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U. S NAVAL PROVING GROUND
DAHLGREN VIRGINIA

REPORT NO. 1088

TEST FIRINGS OF 3"/70 GUN BARRELS

56th Partial Report

- -

STRAIN GAGE MEASUREMENTS; 3"/70 AND 5"/54 GUNS

FINAL Report

Copy No. 6

Task Assignment NPG-Re5a-21-1-53

Classification CONFIDENTIAL
SECURITY INFORMATION

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Strain Gage Measurements; 3"/70 and 5"/54 Guns

PART A

SYNOPSIS

1. This report describes the experimental measurement of strains on the breech face of 3"/70 and 5"/54 caliber guns.

2. Breech face strains were investigated by means of wire resistance strain gages located on the breech face, as near the outside diameter as possible.

3. The maximum tangential breech face strain recorded on the 3"/70 caliber gun was 740 micro-inches per inch with a charge weight of 10.50 lbs. and a copper crusher pressure of 23.4 TSI.

4. The maximum tangential breech face strain recorded on the 5"/54 caliber gun was 895 micro-inches per inch with a charge weight of 21.4 lbs. and a copper crusher pressure of 25.7 TSI.

5. It was observed that the tangential strains on both the 3"/70 and 5"/54 caliber guns were slightly greater on the right of the centerline. It is believed that these differences are due to the unsymmetrical structure of the slide and housing and the unsymmetrical location of the interrupted threads in the housing, with respect to the strain gages.

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PART B

INTRODUCTION

1. AUTHORITY:

The work reported herein was conducted under Task Assignment No. NPG-Re5a-21-1-53, reference (a). Specific authority for the tests is contained in references (b) and (c).

2. REFERENCES:

a. BUORD NP9 Re5a-FBW:fl of 3 July 1952
b. Fonecon of 3 November 1952 between Mr. Stengard, BUORD and Mr. Overman, NAVPROV
c. BUORD ltr Re5a-EOS:llh S74-1(3") of 5 November 1952
d. BUORD ltr NP9(11132) - Re5a-JHM:CMJ S74-1(3") of 18 April 1951
e. NPG Report No. 871 of 20 October 1951

3. BACKGROUND:

a. By reference (d) the Naval Proving Ground was requested to conduct a series of experiments to determine the strains induced in the breech faces of 3"/70 and 5"/54 caliber guns by firings conducted at various pressures between service and proof pressure. The purpose of these tests was to collect information to be used in the future design of cartridge cases that will be subjected to high pressures. Results of these tests were reported in reference (e).

b. The strains observed in the early experiments were measured as close to the chamber as possible without the cartridge cases interfering with the gages. They were not as high as expected, presumably because of the effect of the extractor pockets on the axial symmetry of the strain distribution.

c. In order to investigate breech face strains with a minimum extractor pocket effect, a new series of experiments was undertaken in November 1952. This series differed from the first only in the location of the strain gages, which were moved outward as near as possible to the outside diameter of the gun at the breech.

4. OBJECT OF TEST:

a. The immediate object of the tests was to determine the magnitude of tangential strains, due to firing, on the breech face of a 5"/54 caliber gun at service pressure and at copper crusher pressures of 24 and 26 TSI respectively, and on the breech face of a 3"/70 caliber Type G gun at service pressure and near proof pressure.

b. A further object was to measure the radial strains near the tangential gages on both guns, since these measurements would provide, at slight extra cost, information of interest in studying the distribution of the surface strains and stresses.

5. PERIOD OF TEST:

a.	Date of Project Letter	3 November 1952
b.	Date of Specific Directive	5 November 1952
c.	Date Commenced Test	14 November 1952
d.	Test Completed	17 November 1952

PART C

DETAILS OF TEST

6. DESCRIPTION OF ITEM UNDER TEST:

a. Strains were measured on a 3"/70 Type G Mod 7 Gun No. 24579, fired in a 5"/38 Mount with a Mk 24 Mod 5 slide using Mk 10 cases and Ex-24 Mod 2 projectiles. A total of six (6) rounds were fired, three (3) service and three (3) near proof, using HKPC-1 powder.

b. Strains were also measured on a 5"/54 Type G Mod 0, Gun No. 16070, fired in a Mk 28 Mod 2 slide using Mk 7 cases and Mk 41 Mod 0 (70 lb.) projectiles. Ten (10) rounds were fired, four (4) service, three (3) near proof and three (3) proof, using IHBF-3 powder.

7. DESCRIPTION OF TEST EQUIPMENT:

The strain recordings were taken on a four-channel cathode ray oscilloscope and a high speed rotating drum recorded with auxiliary equipment consisting of power supplies, wheatstone bridge, calibrating switch and d. c. amplifiers.

8. PROCEDURE:

a. Both guns were fired with two (2) identical sets of type C-3 strain gages cemented to the right and left of the centerline on the breech faces, as near the outside diameter as possible, and oriented so as to measure the maximum tangential and radial strains. Appendix (A), Figures 1 and 2, shows the locations and orientations of the gages.

b. The resistance of the gages was 505 ohms. The gage factor was 3.43, and calibrations were in increments of one-half (1/2) ohm.

9. RESULTS AND DISCUSSION:

a. Tabulated results of strains for the 3"/70 and 5"/54 caliber guns are contained in Appendix (B), Tables I and II. Reproductions of the original recordings of the firings are contained in Appendix (C), Figures 3 through 7.

b. Graphical comparisons of strains with copper crusher pressures were made both for the current firings and those reported in Naval Proving Ground Report No. 871. These graphs are reproduced in Appendix (C), Figures 8 and 9.

c. The maximum tangential breech face strain recorded on the 3"/70 caliber gun was 740 micro-inches per inch with a charge weight of 10.50 lbs. and a copper crusher pressure of 23.4 TSI.

d. The maximum tangential breech face strain recorded on the 5"/54 caliber gun was 895 micro-inches per inch with a charge weight of 21.4 lbs. and a copper crusher pressure of 25.7 TSI.

e. It is noted that the tangential strains on both the 3"/70 and 5"/54 caliber guns are slightly greater on the right of the centerline. It is believed that these differences may be attributed to the unsymmetrical structure of the slide and housing and the locations of the gages with respect to the threads on the breech end.

Strain Gage Measurements; 3"/70 and 5"/54 Guns

- -

The tests upon which this report is based were conducted by:
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NPG REPORT NO. 1088

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Fifty-Sixth Partial Report

on

Test Firings of 3"/70 Gun Barrels

- -

Final Report

on

Strain Gage Measurements; 3"/70 and 5"/54 Guns

Project No.: NPG-Re5a-21-1-53
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Date: FEB 12 1953

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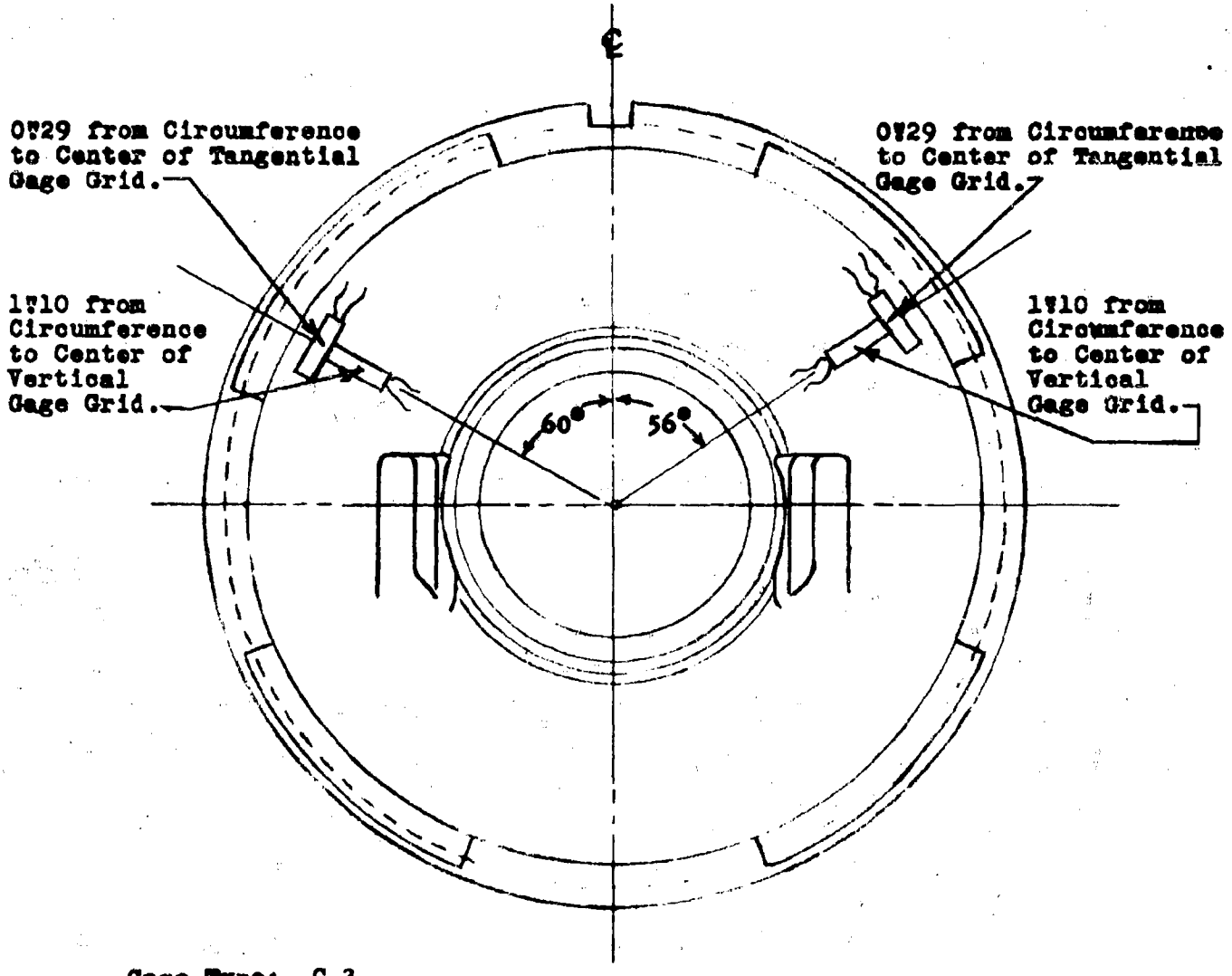
3"/70 TYPE G, MOD. 7, GUN NO. 24579
LOCATIONS OF STRAIN GAGES ON GUN BREECH FACE



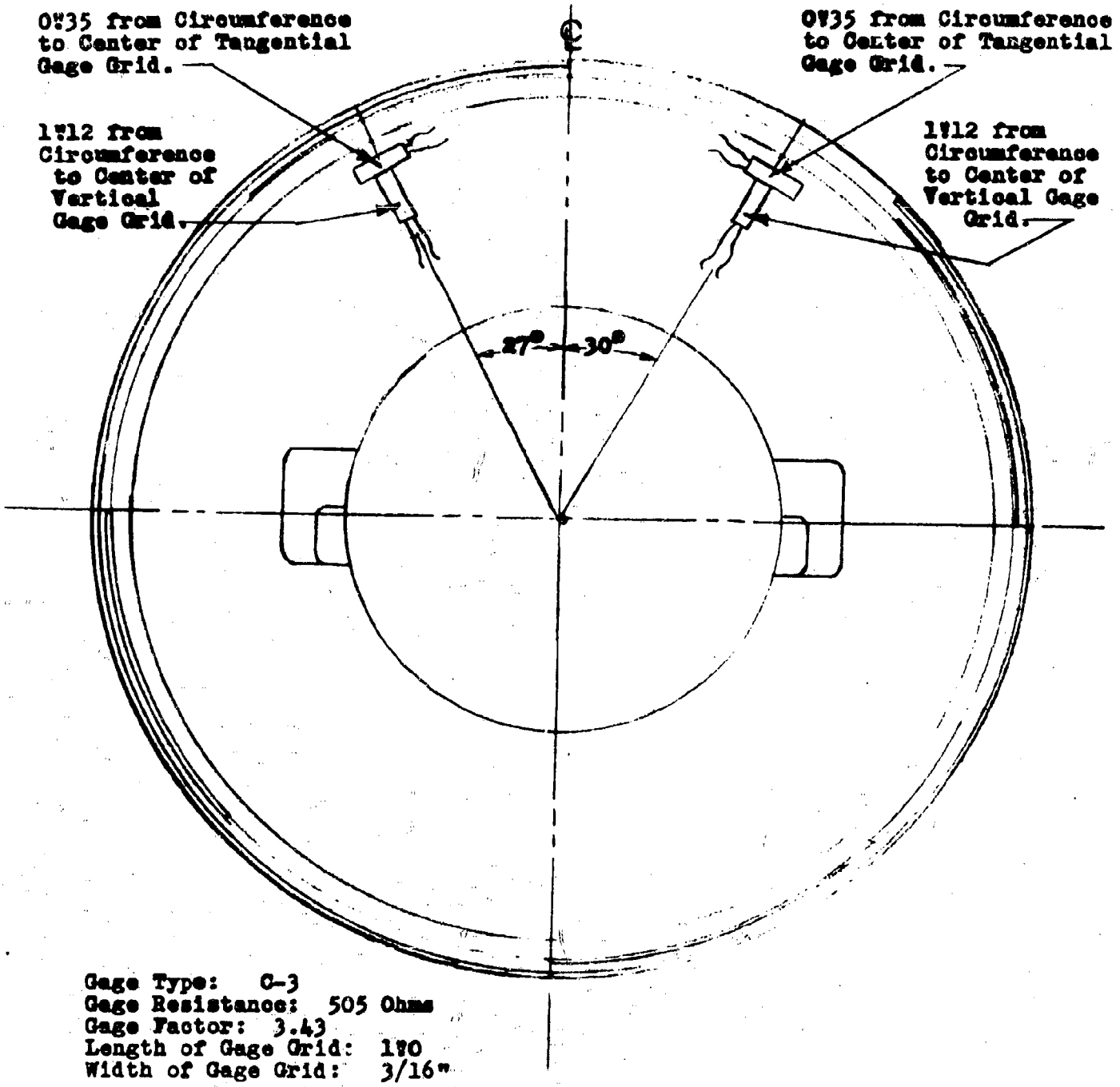
Gage Type: C-3
Gage Resistance: 505 Ohms
Gage Factor: 3.43
Length of Gage Grid: 1"0
Width of Gage Grid: 3/16"

U.S. NAVAL PROVING GROUND

14 November 1952

FIGURE 1

5"/54 TYPE G, MOD. 0, GUN NO. 16070
LOCATIONS OF STRAIN GAGES ON GUN BREECH FACE



Gage Type: C-3
Gage Resistance: 505 Ohms
Gage Factor: 3.43
Length of Gage Grid: 1"0
Width of Gage Grid: 3/16"

U.S. NAVAL PROVING GROUND

17 November 1952

FIGURE 2

TABLE I

3"/70 TYPE G, MOD 0, GUN NO. 24579
STRAINS ON GUN BREECH FACE
(0".29 from circumference to center of Tangential Gage)

14 November 1952

Round	STRAINS IN MICRO-INCHES PER INCH Tangential Left of Centerline	Tangential Right of Centerline	Vertical (Radial) Left of Centerline	Copper Crusher Pressure (TSI)	Powder Index	Charge Weight (lbs.)
1	695	655	-260	22.5	HKPC-1	10.11
2	690	655	-280	22.4	"	"
3	665	610	-255	21.5	"	"
4	735	665	-275	23.0	"	10.50
5	720	695	-300	23.3	"	"
6	740	695	-300	23.4	"	"

TABLE II

5"/54 TYPE G, MOD 0, GUN NO. 16070
STRAINS ON GUN BREECH FACE
(0.35 from circumference to center of Tangential Gage)

17 November 1952

Round	STRAINS IN MICRO-INCHES PER INCH: Tangential Left of Centerling	Tangential Right of Centerling	Vertical (Radial) Right of Centerline	Copper Crusher Pressure (TSI)	Powder Index	Charge Weight (lbs.)
1	595	525	-290	18.0	IHBF-3	18.0
2	635	565	-325	18.6	"	"
3	595	540	-280	17.8	"	"
4	840	735	-495	22.5	"	20.7
5	830	710	-495	23.1	"	"
6	810	725	-490	23.4	"	"
8	895	800	-570	25.7	"	21.4
9	895	795	-565	24.4	"	"
10	605	545	-260	17.1	"	18.0

3"/70 Type G, Mod. 7, Gun No. 24579

Strains On Gun Breech Face

Timing Pips Are At One Millisecond Intervals

Reading From Top To Bottom:

Rd.	Strains in Micro-inches per Inch: Vertical	Tangential Right of Centerline	Tangential Left of Centerline	Copper Crusher Pressure (TSI)	Powder Index	Projectile
1	-260	655	695	22.5	HKPC-1	KX24-2
2	-280	655	690	22.4	HKPC-1	KX24-2
3	-255	610	665	21.5	HKPC-1	KX24-2

U.S. Naval Proving Ground

14 November 1952

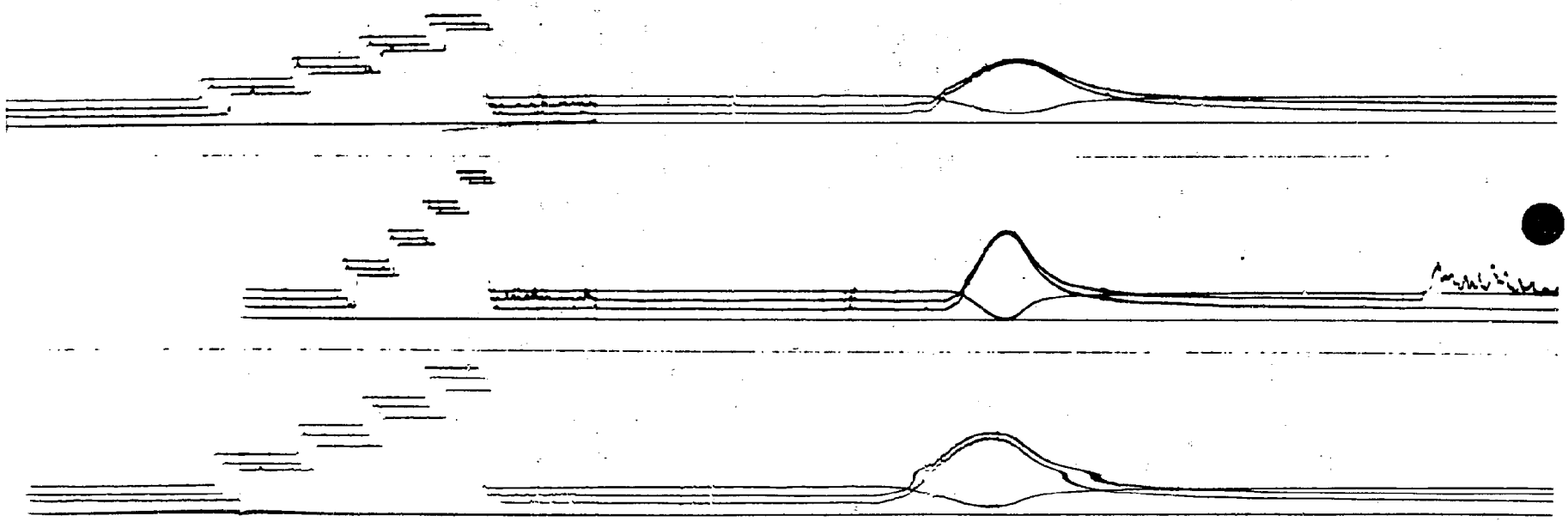


FIG. 3

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3"/70 Type G, Mod. 7, Gun No. 24579

Strains On Gun Breech Face

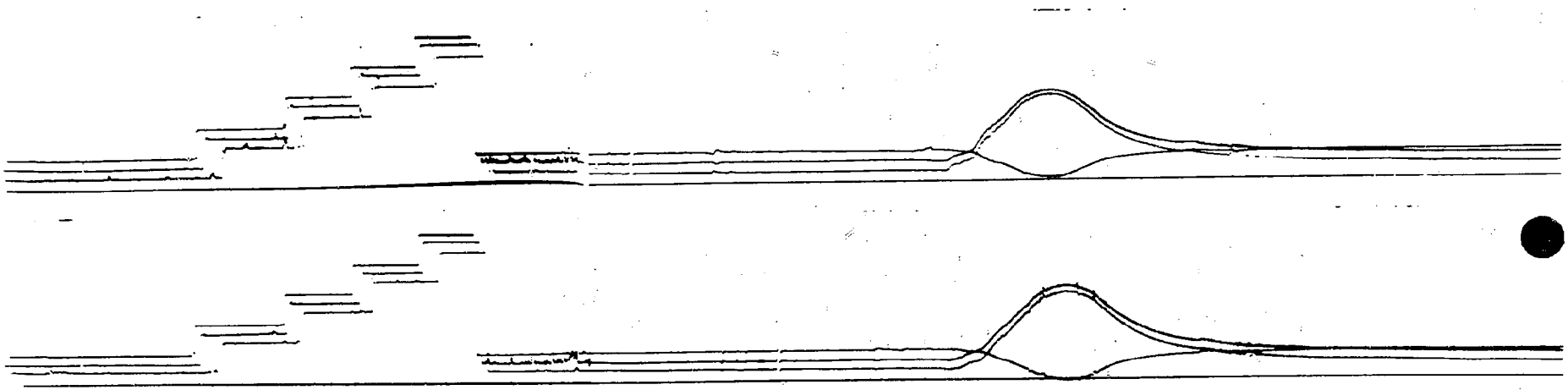
Timing Pips Are At One Millisecond Intervals

Reading From Top To Bottom:

Rd.	Strains in Micro-inches per Inch: Vertical	Tangential Right of Centerline	Tangential Left of Centerline	Copper Crusher Pressure (TSI)	Powder Index	Projectile
4	-275	665	735	23.0	HKPC-1	EX24-2
5	-300	695	720	23.3	HKPC-1	EX24-2
6	-300	695	740	23.4	HKPC-1	EX24-2

U.S. Naval Proving Ground

14 November 1952



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5"/54 Type G, Mod. O, Gun No. 16070

Strains On Gun Breech Face

Timing Pips Are At One Millisecond Intervals

Reading From Top To Bottom:

Rd.	Strains in Micro-inches per Inch: Vertical	Tangential Right of Centerline	Tangential Left of Centerline	Copper Crusher Pressure (TSI)	Powder Index	Projectile
1	-290	525	595	18.0	IHBF-3	Mk. 41-0
2	-325	565	635	18.6	IHBF-3	Mk. 41-0
3	-280	540	595	17.8	IHBF-3	MK. 41-0

U.S. Naval Proving Ground

17 November 1952

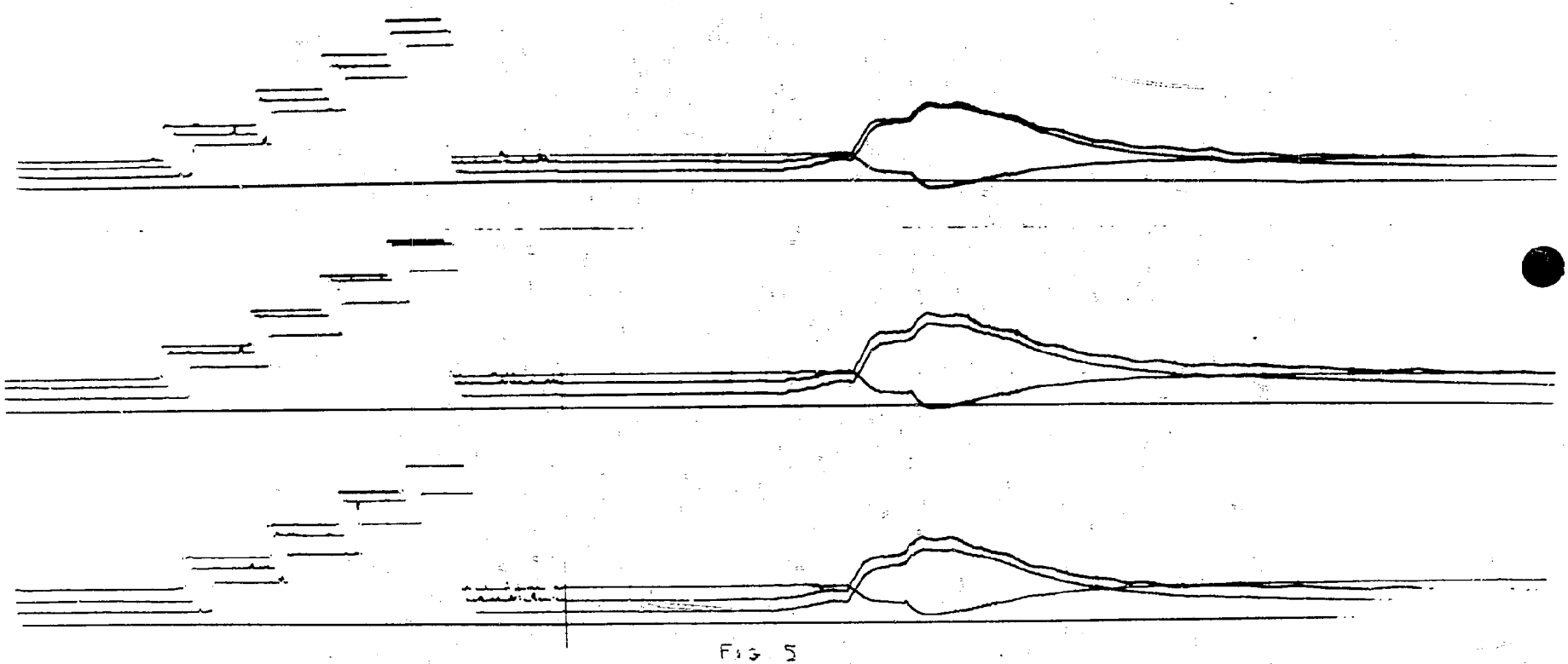

Fig 5

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5"/54 Type G, Mod. 0, Gun No. 16070

Strains On Gun Breech Face

Timing Pips Are At One Millisecond Intervals

Reading From Top To Bottom:

Rd.	Strains in Micro-inches per Inch: Vertical	Tangential Right of Centerline	Tangential Left of Centerline	Copper Crusher Pressure (TSI)	Powder Index	Projectile
4	-495	735	840	22.5	IHBF-3	Mk. 41-0
5	-495	710	830	23.1	IHBF-3	Mk. 41-0
6	-490	725	810	23.4	IHBF-3	MK. 41-0

U.S. Naval Proving Ground

17 November 1952

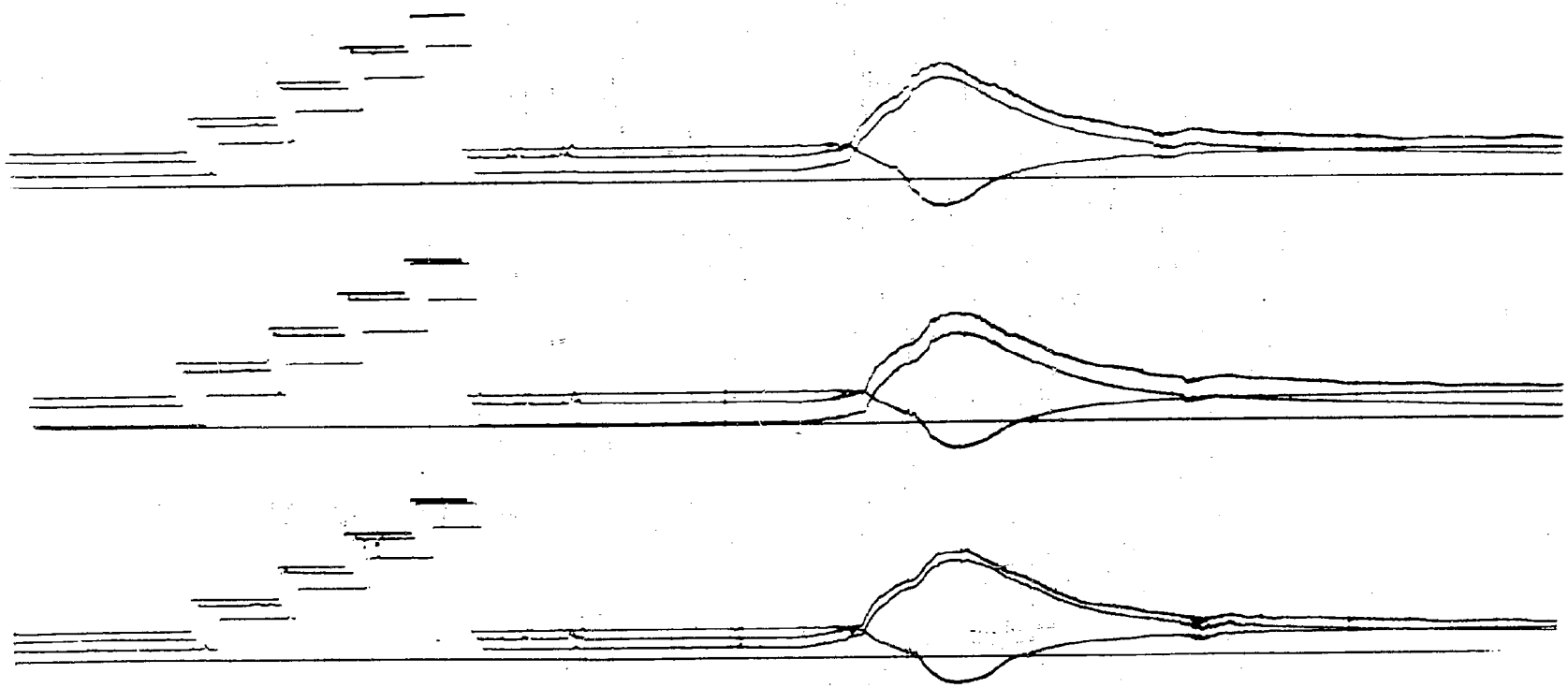


FIG 6

5"/54 Type G, Mod. 0, Gun No. 16070

Strains On Gun Breech Face

Timing Pips Are At One Millisecond Intervals

Reading From Top To Bottom:

Rd.	Strains in Micro-inches per Inch: Vertical	Tangential Right of Centerline	Tangential Left of Centerline	Copper Crusher Pressure (TSI)	Powder Index	Projectile
8	-570	800	895	25.7	IHBF-3	Mk. 41-0
9	-565	795	895	24.4	IHBF-3	Mk. 41-0
10	-260	545	605	17.1	IHBF-3	Mk. 41-0

U.S. Naval Proving Ground

17 November 1952

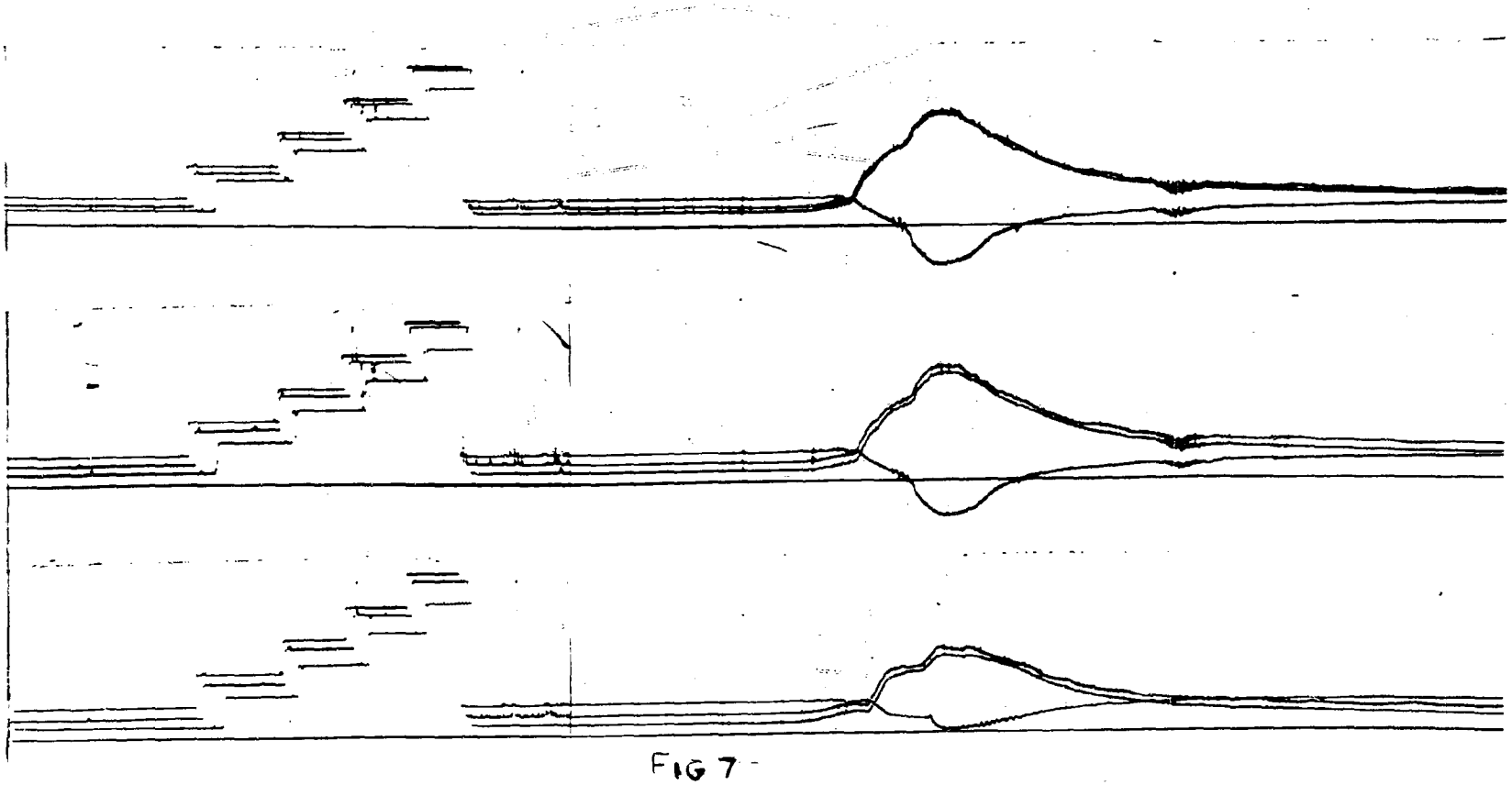
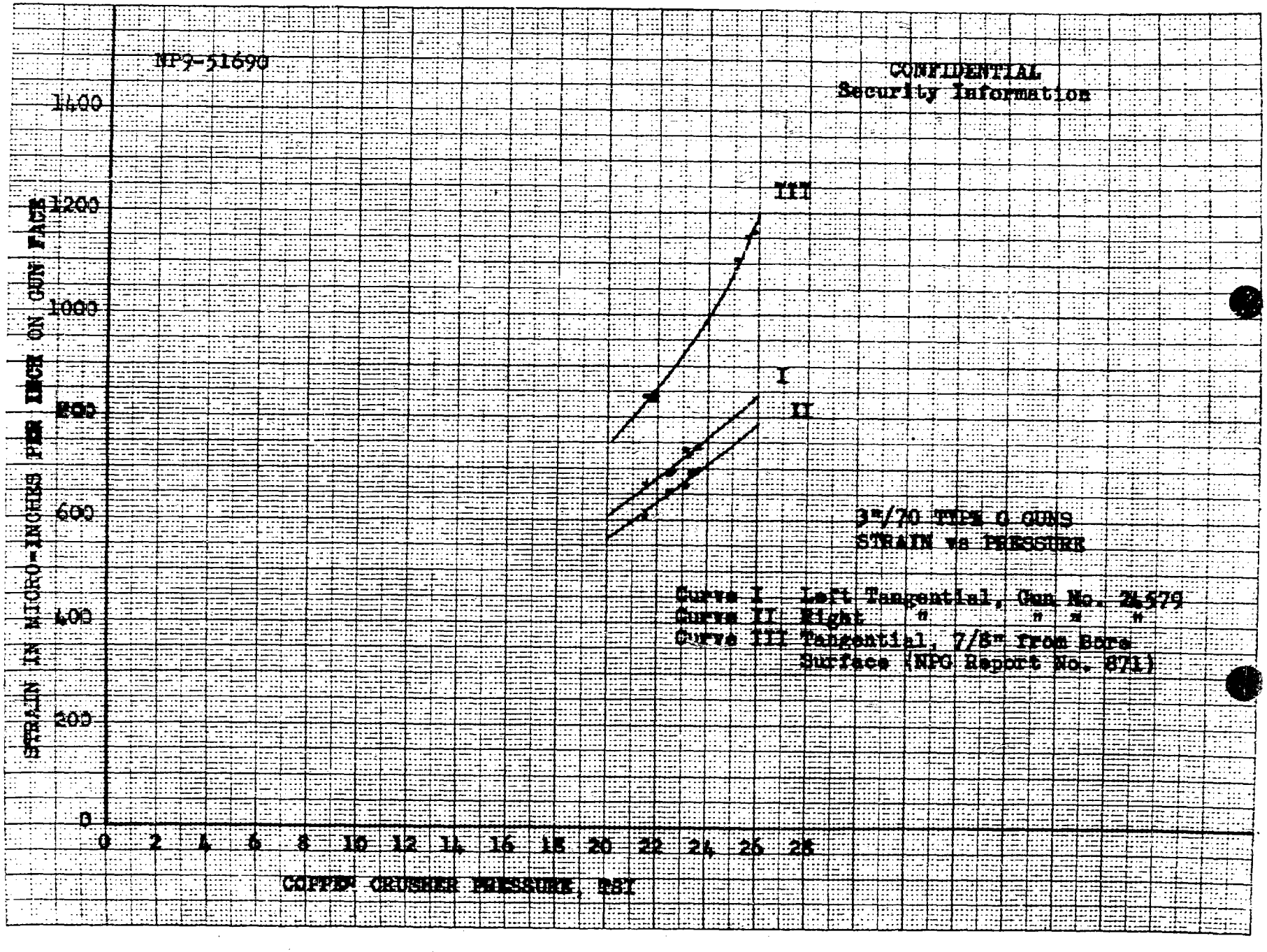


FIG 7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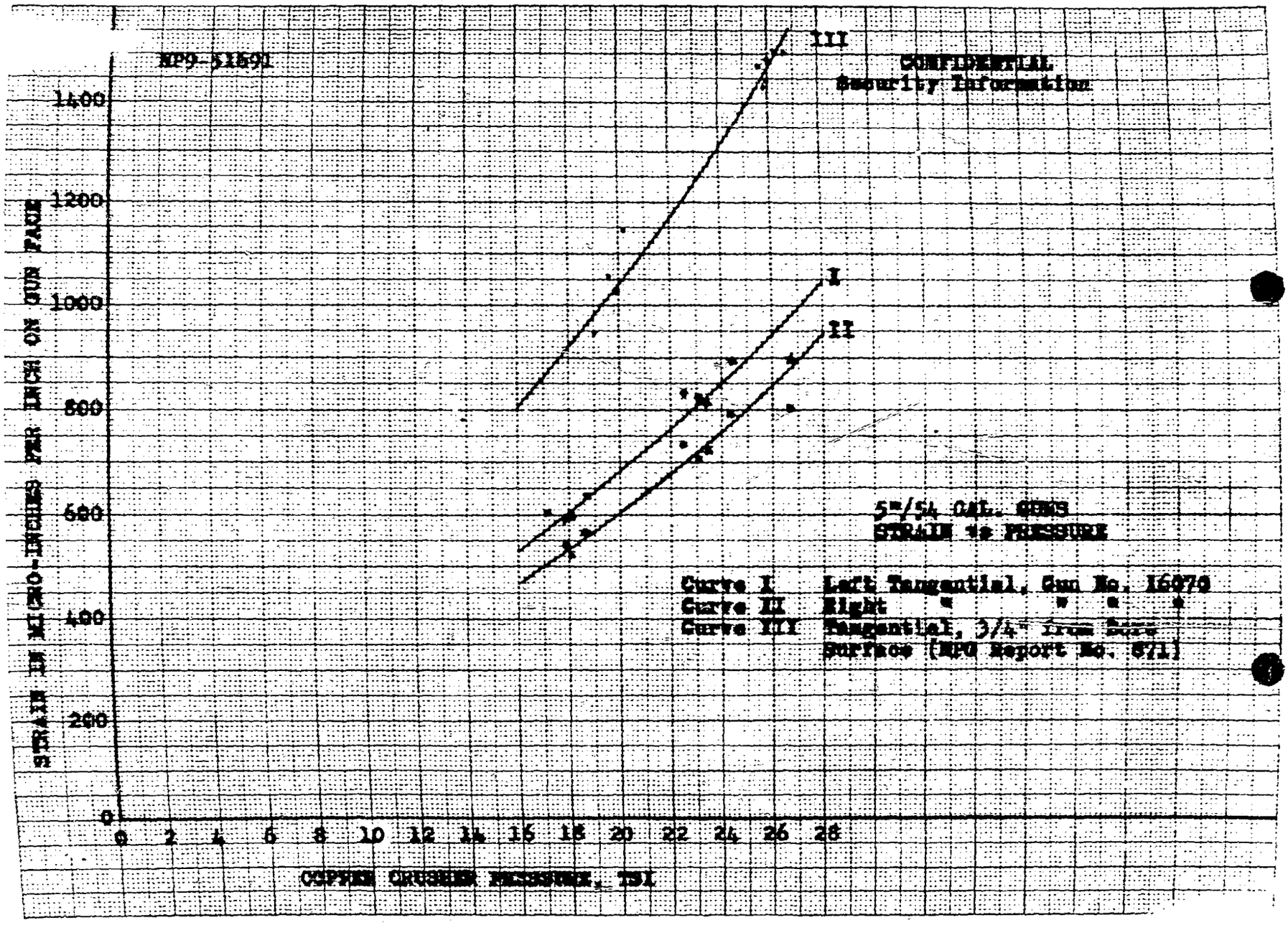
STRAIN IN MICRO-INCHES PER INCH ON GUN FACE
1400
1200
1000
800
600
400
200
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28
COPPER CRUSHER PRESSURE, PSI
III
I
II
3"/70 TIPS O GUNS
STRAIN vs PRESSURE
Curve I Left Tangential, Gun No. 26579
Curve II Right " " " "
Curve III Tangential, 7/8" from Bore
Surface (NPG Report No. 871)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5"/54 CAL. GUNS
STRAIN vs PRESSURE
Curve I Left Tangential, Gun No. 16079
Curve II Right " " " "
Curve III Tangential, 3/4" from Bore Surface (NPG Report No. 871)
I
II
III
STRAIN IN MICRO-INCHES PER INCH ON GUN FACE
0
200
400
600
800
1000
1200
1400
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28
COPPER CRUSHER PRESSURE, TSI

FIG 9

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