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Report No. 313/20-1
Watertown Arsenal
Problem K-12

January 18, 1943

EROSION

A Detailed Study of Erosion Data in Report of Erie Proving Ground on "Test of 37 mm M1A2 Seamless Gun Tubes, Forging Numbers 15292-39 and 9191-24 - Firing Record #6097"

OBJECT

To add to subject report available metallurgical information pertaining to the gun steels, and to determine the extent of erosion, the rate of erosion, and the advance of the forcing cone of the two 37 mm M1A2 guns manufactured from seamless tubing and of the 37 mm M1A2 gun manufactured from a centrifugal casting.

REFERENCE

Erie Proving Ground Report, "Test of 37 mm M1A2 Seamless Gun Tubes, Forging Nos. 15292-39 and 9191-24" (W.A. No. 313/20)

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SUMMARY AND CONCLUSIONS

A

1. The steels and yield strengths of each of the tubes tested are as follows:

<u>Tube No.</u>	<u>Process of Manufacture</u>	<u>Steel</u>	<u>Yield Strength at Muzzle (psi)</u>
15292-39	Seamless Tube	Cr-Mo-Si +40 C	86,300
9191-24	Seamless Tube	Cr-Mo +40 C	97,700
2848 (C-7742)	Centrifugal Casting	Cr-Mo-V +20 C	97,500

2. Tube 2848 (centrifugal casting C-7742) was eroded the least and tube 15292-39 (seamless tubing) the most. The difference in the extent of erosion between the tubes was small.

3. The rate of erosion of the lands at the origin of rifling in the three tubes was rapid at first but gradually slowed down. At the 1000th round the rate of change in diameter was around .005"/1000 rounds, whereas at the 6000th round the average rate was .0015"/1000 rounds. The rate of erosion of the grooves was constant and was around .0006"/1000 rounds. In two of the tubes, Nos. 9191-24 (seamless tubing) and 2848 (centrifugal casting C-7742), the rate of erosion of lands and grooves increased markedly after about the 6800th round. This rapid increase in the rate of erosion was not observed in tube No. 15292-39, possibly because of the fact that the test of it was terminated too soon.

A
UNANNOUNCED

4. The rapid increase in the rate of erosion late in the life of the gun tubes is the first to be observed at Watertown Arsenal based on American data on the erosion of cannon.

5. The estimated advance of the forcing cones of 37 mm gun tubes M1A2 No. 9191-24 (seamless tubing) and No. 2848 (centrifugal casting C-7742) did not become extensive until after about the 6800th round.

6. The behavior of the estimated advance of the forcing cone was consistent with reported findings at Aberdeen Proving Ground for guns of other caliber in that, when the dispersion in muzzle velocity became excessive, with increase in the number of rounds fired, the advance of the forcing cone was large.

7. The accuracy life of each of the 37 mm M1A2 gun tubes 9191-24 (seamless tubing) and 2848 (centrifugal casting C-7742) is about 6800 rounds.

Peter R. Kesting
Peter R. Kesting
Metallurgical Engineer

APPROVED:

H. H. ZERNIG
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Colonel, Ordnance Dept.
Director of Laboratory

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C

INTRODUCTION

At the Erie Proving Ground firing tests were carried out with two 37 mm M1A2 gun tubes which were made from seamless steel tubing and one made from a centrifugal casting. The behavior of the former two was compared with that of the latter. The purpose of this work was to determine the suitability of seamless tubing for the manufacture of 37 mm gun barrels.

In carrying out the tests, periodic observations of pressure, muzzle velocity, bore diameter, accuracy and yaw were made throughout the life of the barrels. After quite a large number of rounds had been fired under usual circumstances the barrels were subjected to pressure firings. A report on "Test of 37 mm M1A2 Seamless Gun Tubes, Forging Nos. 15292-39 and 9191-24" was issued by Erie Proving Ground giving complete records of observations. A copy received by Watertown Arsenal was assigned the No. 313/20 for filing purposes. The present report is regarded as supplemental to the basic one. Its purpose is to supply metallurgical information taken from inspection data pertaining to the gun tubes used in the test, and more particularly to make a detailed study of the erosion data.

In most work guns at Proving Grounds the ammunition is usually varied and pressures and muzzle velocities are usually changed from one group of rounds to the next. Intercomparison of the behavior of gun tubes is difficult if not impossible under such conditions. However, throughout the endurance firing of these three gun barrels fixed ammunition from the same lot was used. For this reason the data are important.

In the Erosion Test Data Sheet, given in Appendix A, are: the conditions under which the firing tests were conducted; a description of the gun tubes, including their chemical analyses, mechanical properties, and macrostructures; and a description of the ammunition used in the endurance firing, including the chemical analysis and dimensions of the propellant powder grains.

During manufacture the seamless tubings were upset by forging at one end in order to obtain sufficient stock for the breech ends of the gun barrels. Insufficient metal was available at the time of inspection for determining the tensile properties at the breech ends of the tubes actually used in the firing tests. But a study of similar pieces of upset tubing was carried out by those involved in the development of this method of manufacture of gun barrels. The metallurgical data in this report pertains only to the metal used in the gun tubes which were fired.

PROCEDURE FOLLOWED IN THE STUDY OF EROSION OF THE THREE GUN BARRELS

The erosion data were taken from the Erie Proving Ground Stargaugage Records which are part of Firing Record #8097.

The advance of the forcing cone was not measured at Erie Proving Ground. It was estimated by taking from a plot of the stargaugage records, the increase in distance from the breech end of the point where the diameter of the

land was worn to the extent of the nominal diameter of the groove.

Graphs were made for only that part of the life of the gun tubes during which all firing was carried out with ammunition from Lot No. 5315-2 having 100% charge with 6.34 oz. of single base powder and the practice projectile M55A1.

RESULTS

Tabulated in Appendix B are the data showing the diameters of the lands and grooves at 9.75" from the breech end (near the origin of rifling), the changes in diameters at this point, the estimated advance of the forcing cone, the maximum major axis and maximum orientation of yaw, the mean radius of dispersion on target, the observed pressures, the estimated and measured muzzle velocities, and the dispersion or range in measured muzzle velocity as observed throughout the life of the gun tubes. In Fig. 1 the relationship between the number of rounds fired and the following data pertaining to gun tube 15292-39 are shown:

- A - the erosion of lands and grooves at 9.75" from the breech end
- B - the estimated advance of the forcing cone
- C - the measured muzzle velocity
- D - the dispersion in muzzle velocity as measured by the range in muzzle velocity
- E - the size of target as measured by the mean radius of dispersion at the target

Similar information is shown on Figs. 2 and 3 for gun tubes 9151-24 and 2843 (C-7742) respectively.

Erosion curves for lands at 9.75", 10", 10.5", 11", and 12" from the breech end of each gun are shown on Figs. 4, 5, and 6. In Fig. 7 the erosion data for the lands at 9.75" from the breech end of the three tubes are shown in order to facilitate the comparison of the three guns.

The extent of erosion and the rate of erosion of the lands and grooves at 9.75" from the breech end at the 1000th, 6000th, and 7500th round are tabulated in Table I.

Table I

Extent of Erosion and Rate of Erosion at 9.75" from
Breech End of 37 mm M1A2 Gun Tubes, Nos. 15292-39,
9191-24, and 2848 (C-7742) at 1000th, 6000th, and
7500th Round

Extent of Erosion:

Gun Tubes	15292-39		9191-24		2848 (C-7742)	
	Seamless Tubing		Seamless Tubing		Centrifugal Casting	
	0.001"					
	Land	Groove	Land	Groove	Land	Groove
1000th Round	7.0	0.6	4.4	0.6	4.2	0.5
6000th Round	23.2	3.5	21.2	3.8	19.3	2.8
7500th Round	--	--	52.	38.	37.	25.

Rate of Erosion:

	0.001"/1000 Rounds					
	Land	Groove	Land	Groove	Land	Groove
1000th Round	5.2	0.6	4.4	0.6	4.2	0.5
6000th Round	1.0	0.6	1.7	0.6	1.2	0.5
7500th Round	--	--	59.	44.	22.	28.

DISCUSSION

Erosion

Up to approximately the 6800th round the rate of erosion of the lands in each of the tubes was rapid at first, then slowed down, whereas that of the grooves appeared to be constant. This is indicated in all the figures and in Table I. But the extent and rate of erosion of the lands and grooves of tubes 9191-24 (seamless tubing), and 2848 (centrifugal casting C-7742) increased markedly after about the 6800th round. This change was not limited to the origin of rifling but occurred along the length of the barrel forward from this point up to at least 12 inches from the breech end, as shown in Figs. 5 and 6.

No change in the conditions of firing was found that would account for this marked difference in extent of erosion. The high pressure firings to which all the tubes were subjected occurred at a period later in the life of the tubes than is now under study.

This increase in the rate of erosion late in the life of the gun was not observed in tube 15292-39. However, there was fired in this one tube a total of only 6752 rounds and the rapid erosion was first noticed in the other tubes only at the 7236th round. It may well be that tube 15292-39 had not been fired long enough to establish the condition favorable to the rapid erosion rate.

This is the first instance that has come to the attention of this Arsenal of American data showing a marked increase in the rate of erosion at the origin of rifling late in the life of some cannon fired under constant conditions throughout.

More information regarding reproducibility of data is needed before conclusions can be reached regarding effects of composition, hardness, and processing upon erosion. In general, it again appears that the effects of such factors are small within the range studied.

Advance of the Forcing Cone

The advance of the forcing cone could only be estimated. In practice there is to be anticipated a small though measurable advance followed by a more rapid one. In this study the anticipated small measurable advance is about 1/4 inch in approximately 7000 rounds.

The rapid advance becomes noticeable after the 7236th round in tubes 9191-24 and 2848 (C-7742), but is not noticeable in tube 15292-39. The latter tube has already been found to have been taken out of service before the rapid erosion occurred.

At the time the rapid advance of the forcing cone and the rapid erosion become noticeable, the dispersion in muzzle velocity increases markedly. The average muzzle velocity begins to fall rapidly at about this time too. The loss in accuracy, as shown by the increase in radius of dispersion at

the target also occurs at this point. The accuracy life of the two 37 mm M1A2 barrels fired under the prevailing conditions may then be considered to be 6800 rounds.

In general, there are inadequate data concerning the advance of the forcing cone before and beyond the 7000th round. However, the indications are consistent with recent observations of Aberdeen Proving Ground regarding the advance of the forcing cone and its correlation with the loss in muzzle velocity and dispersion in muzzle velocity. The curve of the advance of the forcing cone vs. the number of rounds tends to be a straight line, whereas the curve for the extent of erosion of the lands vs. the number of rounds does not. The erosion curve is not as suited as the forcing cone curve for predicting loss in muzzle velocity.

Firing Conditions

A review of the firing conditions recorded in Appendix A reveals that the rate of fire in rounds per period, rounds per burst, and rounds per cycle varied quite widely. The temperature of the gun tubes would likewise vary because it is dependent on the rate of fire. This lack of control may account for some of the variations shown in the erosion curve. However, the temperature control may be better than the record indicates. If the correct interpretation of the description of the procedure during firing is that the tubes were cooled after each burst, which for the most part was 20 rounds in length, then the temperatures reached at the end of each burst may never have been excessive and may have been reasonably uniform.

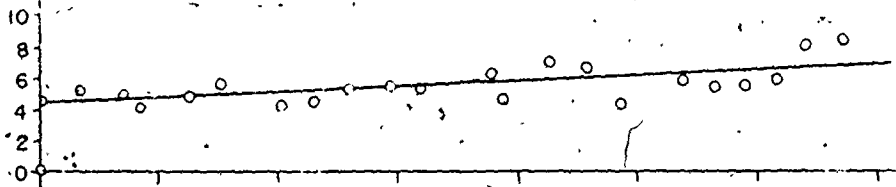
The firing conditions are not sufficiently specified so that, should it be desired to test another gun material, it would not be possible to fire it exactly like the tubes in this report. Therefore, another tube representative of present manufacture would have to be fired as a companion to the tube under test. However, the extent of erosion of the subject 37 mm M1A2 gun tubes is small enough to indicate the desirability of using another model of shorter normal life for erosion tests. Consideration has already been given to the 37 mm M3 gun for this use.

Acknowledgment

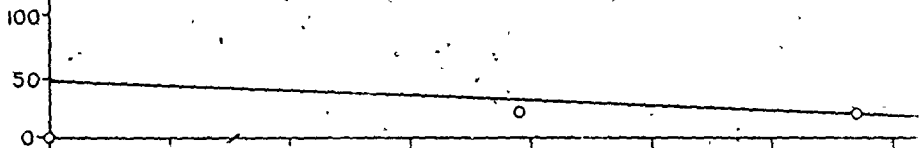
Acknowledgment is made to F. D. Weinfeld for his assistance in tabulating the data.

FIGURES

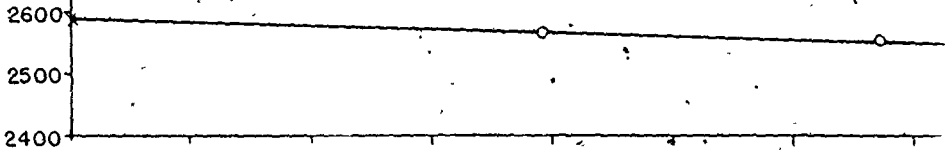
TARGET SIZE
MEAN RADIUS OF
DISPERSION INCHES



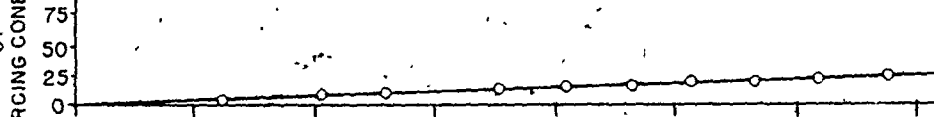
DISPERSION IN MUZZLE
VELOCITY F/S



MUZZLE VELOCITY F/S



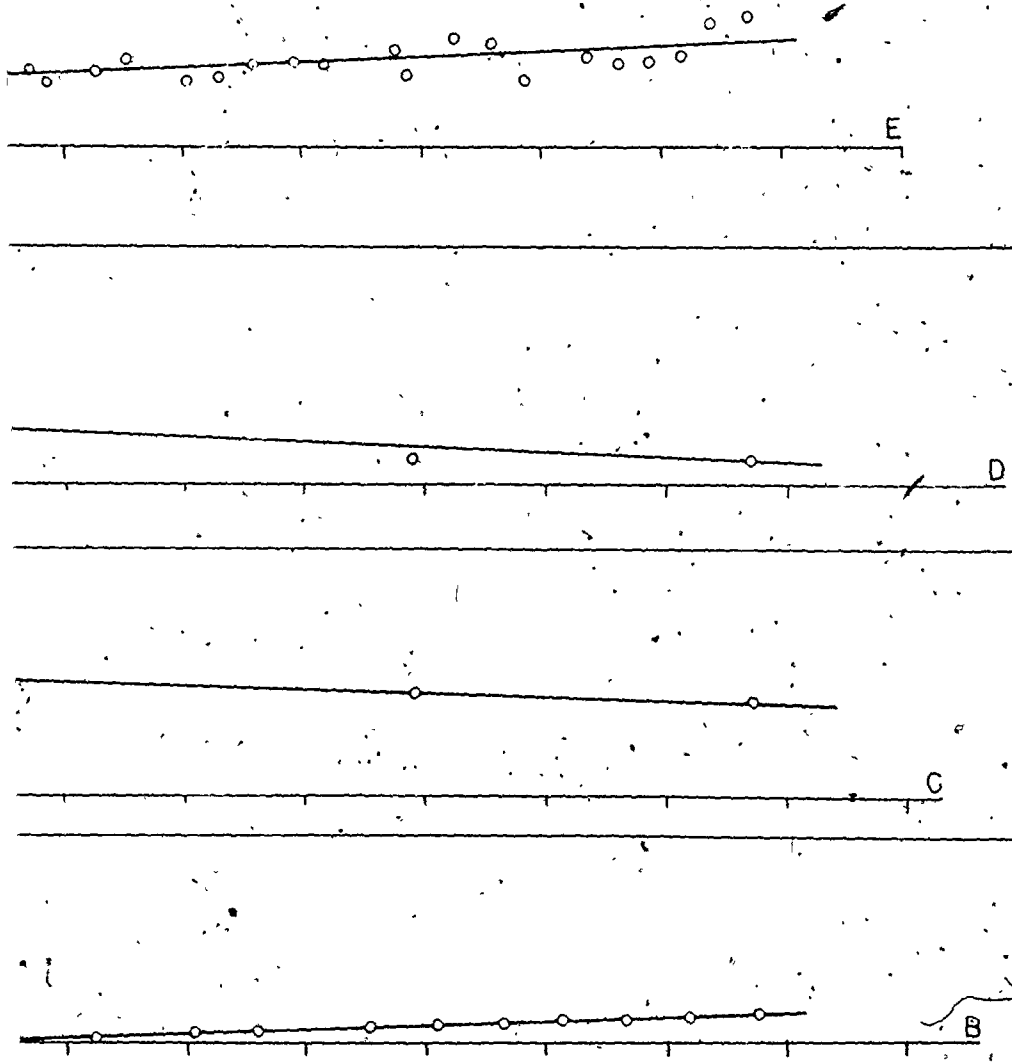
ESTIMATED ADVANCE
OF
FORCING CONE INCHES



N DIA INCHES

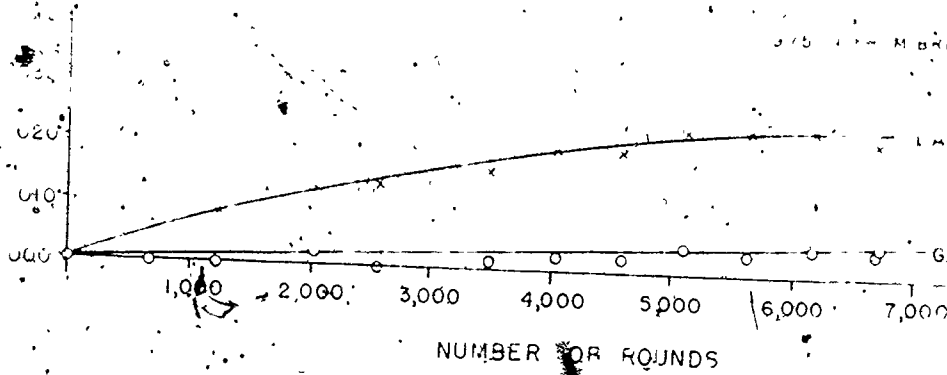
050
040

975 IN FROM BRG



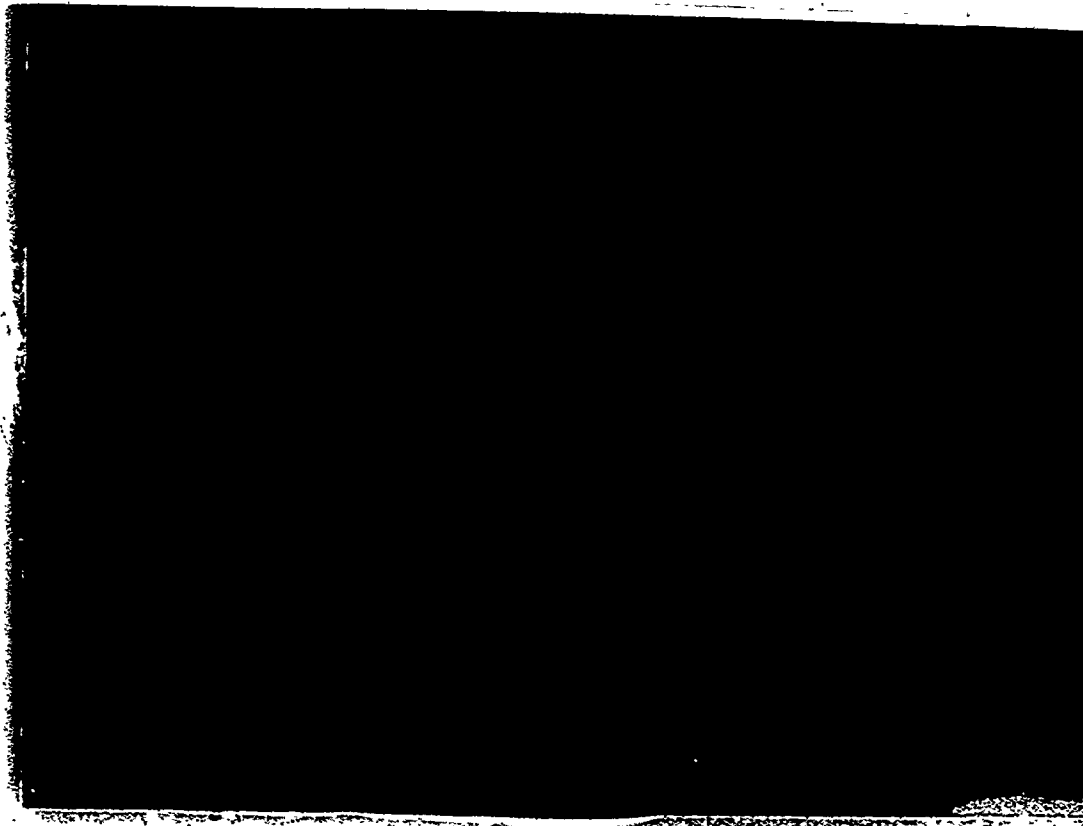
975 IN FROM BREEGH END

EROSION CHANGE IN D



RELATIONSHIP BETWEEN NUMBER OF ROUNDS FIRED USING STANDARD...
EROSION, ESTIMATED ADVANCE OF FORCING CONE, MUZZLE VELOCITY, DISPER...
VELOCITY AND TARGET SIZE FOR 37 MM GUN TUBE M1A2 NO 1529
(SEAMLESS TUBING)

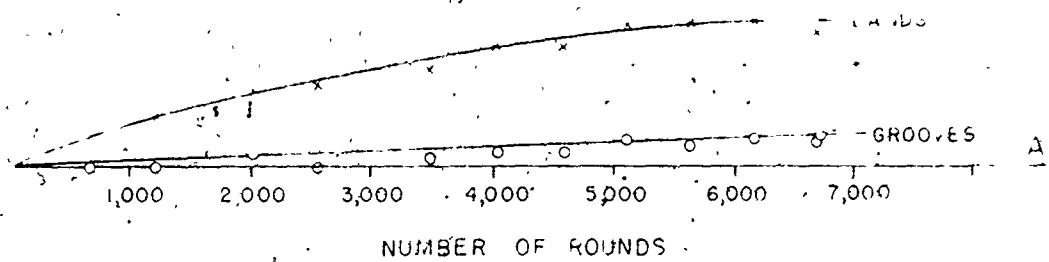
FIG. 1



BR
LA

37 MM M BREECH ENL

GR
300

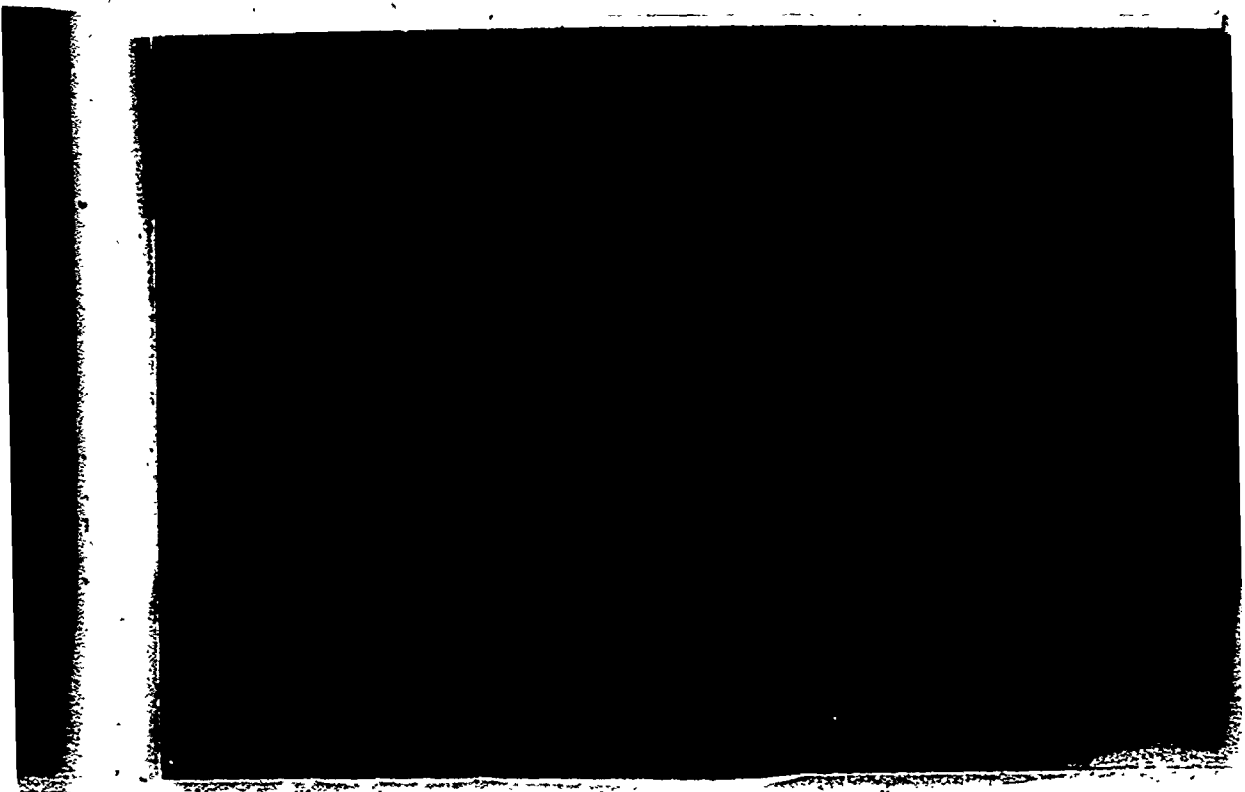


MAR
SER
529

RELATIONSHIP BETWEEN NUMBER OF ROUNDS FIRED USING STANDARD CHARGE AND EROSION, ESTIMATED ADVANCE OF FORGING CONE, MUZZLE VELOCITY, DISPERSION IN VELOCITY AND TARGET SIZE FOR 37 MM GUN TUBE MIA2 NO 15292 - 39 (SEAMLESS TUBING)

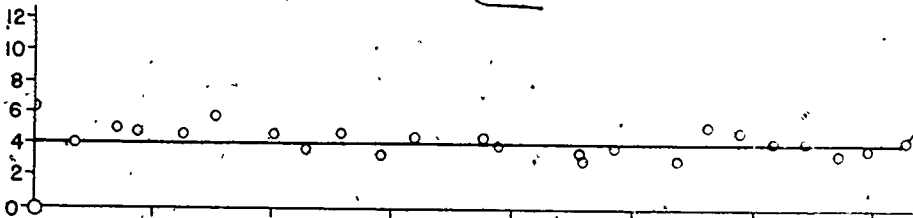
FIG 1

EE-16



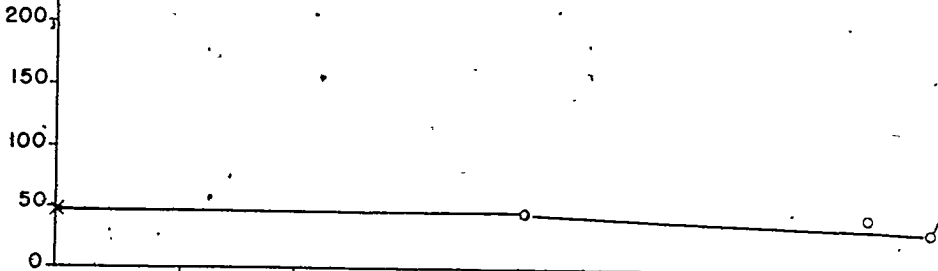
TARGET SIZE
MEAN RADIUS OF
DISPERSION — INCHES

12
10
8
6
4
2
0



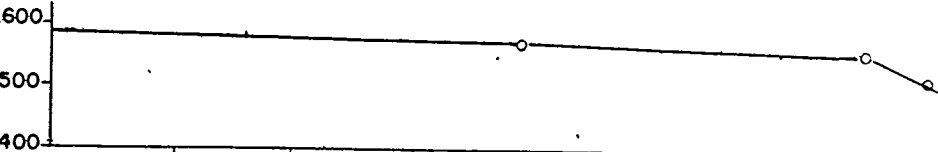
DISPERSION IN MUZZLE
VELOCITY F/S

200
150
100
50
0



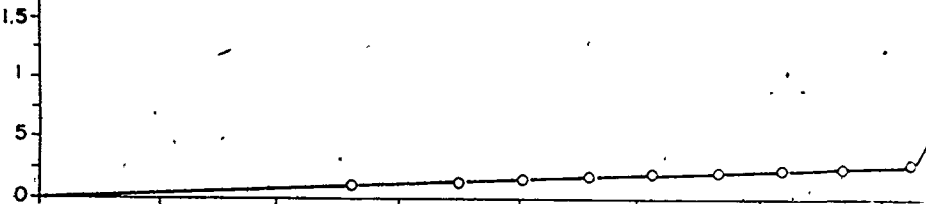
MUZZLE
VELOCITY F/S

2600
2500
2400



ESTIMATED ADVANCE
OF FORGING CONE IN
INCHES

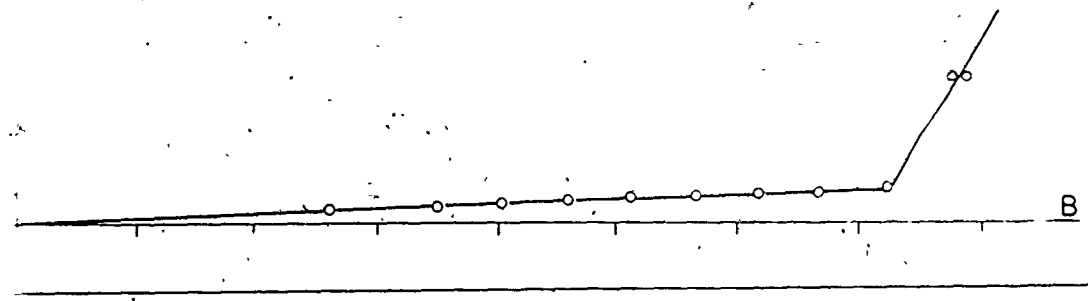
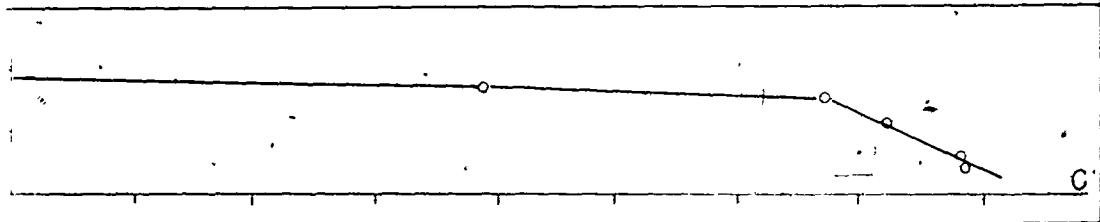
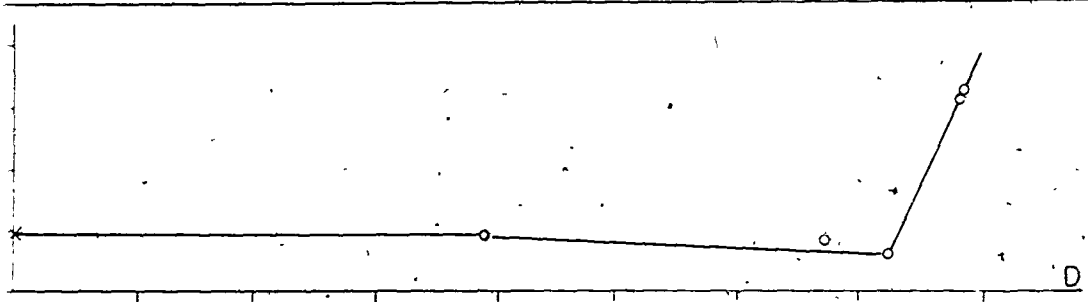
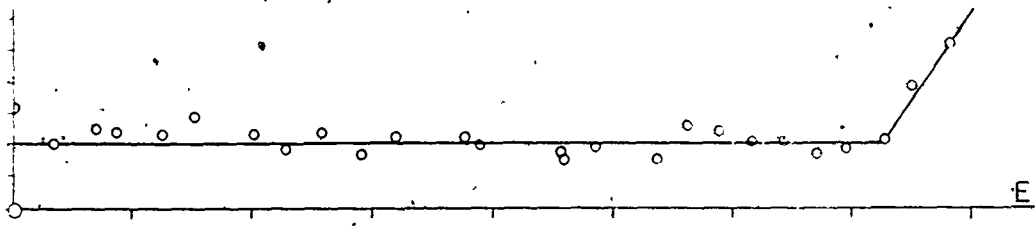
1.5
1
0.5
0



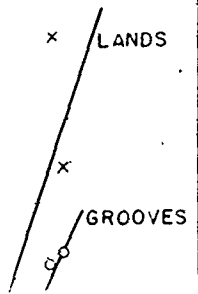
AMETER INCHES

0.090
0.080
0.070
0.060

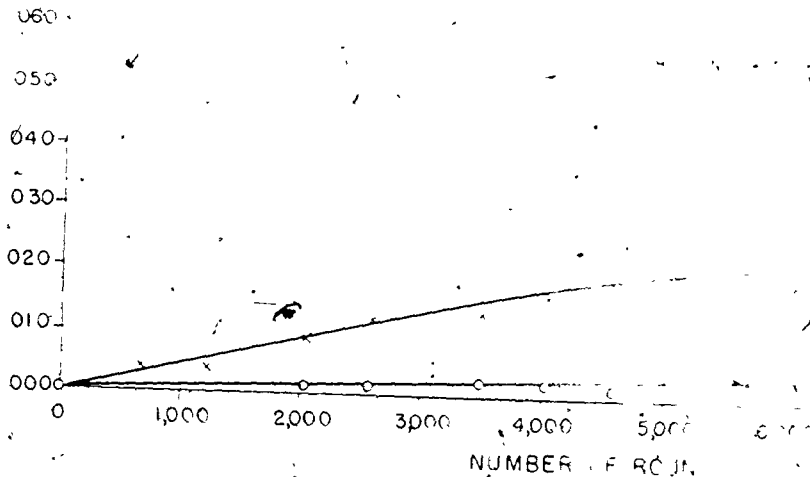




975 IN FROM BREECH END

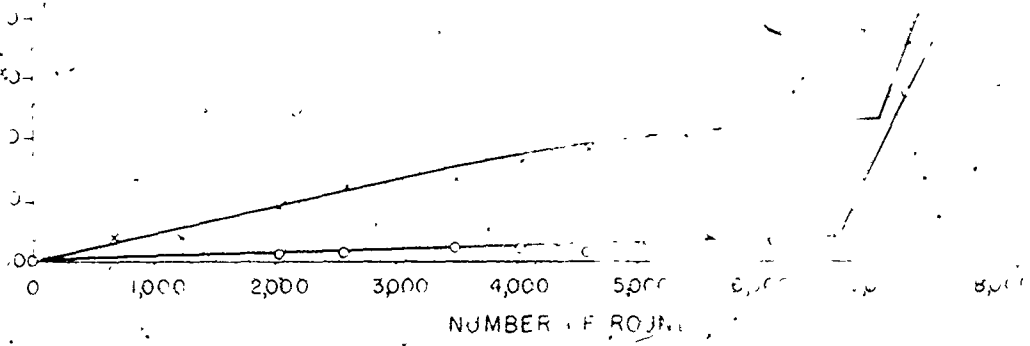


EROSION CHANGE OF DIAMETER:



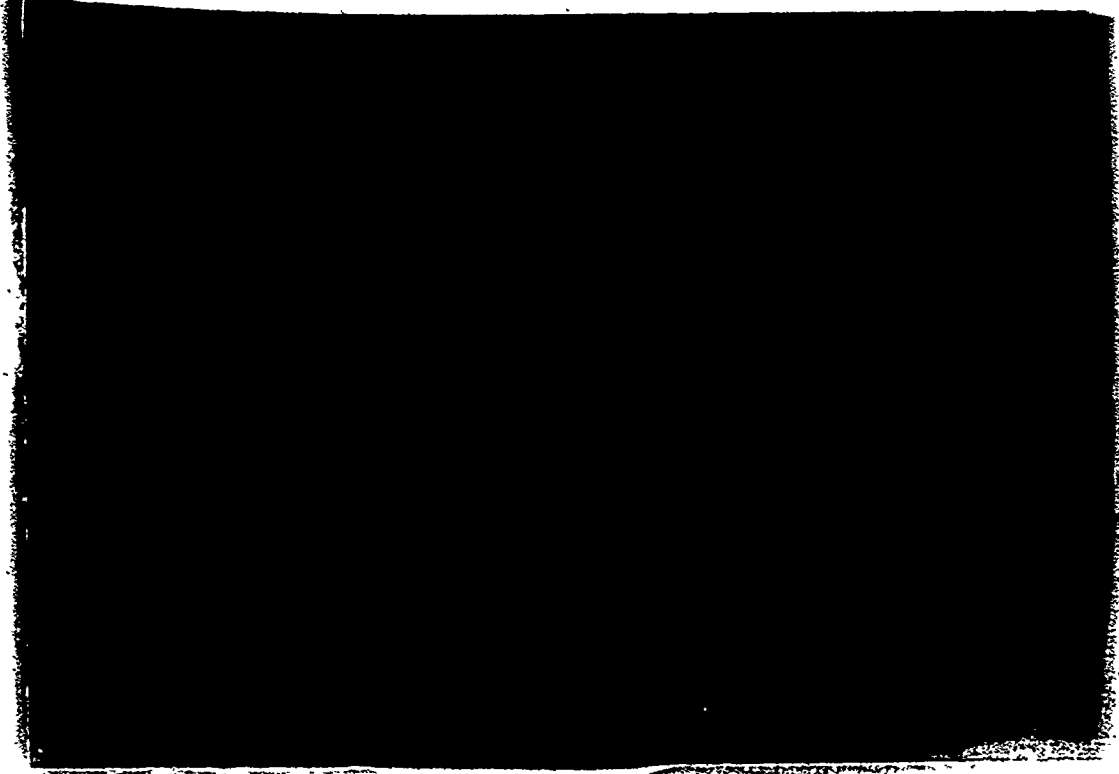
RELATIONSHIP BETWEEN NUMBER OF ROUNDS FIRED AND THE
ESTIMATED ADVANCE OF FORCING CONE MIDDLE SECTION DIFFERENTIAL
TARGET SIZE 37MM GUN TUBE M1A2 MC 9191-24 (SEAMLESS)

FIG

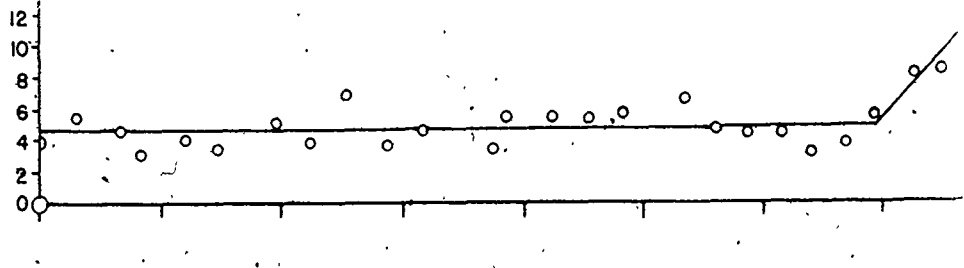


RELATIONSHIP BETWEEN NUMBER OF ROUNDS FIRED USING 37MM GUN TUBE MIA2 NC 9191-24 (SEAMLESS TUBING) AND ESTIMATED ADVANCE OF FORGING COHE M 22 E VELOCITY DIFFERENCE IN VELOCITY AT TARGET SIZE 37MM GUN TUBE MIA2 NC 9191-24 (SEAMLESS TUBING)

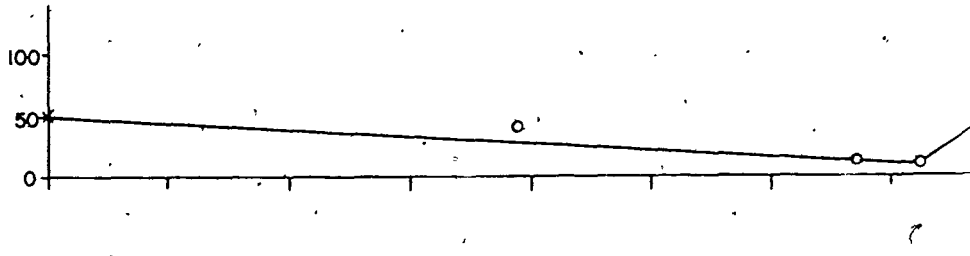
FIG



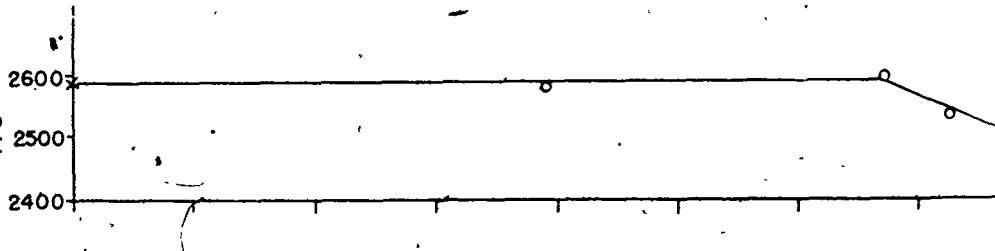
TARGET SIZE
MEAN RADIUS OF
DISPERSION IN INCHES



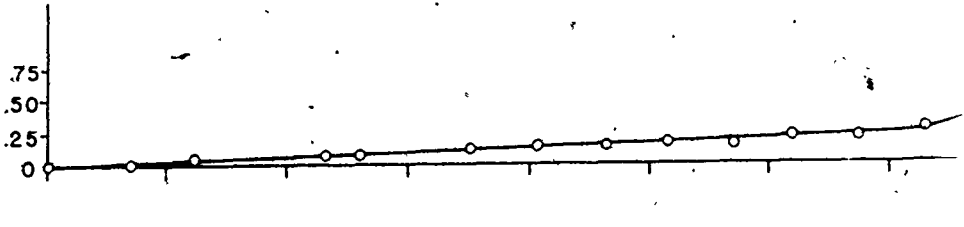
DISPERSION IN MUZZLE
VELOCITY F/S



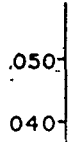
MUZZLE VELOCITY
F/S

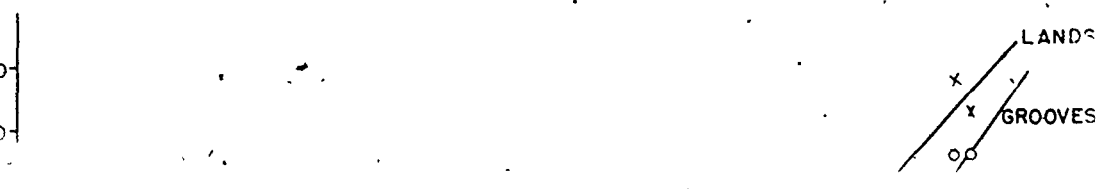
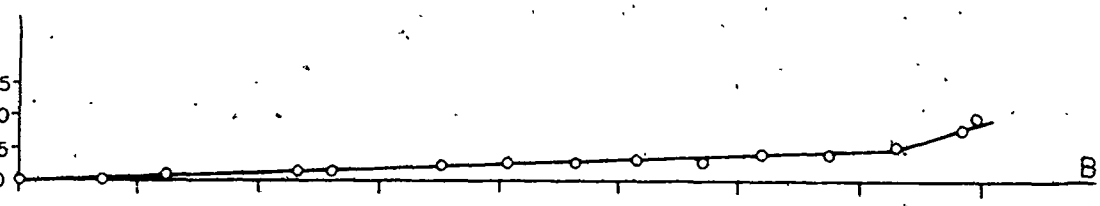
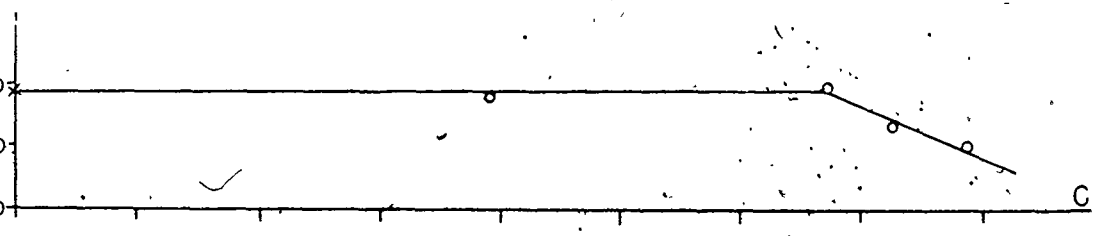
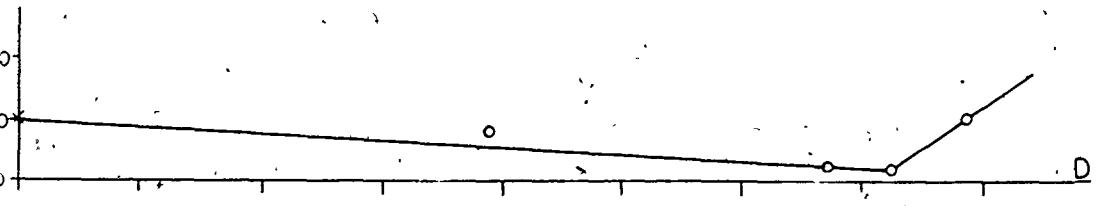
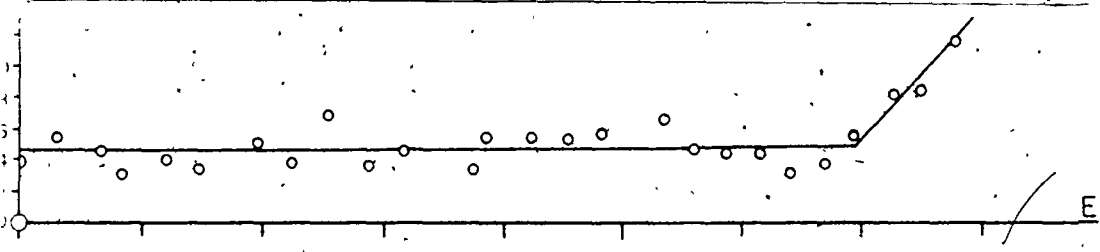


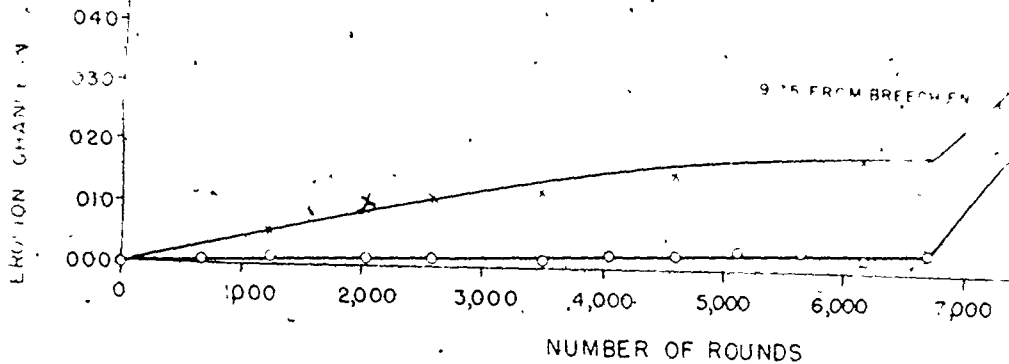
ESTIMATED ADVANCE
OF FORCING CONE--IN



DIA. INCHES

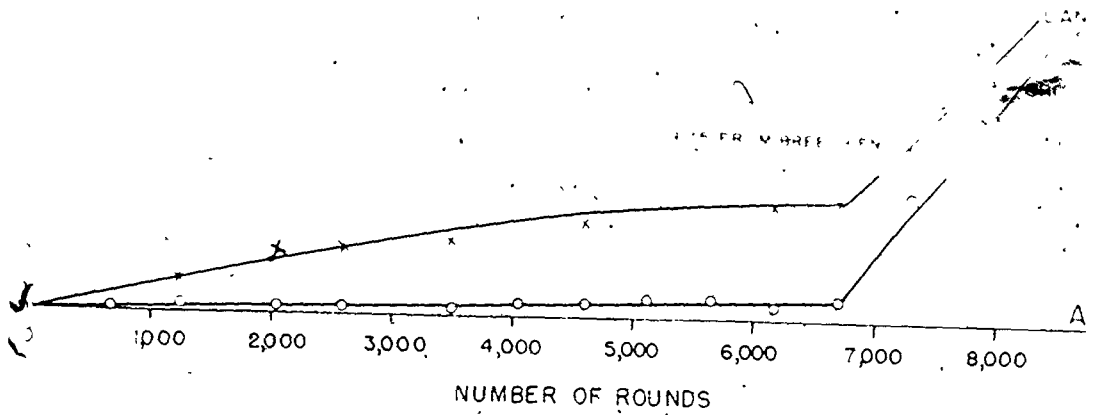






RELATIONSHIP BETWEEN NUMBER OF ROUNDS FIRED USING STANDARD CHARGE, EROSION, ESTIMATED ADVANCE OF FORGING CONE, MUZZLE VELOCITY, DISCREPANCY IN VELOCITY AND TARGET SIZE 37 MM GUN TUBE M1A2 NO 284 (CENTRIFUGAL CASTING-7742)

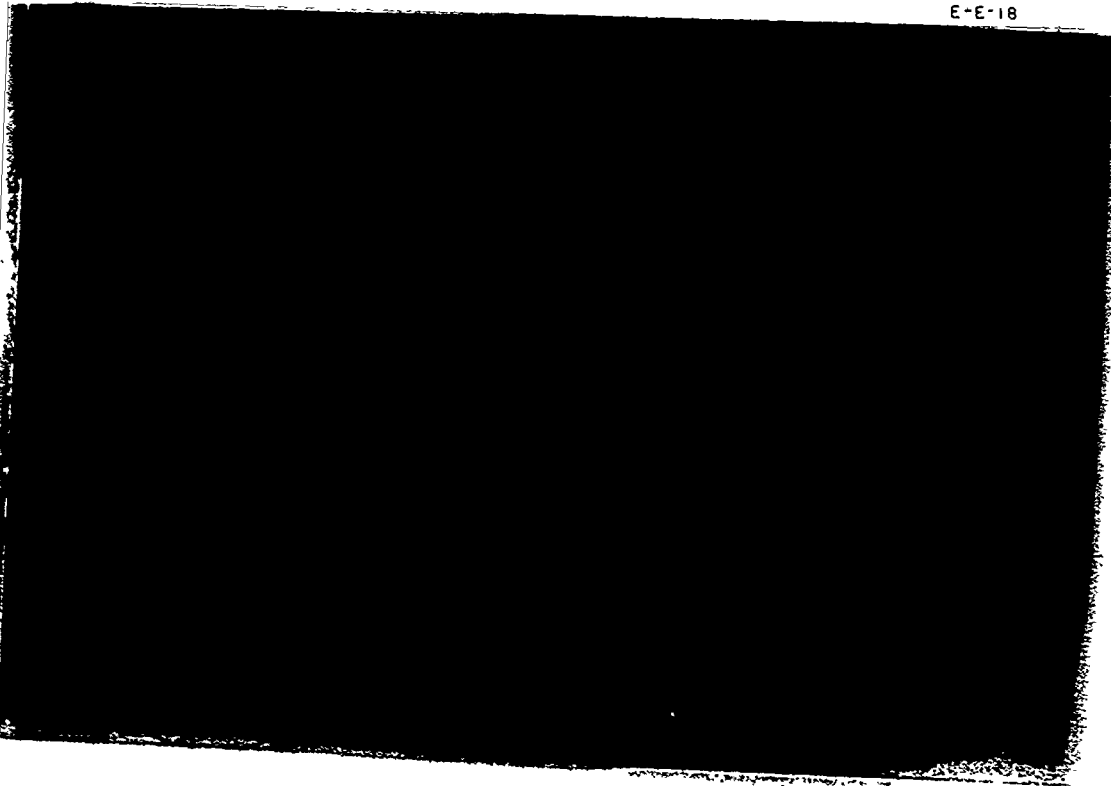
FIG 3



RELATIONSHIP BETWEEN NUMBER OF ROUNDS FIRED USING STANDARD CHARGE AND EROSION, ESTIMATED ADVANCE OF FORGING CONE, MUZZLE VELOCITY, DISPERSION IN VELOCITY AND TARGET SIZE 37 MM GUN TUBE MIA2 NO 2848 (CENTRIFUGAL CASTING-7742)

FIG. 3

E-E-18



050 - RELATIONSHIP BETWEEN NUMBER OF ROUNDS FIRED AT STANDARD CHARGE AND EROSION OF LANDS AT VARIOUS DISTANCES FROM BREECH END
 37 M.M. M1A2 GUN TUBE NO 15292-39 (SEAMLESS TUBING)

EROSION CHANGE IN DIAMETER INCHES

DISTANCE FROM BREECH END IS INDICATED FOR EACH CURVE

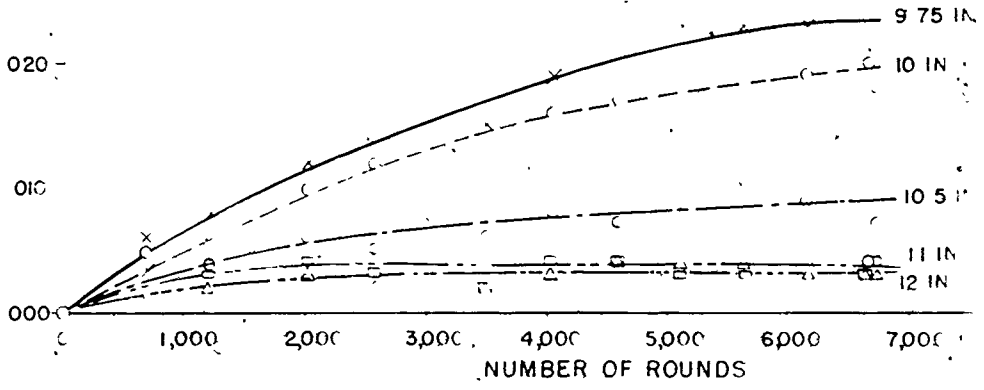


FIG 4

E-1

RELATIONSHIP BETWEEN NUMBER OF ROUNDS FIRED AT STANDARD CHARGE AND EROSION OF LANDS AT VARIOUS DISTANCES FROM BREECH END OF 37 M.M. M1A2 GUN TUBE NO 15292-39 (SEAMLESS TUBING)

DISTANCE FROM BREECH END IS INDICATED FOR EACH CURVE

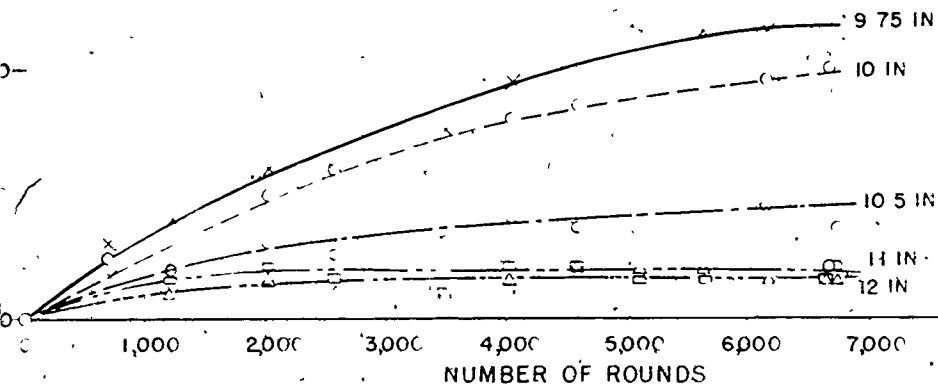
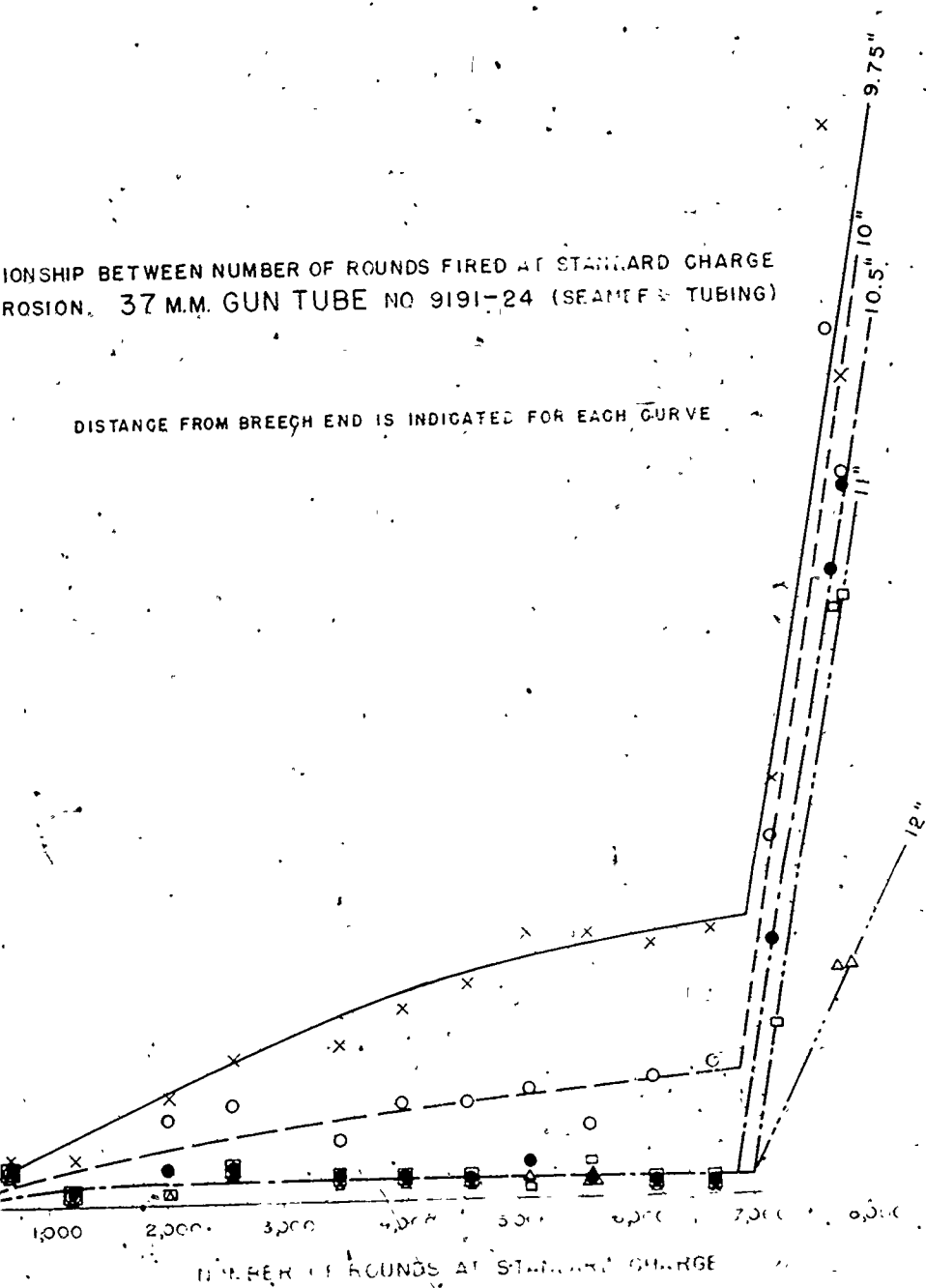


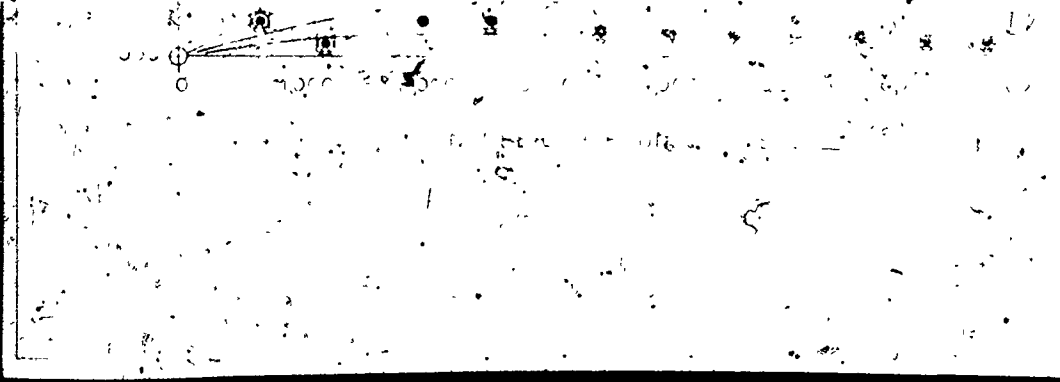
FIG 4

E-E-19

RELATIONSHIP BETWEEN NUMBER OF ROUNDS FIRED AT STANDARD CHARGE
 AND WEAR OF 37 M.M. GUN TUBE NO 9191-24 (SEAMLESS TUBING)

DISTANCE FROM BREECH END IS INDICATED FOR EACH CURVE





101

1000

1000

1000

1000

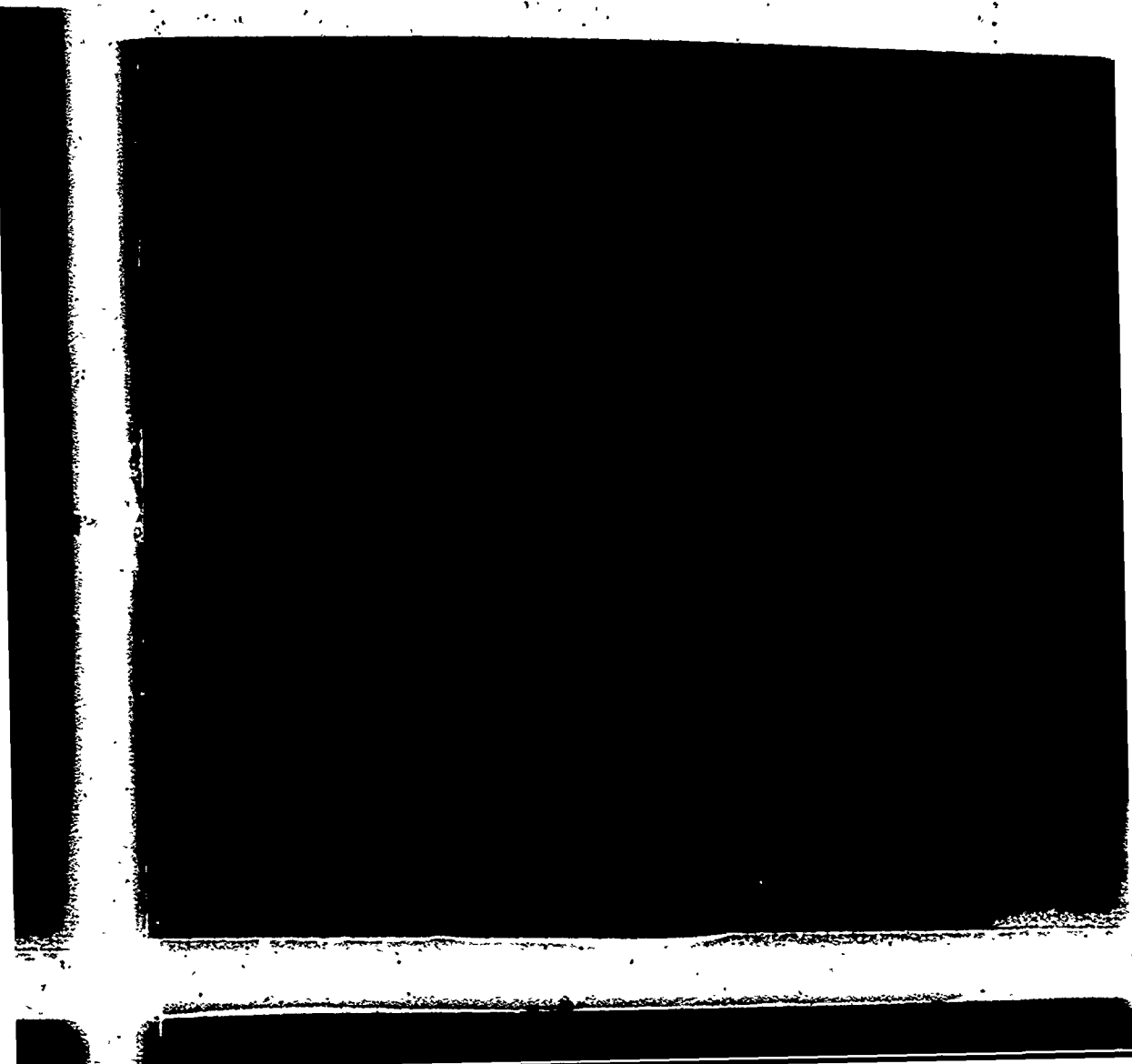
1000

1000

1000

1000

1000



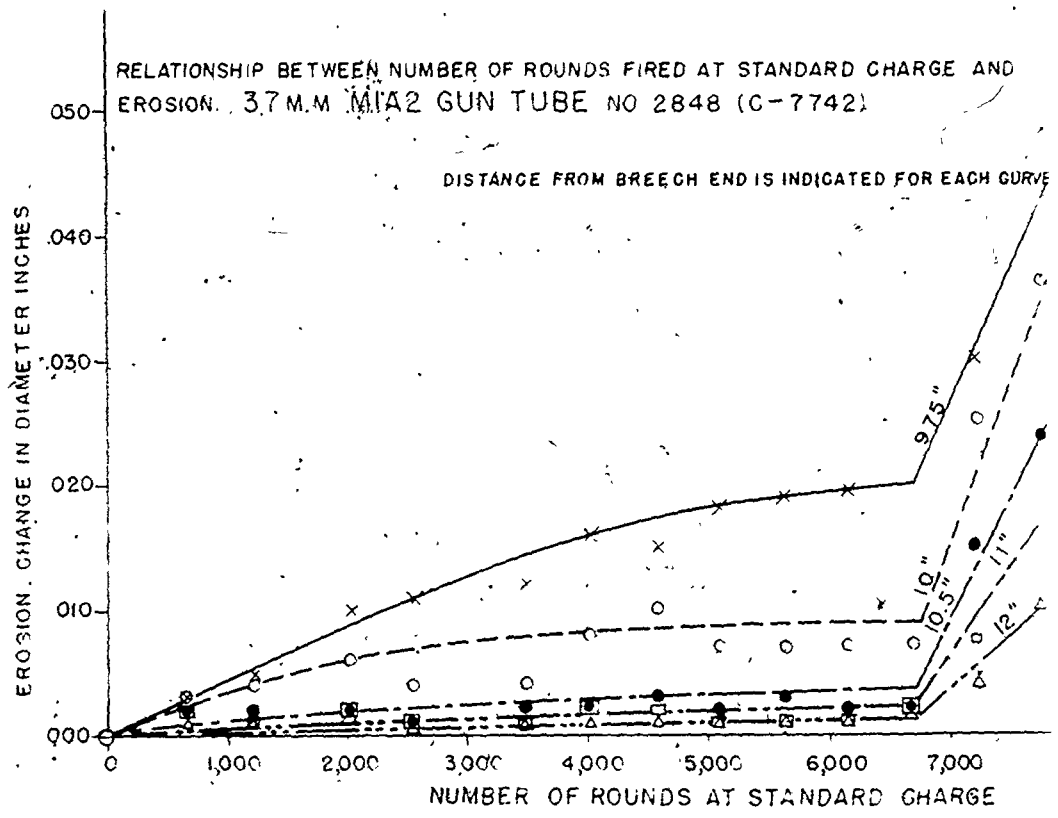


FIG 6

RELATIONSHIP BETWEEN NUMBER OF ROUNDS FIRED AT STANDARD CHARGE AND EROSION 37 M.M MIA2 GUN TUBE NO 2848 (C-7742)

DISTANCE FROM BREECH END IS INDICATED FOR EACH CURVE

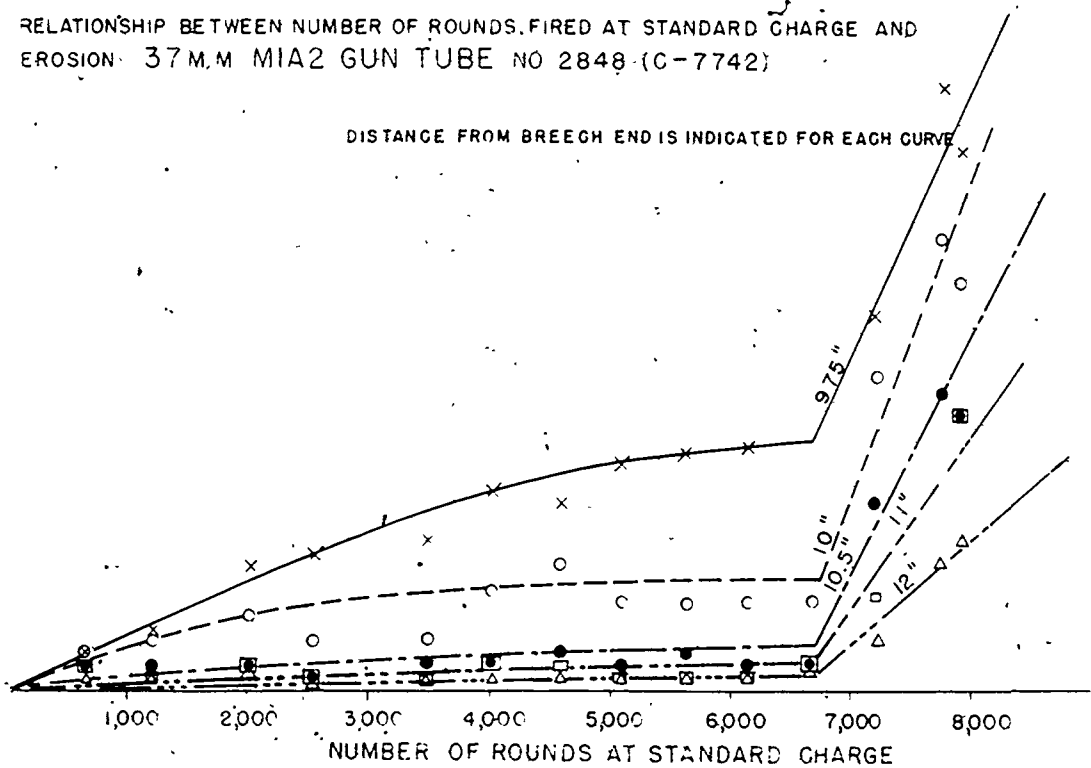
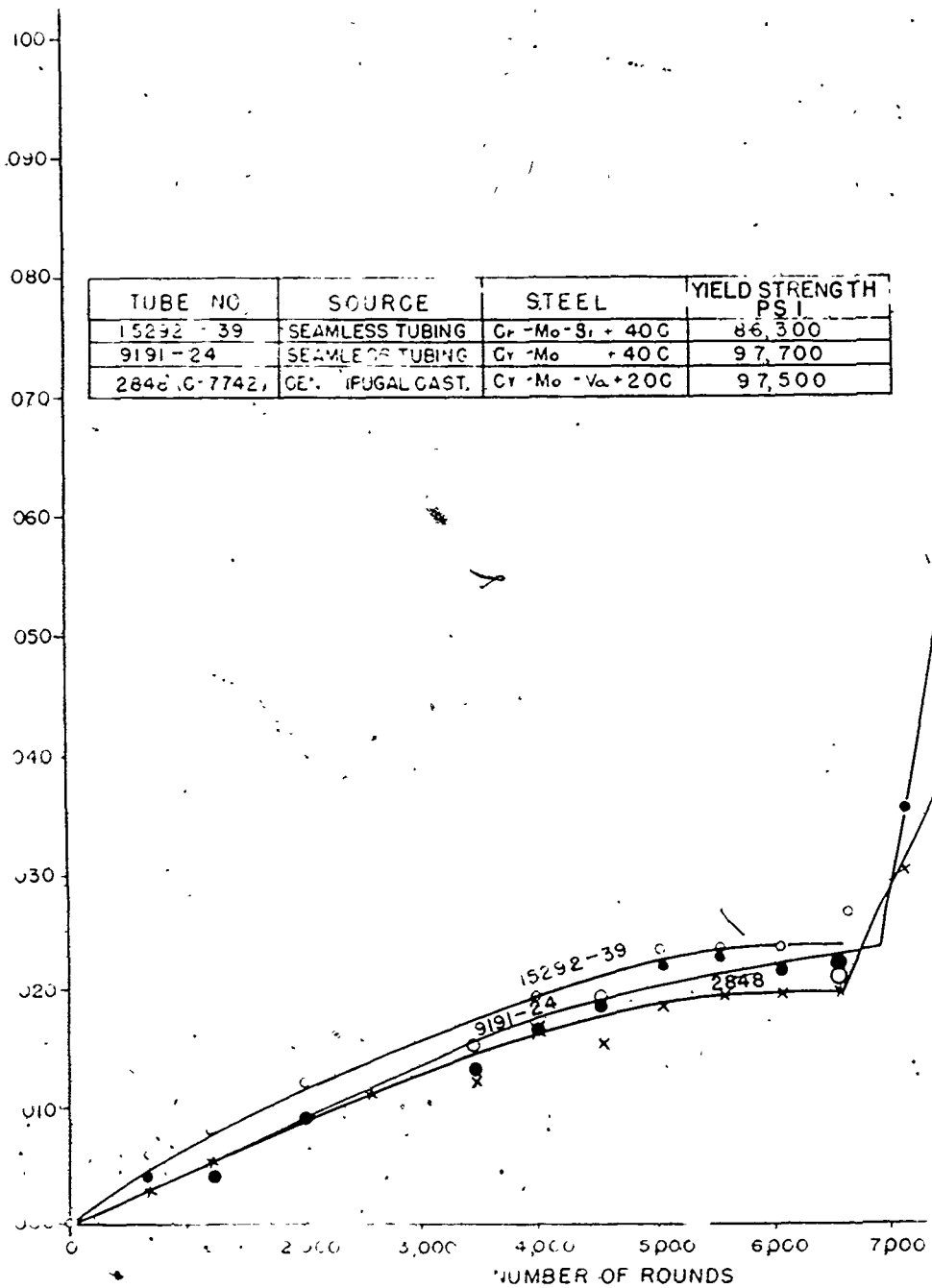


FIG 6

E-E 21

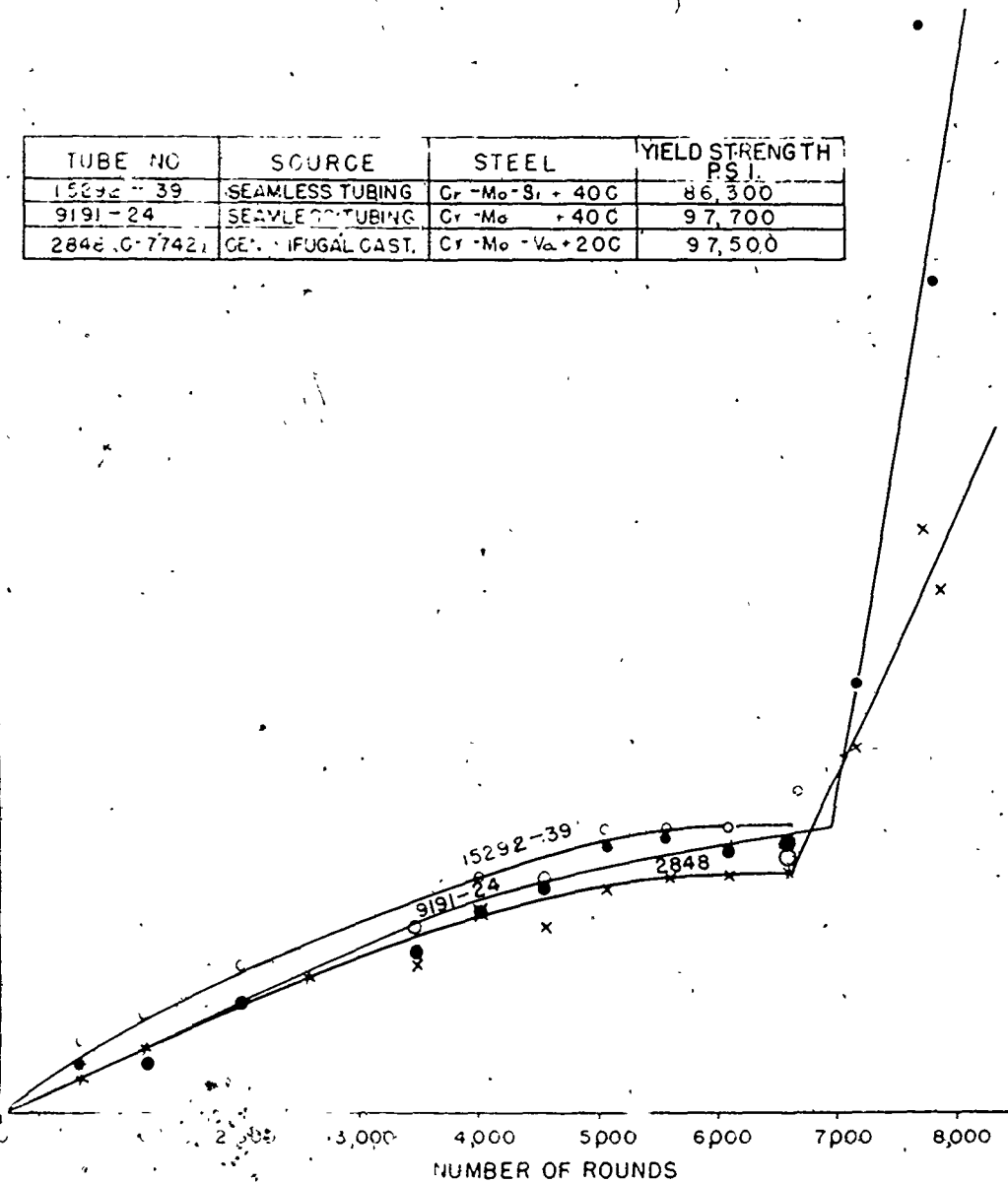
EROSION CHANGE IN DIAMETER INCHES



EROSION OF 1.315 DIA 2 GUN TUBES AT 975 IN FROM B...

... ..

TUBE NO	SOURCE	STEEL	YIELD STRENGTH PSI
15292-39	SEAMLESS TUBING	Cr-Mo-Si + 40C	86,300
9191-24	SEAMLESS TUBING	Cr-Mo + 40C	97,700
2848 (C-7742)	CENTRIFUGAL CAST	Cr-Mo-Va + 20C	97,500



2 1/2 IN. 3.000 4.000 5.000 6.000 7.000 8.000
 NUMBER OF ROUNDS
 2 1/2 IN. GUN TUBES AT 975 IN FROM BREECH

6424-6012

6692

6691-6706

1.470

1.502

022

004

20

1.52

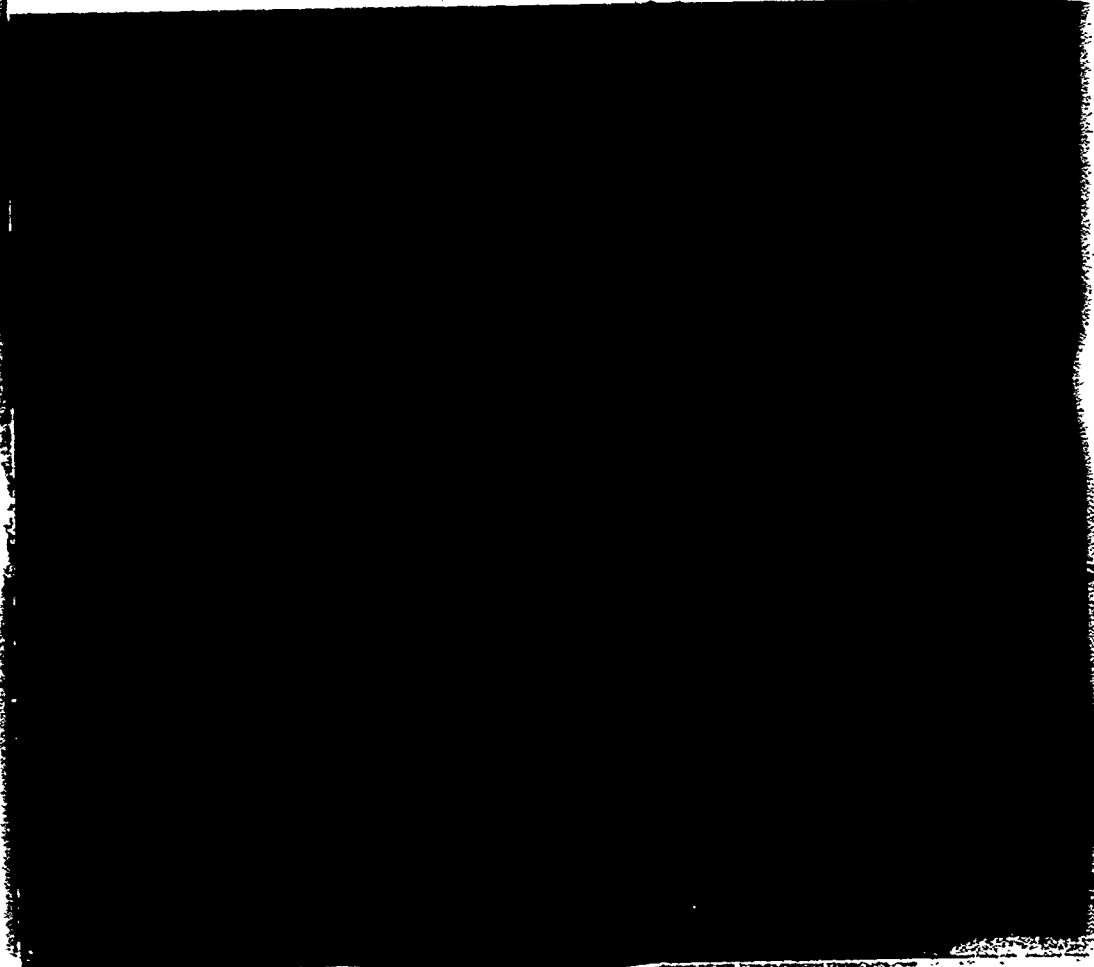
75

4.34

821

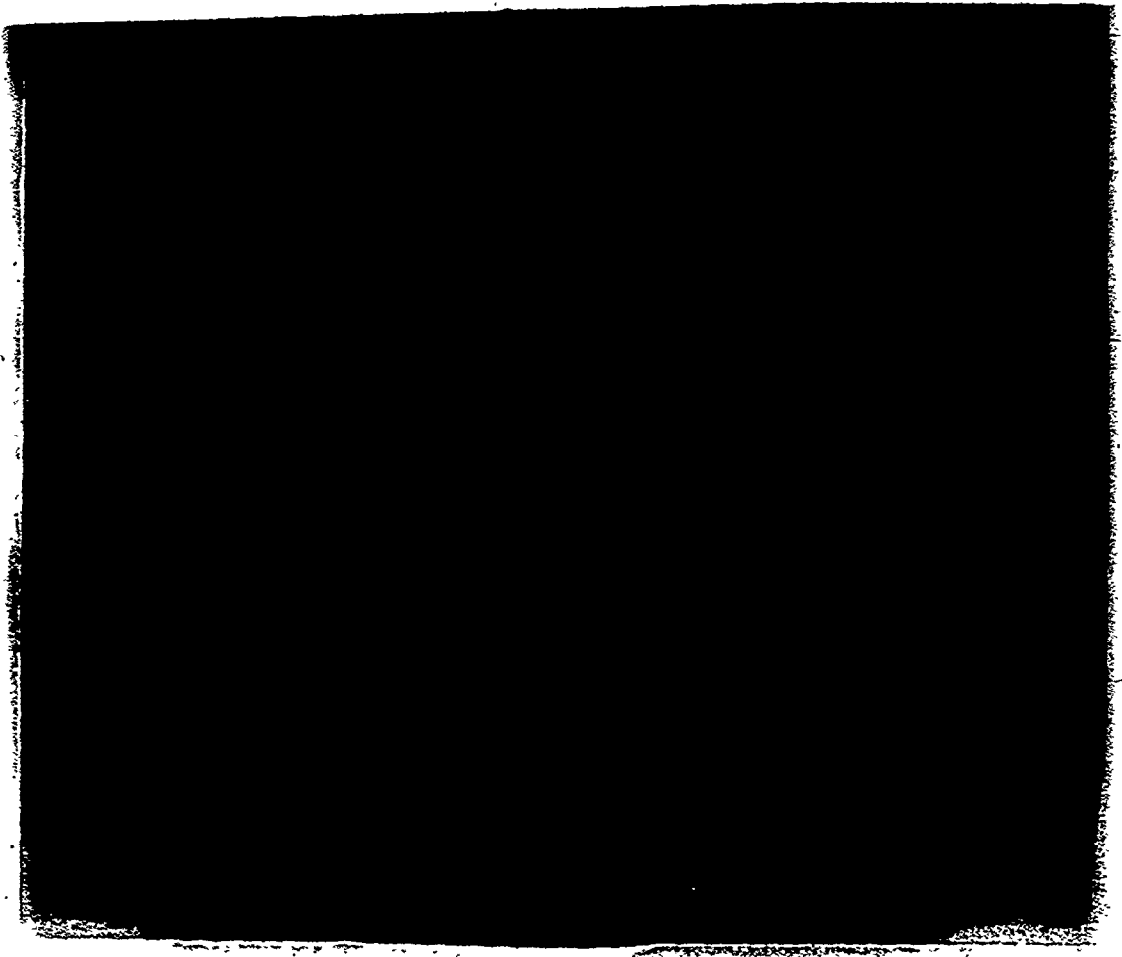
WHEN PROUD

... BEC A ... FROM
... E ...



UNCO 6300 7pre 8000
MSE + ROUNDS

5 1/2" TUBES A 5 1/2" FROM CENTER
END OF TUBES



APPENDIX A - EROSION TEST DATA SHEET

APPENDIX A

EROSION TEST DATA SHEET

Caliber - 37 mm Place - Erie Proving Ground
Model - M1A2 Date - October 25 to December 11, 1941
Tube Nos. - 15292-39 Test No. - Firing Record No. 8097
 9191-24 Exorder No. - -- Experimenter - --
 2848 (C-7742)

Total No. of Rounds Fired - 6752 in Tube No. 15292-39
 7910 " " " 9191-24
 7957 " " " 2848 (Centrifugal Casting C-7742)

No. of Rounds Fired with fixed ammunition for endurance testing and observations of muzzle velocity and accuracy: 6728 in Tube No. 15292-39
 7877 " " " 9191-24
 7928 " " " 2848 (C-7742)

Rate of Fire for Endurance Testing:

Rounds per minute -- Not given (Gun fires approximately 120 rounds per minute in 10-round clips)

Rounds per burst -- Not constant (Rounds were fired in groups varying from 10 to 50 rounds each, though 20 round groups predominated. Several groups were fired in each cycle of rapid fire tests so that from 100 to 450 rounds per cycle were fired. The time of firing each group was recorded so that the average period for each 10-round clip could be estimated. This average period varied from 1 minute per 10-round clip to 6-1/2 minutes per 10-round clip.)

Cooling between cycles -- Wet rags were applied to the outside surface after each series of rapid fire rounds until the temperature of the surface was sufficiently low. It is not positively known whether the series referred to the 10 to 50 round groups or to the 100 to 450 round cycles previously mentioned, though the former is most likely.

Temperature control - None used

Temperatures reached - None measured

Observations - Given in Appendix B are data pertaining to stargauge records, estimated advance of the forcing cone, yaw, target size, pressure, velocity and condition of bore. Target distance was changed at the 6160th round in each gun from 330 yards to 436 yards.

Description of Tubes or Barrels:

Caliber - 37 mm Type - A.A. Model - M1A2
 Drawing - --- Revision Date - ---
 Length of Rifling - Probably 53.53 calibers
 Manufacturer of Barrel - Tubes 15292-39 and 9191-24 not known
 Tube 2848 (C-7742) Watervliet Arsenal
 Material Designation - Tubes 15292-39 and 9191-24 Cr-Mo-Si and Cr-Mo
 Tube 2848 (C-7742) Seamless Tubing, Cr-Mo-V
 Maker of Material - Tubes 15292-39 and 9191-24, Tinkin Roller Bearing Co.
 Tube 2848 (C-7742) Watertown Arsenal
 Specification No. - --- Heat No. - ---

Chemical Analysis:

Tube No.	C	Mn	Si	P	S	Cr	Mo	V
15292-39	.57	.46	.755	.008	.018	1.31	.50	Trace
9191-24	.41	.73	.275	.016	.020	1.14	.24	"
2848 (C-7742)	.215	.80	.21	.012	.017	.945	.47	.145

(Data taken from W.A. Laboratory Report No. 310/3476, 314/7742, and O.O. Form 1234, Heat No. C-7742.)

Heat Treatment:

No. 15292-39 - 1700°F, 4 hrs., air cooled
 1500°F, 4 oil quenched
 2250°F, 4 air cooled
 9191-24 - 1700°F, 4 air cooled
 1600°F, 4 oil quenched
 1050°F, 4 air cooled
 2848 (C-7742) - 2200°F, 16 air cooled
 1650°F, 6 water quenched, 4 hrs. 6½ min.
 B 1210°F) 6 furnace cooled
 M 1225°F) 6

Centrifugal Casting - Tube 2848 (C-7742) Tubing - 15292-39, 9191-24 Seamless
 Forging - --- Barstock - ---

Mechanical Properties:

Tube No.	Y.S. Prop. Method	T.S.	Elong. %	Red. of Area %	Impact Values
15292-39	86,300 Muzzle	116,300	18.	44.	37 ft/lbs
9191-24	97,700 "	127,800	15.	39.	34 ft/lbs
2848 (C-7742)	97,500 "	121,000	18.	58.	---
	100,000 Breech	125,000	18.	58.	---

Impact Specimen - Notched Tension Charpy

Hardness:

0'clock Position	Tube No. 15292-39 B.H.N.	Tube No. 9191-24 B.H.N.
12 (outside)	235	248
12 (midwall)	255	269
12 (bore)	241	248
6 (bore)	241	255
6 (midwall)	248	269
6 (outside)	241	241

(Data taken from W.A. Lab. Rpt. 313/189 and O.O. Form 1234 Heat No. C-7742)

Macrostructure is satisfactory for each gun
 Macrographic Report No. - No report, but photomicrographs W.A. 223-1947
 and W.A. 223-1946 pertaining to the seamless
 tubes are attached. Macro report for centrifugal
 casting C-7742 of Gun No. 2848 is attached.

Microstructure - No report
 Grain Size - Not observed Goldworked - No
 Per cent increase in bore diameter - --
 Finish of Bore: Hone, Broach or Not known

DESCRIPTION OF AMMUNITION: Ammunition Lot No. 5315-2 was used for rapid
 fire tests.

Powder Description Sheet Data:
 Maker - E. I. du Pont de Nemours & Co., Inc., Carney Point, N. J.
 Contract No. - W-672-ORD-3417, November 5, 1940
 Specification No. - 50-12-3, Revision of March 14, 1939
 U.S. Army Lot No. X-4386 of 1941 Type II for 37 mm Gun, M1A2
 Nitrocellulose Accepted Blends Nos. 5770, 5771, 5772
 Nitrogen Content (per cent) K.I. Starch Test (65.5°C) Stability Test (135°C)
 Maximum 13.16 45' + 30 min.
 Minimum 13.16 45' + 30 min.
 Average 13.16 45' + 30 min.

TESTS OF FINISHED POWDER:

Constituent	Inspector's Analysis
Nitrocellulose	83.19%
DNT and DEP (DNT - 10%) (DEP - 5%)	14.57%
Potassium Sulphate added	.96%
Diphenylamine added	1.00%
Volatile solvent	.19%
Moisture	.43%
Ash	.08%
Glazed with graphite	.28%
Stability and Physical Tests:	
135°C heat test, S.P.	55 min.
Explosion	None
Form of Grain	Cylindrical
No. of perforations	1
No. of grains per pound	22,660
Burning surface per pound (sq. inches)	1,761
Gravity density, or pounds per cu.ft.	49
Specific Gravity	1.58
Hygroscopticity	1.09

Grain Dimensions:

	Inspector's Analysis	Mean Variation in Per cent of Mean Dimension
Length (L)	.2807 in.	2.29
Diameter (D)	.0634 "	2.30
Diameter of Perforations (D)	.0183 "	
Web Average	.0225	
Difference between inner and outer web in per cent of web average	% Var. above median from av. Web % Var. below median from Av. Web	8.00 8.00
L:D (Y)	4.43%	
D:d (X)	3.46	
Date Packed - 1/14/41	Date Offered - 1/14/41	Date Sampled - 1/17/41

Remarks: ---

Weight of Charge - 6.34 oz. at 70°F, with 1.34 lbs. projectile, at
muzzle velocity of 2600, developed 28,300 p.s.i.
pressure

Pressure-time curve for type of gun under test is not attached.

Primer:

Kind - -- Type - -- Designation - --
Lot No. -- Weight -- Composition - --

Projectile:

Kind - H.E. Practice Type 37 mm Model M55A1
Drawing No. 75-2-278 Revision Date --
Nominal Weight - 1.34 lbs. Loading: Hand, Machine --
Material of Projectile -- Material of Band --
Material of Jacket --
Sample Rounds:

Number of Rounds in Sample	No data available		
Diameters of Projectiles: Average	_____	*Mean Dev. _____	**Range _____
	in.	in.	in.
Weights of Projectiles: Average	_____	*Mean Dev. _____	** Range _____
	oz.	oz.	oz.
Weights of Propellant	Average	*Mean Dev. _____	** Range _____
Charges:	_____	oz.	oz.
Muzzle Velocities: Average	_____	*Mean Dev. _____	** Range _____
	f/s	f/s	f/s

Cartridge Case:

Material No data available Drawing No. --
Revision Date _____ Maker _____ Lot No. _____

* Mean deviation = $\frac{\text{sum of deviations}}{\text{number of observation}}$

** Range = Absolute difference between value of smallest item and value of greatest item.

WATERTOWN ARSENAL

Laboratory Report No. C-7742Ex. O. 620Date March 22, 1941

MACROGRAPHIC TEST

on

1 - 37-mm Gun - Centrifugal Casting No. C-7742Condition **As cast**Present Length **100"**Test Metal Location B Disc **2.5"** from end

Additional Data

M Disc **2.5"** from end**None**Characteristics & MacrostructureGrain - 0.1. **5.85"** I.D. **.71"**

There is a ring of casting segregates near the 1.3" diameter. From this diameter to the outside there are columnar dendrites. A ring of casting segregates is seen near the 4.6" diameter.

Matrix - 0.5 **3.00"** I.D. **.28"**

The gun body area has a mixed dendritic structure. There are a few scattered impurities. The bore is filled with slag.

Recommendation**Accept. Continued manufacture.**

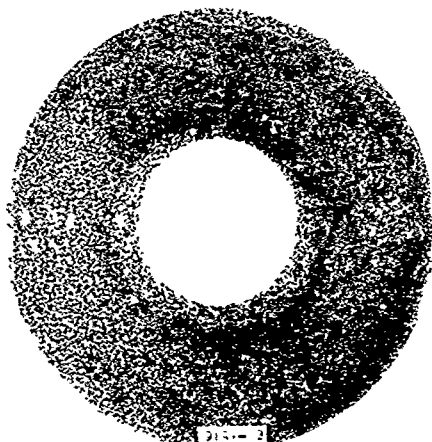
Tested by _____

N. L. ReedAccepted **ACCEPTED**

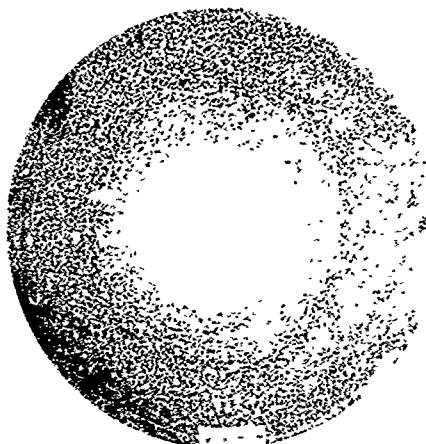
Information

Rejected

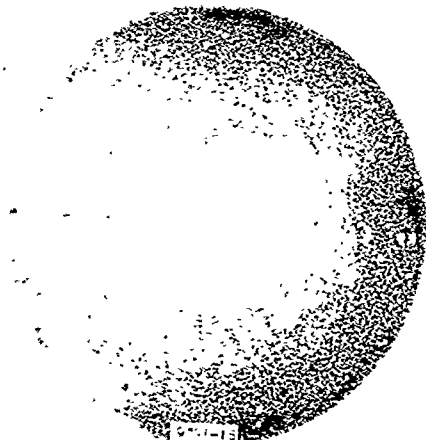
Centrifugal Casting C-7742



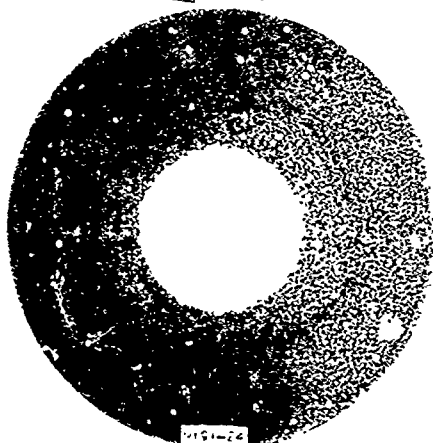
215-2



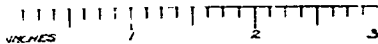
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215-4



215-2c

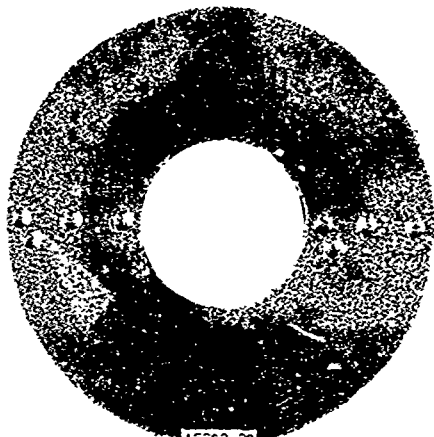


INCHES

ORDNANCE DEPT U.S.A.

WATERLOO ARSENAL

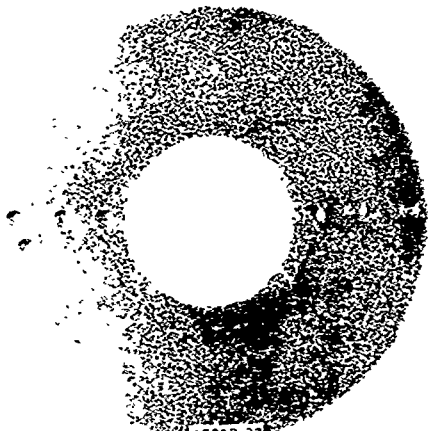
30 W. HAMPSHIRE ST. TORONTO
CAN. 100. 100. 100. 100.



15292-29



15292-35



15292-37



15292-39



ORDNANCE DEPT U.S.A.

WATERTOWN ARSENAL

37 MM SEAMLESS GUN TUBING

AUG. 25, 1941 W.A. 223-1947

APPENDIX B - DETAILED HISTORY OF FIRING

APPENDIX B

EROSION STUDY

37 mm Gun Tube M1A2, No. 9191-2
Detailed History of Firing

Round No.	**Diameter		**Change in		Estimated Advance of Forcing Cone (Inches)	Yaw Maximum Orientation (Degrees)		Target Mean Radius of Dispersion (Inches)	*Pressure Charge per cent	*Pressure Measurement p. s. i.
	Land (Inches)	Groove (Inches)	Land (Inches)	Groove (Inches)		(Inches)	(Inches)			
	1.458	1.498								
1 - 10	--	--	--	--	--	--	--	6.20	Std.	--
11 - 13	--	--	--	--	--	0	0	--	"	--
314 - 316	--	--	--	--	--	0	0	--	"	--
332 - 341	--	--	--	--	--	--	--	3.98	"	--
691	1.462	1.498	.004	.000	0	--	--	--	"	--
692 - 701	--	--	--	--	--	--	--	4.93	Std.	--
702 - 704	--	--	--	--	--	0	0	--	"	--
855 - 857	--	--	--	--	--	1.50	115	--	"	--
858 - 867	--	--	--	--	--	--	--	4.72	"	--
1235	1.462	1.498	.004	.000	0	--	--	--	"	--
1246-1255	--	--	--	--	--	--	--	4.74	Std.	--
1506-1515	--	--	--	--	--	--	--	5.79	"	--
2019-2028	--	--	--	--	--	--	--	4.51	"	--
2029-2031	--	--	--	--	--	0	0	--	"	--
2031	1.467	1.499	.000	.001	.05	--	--	--	"	--
2282-2294	--	--	--	--	--	0	0	--	Std.	--
2285-2294	--	--	--	--	--	--	--	3.83	"	--
2574	1.470	1.499	.012	.001	.10	--	--	--	"	--
2575-2577	--	--	--	--	--	0	0	--	Std.	--
2578-2587	--	--	--	--	--	--	--	4.76	"	--
2924-2936	--	--	--	--	--	0	0	3.42	"	--
3188-3190	--	--	--	--	--	0	0	--	"	--
3191-3200	--	--	--	--	--	--	--	4.43	"	--
3502	1.471	1.500	.013	.002	.10	--	--	--	"	--
3757-3755	--	--	--	--	--	0	0	--	Std.	--
3759-3768	--	--	--	--	--	--	--	4.65	"	--
3870-3882	--	--	--	--	--	0	0	4.01	"	--
3898-3906	--	--	--	--	--	--	--	--	"	26400
4046	1.474	1.500	.016	.002	.15	--	--	--	"	--
4247-4240	--	--	--	--	--	0	0	--	Std.	--
4250-4266	--	--	--	--	--	0	0	3.69	"	--
4568-4577	--	--	--	--	--	--	--	3.41	"	--
4598	1.476	1.499	.018	.001	.15	--	--	--	"	--
4849-4862	--	--	--	--	--	1.50	137	3.91	Std.	--
5113	1.480	1.501	.022	.003	.20	--	--	--	"	--
5124-5126	--	--	--	--	--	1.55	40	--	Std.	--
5378-5390	--	--	--	--	--	1.50	186	3.15	"	--
5634-5646	1.480	1.502	.022	.004	.20	1.50	90	5.37	"	--
5897-5909	--	--	--	--	--	1.59	150	4.97	"	--
6149	1.479	1.501	.021	.003	.20	--	--	--	"	--
6170-6182	--	--	--	--	--	1.52	162	4.31	Std.	--
6424-6442	--	--	--	--	--	1.52	35	4.34	"	--
6692	1.480	1.502	.022	.004	.20	--	--	--	"	--

APPENDIX B

2

EROSION STUDY

37 mm Gun Tube M1A2, No. 9191-24 (Forging)¹
Detailed History of Firing

Yaw in mils (Degrees)	Target Mean Radius of Dispersion (Inches)	Charge per cent	*Pressure as Measured p. s. i.	*Velocity Estimated Measured f/s	Range in Measured Velocity f/s	Remarks
--	6.20	Std	--	2600	--	
0	--	"	--	2600	--	
0	--	"	--	2600	--	
--	3.98	"	--	2600	--	
--	--	"	--	--	--	
--	4.93	Std.	--	2600	--	Corroding 35 - 60° from rear face. Light ring of erosion to rear of Origin of Rifling.
0	--	"	--	2600	--	
115	--	"	--	2600	--	
--	4.72	"	--	2600	--	
--	--	"	--	--	--	
--	4.74	Std.	--	2600	--	Ring of erosion in straight of chamber, and signs of erosion 20° from Origin of Rifling.
--	5.79	"	--	2600	--	
--	4.51	"	--	2600	--	
0	--	"	--	2600	--	
--	--	"	--	--	--	
0	--	Std.	--	2600	--	Ring of erosion in straight of chamber. Corroding 20° from Origin of Rifling.
--	3.83	"	--	2600	--	Ring of erosion increased. Erosion in various parts of lands and grooves.
--	--	"	--	--	--	
0	4.76	Std.	--	2600	--	
0	3.42	"	--	2600	--	
0	--	"	--	2600	--	
--	4.43	"	--	2600	--	
--	--	"	--	--	--	
0	--	Std.	--	2600	--	Ring of erosion increased.
--	4.65	"	--	2600	--	
0	4.01	"	--	2500	--	
--	--	"	26400	2573	41	
--	--	"	--	--	--	
0	--	Std.	--	2600	--	Increased erosion in straight of chamber.
0	3.69	"	--	2600	--	
--	3.41	"	--	2600	--	
--	--	"	--	--	--	
137	3.91	Std.	--	2600	--	Light pits in grooves
--	--	"	--	--	--	
40	--	Std.	--	2600	--	Ring of erosion advancing into rifling. Pits in grooves.
185	3.15	"	--	2600	--	Continued advance of erosion ring
90	5.37	"	--	2600	--	Grooves roughly pitted.
150	4.97	"	--	2600	--	
--	--	"	--	--	--	
160	4.31	Std.	--	2600	--	
75	4.32	"	--	2600	--	
--	--	"	--	--	--	
0	--	Std.	--	--	2555	Lands at Origin of Rifling tending to be flattened.
--	3.48	"	--	2600	--	
0	4.33	"	--	2600	--	
--	--	"	--	--	--	
117	--	Std.	--	--	2515	29
--	--	"	--	--	--	Marked erosion of grooves. Extra heavy pitting in straight of Origin of Rifling.

6824-6842	--	--	--	--	--	1.52	102	4.31	Std.	--
6692	1.420	1.502	.022	.004	.20	1.52	35	4.34	"	--
6693-6706	--	--	--	--	--	0	0	--	Std.	--
6709-6718	--	--	--	--	--	--	--	3.48	"	--
6971-6986	--	--	--	--	--	0	0	4.33	"	--
7236	1.493	1.525	.035	.027	.25	--	--	--	"	--
7240-7252	--	--	--	--	--	1.70	117	--	Std.	--
7273-7282	--	--	--	--	--	--	--	4.53	"	--
7523-7538	--	--	--	--	--	1.52	101	7.74	"	--
7788	1.647	1.550	.089	.052	1-1/4	--	--	--	--	--
7799-7815	--	--	--	--	--	1.55	97	10.72	Std.	--
7842-7848	--	--	--	--	--	--	--	--	"	--
7859-7868	--	--	--	--	--	--	--	--	"	--
7877	1.526	1.552	.068	.054	1-1/4	--	--	--	100	***31200
7879-7885	--	--	--	--	--	--	--	--	110	***36775
7896	1.524	1.557	.066	.059	1-1/4	--	--	--	135	****47900
7899	--	--	--	--	--	--	--	--	150	****63600
7910	1.550	1.561	.100	.063	2-1/4	--	--	--	190	****83700

- Rated Pressure 28300 p.s.i. and Rated Velocity 2600 f/s with 0.34 oz. propellant charge. Ammunition Lot No. 15-2.
 - At 0.75" from Breach End.
 - High pressure rounds used powder from Dupont Lot 41350-1940.
 - High pressure rounds used powder from Lot 4164-1939.
- 1 Seamless Tubing

35	4.34	Std.	---	2600	---	---
0	---	---	---	2600	---	---
0	3.48	Std.	---	---	2555	41
0	4.33	"	---	2600	---	---
---	---	---	---	---	---	---
117	---	Std.	---	---	2515	29
---	4.53	"	---	2600	---	---
101	7.74	"	---	2600	---	---
---	---	---	---	---	---	---
97	10.71	Std.	---	2600	---	---
---	---	"	---	---	2463	156
---	---	"	---	---	2445	153
---	---	100	***31200	---	---	---
---	---	110	***36775	---	---	---
---	---	135	****47900	---	---	---
---	---	150	****63600	---	---	---
---	---	190	****83700	---	---	---

Lands at Origin of Rifling
tending to be flattened.

Marked erosion of grooves.
Extra heavy pitting ^{up} in
advance of Origin of Rifling.
Copper deposits heavy
throughout tube.
Land at 6-9-12 o'clock
blown away 1 to 2" forward
from Origin of Rifling.

2600 f/s with 0.34 oz. propellant charge. Ammunition Components: shell practice M55A1 and

74350-1940.
939.

3

4

4

E-26

APPENDIX B

EROSION STUDY

37 mm Gun Tube M1A2, No. 15292-39 (1)
Detailed History of Firing

Round No.	**Diameter Land Groove (Inches)	**Change in Diameter Land Groove (Inches)	Estimated Advance of Forcing Cone (Inches)	Yaw Maximum Axis Orientation (Degrees)	Target Mean Radius of Dispersion (Inches)	Charge per cent	*Precedence Mean Pa
	1.458	1.497					
1 - 10	--	--	--	--	4.53	--	Std.
11 - 13	--	--	--	0	0	--	"
314 - 316	--	--	--	1.52	76	--	"
332 - 341	--	--	--	--	--	5.16	"
691	1.464	1.497	.006	.000	.05	--	--
692 - 701	--	--	--	--	--	4.82	Std.
702 - 704	--	--	--	1.50	57	--	"
855 - 857	--	--	--	1.63	152	--	"
*75 - 885	--	--	--	--	--	4.08	"
1235	1.466	1.497	.008	.000	.05	--	--
1246-1255	--	--	--	--	--	4.78	Std.
1506-1515	--	--	--	--	--	5.62	"
2017-2025	--	--	--	--	--	4.19	"
2029-2031	--	--	--	1.50	163	--	"
2031	1.470	1.499	.012	.002	.10	--	--
2282-2284	--	--	--	1.53	111	--	Std.
2285-2294	--	--	--	--	--	4.41	"
2574	1.471	1.497	.013	.000	.10	--	--
2575-2587	--	--	--	1.50	175	5.29	Std.
2924-2936	--	--	--	1.50	133	5.39	"
3187-3189	--	--	--	1.50	142	--	"
3193-3203	--	--	--	--	--	5.12	"
3502	1.473	1.498	.015	.001	.10	--	--
3753-3769	--	--	--	1.50	120	6.25	Std.
3870-3876	--	--	--	1.70	132	4.62	"
3899-3905	--	--	--	--	--	--	--
4046	1.477	1.499	.019	.002	.15	--	--
4247-4262	--	--	--	1.70	101	6.99	Std.
4563-4578	--	--	--	1.60	163	6.61	"
4648	1.477	1.499	.019	.002	.15	--	--
4842-4853	--	--	--	1.60	192	4.72	Std.
5113	1.481	1.501	.023	.001	.20	--	--
5124-5126	--	--	--	1.55	121	--	Std.
5378-5390	--	--	--	1.52	154	6.78	"
5632-5641	--	--	--	--	--	5.32	"
5644-5646	1.481	1.500	.023	.003	.20	1.55	157
5877-5909	--	--	--	1.52	141	5.54	"
6159	1.481	1.501	.023	.004	.20	--	--
6170-6183	--	--	--	1.55	154	5.88	Std.
6425-6437	--	--	--	1.60	159	8.00	"
6692	1.479	1.501	.021	.004	.20	--	--
6693-6707	--	--	--	1.60	87	--	Std.
6711-6720	--	--	--	--	--	8.78	"
6728	1.484	1.502	.026	.005	.20	--	100
6730-6731	--	--	--	--	--	--	110

APPENDIX B

EROSION STUDY

37 mm Gun Tube M1A2, No. 15292-39 (Forging)¹
Detailed History of Firing

Yaw Maximum Major Orientation (Inches)	Orientation (Degrees)	Target Mean Radius of Dispersion (Inches)	Charge per cent	Pressure as Measured p.s.i.	Velocity		Range in Measured Velocity f/s	Remarks
					Estimated f/s	Measured f/s		
0	0	4.53	Std.	--	2600	--	--	
52	76	--	"	--	2600	--	--	
--	--	5.16	"	--	2600	--	--	
--	--	--	--	--	--	--	--	
50	57	4.82	Std.	--	2600	--	--	Coppering 36.5-51° from rear face. Light ring of erosion in straight of chamber.
63	152	--	"	--	2600	--	--	
--	--	4.08	"	--	2600	--	--	
--	--	--	--	--	--	--	--	
--	--	4.78	Std.	--	2600	--	--	Coppering 32.5-45° from rear face. Ring of erosion in straight of chamber.
--	--	5.62	"	--	2600	--	--	
50	163	4.19	"	--	2600	--	--	
--	--	--	--	--	--	--	--	
53	111	--	Std.	--	2600	--	--	Ring of erosion is larger. Erosion on lands and grooves 21° from Origin of Rifling.
--	--	4.41	"	--	2600	--	--	
50	175	5.29	Std.	--	2600	--	--	Ring of erosion larger. Erosion on lands and grooves increased. Copper deposits less.
50	133	5.39	"	--	2600	--	--	
50	142	--	"	--	2600	--	--	
--	--	5.12	"	--	2600	--	--	
50	120	5.25	Std.	--	2600	--	--	Ring of erosion increases. Copper deposits less.
70	132	4.62	"	--	2500	--	--	
--	--	--	--	2600	--	2550	21	
70	101	6.99	Std.	--	2600	--	--	Marked increase in erosion. Copper deposits very evident. Light pits in grooves.
66	163	6.61	"	--	2500	--	--	
50	192	4.42	Std.	--	2600	--	--	Light pitting in grooves.
55	121	--	Std.	--	2600	--	--	
56	154	5.78	"	--	2600	--	--	
--	--	5.32	"	--	2600	--	--	
55	157	--	"	--	2600	--	--	
52	141	5.54	"	--	2500	--	--	
--	--	--	--	--	--	--	--	
55	154	5.88	Std.	--	2500	--	--	Marked increase in ring of erosion.
50	159	8.00	"	--	2600	--	--	
--	--	--	--	--	--	--	--	
50	87	--	Std.	--	--	2552	12	0.006" erosion at 9.25° from breach face. Lead missing at 9:30 and at 12:00 o'clock 1" from Origin of Rifling.
--	--	8.38	"	--	2600	--	--	
--	--	--	100	***26400	--	--	--	
--	--	--	110	***40300	--	--	--	
--	--	--	--	--	--	--	--	
--	--	--	145	***51600	--	--	--	

6693-6707	--	--	--	--	--	1.60	87	--	Std.	
6711-6720	--	--	--	--	--	--	--	8.38	"	
6728	1.4gt	1.502	.026	.005	.20	--	--	--	100
6730-6731	--	--	--	--	--	--	--	--	110
6739	1.4gt	2	.026	.005	.20	--	--	--	--	
6746-6748	--	--	--	--	--	--	--	--	145
6752	1.400	1.509	.032	.012	.25	--	--	--	165

- Rated Pressure 28300 p s i and Rated Velocity 2600 f/s with 6.3-oz propellant charge Am
 - Ammunition Lot No. 5311-2.
 - At 9.75" from Breech End.
 - High pressure rounds used powder from Tubert Lot X¹¹⁰-1940
 - High pressure rounds used powder from Lot 1161-1935.
- Seamless Tubing

159	8.00	---	---	2600	---	---	0.006" erosion at 9.25"
87	---	Std.	---	---	2552	18	from breech face. Land
---	8.38	"	---	2600	---	---	sliding at 9:30 and at
---	---	100	***36400	---	---	---	12:00 o'clock 1" from
---	---	110	***40300	---	---	---	Origin of Rifling.
---	---	---	---	---	---	---	---
---	---	145	***51600	---	---	---	---
---	---	165	***55800	---	---	---	---

600 r/s with 6.3- oz propellant charge Ammunition Components. shell practice M55A1 and

X240-1940
939.

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L-24

APPENDIX B

EROSION STUDY

37 mm Gun Tube V1A2 No 2848 (C)
Detailed History of Firing

Round No.	**Diameter		**Change in Diameter		Estimated Advance of Forcing Cone (Inches)	Yaw Maximum Orientation (Inches/Degrees)		Target Mean Radicle of Distortion (Inches)	Charge per cent	*Pressure as Measured p.s.i.
	Land	Groove	Land	Groove		Major Axis	Minor Axis			
1 -10	1.458	1.498	0	0				3.96	Std	
11 -13									*	
314 -316									*	
319 -328								5.48	*	
551	1.461	1.498	.003	.000	0					
692 -701								4.60	Std	
702 -704									*	
855 -857									*	
858 -867								3.20	*	
1235	1.463	1.499	.005	.001	10					
1246-1255								3.99	Std	
1506-1515								3.51	*	
2016-2025								5.20	*	
2029-2031									*	
2032	1.468	1.499	.010	.001	10					
2282-2294								3.99	Std.	
2574	1.469	1.499	.011	.001	10					
2575-2587								6.95	Std	
2924-2936						1.75	142	3.61	*	
3187-3200						1.50	151	4.54	*	
3502	1.470	1.499	.012	.001	10					
3753-3768						1.52	129	3.11	Std	
3870-3882						1.50	90	5.35	*	
3898-3902									*	
3905-3906									*	26200
4046	1.474	1.500	.016	.002	15					
4247-4259						1.50	90	5.29	Std	
4563-4577						1.52	115	5.29	*	
4598	1.473	1.500	.015	.002	15					
4852-4861								5.70	Std.	
5113	1.476	1.501	.018	.003	15					
5377-5390						0	0	6.62	Std	
5632-5646						1.52	122	4.67	*	
5646	1.477	1.501	.019	.003	15					
5897-5909						1.50	88	4.39	Std	
6159	1.477	1.500	.019	.002	20					
6170-6182						0	0	4.38	Std	
6424-6437						1.50	80	3.21	*	
6692	1.478	1.501	.020	.003	20					
6692-6695						0	0		Std	
6701-6705									*	
6708-6717								3.60	*	
6971-6983						1.50	70	5.65	*	
7236	1.488	1.519	.030	.001	25					
7242-7249						0	0		Std.	
7273-7282								8.14	*	

APPENDIX B

EROSION STUDY

37 mm Gun Tube M1A2 No 2848 (C7742)¹
Detailed History of Firing

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Munition Orientation (Degrees)	Target Mean Radius of Distortion (Inches)	Charge per cent	*Pressure as Measured p.s.i.	**Velocity		Range in Measured Velocity f/s	Remarks
				Estimated f/s	Measured f/s		
--	3.96	Std	--	2600	--	--	
0	--	"	--	2630	--	--	
3	--	"	--	2600	--	--	
--	5.42	"	--	2600	--	--	
--	4.60	Std	--	2600	--	--	Coppering 33-48" from rear face. Light ring of erosion in straight of chamber.
0	--	"	--	2600	--	--	
0	--	"	--	2600	--	--	
--	3.20	"	--	2600	--	--	Reduction in coppering.
--	3.99	Std	--	2600	--	--	
--	3.51	"	--	2600	--	--	
--	5.20	"	--	2600	--	--	
0	--	"	--	2600	--	--	Reduction in coppering.
0	3.99	Std.	--	2600	--	--	Heavy coppering Erosion ring in straight of chamber
--	6.95	Std.	--	2600	--	--	
142	3.61	"	--	2600	--	--	
154	4.76	"	--	2600	--	--	Ring of erosion deeper
129	3.11	Std	--	2600	--	--	Depression 17-1/2" from breech
90	5.36	"	--	2600	2574	19	
--	--	"	26200	2600	--	--	Ring of erosion increasing in diameter
90	5.29	Std	--	--	--	--	
115	5.29	"	--	2600	--	--	Ring of erosion increased.
--	--	--	--	--	--	--	Light pits on lands and grooves at Origin of Rifling
--	5.70	Std	--	2600	--	--	Ring of erosion increased. Region of pits extending forward.
0	6.62	Std	--	2600	--	--	
122	4.67	"	--	2600	--	--	Grooves rough
88	4.39	Std	--	2600	--	--	Heavy coppering.
--	--	--	--	--	--	--	
1	4.38	Std	--	2600	--	--	
80	3.21	"	--	2600	--	--	Lands flattened 1" forward from Origin of Rifling
6	--	Std	--	2600	2585	12	
--	3.00	"	--	2600	--	--	
70	5.65	"	--	2600	--	--	
--	--	--	--	--	--	--	
0	--	Std	--	--	2530	10	Heavy erosion ring 5" forward from Origin of Rifling First notable increase in erosion of groove
137	8.14	"	--	2600	--	--	Ring of erosion deepened considerably. Deep pits in straight of chamber.
134	11.61	Std.	--	2600	--	--	
--	--	"	--	--	2500	52	

6700-6717	--	--	--	--	--	--	--	9.50	--	--
6971-6983	--	--	--	--	--	1.50	70	5.65	--	--
7236	1.488	1.519	.030	.021	25	--	--	--	--	--
7242-7249	--	--	--	--	--	0	0	--	Std.	--
7273-7282	--	--	--	--	--	--	--	8.14	--	--
7523-7538	--	--	--	--	--	1.60	137	8.40	--	--
7788	1.506	1.534	.048	.036	4	--	--	--	--	--
7800-7831	--	--	--	--	--	1.60	134	11.61	Std.	--
7844-7848	--	--	--	--	--	--	--	--	--	--
7928	1.501	1.534	.043	.036	.5	--	--	--	100	****34300
7930-7934	--	--	--	--	--	--	--	--	110	Av 37300
7935-7937	--	--	--	--	--	--	--	--	115	40500
7938	--	--	--	--	--	--	--	--	120	47500
7952	1.504	1.536	.046	.038	.5	--	--	--	170	62300
7957	1.506	1.540	.048	.042	.5	--	--	--	185	75300

* Rated Pressure 28300 p.s.i. and Rated Velocity 2600 f/s with 6.34 oz. propellant charge.

** At 9.75" from Breech End.

*** Ammunition Components, see practice M55A1 and Ammunition Lot No. 5315-2.

**** High pressure rounds used loader from DuPont Lot X4350-1940.

¹Centrifugal Casting

3

0	4.38	Std.	---	2600	---	---
80	3.21	"	---	2600	---	---
---	---	---	---	---	---	---
0	---	Std	---	2600	---	---
---	---	"	---	---	2589	12
---	4.90	"	---	2600	---	---
70	5.65	"	---	2600	---	---
---	---	---	---	---	---	---
0	---	Std.	---	---	2530	10
---	8 14	"	---	2600	---	---
137	8 40	"	---	2600	---	---
---	---	---	---	---	---	---
13-	11 61	Std.	---	2600	---	---
---	---	"	---	---	2500	52
---	---	100	****	34300	---	---
---	---	110	Av	37300	---	---
---	---	115		40500	---	---
---	---	120		47500	---	---
---	---	170		62300	---	---
---	---	185		75300	---	---

Lands flattened 1" forward from Origin of Rifling.

Heavy erosion ring 5" forward from Origin of Rifling. First notable increase in erosion of groove. Ring of erosion deepened considerably. Deep pits in straight of chamber.

0 f/w with 6.34 oz. propellant charge.

ammunition Lot No. 5315-2.
350-1940.

E-2-25

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