-1 loaded). Fuze Delay: 290±40 microseconds.

Figure 6

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APPENDIX 8



NP9-63118 22 January 1953
Functioning Test of T2025E2 P.D. fuze for 2.75 rocket. Fired from NPG 1050 ft. launcher with 5" HVAR motor. View: Rd. 6 - Impact of rocket on .375 aluminum, 24ST alloy at 0° obliquity. Striking Velocity: 1680 ft/sec. Fuze Action: HO (HBX-1 loaded).
Figure 7

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APPENDIX B



NP9-63119

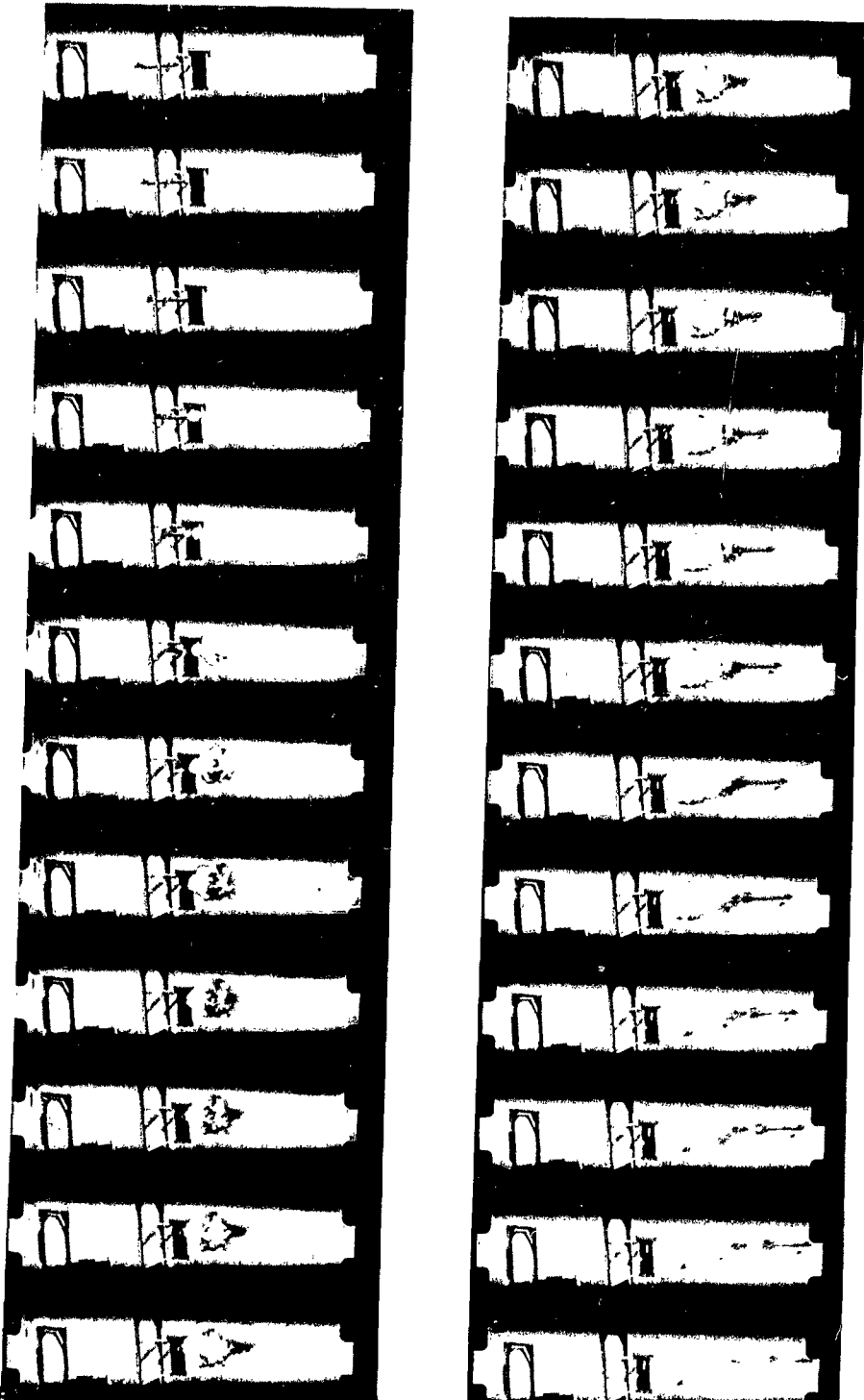
5 February 1953

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View of static detonation of 2#75 rocket head Mk 1, HBX-1 loaded.
The head did not contain a fuze. Explosive Action: High order.

Figure 8



NP9-63515

28 April 1953

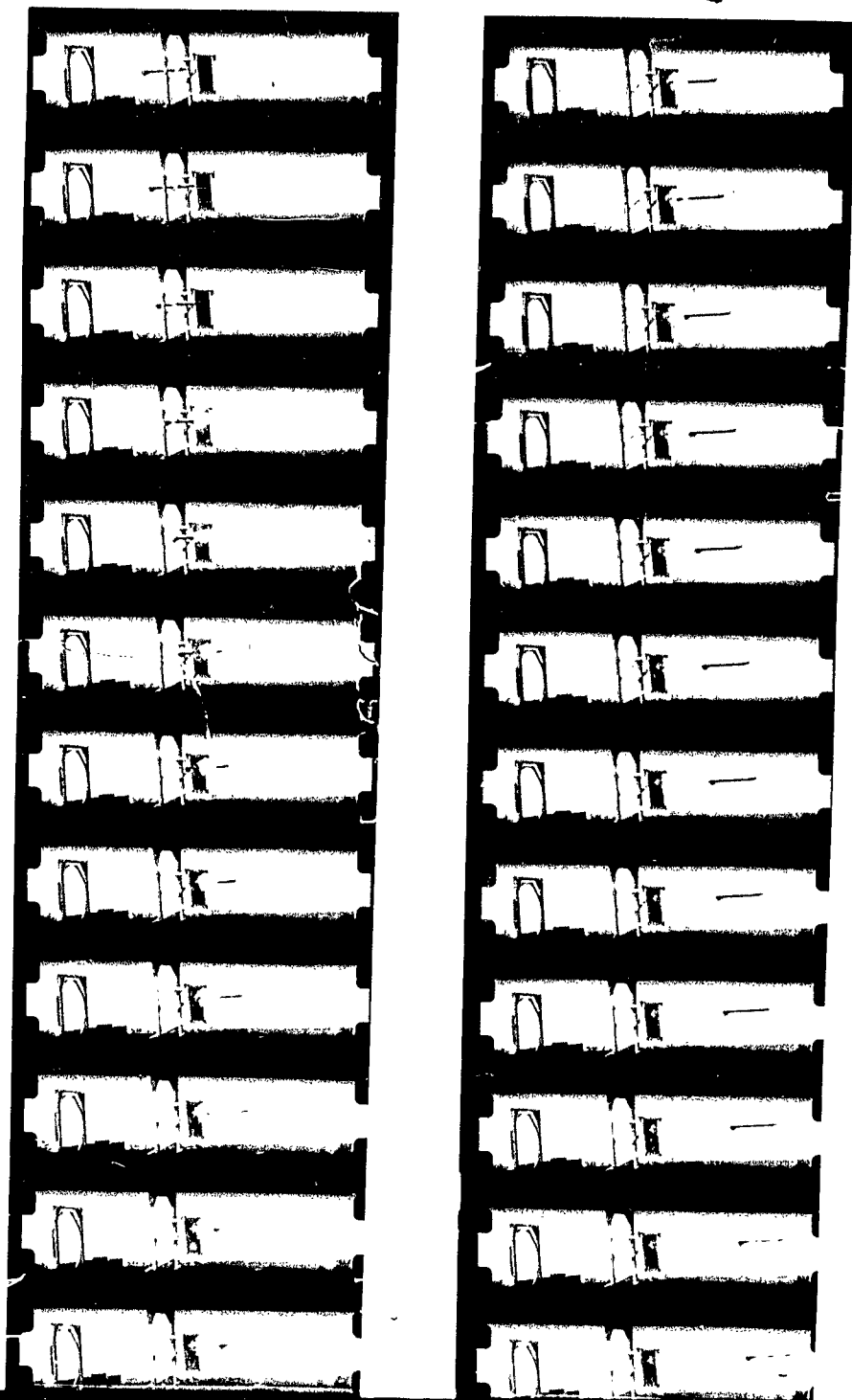
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Functioning Test of T2025E2 P.D. Fuze for 2775 rocket. Fired from NPG 1050 ft. launcher with 5" HVAR motor. View: Rd. 10 - Impact of rocket on 7032 aluminum, 24ST alloy at 0° obliquity. Striking Velocity approximately 1700 ft/sec. Fuse Action: HO (Black powder loaded head).

Figure 9

SECURITY INFORMATION

2775 rocket. Fired from NPG 1050 ft. launcher with 5" HVAR motor. View: Rd. 10 - Impact of rocket on 7032 aluminum, 24ST alloy at 0° obliquity. Striking Velocity approximately 1700 ft/sec. Fuse Action: HO (Black powder loaded head).



NP9-63516 28 April 1953
Functioning Test of T2025E2 P.D. Fuze for 2875 rocket. Fired from
NPG 1050 ft. launcher with 5" HVAR motor. View: Rd. 11 - Impact
of rocket on 7032 aluminum, 24ST alloy at 0° obliquity. Striking
Velocity approximately 1700 ft/sec. Fuze Action: DUD.
Figure 10

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NP9-63517

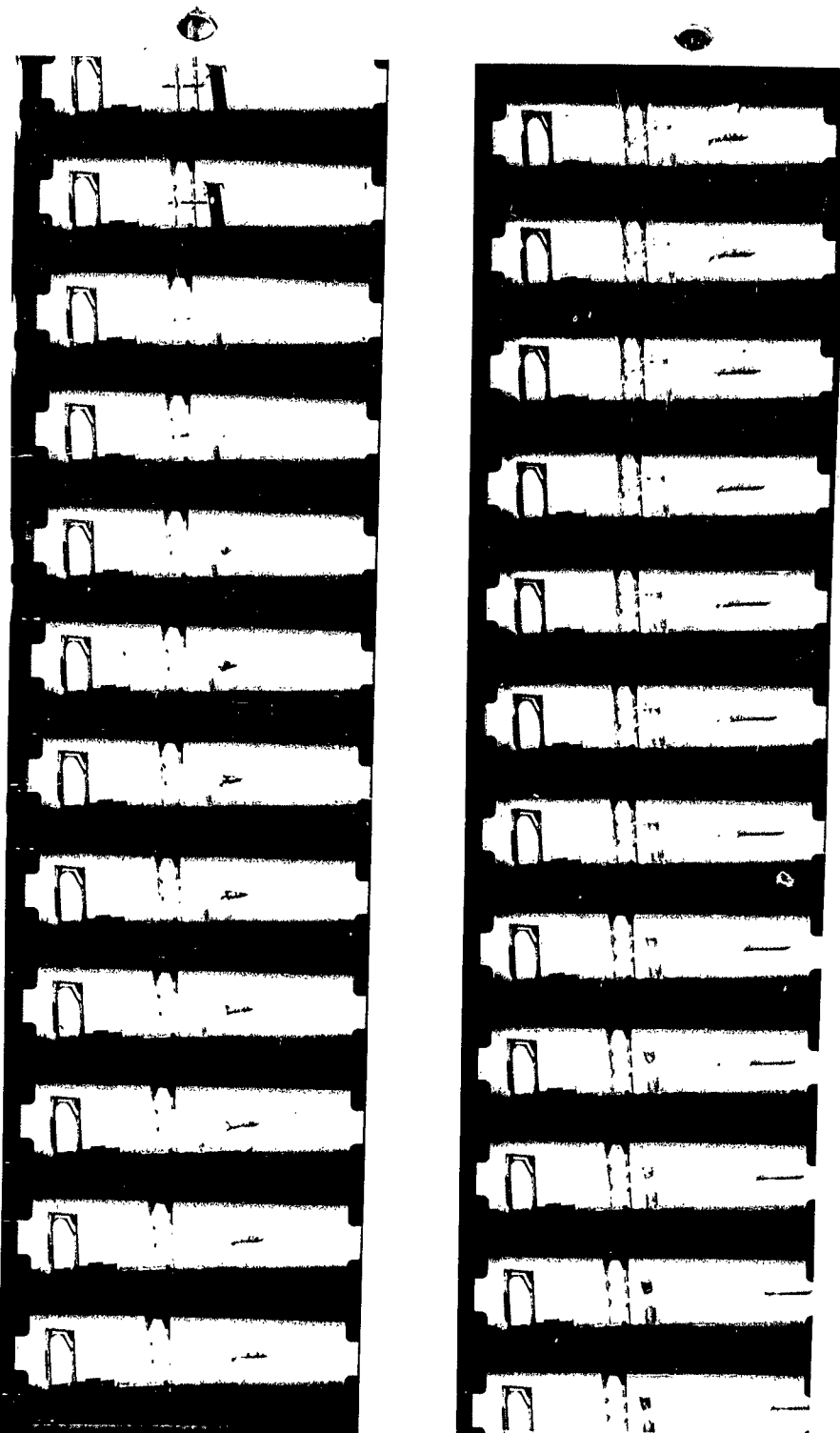
28 April 1953

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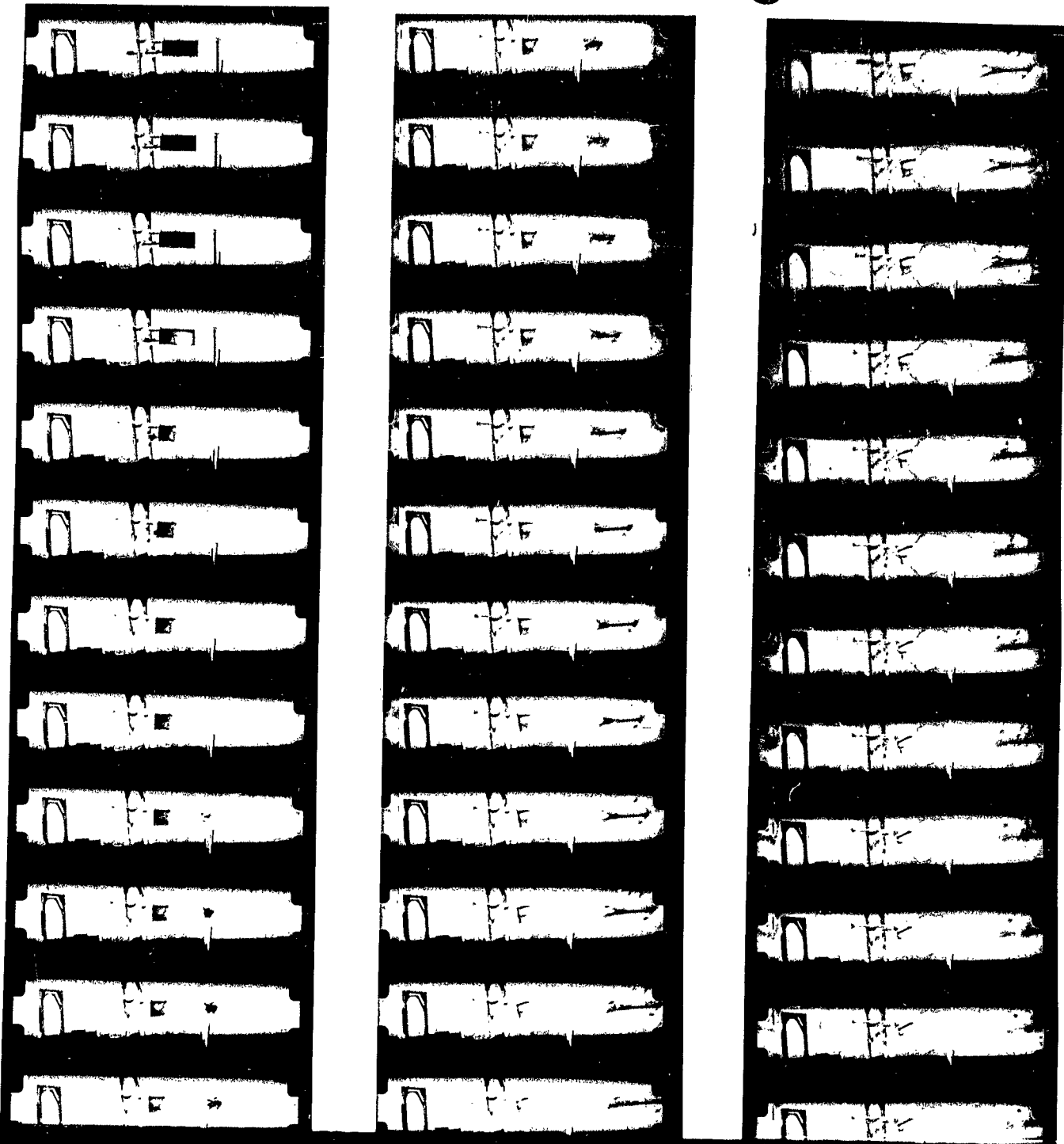
SECURITY INFORMATION

Functioning Test of T2025E2 P.D. Fuze for 2875 rocket. Fired from NPG 1050 ft. launcher with 5" HVAR motor. View: Rd. 12 - Impact of rocket on 375 aluminum, 24ST alloy at 60° obliquity. Striking Velocity 1783 ft/sec. Fuze Action: HO (Black powder loaded head).

Figure 11



NP9-63518 28 April 1953 CONFIDENTIAL
Functioning Test of T2025E2 P.D. Fuze for 2775 rocket. Fired from SECURITY INFORMATION
NPG 1050 ft. launcher with 5" HVAR motor. View: Rd. 13 - Impact
of rocket on 7375 aluminum, 24ST alloy at 0° obliquity. Striking
Velocity 1780 ft/sec. Fuze Action: DUD.
Figure 12



NP9-63519

28 April 1953

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SECURITY INFORMATION

Functioning Test of T2025E2 P.D. Fuze for 2 7/8" rocket. Fired from NPG 1050 ft. launcher with 5" HVAR motor. View: Rd. 14 - Impact of rocket on 3/4" 375 aluminum, 24ST alloy at 60° obliquity. Striking Velocity 1762 ft/sec. Fuze Action: HO (Black powder loaded head).

Figure 13

PC-0520

5 May 1953

Penetration test of inert 2875 Mk I rocket head against "375 aluminum, 24ST alloy at 30° Celsius. Fired from 1050 ft. launcher with 5" HVAR motor, Striking Velocity approximately 1,000 ft/sec. View shows Ballistic Synchro pictures of Nos. 1 and 2 about 1/2 sec. behind the target plate. The aluminum head-to-motor adapter has shattered resulting in a breaking of the motor. The condition of the head cannot be determined from these pictures.

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SECURITY INFORMATION

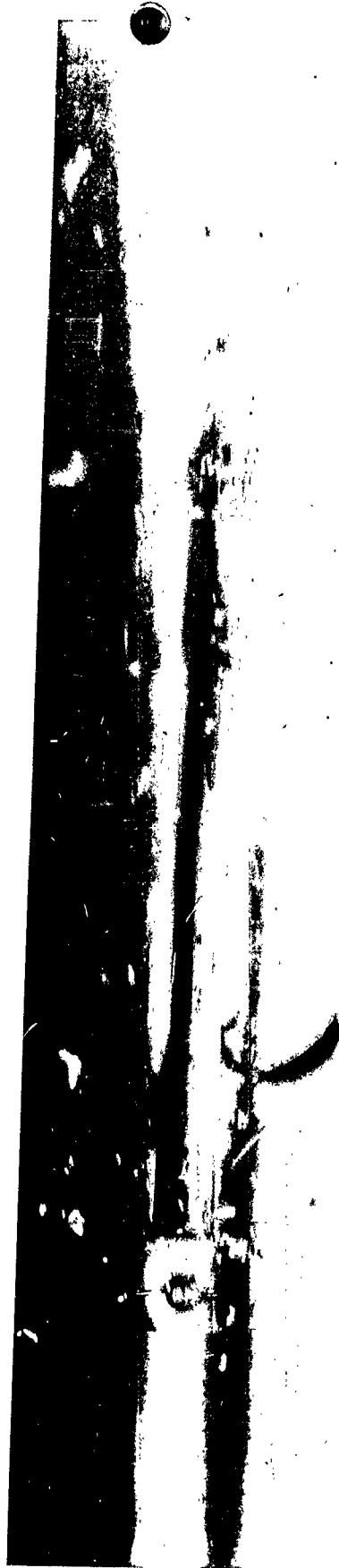


Figure 14

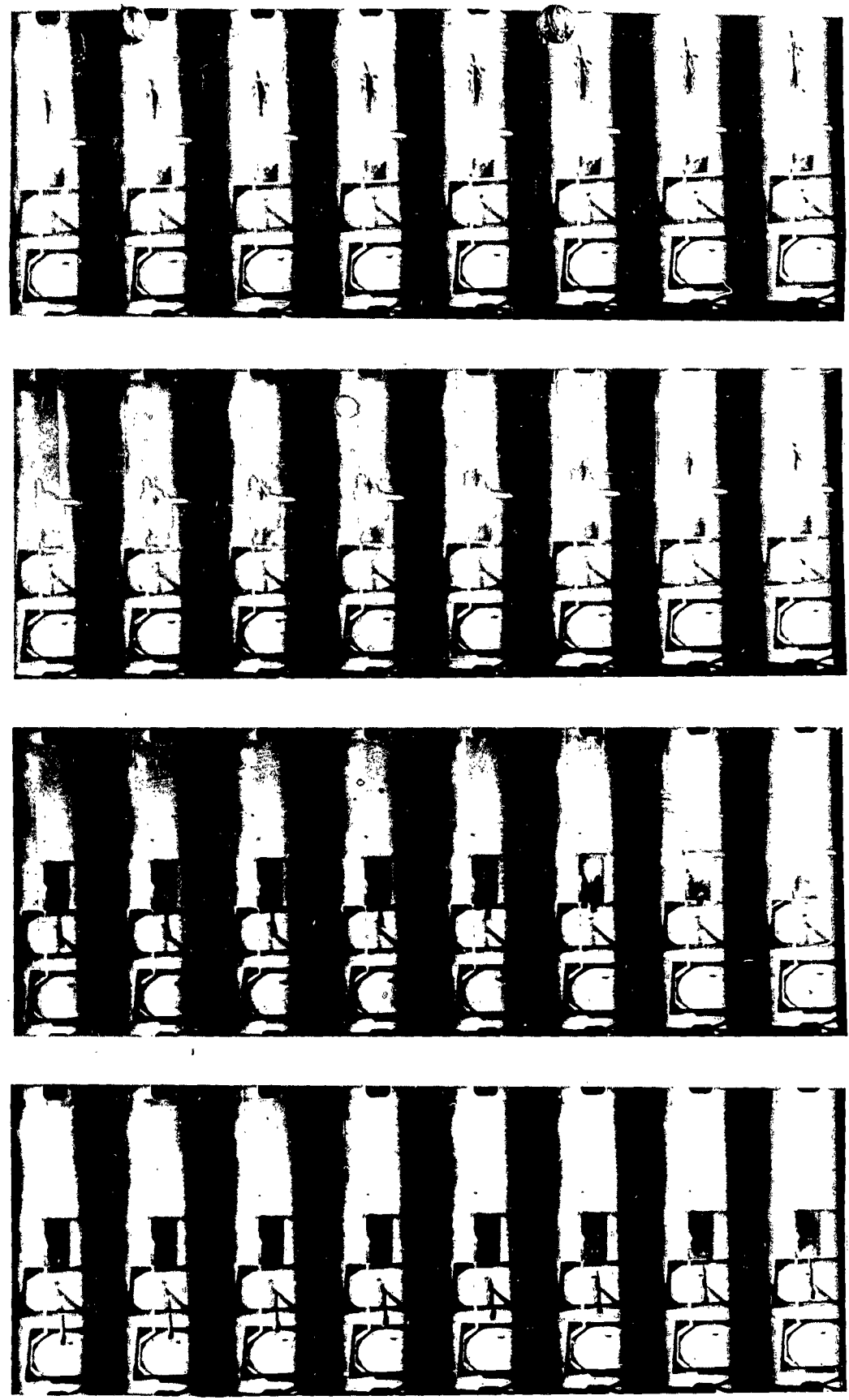
NP9-63521

5 May 1953

Penetration Test of inert 2475 Mk I rocket head against 7375 aluminum, 24ST alloy at 60° obliquity. Fired from NPG 1050 ft. launcher with 5" HVAR motor. Striking Velocity 1773 ft/sec. View shows 35mm Fastax camera film of Rd. 2. The aluminum head-to-motor adapter has shattered resulting in a break up of the motor. The condition of the head cannot be determined from these pictures. Note the extensive plate flash.

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Figure 15

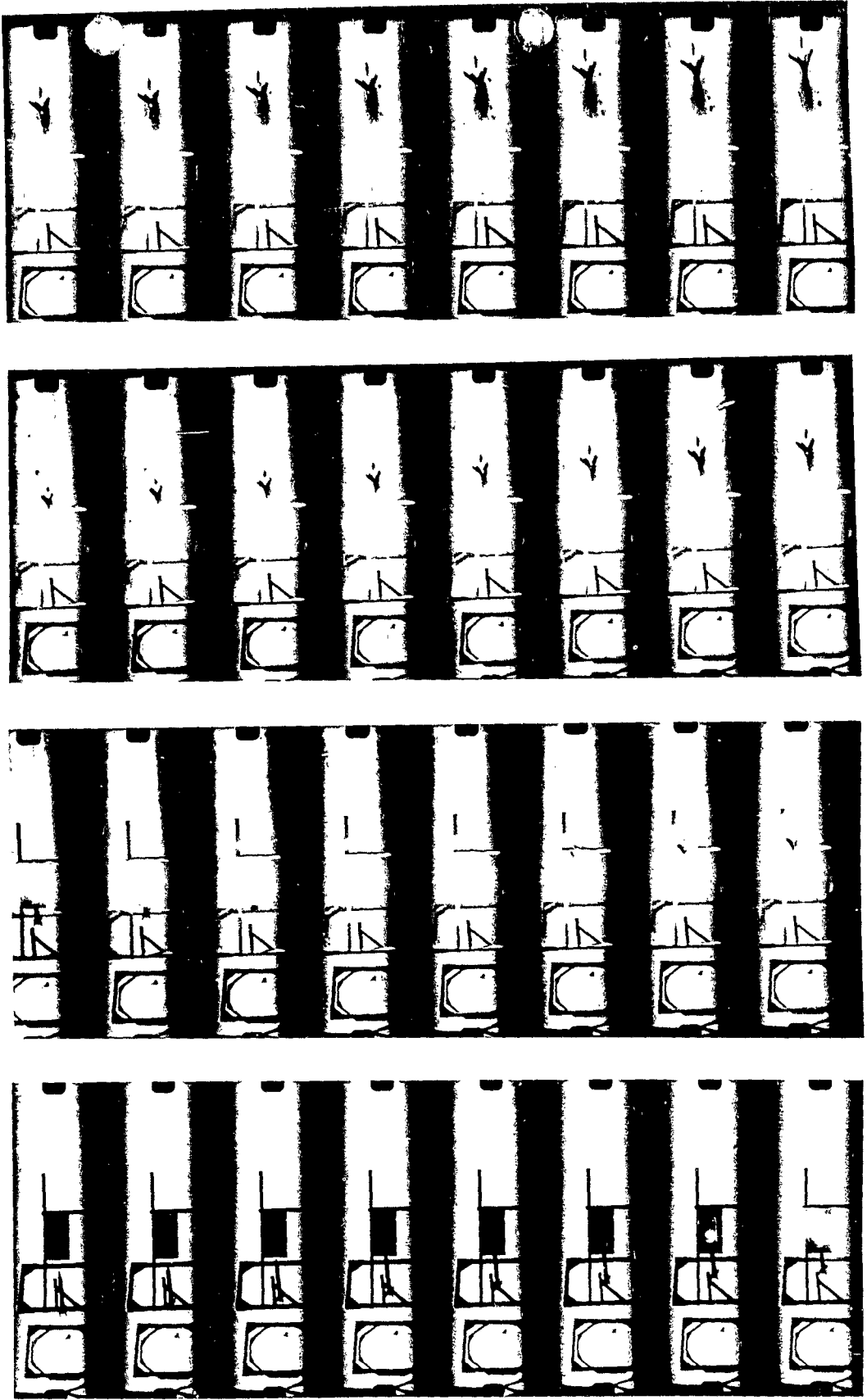


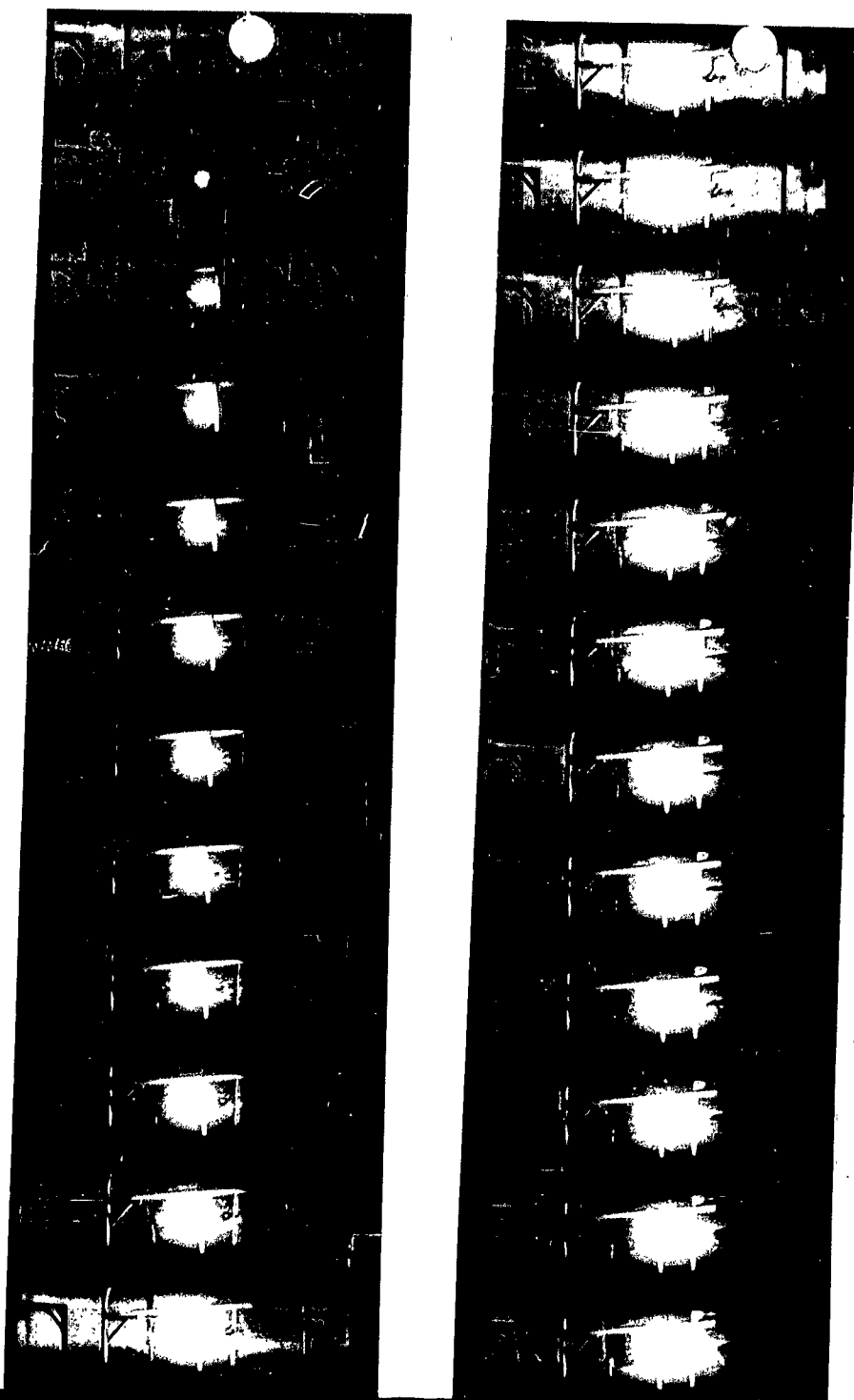
NP9-63522

8 May 1953

Penetration Test of inert 2475 Mk 1 rocket head against V375 aluminum, 24ST alloy at 60° obliquity. Fired from NPG 1050 ft. launcher with 5th HVAR motor. Striking Velocity approximately 1800 ft/sec. View shows 35mm Fastax camera film of Rd. 3. The aluminum head-to-motor adapter has shattered resulting in a break up of the motor. The condition of the head cannot be determined from these pictures. Note the extensive plate flash.

Figure 16





NP9-63523

8 May 1953

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Penetration Test of inert 2W75 Mk 1 rocket head against 7375 aluminum, 24ST alloy at 60° obliquity. Fired from NPG 1050 ft. launcher with 5th HVAR motor. Striking Velocity 1783 ft/sec. View shows 35mm Fastax camera film of Rd. 4. The head-to-motor aluminum adapter has shattered resulting in a break up of the motor. The condition of the head cannot be determined from these pictures. Note the extensive plate flash.

Figure 17