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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO. 937

TEST AND DEVELOPMENT OF
3"/70 AA PROBERT PROJECTILES

40th Partial Report

TEST OF 3"/70 AA PROJECTILES
FIRED IN GUN WITH OILY BORE

FINAL Report

Copy No. 11

Task

Assignment NPG-Re5a-21-1-52

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APR 4 1952

Test of 3"/70 AA Projectiles Fired in Gun with Oily Bore

PART A

SYNOPSIS

1. Twelve (12) 3"/70 AA Projectiles Type Ex 24 Mod 9 were fired for recovery in the 3"/70 gun Type G Mod 9 No. 24581. The subject gun, although having been fired only 554 equivalent service rounds, was in a badly worn condition due to spiral wear.
2. The worn barrel was oiled with Navy Symbol 5190 oil to determine the effect on the rotating bands and the spin rate on the 3"/70 AA Projectiles.
3. The firing was conducted in groups of three rounds each, the bore of the gun being oiled prior to the firing of the first round of each group.
4. It is concluded that the presence of oil in the bore of a 3"/70 G-9 gun decreases band wear.

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Test of 3"/70 AA Projectiles Fired in Gun with Oily Bore

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Test of 3"/70 AA Projectiles Fired in Gun with Oily Bore

PART B

INTRODUCTION

1. AUTHORITY:

This program was authorized by reference (a).

2. REFERENCES:

- a. BUORD ltr S74-1(3")Re5a-JHM:cmj Ser 26029 of 21 September 1951 to NAVPROV
- b. NPG Report No. 750 of 20 March 1951
- c. BUORD Sk No. 328486 3"/70 AA Projectile Type Ex 24 Mod 9

3. BACKGROUND:

The Bureau of Ordnance requested a special firing program, as outlined in reference (a), of Ex 24 Mod 9 projectiles in gun Type G Mod 9 No. 24581, this gun being in a badly worn condition although having fired only 554 equivalent service rounds. All rounds were to be fired for spin and recovery, with a charge of any available 3"/70 cool powder such as to give a velocity of 3400 ft./sec. in a new gun.

4. OBJECT OF TEST:

The object of this test was to determine the effects of an oily bore on rotating bands and spin rate of 3"/70 AA projectiles.

5. PERIOD OF TEST:

- | | |
|------------------------|-------------------|
| a. Date of Directive | 21 September 1951 |
| b. Date Test Commenced | 30 October 1951 |
| c. Date Test Completed | 9 November 1951 |

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Test of 3"/70 AA Projectiles Fired in Gun with Oily Bore

PART C

DETAILS OF TEST

6. DESCRIPTION OF ITEM UNDER TEST:

a. Projectile: 3"/70 AA projectile Type Ex 24 Mod 9 manufactured in accordance with reference (c), inert loaded, and assembled with flat-nosed dummy nose plugs (Figure 14).

b. Gun: The 3"/70 gun barrel Type G Mod 9 No. 24581 has .045 constant depth rifling with a 1 in 25 caliber twist, and also has the long run-up similar to the Type G Mod 7 barrel. The subject barrel is in a badly worn condition due to spiral wear.

7. PROCEDURE:

Twelve (12) 3"/70 AA projectiles Type Ex 24 Mod 9 were prepared for recovery firing in the Type G Mod 9 gun, the charge weight being such as to give a velocity of 3400 ft./sec. in a new gun. All projectiles were opsom salt loaded to a weight of 15 lbs. and fitted with flat nose plugs (Figure 14). The ogive of each projectile was marked with a scribe mark to determine the loading position in the gun, and each projectile rubber crimped in the case. Ordinarily the rounds are placed in the gun with the scribe mark at 12 o'clock but due to the instrumentation it was impossible to do this in all cases. The o'clock position of each projectile was noted and marked on the round after recovery. The view on the left in the after firing photographs (Figures 2-13, inclusive) represents the 12 o'clock position. In preparing the gun for firing, a bristle-head sponge was saturated with Navy Symbol 5190 oil and passed twice, forward and back, through the entire length of the bore. After each such oiling a three round group was fired for recovery. Spin was measured by the wire impression method (described in Appendix (D)). Pressure-time records and tangential strain-gage readings were taken on all rounds with the exception of Round No. 897 (Figure 9). On this round the P-T gage loads were cut prior to firing.

Test of 3"/70 AA Projectiles Fired in Gun with Oily Bore

8. RESULTS AND DISCUSSION:

Complete before and after firing data are given in Table I (Appendix (A)) and photographs of the projectiles are included as Figures 1-13, inclusive. Pressure-time and barrel strain measurements are included as Table II (Appendix (C)). Photographs of the oscillograph records are included as Figures 15-17, inclusive.

The results shown in Table I indicate that full spin was obtained with the bore in an oily condition, whereas some loss of spin occurred in the succeeding rounds of each firing group. The third round of each group gave in all cases slightly higher spin than the second. The recovered projectiles show considerable band wear for the first round in each group, and complete band wear for all other rounds. Barrel strains, as would be expected, were higher for the rounds with oily bore, by about 45% (peak). In flight the projectiles showed only slight dispersion and yaw.

A previous test of the effect of an oily bore, fired in a new G-1 gun and reported in reference (b), gave similar results.

PART D

CONCLUSIONS

9. It is concluded that:

The presence of oil in the bore of a 3"/70 G-9 gun decreases band wear.

Test of 3"/70 AA Projectiles Fired in Gun with Oily Bore

The tests upon which this report is based were conducted by:
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Captain, USN
Ordnance Officer
By direction

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**U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA**

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Fortieth Partial Report

on

Test and Development of 3"/70 AA Probort Projectiles

Final Report

on

Test of 3"/70 AA Projectiles Fired in Gun with Oily Bore

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Project No.: NPG-Ro5a-21-1-52
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Date:

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Test of 3rd/70 AA Projectiles Fired in Gun with Oily Bore

TABULAR

COMPLETE BEFORE AND AFTER FIRING DATA

Test of 3rd/70 AA Projectiles Type Ex 24 Mod 9 in Gun Type G Mod 9 No. 24581

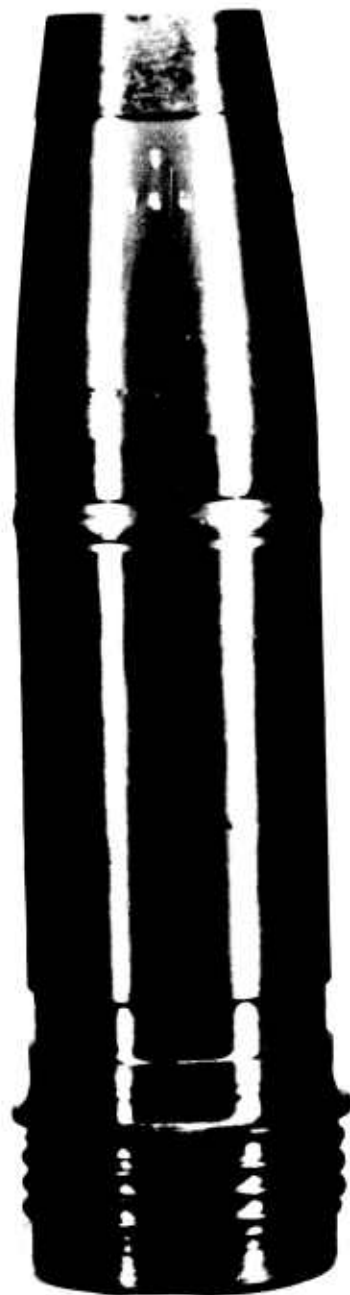
Proj. No.	Firing Order 11/9/51	Bore Condition	Powder Charge (lbs.)	Average Pressure (t.s.i.)	Muzzle Velocity (ft./sec.)	% Nominal Spin	Wt. (lbs.)	Yaw at 423 ft. from Gun Maximum Hole (in.)
890	1		HK FCL 10.01	20.1	3366		15.0	3-1/8
891	2	oily	"	19.4	3318	99.8	14.94	3-1/8
892	3	dry	"	19.6	3370	86.9	14.99	3
893	4	dry	"	19.9	3372	89.4	15.0	3
894	5	oily	"	19.8	3330	98.6	14.86	3-1/2
895	6	dry	"	20.4	3360	85.7	15.0	3-1/8
896	7	dry	"	19.8	3367	88.6	14.95	3-1/8
897	8	oily	"	20.6	3356	98.6	14.97	3-1/8
898	9	dry	"	20.3	3393	88.1	14.90	3
899	10	dry	"	19.4	3368	89.4	14.93	3
900	11	oily	"	19.9	3359	99.8	14.87	3-1/4
901	12	dry	"	20.2	3400	89.4	14.88	3-1/8
	13	dry	"	19.1	3394	91.4	14.95	3

NOTES: Gun Type G Mod 9 No. 24581 had 554 ESR at start of test.

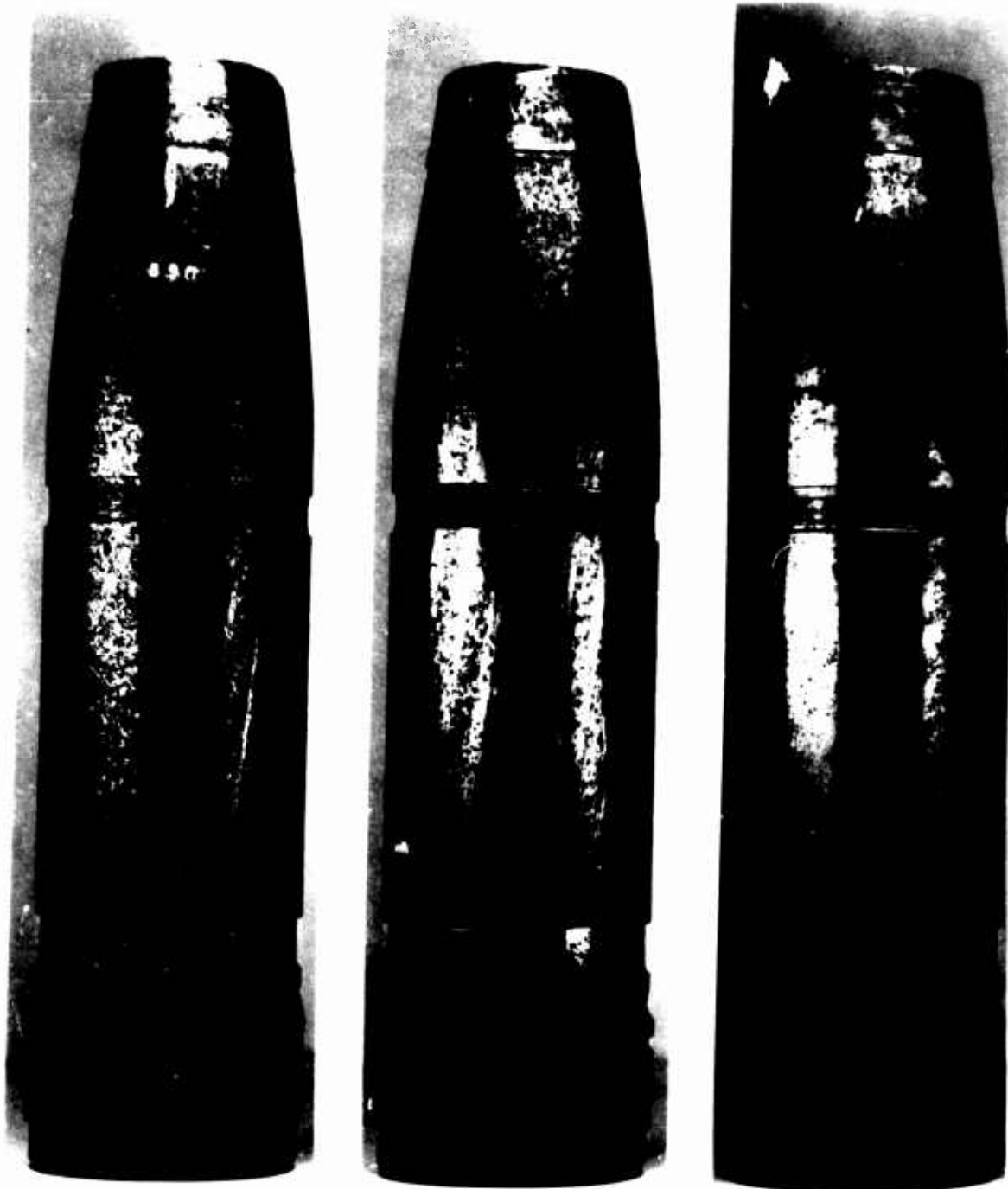
Ex 24-9 projectiles rubber crimped to Ex 5 cases.

Gun was oiled with Bristle-head sponge, saturated with Navy Symbol 5190 oil.

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MP9-46911 2 November 1951 CONFIDENTIAL
3"/70 AA Projectile Type Ex 24 Mod 9 before firing.
Figure 1



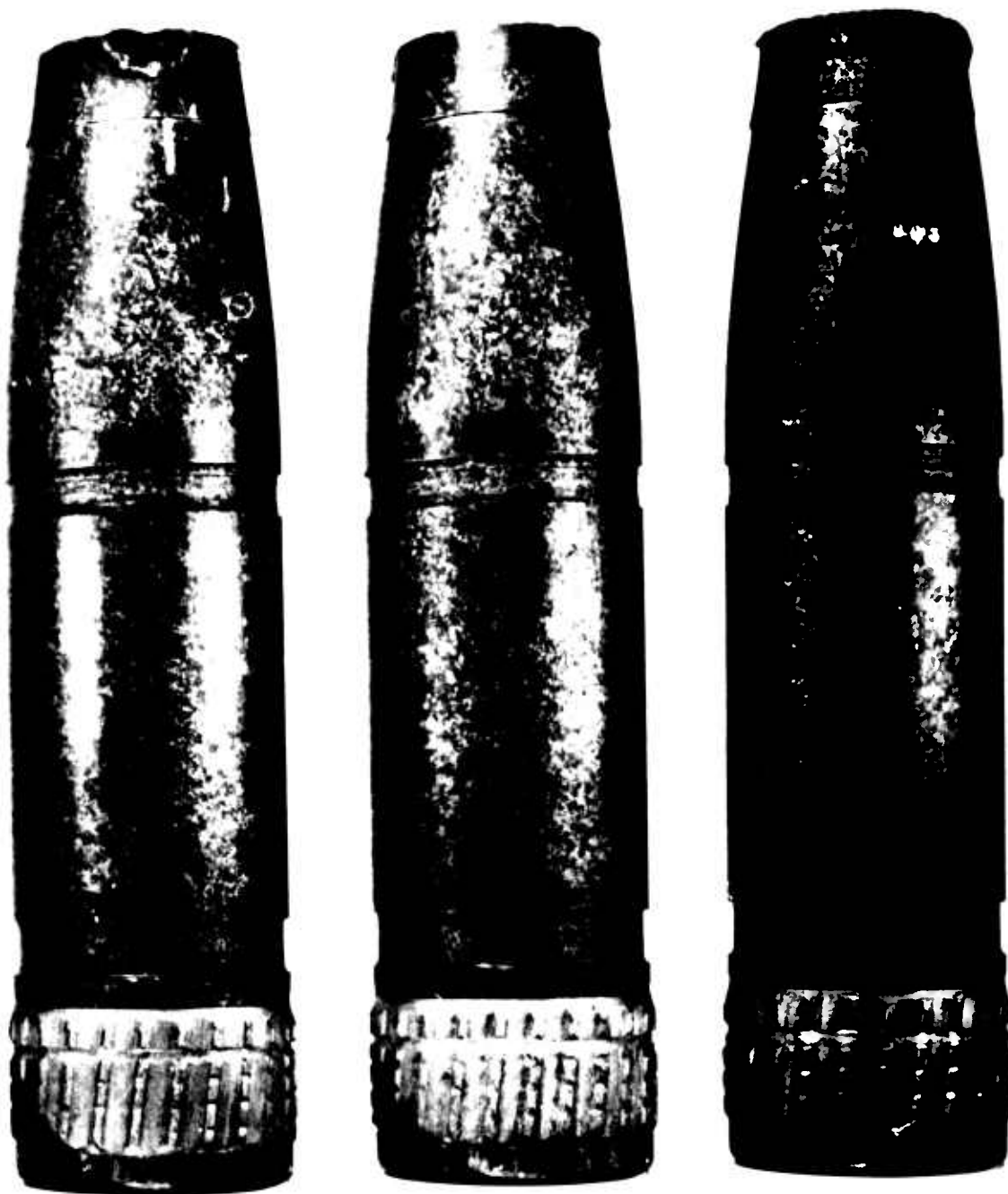
NP9-46912 9 November 1951 CONFIDENTIAL
Three views (120° apart) of recovered 3"/70 AA Projectile
Type Ex 24 Mod 9. Projectile No. 890 (oily bore).
Figure 2



NP9-46913 9 November 1951 CONFIDENTIAL
Three views (120° apart) of recovered 3"/70 AA Projectile
Type Ex 24 Mod 9. Projectile No. 891 (dry bore).
Figure 3



NP9-46914 9 November 1951 CONFIDENTIAL
Three views (120° apart) of recovered 3"/70 AA Projectile
Type Ex 24 Mod 9. Projectile No. 892 (dry bore).
Figure 4



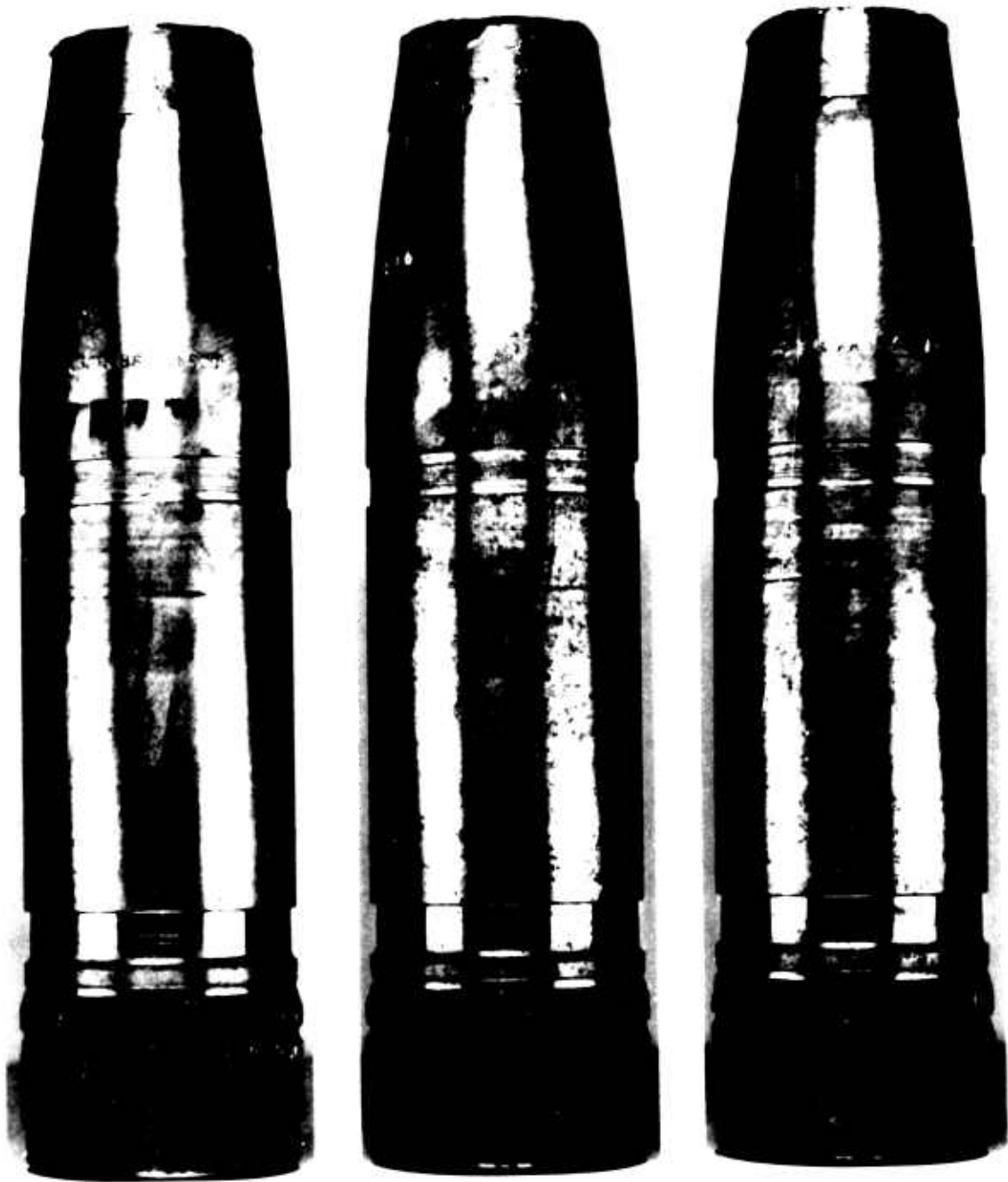
NP9-46915 9 November 1951 CONFIDENTIAL
Three views (120° apart) of recovered 3"/70 AA Projectile
Type Ex 24 Mod 9. Projectile No. 893 (oily bore).
Figure 5



NP9-46916 9 November 1951 CONFIDENTIAL
Three views (120° apart) of recovered 3"/70 AA Projectile
Type Ex 24 Mod 9. Projectile No. 894 (dry bore).
Figure 6



NP9-46917 9 November 1951 CONFIDENTIAL
Three views (120° apart) of recovered 3"/70 AA Projectile
Type Ex 24 Mod 9. Projectile No. 895 (dry bore).
Figure 7



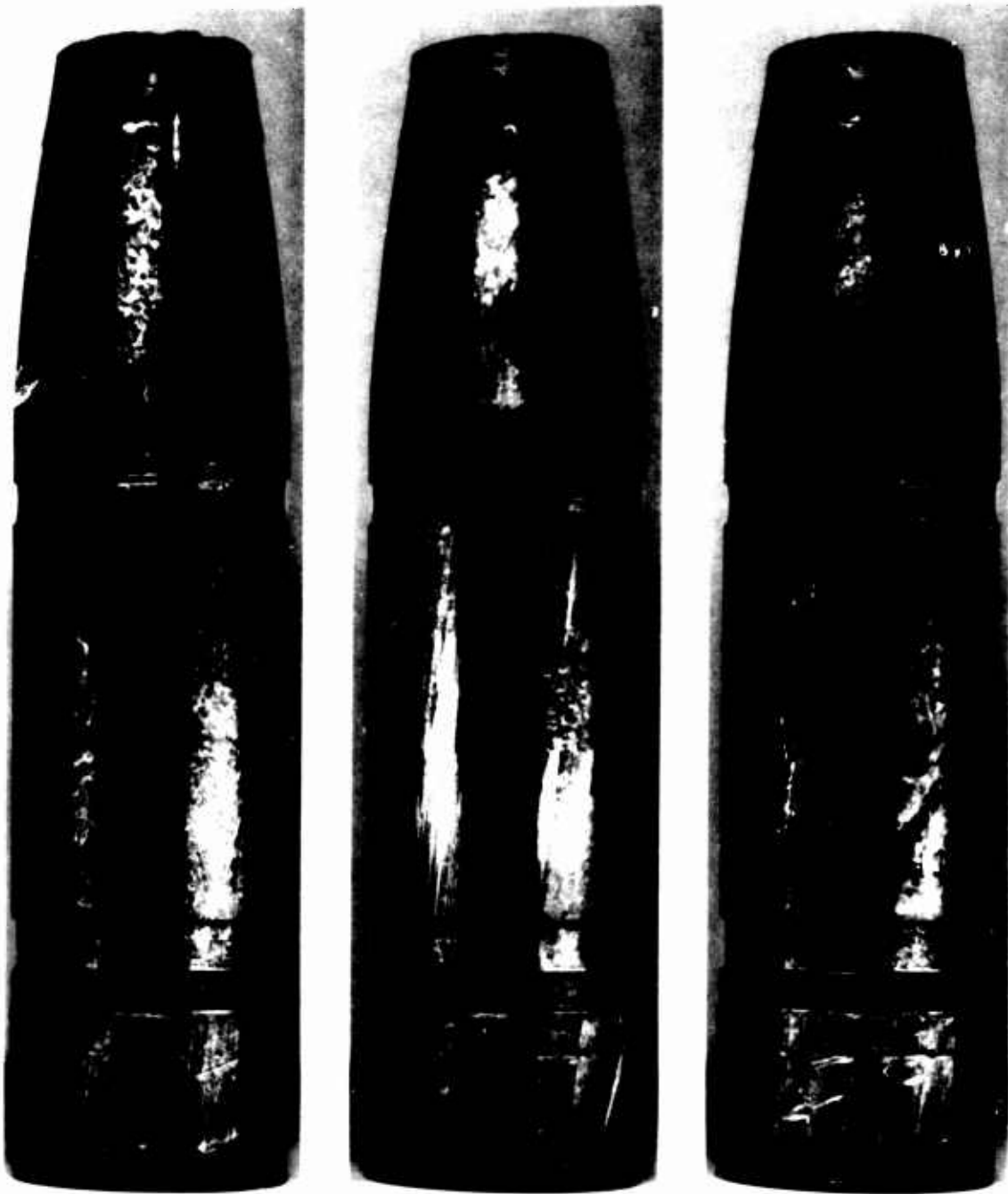
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Three views (120° apart) of recovered 3"/70 AA Projectile
Type Ex 24 Mod 9. Projectile No. 896 (oily bore).

Figure 8



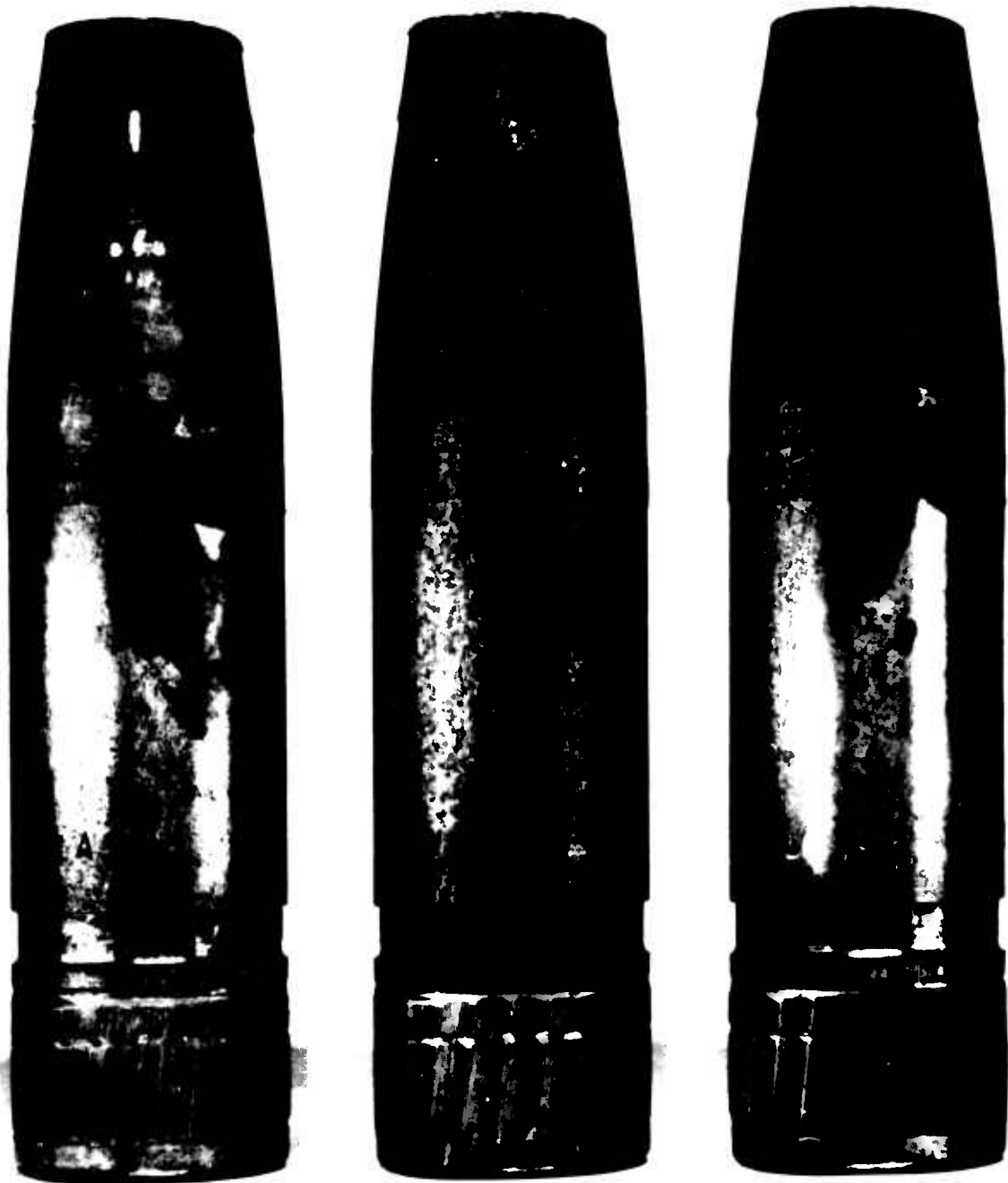
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Three views (120° apart) of recovered 3"/70 AA Projectile
Type Ex 24 Mod 9. Projectile No. 897 (dry bore).

Figure 9



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Three views (120° apart) of recovered 3"/70 AA Projectile
Type Ex 24 Mod 9. Projectile No. 898 (dry bore).

Figure 10



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Three views (120° apart) of recovered 3"/70 AA Projectile
Type Ex 24 Mod 9. Projectile No. 899 (oily bore).

Figure 11



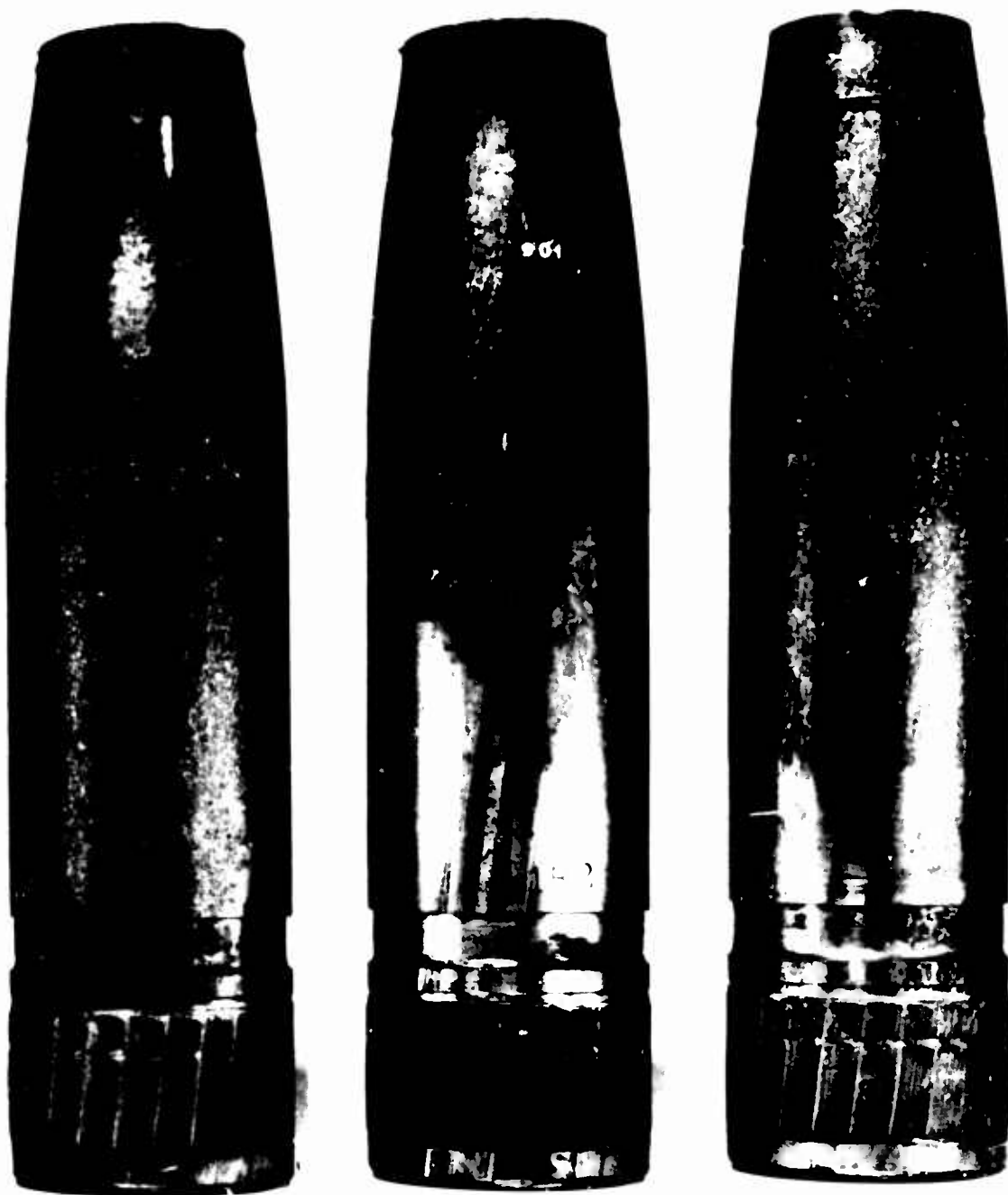
NP9-46922

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Three views (120° apart) of recovered 3"/70 AA Projectile
Type Ex 24 Mod 9. Projectile No. 900 (dry bore).

Figure 12



NP9-46923

9 November 1951

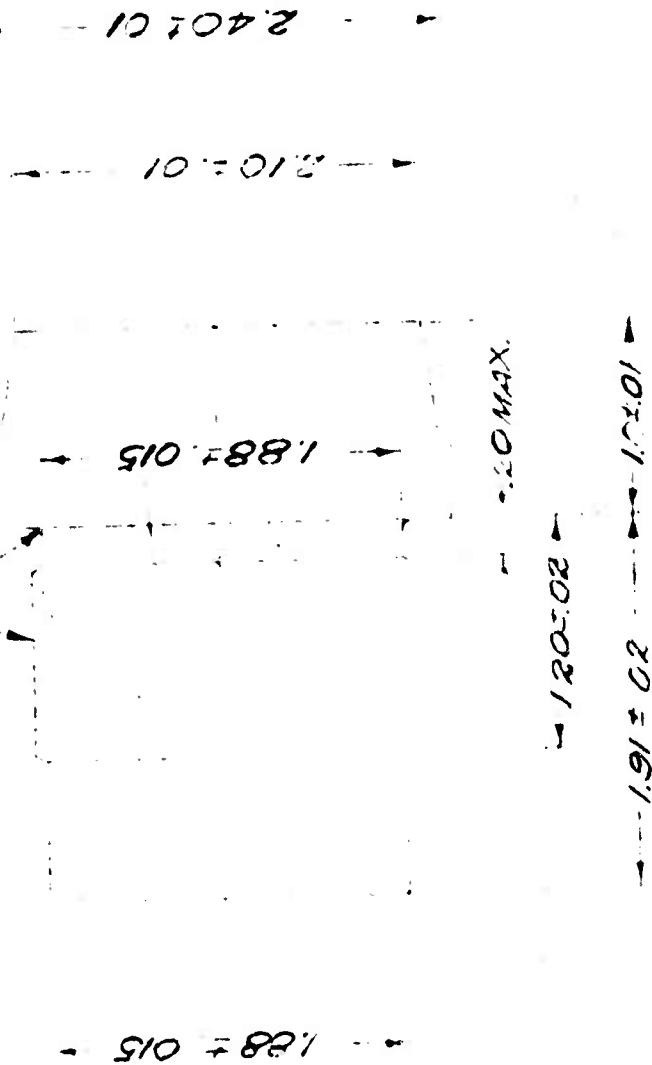
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Three views (120° apart) of recovered 3"/70 AA Projectile
Type Ex 24 Mod 9. Projectile No. 901 (dry bore).

Figure 13

2000-12NS-2RH
 NUT DIA = 2.000-0.012
 WASH DIA = 1.9459-0.0077
 WASH DIA = 1.8978 MAX.

0.06 R. MAX.



DUMMY NOSE PLUG (FLAT NOSE)

MATERIAL: STEEL, FORGED
 OR ROLLED STOCK

WEIGHT: 2.65 ± 0.05 LBS.

NOTE: BREAK SHARP EDGES

REF: SEE BUORD SK 238268

APL 107
 9/27/49

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Test of 3"/70 AA Projectiles Fired in Gun with Oily Bore

TABLE II

**BARREL STRAIN
DATA OBTAINED ON
3"/70 Gun, Type G, Mod 9, No. 24581**

Date Fired: 9 November 1951

Rounds	Maximum Pressure (PSI)	BARREL STRAINS (μ in/in)					
		Gage Locations (Inches from Muzzle)					
		6"		36"		72"	
		Peak	Plateau	Peak	Plateau	Peak	Plateau
1	-	883	794	535	523	431	423
2*	51,200	1003	783	1018	500	758	439
3	51,600	782	718	553	506	483	465
4	51,600	773	718	500	477	382	362
5*	56,300	1025	794	833	523	730	470
6	52,500	753	712	506	471	423	394
7	51,000	765	736	530	494	429	412
8*	56,000	842	782	712	500	623	441
9	-	712	694	518	494	476	441
10	49,000	759	712	565	506	442	418
11*	47,200	806	765	677	600	659	523
12	54,600	972	836	523	453	453	429
13	51,500	730	712	488	453	418	335

* Oil in gun bore

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APPENDIX C

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3"/70 GUN TYPE G, MOD. 7, NO. 24581

PRESSURE-TIME and BARREL TRAIN MEASUREMENTS

TIMING MARKS - 1000 CPS; MAXIMUM CALIBRATION STEPS 2.0 OHMS
READING FROM TOP TO BOTTOM:

ROUNDS 1, 2, 3, 4.

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Figure 12-

NP9-46756

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3"/70 GUN, TYPE G, MOD. 9, NO. 24581

PRESSURE-TIME and BARREL STRAIN MEASUREMENTS

TIMING MARKS - 1000 CPS; MAXIMUM RELAXATION STEPS 2.0 OHMS
READING FROM TOP TO BOTTOM:

ROUNDS 5, 6, 7, & 8.

U.S. NAVAL PROVING GROUND

9 NOVEMBER 1951

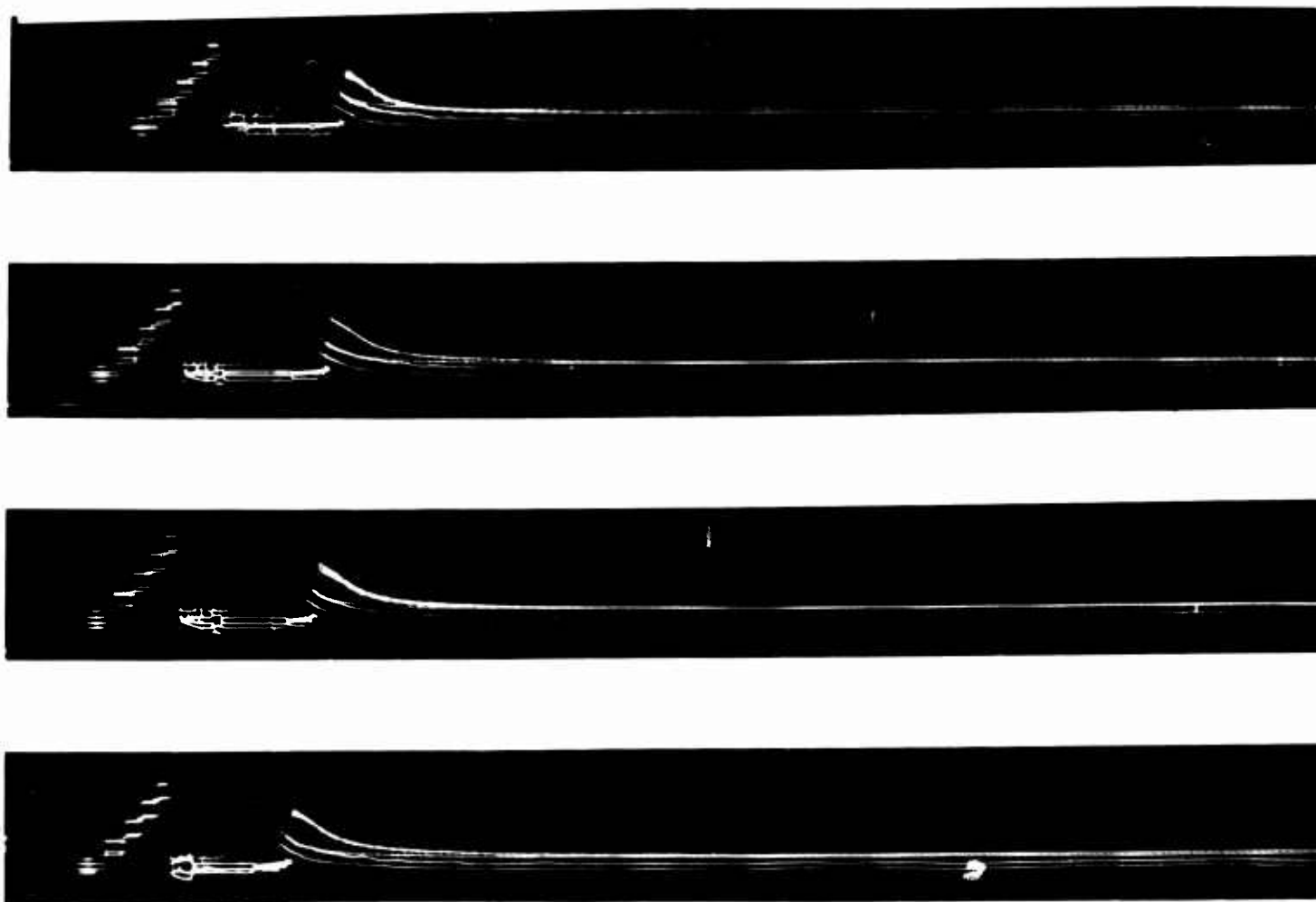


Figure 16

NP9-46757

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3"/70 GUN, TYPE G, MOD. 9, NO. 24581

PRESSURE-TIME and BARREL STRAIN MEASUREMENTS

TIMING MARKS - 1000 CPS; MAXIMUM CALIBRATION STEPS 2.0 OHMS
READING FROM TOP TO BOTTOM:

ROUNDS 9, 10, 11, 12, & 13.

U.S. NAVAL PROVING GROUND

9 NOVEMBER 1961



Figure 1

Test of 3"/70 AA Projectiles Fired in Gun with Oily Bore

Wire Impression Method of Determining Spin

Two screens are set up 41 $\frac{1}{5}$ apart, each screen consisting of a metal frame with wood inserts, holding an array of parallel equidistant vertical copper wires. The spacing of the wires is 1/2" for the first screen and 3/4" for the second. The projectile is fitted with a flat-nosed dummy nose plug or the equivalent, so that after passing through the screens it bears two sets of impressions of the wires. The angle between the two sets of impressions is measured and from this measurement the rifling of the gun, the muzzle velocity, and the velocity at the spin screens, is computed the percentage of nominal spin. It is assumed that over the short distances involved the spin retardation is negligible.

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APPENDIX E