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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO 1109

PROJECTILE ROTATING BANDS AND RELATED COMPONENTS

6th Partial Report

DETERMINATION OF OBTURATION EFFECTIVENESS
OF ROTATING BANDS BY PHOTOGRAPHIC MEANS

FINAL Report

Task
Assignment NPG-Re3b-225-1-53

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Classification RESTRICTED
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7-11-53

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Determination of Obturation Effectiveness of
Rotating Bands by Photographic Means

PART A

SYNOPSIS

1. This report covers tests conducted to explore the feasibility of determining the obturation effectiveness of rotating bands by photographic means.
2. High-speed movies were taken of the muzzle region at the time of emergence of the projectile to determine whether, and to what extent, propellant gases emerge before ejection of the projectile. Two (2) 3"/70 guns, one (1) new and one (1) old gun, were used in these initial tests. It was thought that obturation in an old gun might be sufficiently ineffective in comparison to that in a new gun that differences would be disclosed by photographs. In addition, rubber sealing cups were used on some projectiles to enhance the contrast between good and poor obturation.
3. Differences in obturation were observed in each gun between warming rounds and rounds from a warm gun and between rounds with and without sealing cups on the projectile. These differences involved both the density of the gas leaking ahead of the projectile and the time at which the gas appeared at the muzzle relative to ejection of the projectile.
4. Obturation was somewhat more effective in the new gun than in the old when using projectiles without sealing cups. The cone of emerging gases preceding ejection from the old gun was appreciably more dense and larger in diameter than from the new gun at any given time relative to ejection of the projectile.
5. Obturation was as effective in the old gun as in the new when sealing cups were used in both. Better obturation was obtained in the old gun with sealing cups than in the new gun without cups.
6. On the basis of these tests, high-speed moving pictures of the muzzle region at the time of emergence of the projectile provide an excellent qualitative comparison of the relative obturation effectiveness obtained under varying conditions of gun wear and barrel design.

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NPG REPORT NO. 1109

Determination of Obturation Effectiveness of
Rotating Bands by Photographic Means

TABLE OF CONTENTS

	<u>Page</u>
SYNOPSIS	1
TABLE OF CONTENTS.	2
AUTHORITY.	3
REFERENCES	3
BACKGROUND	3
OBJECT OF TEST	3
PERIOD OF TEST	3
DESCRIPTION OF ITEM UNDER TEST	4
DESCRIPTION OF TEST EQUIPMENT.	4
PROCEDURE.	4
RESULTS AND DISCUSSION	5
CONCLUSIONS.	6
APPENDIX A - NPG PHOTOGRAPHS	FIGURES 1-2 (Incl)
APPENDIX B - DISTRIBUTION.	1 (Only)

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NPG REPORT NO. 1109

Determination of Obturation Effectiveness of
Rotating Bands by Photographic Means

PART B

INTRODUCTION

1. AUTHORITY:

The work reported herein was conducted under Task Assignment No. NPG-Re3b-225-1-53 as established by reference (a). Specific authority for the tests is contained in reference (b).

2. REFERENCES:

- a. BUORD Conf ltr NP9 (Re3b)MRH:mt Ser 42696 of 29 Jul 1952
- b. BUORD Rest ltr NP9 Re3b MAS:mt of 9 Aug 1952

3. BACKGROUND:

Representatives of the Projectile Section, Research and Development Division, of the Bureau of Ordnance, during a visit to the Naval Proving Ground expressed the need for a method of measuring the effectiveness of obturation of sealing bands under varying conditions of gun wear and band design. An examination of certain photographs taken at the Naval Proving Ground suggested that photographs of the muzzle region at the time of emergence of the projectile might provide one (1) method of determining obturation effectiveness by disclosing whether, and to what extent, propellant gases emerge before ejection of the projectile. As a result, the Naval Proving Ground was requested, by reference (b) to explore the feasibility of the photographic method. Other methods of determining obturation effectiveness are also under consideration at the Naval Proving Ground. These involve measuring the gas leakage ahead of the projectile during the first few inches of projectile travel.

4. OBJECT OF TEST:

The object of the tests was to explore the feasibility of determining the effectiveness of rotating band obturation by photographic means.

5. PERIOD OF TEST:

- | | |
|------------------------------|------------------|
| a. Date of Project Letter | 29 July 1952 |
| b. Date of Special Directive | 9 August 1952 |
| c. Date Commenced Test | 29 October 1952 |
| d. Test Firing Completed | 12 November 1952 |

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SECURITY INFORMATION

Determination of Obturation Effectiveness of
Rotating Bands by Photographic Means

PART C

DETAILS OF TEST

6. DESCRIPTION OF ITEM UNDER TEST:

Firings were conducted in two (2) 3"/70 Type G Mod 7 guns. Gun No. 24579 had an ESR of 1206 and gun No. 26743 an ESR of 52. The ammunition used was HKPC-1 powder, Ex. 24-10 projectiles and Mk 45 primers. Hard rubber sealing cups were used on the base of the projectiles on specified rounds.

7. DESCRIPTION OF TEST EQUIPMENT:

High-speed movies were taken with a 16mm Fastax camera equipped with a 2" or 4" lens plus a K-2 filter and super XX film operating at approximately 5000 frames per second. The operation of the camera was synchronized with gun firing by means of an intervalometer.

8. PROCEDURE:

Two (2) 3"/70 Type G Mod 7 guns, one (1) new and one (1) old, were used in these initial tests. It was thought that obturation in an old gun might be so ineffective in comparison to that in a new gun that differences would be readily disclosed by photographs. The contrast between good and poor obturation was further increased by using sealing cups on the base of some projectiles fired in each gun.

On the preliminary firing conducted on this test, two (2) service rounds were fired in each of the guns. In each gun, a sealing cup was used on the base of the projectile of the second round. Because of the failure of the camera on the first round in the second gun, a third round without sealing cup was fired. The camera was set up to photograph the gun muzzle and the area in front of the muzzle to show the emergence of the projectile and the size and shape of the ejected gases.

An analysis of the photographs from the first test showed the desirability of conducting a second firing as follows: A series of three rounds consisting of: (1) a warming round without sealing cup, (2) a service round without sealing cup, and (3) a service round with sealing cup on the projectile was fired from each gun. The image size was doubled and the field of view halved in this firing by using a 4" lens instead of the 2" lens used on the first firing.

Determination of Obturation Effectiveness of
Rotating Bands by Photographic Means

9. RESULTS AND DISCUSSION:

A study of the photographs obtained on the first firing indicated that differences in obturation effectiveness existed between rounds fired in a gun when cold and when warm, between rounds with and without sealing cups, and between guns at different stages of wear. The second firing was conducted to clearly differentiate the effects of these different conditions on obturation.

The results from the first firing showed that the field of view covered by the camera could be reduced to about half, thereby obtaining a larger photographic image which would materially increase the usefulness of the photographs. These benefits were achieved in the second firing by using a 4" lens on the camera instead of the 2" lens without moving the camera closer to the gun muzzle and into the higher blast area.

The photographs obtained on the second test are enclosed as Figures 1 and 2 of Appendix (A). The frame rate for these pictures varies from 5270 to 5400 frames per second and averages 5320 frames per second. A distance of six (6) inches is indicated by the distance (center to center) between the two (2) black bands on the gun barrel. (The band nearest the muzzle in Figure 1 was for identification of barrel only). The time of arrival of the nose of the projectile in the muzzle plane is indicated for each round. The forward edge of the rotating band (13.2 inches from the nose) will arrive in the muzzle plane approximately 33 microseconds later.

Differences in effectiveness of obturation were observed between warming rounds from cold guns and service rounds from warm guns. In both guns the gases emerging ahead of the projectile were more dense on the warming rounds, but appeared at the muzzle earlier in time relative to ejection of the projectile on the service rounds from warm guns. Compare rounds 1 and 2 in Figures 1 and 2.

The use of sealing cups on the projectile resulted in a marked reduction in the density of gases emerging ahead of the projectile over similar rounds without sealing cups. This result was obtained in both guns as will be seen in comparing rounds 2 and 3 in Figures 1 and 2. Also, the first appearance of gases at the muzzle was delayed over that for similar rounds without cups.

Determination of Obturation Effectiveness of
Rotating Bands by Photographic Means

Obturation on rounds without sealing cups was somewhat more effective in the new gun than in the old. The cone of emerging gases preceding ejection of the projectile from the old gun was appreciably more dense and larger in diameter at a given time relative to ejection. These differences will be noted in comparing rounds 2 of Figures 1 and 2. That more marked differences were not observed between the guns is probably to be explained by the fact that, while the old gun had a high ESR, it did not show excessive bore enlargement.

A comparison of rounds 3 of Figures 1 and 2 shows that by the use of sealing cups, obturation is obtained in the old gun equal to that in the new gun. Better obturation was obtained in the old gun with sealing cups than in the new gun without cups. The results obtained on these tests indicate that the use of the hard rubber sealing cups on projectiles would materially reduce the gas leakage in worn guns.

In applying the photographic method of the study of obturation effectiveness, it is recommended that control rounds be included in each test firing to provide a standard of comparison and to compensate for those variations in atmospheric conditions which affect gun performance and photographic results.

PART D

CONCLUSIONS

On the basis of these tests, it is concluded that high-speed moving pictures of the muzzle region at the time of emergence of the projectile provide an excellent qualitative comparison of the relative obturation effectiveness obtained under varying conditions of gun wear and band design.

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NPG REPORT NO. 1109

Determination of Obturation Effectiveness of
Rotating Bands by Photographic Means

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NPG REPORT NO. 1109

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Sixth Partial Report

on

Projectile Rotating Bands and Related Components

Final Report

on

Determination of Obturation Effectiveness of
Rotating Bands by Photographic Means

Project No.: NPG-Re3b-225-1-53
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U. S. Naval Proving Ground
Armament Laboratories Division
Obturation Effectiveness of Rotating Bands
3"70 Type G Mod.7 No. 24579
E. S. R. 1206
12 Nov. 1952

Round No. 1
Cold Gun
No Sealing Cup



Round No. 2
Warm Gun
No Sealing Cup



Round No. 3
Warm Gun
With Sealing Cup



Nose of Projectile
in Muzzle Plane

Figure 1

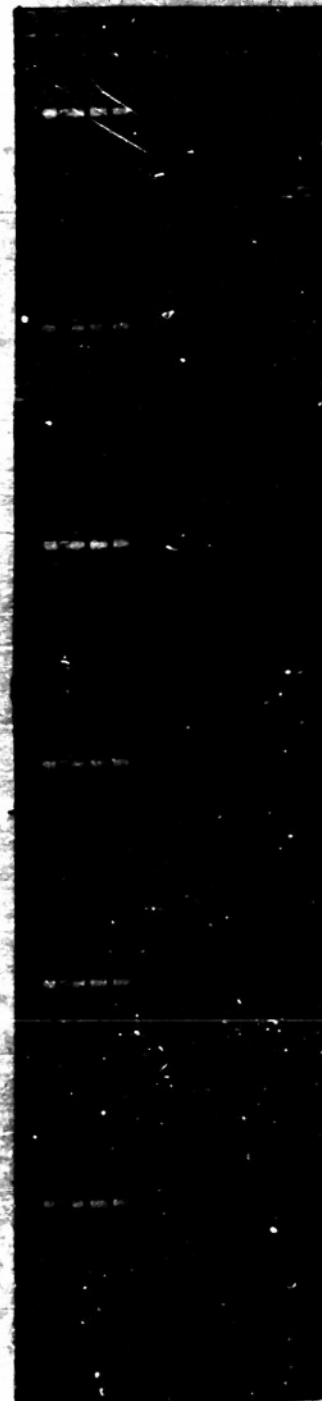
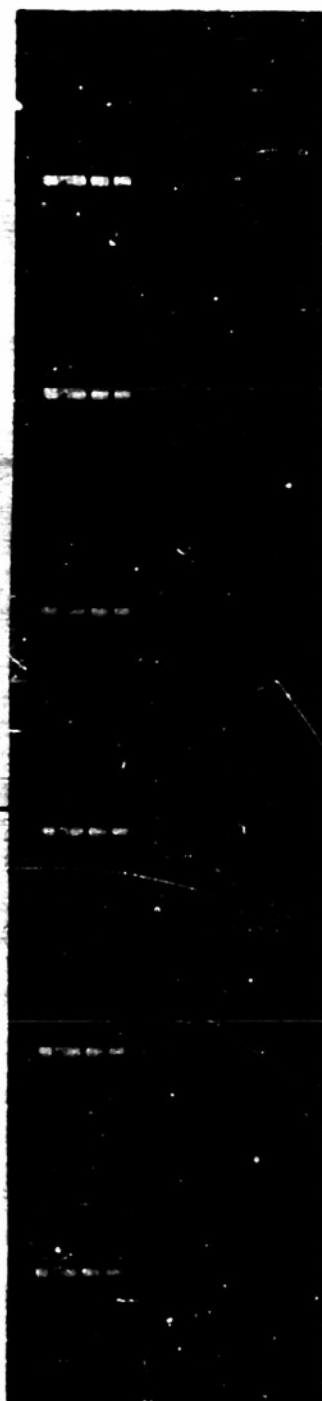
NP9-51745

U. S. Naval Proving Ground
Armament Laboratories Division
Obturation Effectiveness of Rotating Bands
3"70 Type G Mod.7 No.26743
E. S. R. 52
12 Nov. 1952

Round No. 1
Cold Gun
No Sealing Cup

Round No. 2
Warm Gun
No Sealing Cup

Round No. 3
Warm Gun
With Sealing Cup



Nose of Projectile
in Muzzle Plane



Figure 2