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*Naval Surface Weapons Center
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Naval Proving Ground, Dahlgren, Va. (NPG Report 943)

-Seventh Partiel Report on Development of a Cool Propellant for the
Caliber Gun - Final Report on Ballistic Test of Cool Propellants
12, EX-6841, and EX-6842 - and Appendixes A thru D

L. D. 26 March '52 23pp. graphs

ants, Cool
, Propellant -
tics

Ordnance and Armament (22)
Explosives (6)

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NPG REPORT NO. 943

Ballistic Test of Cool Propellants
EX-6802, EX-6841, and EX-6842

PART A

SYNOPSIS

1. This is the twenty-seventh partial report on the "Development of a Cool Propellant for the 3"/70 Caliber Gun" and the final report on the "Ballistic Test of Cool Propellants EX-6802, EX-6841, and EX-6842".
2. From the results of the subject tests, it is concluded that for the 3"/70 caliber large chamber gun:
 - a. The subject propellants were of satisfactory quickness and ~~static~~ uniformity.
 - b. EX-6842 had slightly better flash suppression characteristics than EX-6841.
 - c. EX-6802 showed no indication of dangerously high pressures when fired over the temperature range of 90°F to 165°F.

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Ballistic Test of Cool Propellants
EX-6802, EX-6841, and EX-6842

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PART B

INTRODUCTION

1. AUTHORITY:

Task Assignment NPG-Ro2d-62-1-52 of 6 August 1951
BUORD Conf ltr Ro2d-CNB:aph NP9 Ser 19376 of 13 April 1951
BUORD Conf ltr Ro2d-CNB:aph NP9 Ser 22453 of 3 July 1951

2. REFERENCES:

- a. Task Assignment NPG-Ro2d-62-1-52 of 6 August 1951
- b. BUORD Conf ltr Ro2d-CNB:aph NP9 Ser 19376 of 13 April 1951
- c. BUORD Conf ltr Ro2d-CNB:aph NP9 Ser 22453 of 3 July 1951
- d. TelCon from BUORD (Ro2d: C. N. Bernstein) to NPG (OMI: L. D. Weber) of 18 April 1951
- e. NPG Report No. 591 of 10 July 1950 (Conf)
- f. NPG Report No. 760 of 13 April 1951 (Conf)
- g. Description Sheets of Manufacture and Closed Bomb Data (asstr)

3. BACKGROUND:

Reference (a) set up the general task for the development of a cool propellant for the 3"/70 caliber gun. Reference (b) described EX-6802 as a cool picrite propellant (1950°F) containing 1% lead carbonate. This lot was prepared for use in gun-projectile evaluation trials. Reference (d) stated the possibility that assembled 3"/70 caliber ammunition containing picrite propellant will reach temperatures of 120°F to 165°F in the "on mount magazine". The Proving Ground was, therefore, requested to fire EX-6802 at these powder temperatures in order to determine the pressures that would be reached. Reference (c) described EX-6841 and EX-6842 as being cool picrite propellants (1950°F) containing 1% lead carbonate and 1% potassium sulfate. The Proving Ground was directed to compare the ballistic performance of these propellants with other similar propellants reported in references (e) and (f).

4. OBJECT OF TEST:

To evaluate the ballistic performance of the subject propellants.

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EX-6802, EX-6841, and EX-6842

5. PERIOD OF TEST:

a. Dates Project Letters	6 August 1951 13 April 1951 3 July 1951
b. Dates Materials Received	13 April 1951 28 June 1951
c. Date Commenced Tests	24 April 1951
d. Tests Completed	21 December 1951

PART C

DETAILS OF TESTS

6. DESCRIPTION OF ITEMS UNDER TEST:

Reference (g) described the subject propellants as follows:

a. Chemical Composition:

	<u>EX-6802</u>	<u>EX-6841</u>	<u>EX-6842</u>
Nitrocellulose (13.20%N)	20.13	20.33	20.15
Nitroglycerine	10.15	9.55	9.11
Picrite	58.75	59.09	60.24
Centralite	1.82	1.74	1.87
Dibutylphthalate	9.15	9.29	8.63
PbCO ₃	0.88	0.94	0.87
K ₂ SO ₄	--	1.04	1.00
Flame Temperature (°K)	1972	1936	1974

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b. Grain Geometry and Closed Bomb Data:

<u>Sample</u>	<u>Length</u> <u>(in.)</u>	<u>Diam.</u> <u>(in.)</u>	<u>Av. Web</u> <u>(in.)</u>	<u>No. of</u> <u>Perfor.</u>	<u>RQ*</u> <u>(%)</u>	<u>RF*</u> <u>(%)</u>
EX-6802	0.3760	0.1648	0.0279	7	99.0	97.1
EX-6841	0.3732	0.1645	0.0284	7	98.5	95.9
EX-6842	0.3470	0.1674	0.0259	7	108.3	96.4

* Based on EX-6586 as 100% at 90°F.

7. PROCEDURE:

The subject propellants were fired in the 3"/70 caliber large chamber gun. Muzzle velocities, maximum pressures (copper crusher), and ejection times were recorded. Pressure-time records were obtained with EX-6802 over the powder temperature range of 90°F to 165°F.

8. RESULTS AND DISCUSSION:

The results of the subject tests are given in detail in the Appendices and are summarized below:

a. Uniformity:

Gun:	3"/70 Caliber, Type G-2, No. 24491 3"/70 Caliber, Type G-12, No. 24927
Projectile:	As indicated. Epsom salt loaded (15.00 lbs.)
Cartridge Case:	As indicated. Exp. No. 5, Steel, Rubber Crimped. British cases used with British projectiles.
Primer:	XC-M11
Lead Filling:	None
Wad:	Cardboard

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Ballistic Test of Cool Propellants
EX-6802, EX-6841, and EX-6842

Proj.: EX-24-2

Case: Exp. No. 5

Date	Gun	Powder	Charge (lbs.)	Velocity (f/s)	Pressure (t.s.i.)	Ej. Time (millsec.)	No. of Rds.
4-24-51	G-2	EX-6757	10.58	3403±11	19.5±0.3	15±1	5
"	"	EX-6802	10.00	3427±9	21.2±0.2	14±1*	5

Proj. EX-24-5

Case: Exp. No. 5

7-9-51	G-2	EX-6802	9.90	3437±7	21.7±0.2	13±0	5
"	"	EX-6842	9.75	3411±2	22.0±0.3	14±1*	5
"	"	EX-6841	10.05	3378±14	20.3±0.4	14±1*	5

Proj: British

Case: British

7-30-51	G-12	EX-6802	9.90	3401±5	21.2±0.3	14±1	5
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* 4 rds. only

b. Charge Determination:

Powder	Proj.	Velocity (f/s)	Charge (lbs.)	Pressure (t.s.i.)
EX-6802	24-2	3400	9.87	20.7
EX-6802	24-5	3400	9.75	21.1
EX-6841	24-5	3400	10.14	20.7
EX-6842	24-5	3400	9.71	21.9
EX-6802	British	3400	9.90	21.2

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Ballistic Test of Cool Propellants
EX-6802, EX-6841, and EX-6842

c. High Temperature Performance:

Powder: EX-6802
Charge: 9.87 lbs.
Gun: 3"/70 Caliber, Type G-2, No. 24491
Case: Exp. No. 5, Steel, Rubber Crimped
Projectile: EX-24-2 (15.00 lbs.) Epsom Salt Loaded
Primer: XC-M11
Wad: Cardboard

<u>Powder Temp. (°F)</u>	<u>Velocity (f/s)</u>	<u>Pressure (t.s.i.)</u>	<u>Ej. Time (millisec.)</u>	<u>No. of Rds.</u>
90	3405±8	21.6±0.1	15±0	3
122	3441±3	23.4±0.2	13±0	3
138	3467±7	24.0±0.1	15±0	3
155	3489±6	24.9±0.1	12±0	3
165	3490±6	25.3±0.1	12±0	5

d. All of the subject propellants were of satisfactory quickness and ballistic uniformity for use in the 3"/70 caliber large chamber gun.

e. EX-6802 performed very satisfactorily at high temperatures. The maximum pressure attained was 25.3 t.s.i. (copper) at 165°F. This would indicate that there is likely to be no danger of high pressures because of temperatures reached in the "on mount" magazine.

f. EX-6842 was slightly better with regard to flash suppression than EX-6841 or other sulfated samples reported in references (e) and (f). There were no indications of flash on any of the five rounds fired at full velocity. There were, however, small traces of flash on the two rounds fired above full velocity. EX-6841 showed small traces of flash on four of the five full velocity rounds as well as the two high rounds. Sulfated propellants reported in references (e) and (f) consistently showed traces of flash.

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EX-6802, EX-6841, and EX-6842

PART D

CONCLUSIONS

9. From the results of the subject tests, it is concluded that for the 3"/70 caliber large chamber gun:

a. The subject propellants were of satisfactory quickness and ballistic uniformity.

b. EX-6842 had slightly better flash suppression characteristics than EX-6841.

c. EX-6802 showed no indication of dangerously high pressures when fired over the temperature range of 90°F to 165°F.

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Ballistic Test of Cool Propellants
EX-6802, EX-6841, and EX-6842

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NPG REPORT NO. 943

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Twenty-Seventh Partial Report
on
Development of a Cool Propellant
for the 3"/70 Caliber Gun

Final Report
on
Ballistic Test of Cool Propellants
EX-6802, EX-6841, and EX-6842

Project No.: NPG-Re2d-62-1-52

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U. S. Naval Proving Ground, Dahlgren, Va. (NPG Report 943)

Twenty-Seventh Partiel Report on Development of a Cool Propellant for the
3"/70 Caliber Gun - Final Report on Ballistic Test of Cool Propellants
EX-6802, EX-6841, and EX-6842 - and Appendixes A thru D

Weber, L. D. 28 March '52 23pp. graphs

Propellants, Cool
Powder, Propellant -
Ballistics

Ordnance and Armament (22)
Explosives (6)

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Ballistic Test of Cool Propellants
EX-6802, EX-6841, and EX-6842

TABULATION OF FIRING DATA

Gun: 3"/70 Caliber, Type G-2, No. 24491
Type G-12, No. 24927

Projectile: EX-24-2 (15.00 lbs.) Epsom Salt Loaded
EX-24-5 (15.00 lbs.) Epsom Salt Loaded
British (15.00 lbs.)

Cartridge Case: Exp. No. 5, Steel, Rubber Crimped
British, Steel, Rubber Crimped

Primer: XC-M11

Lead Foil: None

Powder Temp: As indicated

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CONFIDENTIAL Ballistic Test of Cool Propellants EX-6802, EX-6841, and EX-6842 NPG REPORT NO. 943

Date: 24 April 1951

Proj.: EX-24-2

Gun: Type G-2, No. 2491

Rd. No.	Powder	P.F.D. (in.)	Charge (lbs.)	Velocity (ft/s)	Pressure (t.s.f.)	Mj. Time (milli-sec.)	Flash (ft)	Score (ft)
1	EX-6757	1.7	10.58	3418	20.0	14	80	125
2	"	"	"	3403	19.7	13	80	125
3	"	"	"	3424	19.8	15	100	100
4	"	"	"	3387	19.8	17	100	100
5	"	"	"	3400	19.0	14	80	125
6	"	"	"	3395	19.3	14	80	125
Mean of 5 rounds								
			10.58	3403±11	19.5±0.3	15±1		
7	EX-6802	5.1	9.30	3282	18.6	16	Trace	125
8	"	2.6	10.10	3449	21.5	13	50	125
9	"	1.7	9.90	3394	20.7	14	25	125
10	"	5.8	8.80	3153	16.1	15	25	125
11	"	"	"	3187	16.8	14	0	125
12	"	"	"	3163	16.9	14	25	125
Mean of 3 rounds								
			8.80	3168±13	16.6±0.3	14±0		
13	EX-6802	2.6	9.80	3370	21.2	14	0	125
14	"	1.7	10.00	3432	21.2	13	25	125
15	"	"	"	3426	21.0	17	Trace	125
16	"	"	"	3407	21.3	-	0	125
17	"	"	"	3437	21.8	13	20	125
18	"	"	"	3435	20.9	14	25	125
Mean of 5 rounds								
			10.00	3427±9	21.2±0.2	14±1		
19	EX-6802	1.7	10.20	3468	21.9	18	50	125
20	"	"	"	3456	21.8	-	Trace	150
Mean of 2 rounds								
			10.20	3462±6	21.9±0.1	18±		
* 4 rds. only								
** 1 rd. only								

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Ballistic Test of Cool Propellants EX-6802, EX-6841, and EX-6842

MPG REPORT NO. 943

Date: 9 July 1951

Proj.: EX-24-5

Gun: Type G-2, No. 24491

Rd. No.	Powder	P.P.D. (in.)	Charge (lbs.)	Velocity (f/s)	Pressure (t.s.i.)	Rj. Time (millisec.)	Flash (%)	Stroke (%)
1	EX-6802	5.2	8.90	3199	17.1	-	0	125
2	"	"	"	3202	17.7	16	0	150
3	"	"	"	3204	18.4	13	Trace	150
4	"	"	"	3165	17.5	16	0	150
Mean of 3 rounds			8.90	3190±17	17.9±0.4	15±1		
5	EX-6802	2.6	9.70	3372	20.9	17	75	100
6	"	1.7	9.90	3428	21.3	13	40	125
7	"	"	"	3435	21.6	14	Trace	150
8	"	"	"	3448	21.9	13	Trace	150
9	"	"	"	3442	21.9	13	Trace	125
10	"	"	"	3430	21.9	13	100	100
Mean of 5 rounds			9.90	3437±7	21.7±0.2	13±0		
11	EX-6802	1.7	10.10	3471	22.4	15	0	150
12	"	"	"	3487	22.7	12	Trace	150
Mean of 2 rounds			10.10	3479±8	22.6±0.1	14±2		
13	EX-6842	6.0	8.50	3091	17.3	15	0	150
14	"	2.7	9.50	3367	21.2	13	0	150
15	EX-6842	1.7	9.75	3411	21.2	13	0	150
16	"	"	"	3415	22.1	15	0	150
17	"	"	"	3409	22.5	15	0	150
18	"	"	"	3413	22.0	13	0	150
19	"	"	"	3409	22.1	-	0	150
Mean of 5 rounds			9.75	3411±2	22.0±0.3	14±1*		

* 4 rds. only

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APPENDIX A

Date: 9 July 1951 (Cont'd)

Rd. No.	Powder	P.F.D. (in.)	Charge (lbs.)	Velocity (ft/s)	Pressure (p.s.i.)	Ej. Time (msec.)	Flame (ft)	Smoke (ft)
20	EX-6842	1.7	9.95	3456	22.8	12	Trace	150
21	"	"	"	3462	22.9	13	Trace	150
Mean of 2 rounds			9.95	3459±1	22.9±0.1	13±1		
22	EX-6842	6.0	8.50	3091	16.5	15	0	150
23	"	"	"	3091	17.2	14	0	150
24	"	"	"	3102	17.0	17	0	150
Mean of 3 rounds			8.50	3095±5	16.9±0.3	15±1		
25	EX-6841	5.4	9.00	3121	16.1	14	0	150
26	"	2.4	9.90	3339	20.1	15	0	150
27	"	1.7	10.05	3392	20.9	14	Trace	150
28	"	"	"	3366	20.5	13	Trace	150
29	"	"	"	3375	20.1	14	0	150
30	"	"	"	3401	20.0	13	Trace	150
31	"	"	"	3353	19.8	13	Trace	150
Mean of 5 rounds			10.05	3378±14	20.3±0.4	14±1		
32	EX-6841	1.7	10.25	3410	20.5	13	Trace	150
33	"	"	"	3420	21.4	13	Trace	150
Mean of 2 rounds			10.25	3415±5	21.0±0.5	13±0		
34	EX-6841	5.4	9.00	3112	15.9	15	0	150
35	"	"	"	3122	16.2	16	0	150
36	"	"	"	3126	16.4	14	0	150
Mean of 3 rounds			9.00	3120±5	16.2±0.2	15±1		

* 4 rds. only

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APPENDIX A

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Ballistic Test of Cool Propellants EX-6802, EX-6801, and EX-6802 HFG REPORT NO. 943

Date: 30 July 1951

Proj. and Cartridge Case: British

Gun: Type G-12, No. 24927

Rd. No.	Powder	P.P.D. (in.)	Charge (lbs.)	Velocity (f/s)	Pressure (t.s.i.)	Ef. Time (milli-sec.)	Flack (f)	State (f)
1	EX-6802	5.2	8.90	3085	15.7	-	0	150
2	"	"	"	3123	16.2	16	0	200
3	"	"	"	3109	16.3	16	0	150
4	"	"	"	3116	16.2	15	0	150
Mean of 3 rounds			8.90	3116±5	16.2±0.0	16±0		
5	EX-6802	3.4	9.50	3301	19.6	15	0	150
6	"	2.6	9.70	3337	19.8	14	0	150
7	"	1.7	9.90	3394	21.5	13	0	150
8	"	"	"	3397	20.5	14	0	150
9	"	"	"	3402	21.4	15	0	150
10	"	"	"	3411	21.1	14	25	125
11	"	"	"	3402	21.4	16	0	150
Mean of 5 rounds			9.90	3401±5	21.2±0.3	14±1		
12	EX-6802	1.7	10.10	3447	21.3	16	0	150
13	"	"	"	3447	21.9	13	0	150
Mean of 2 rounds			10.10	3447±0	21.6±0.3	15±2	0	150

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APPENDIX A

Date: 21 December 1951

Proj.: EX-24-1

Gun: Type G-2, No. 24191

Rd. No.	Powder	P.P.D. (in.)	Powder Temp. (°F)	Charge (lbs.)	Velocity (ft/s)	Pressure (p.s.i.)	Ef. Time (milliseconds)	Flash (%)	Score (%)
1*	EX-6802	1.7	90	9.87	3381	21.1	14	0	150
2	"	"	"	"	3419	21.8	14	100	100
3	"	"	"	"	3407	21.9	15	100	100
4	"	"	"	"	3390	21.6	15	Trace	150
Mean of 3 rounds			90	9.87	3405±8	21.8±0.1	15±0		
5*	EX-6802	1.7	90	9.87	3414	21.3	15	Trace	150
6*	"	1.7	122	9.87	3444	23.5	15	100	100
7	"	"	"	"	3440	23.7	13	50	125
8	"	"	"	"	3445	23.3	13	25	125
9	"	"	"	"	3437	23.3	13	25	125
Mean of 3 rounds			122	9.87	3441±3	23.4±0.2	13±0		
10*	EX-6802	1.7	122	9.87	3458	23.1	13	Trace	150
11*	"	1.7	138	9.87	3453	24.1	12	Trace	150
12	"	"	"	"	3459	23.9	15	25	125
13	"	"	"	"	3454	24.0	15	25	125
14	"	"	"	"	3478	24.1	15	100	100
Mean of 3 rounds			138	9.87	3457±7	24.0±0.1	15±0		
15*	EX-6802	1.7	138	9.87	3459	24.2	14	50	125
16*	EX-6802	1.7	155	9.87	3470	24.8	15	50	125
17	"	"	"	"	3492	25.1	12	50	125
18	"	"	"	"	3430	24.7	12	50	125
19	"	"	"	"	3435	24.9	12	50	125
Mean of 3 rounds			155	9.87	3459±6	24.9±0.1	12±0		

* Pressure-time rounds, not included in computing means.

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CONFIDENTIAL Ballistic Test of Cool Propellants EX-6802, EX-6841, and EX-6842 UFG REPORT NO. 943

Date: 21 December 1951 (Cont'd)

Rd. No.	Powder	P.P.D. (in.)	Powder		Charge (lb.)	Velocity (ft/s)	Pressure (k.s.i.)	Ef. Time (msec.)	Flash (%)	Score (%)
			Temp. (°F)							
20*	EX-6802	1.7	155		9.87	3471	25.0	15	50	125
21*	"	1.7	165		9.87	3488	25.4	12	50	125
22	"	"	"		"	3490	25.6	12	50	125
23	"	"	"		"	3492	25.6	12	50	125
24	"	"	"		"	3479	26.9	12	50	125
25	"	"	"		"	3496	25.3	12	25	150
26	"	"	"		"	3493	25.6	12	Trace	150
Mean of 5 rounds			165		9.87	3490±6	25.3±0.1	12-0		
27*	EX-6802	1.7	165		9.87	3480	25.1	12	50	125
28*	"	"	90		9.87	3403	21.0	13	50	125

* Pressure-time rounds, not included in computing means

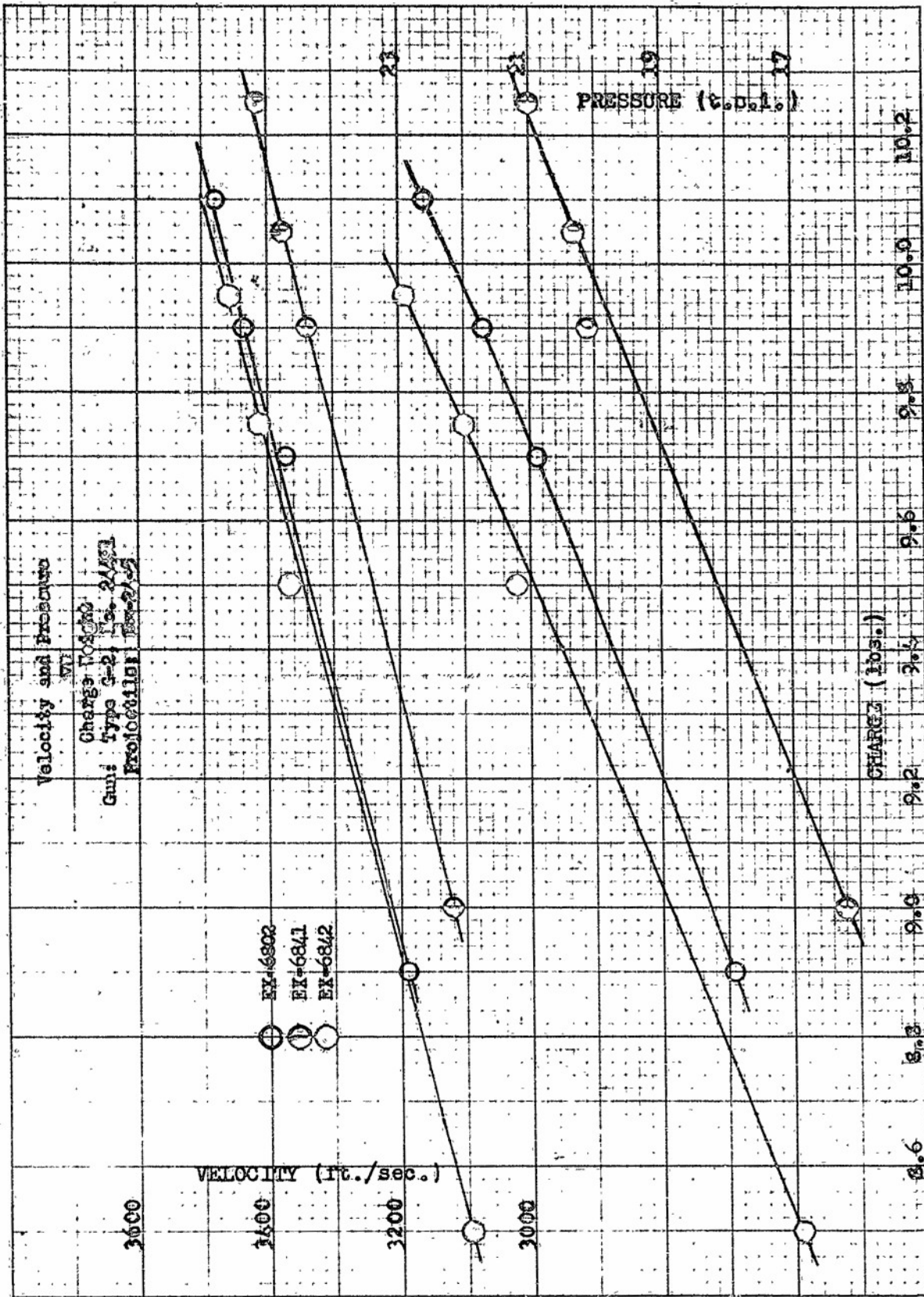
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APPENDIX B

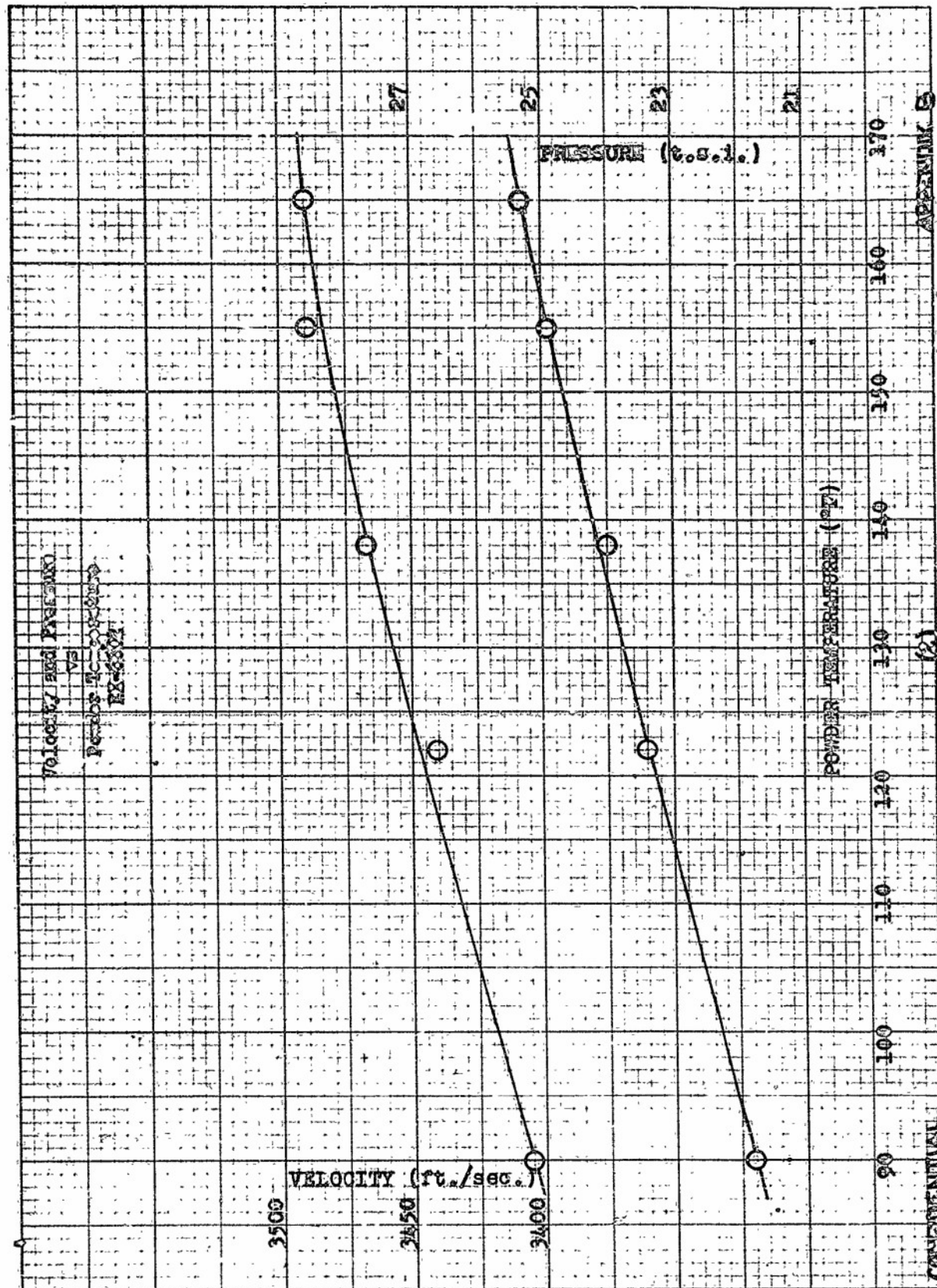
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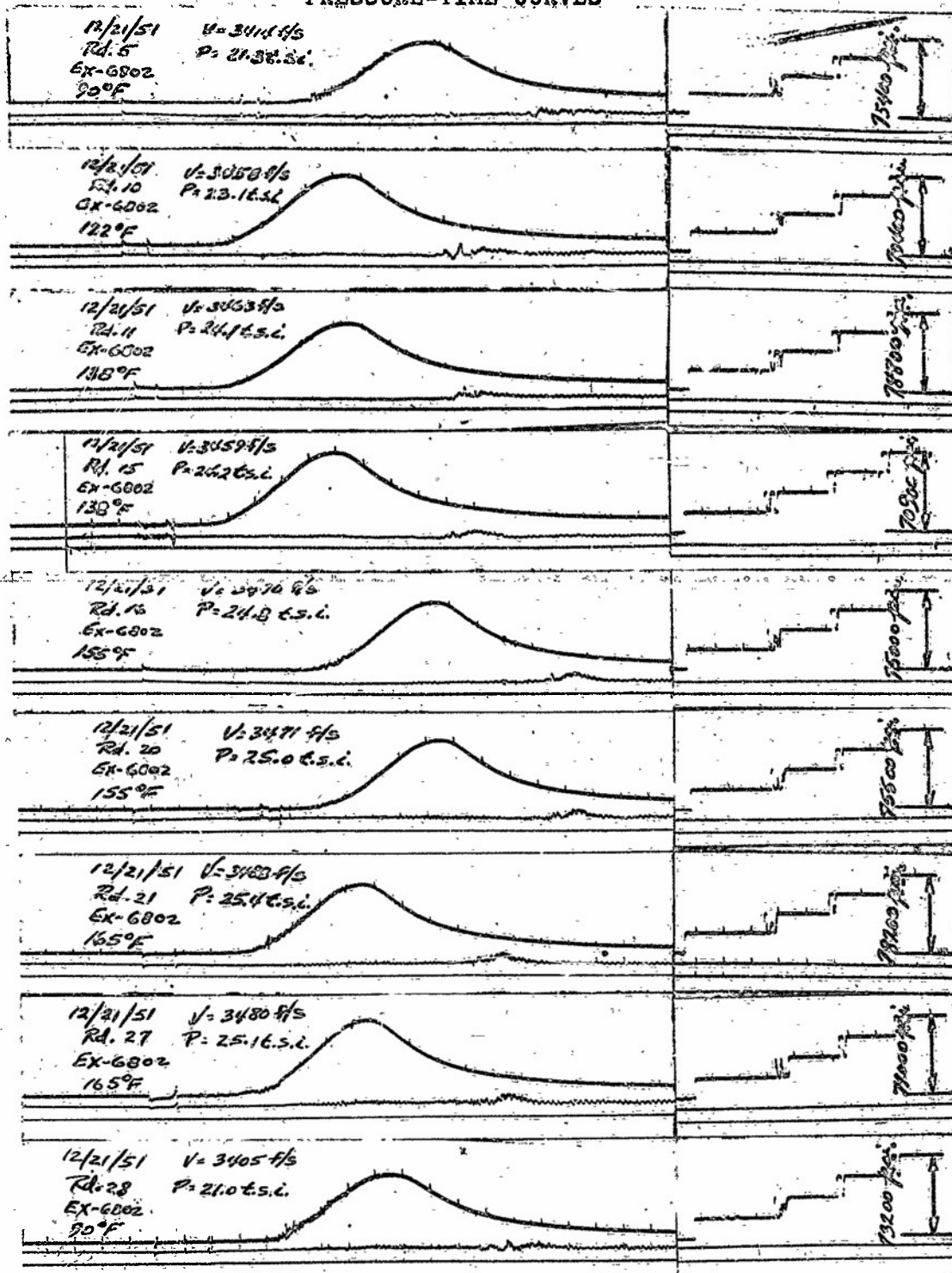
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PRESSURE-TIME CURVES



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