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(1)

FC

U S NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO 973

2.75 AUTOMATIC ROCKET LAUNCHER T-110-E2B

1st Partial Report

Task Assignment NPG-Re8b-119-1-52

Copy No. ____

Classification CONFIDENTIAL SECURITY INFORMATION

2.75 Automatic Rocket Launcher T-110-E2B

PART A

SYNOPSIS

1. RESULTS:

The 2.75 Automatic Rocket Launcher T-110-E2B No. 2, equipped with Tube No. 3, has been fired a total of 104 rounds at the Naval Proving Ground to date, of which 69 were T217 (slugs) and 35 were T132 Practice Rockets. Cyclic rates have been recorded from 632 rounds per minute to 935 rounds per minute. The average muzzle velocity of the T132 Practice Rockets was 1200 fps, with an average peak of 2850 fps at 1050 feet, and a burnt out velocity of 2500 fps still remaining at 2000 feet. The majority of patterns taken at 1000' from the muzzle using T217 (slug) ammunition showed all shots within 3 mils of the center of impact area, however, patterns taken of T132 practice rockets at 1000', 2000' and 3000' showed up to 11 mils dispersion.

2. CONCLUSIONS:

On the basis of the limited number of rounds fired in the one 2.75 T-110-E2B Rocket Launcher received by the Naval Proving Ground, it is concluded that:

a. The basic operating principles of this gun are sound.

b. It will perform at its designed rate of 800-900 rounds per minute.

c. The peak velocity of the T132 rocket exceeds 2800 fps at burn out.

d. Its accuracy is not equal to present service aircraft guns when firing T132 Practice Rockets as received. It is, however, when firing T217 slug rounds at 1000'.

3. RECOMMENDATIONS:

In view of the fact that the 2.75 Rocket Launcher, which weighs only 205 lbs., fires at roughly the same rate and velocity as an AN-M2 or M2 20mm Aircraft Gun, but carries a bursting charge of 1 pound (7000 grains) compared to a 20mm projectile with .017 pounds (119 grains) it is recommended that:

2.75 Automatic Rocket Launcher T-110-E2B

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a. An additional six launchers be obtained and delivered to the Naval Proving Ground for further development and testing.

b. At least 1500 rounds each of T132 (Practice Rocket) and T217 (slug) ammunition be provided for these tests.

c. A high priority be assigned to this work.

d. Certain minor modifications be made to the launcher and ammunition, as contained elsewhere in this report.

2.75 Automatic Rocket Launcher T-110-E2B

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PART B

INTRODUCTION

1. AUTHORITY:

Task Assignment NPG-Re8b-119-1-52, entitled "Aircraft Rocket Launcher T110, Test and Evaluation of", dated 28 July 1951, requested that the Naval Proving Ground conduct functional and developmental firing tests of the subject weapon in accordance (where applicable) with NAVEXOS P-547, "Aircraft Guns Test and Evaluation Manual".

2. REFERENCES:

a. NAVEXOS P-547 "Aircraft Guns Test and Evaluation Manual".
b. Armour Research Foundation of Illinois Institute of Technology Confidential Instructions for Testing 2.75 Automatic Rocket Launchers T-110-E2A and T-110-E2B.
c. Ballistic Research Laboratories ltr APG (3) 471.94/196 of 12 July 1951 to USNOTS, Inyokern, California, giving Trajectory Data for the 2.75 Rocket T131.
d. Confidential Notes on Development Type Material pertaining to 2.75 Automatic Rocket Launcher T-110-E2B, prepared by Rock Island Arsenal, Ordnance Corps, Department of the Army, of September 1951.

3. BACKGROUND:

a. The 2.75 Automatic Rocket Launcher T-110-E2B was designed by the Armour Research Foundation of the Illinois Institute of Technology, and manufactured by the Rock Island Arsenal. This launcher is designed to fire the T131 HE Rocket at a rate of 900 rounds per minute with a muzzle velocity of 1100 fps and a peak velocity of 2900 fps after a burning time of .7 seconds.

4. OBJECT OF TEST:

To determine the suitability of the T-110-E2B Rocket Launcher as forward firing aircraft weapon, the following information is required:

a. Cyclic Rate
b. Rocket Velocity
c. Dispersion
d. Recoil Force
e. Parts Life
f. Reliability

These six items should be obtained at -70°F and +165°F; with the launcher in all attitudes; and under various "G" loadings. The Rocket Velocity should also be obtained at all points from emergence through peak and back to 800 fps after burn out.

5. PERIOD OF TEST:

a.	Date of Project Letter	28 July 1951
b.	Date Necessary Material Received	16 August 1951
c.	Date Test Commenced	30 August 1951
d.	Date Test Completed	Continuing

6. REPRESENTATIVES PRESENT:

Mr. R. E. Stern, Armour Research Foundation of Illinois Institute of Technology - 27 September 1951

Mr. W. D. Bobco, Armour Research Foundation of Illinois Institute of Technology - 20 November 1951

PART C

DETAILS OF TEST

7. DESCRIPTION OF ITEM UNDER TEST:

The 2.75 Automatic Rocket Launcher, (Figures 1, 2 and 3) is a gas operated, sprocket fed mechanism designed to be permanently mounted and have no motion to the rear when fired. It fires the T131 HE Rocket, the T132 Practice Rocket, and the T217 proof (or slug) round. General data follows:

Total Weight of Launcher	205 pounds
Overall Length	94 inches
Overall Width	11 1/4 inches
Overall Height	10 5/8 inches
Length of Tube	72 inches
Diameter at Lands	2.750 inches
Diameter at Grooves	2.820 inches
No. of Grooves	24
Progressive [illegible]	0 to 1 in 12 calibers

2.75 Automatic Rocket Launcher T-110-E2B

Muzzle Velocity (Designed)	1200 fps
Cyclic Rate (Designed)	800 rpm
Trunnion Reaction (Calculated)	30,000 pounds
Weight Complete Round including Case	10.60 pounds
Length Complete Round including Case	17.875 inches
Weight Rocket Projectile	3.80 pounds
Length Rocket Projectile	13.825 inches
Weight Bursting Charge	1.02 pounds
Weight Launcher Propellant	.40 pounds

The T131 HE Rocket consists of a cartridge case, an electric primer, an igniter tube, a propellant or launcher charge, a shot start device, a rocket motor, a head containing a bursting charge, a fuze, and an obturating ring. The T132 Practice Rocket is similar, except that the head is inert loaded and a dummy fuze is used. Figures 4 and 5 show this round. The T217 proof (or slug) rounds omit the entire rocket and head, and substitutes an iron slug of approximately the same weight (Figures 6 and 7).

Operation of the 2.75 Rocket Launcher T-110-E2B is as follows. With a round in place, an electric trigger is depressed which completes the firing circuit and fires the electric primer. This, through the ignitor, sets off the propellant or launcher charge, building up pressure in the cartridge case and against the base of the rocket projectile. When the force against the rocket projectile reaches 500 pounds, the shot start device breaks, permitting the rocket projectile to move forward. This shot start device is a necked down connection between the ignitor tube and the projectile which holds the projectile in place during handling and feeding. As the rocket advances in the cartridge case, its rotating band engages the copper obturating or gas sealing ring and forces it forward against the rear face of the tube, sealing the slight space between the tube and the mouth of the cartridge case. The complete round passes through the obturating ring and enters the tube, where the rotating band is engraved by the lands, and the projectile commences to rotate. The rocket motor ballistite is ignited through the orifices by the burning of the propellant and begins to help accelerate the passage of the projectile through the tube. Six inches forward of the rear face of the barrel are

four 7/32" diameter holes, set 90° apart, which are connected to a gas piston. As the projectile passes these holes, pressure is exerted through them on the gas piston which forces the actuating slide to the rear, compressing the driving springs. No motion of the feed sprocket occurs during this rearward motion, as the cam following rollers are in the straight position of the cam path. A "Fabreeka" buffer stops the slide at the end of its recoil travel, and permits a spring loaded mechanical sear to fall in place and hold it in its most rearward position. If however, another round is in the pickup position, the sear is automatically released, and the driving springs return the slide to its forward position. On the return stroke of the slide, the cam following roller moves along the diagonal camming slot, rotating the sprocket 90° to eject the fired case and bring a new round into firing position. During the rear travel of the actuating slide, a positioning collar which aligns the tube and cartridge case is moved forward by linkage to permit the ejection of the fired case and the positioning of the new round. As the slide continues forward, the collar is forced back over the new round, aligning it and pressing it tightly against the firing pin, to assure contact with the electrical primer in the base of the cartridge case. The electrical circuit to the primer, which has been broken by the movement of the slide, is completed during the final 1/4" of travel, and the cycle repeats itself until ammunition is exhausted or the trigger is released. Forward motion of the actuating slide is cushioned by a hydraulic buffer, and rotation of the feed sprocket by the compression of a set of Belleville washers.

8. DESCRIPTION OF TEST EQUIPMENT:

a. For Firing

(1) A test mount of approximately 1,000,000 #/inch rigidity, securely bolted to a concrete base.

(2) An 8 mf condenser discharge 190 volt D.C. firing circuit.

(3) Two air bottles charged to 1200 psi, with suitable reducing valves and gages.

b. For Obtaining Cyclic Rates

(1) Blast proof dynamic speakers

(2) "Watch Master" Timer

(3) Brush Oscillograph

c. For Obtaining Velocities

(1) Muzzle wire holders

(2) Lumiline Screens

(3) "Potter" counter chronographs

(4) Magnetic Headphones

(5) Miller Oscillograph

(6) Sperry Radio Doppler Chronograph

(7) Cathode Ray Oscillograph

(8) Spiraling Drum Camera

(9) Photoelectric Sky Screens

d. For Projectile Photographs

(1) 35mm Fastax Cameras, with 50mm F/2 lenses, operating at 3200 pictures per second.

(2) Ballistic Synchro Camera.

9. PROCEDURE:

(For Tabulated Firing Data, see Appendix (B), Table I). The 2.75 Automatic Rocket Launcher T-110-E2B, No. 2, fitted with Tube No. 3, was received disassembled by the Naval Proving Ground on 17 July 1951. According to the Artillery Gun Book accompanying the launcher, it had been fired a total of 7 development rounds at Rock Island Arsenal on 29 June 1951, and had then been stargaged and found to be satisfactory. The stargage readings are given in Appendix (C), Table II.

The gun was thoroughly cleaned and assembled, and was mounted on a gun mount having a rigidity of approximately 1,000,000 #/inch, and laid at an elevation of 2° (Figures 2 and 3). Air bottles were connected to the pneumatic charger and the feeder, and an attempt made to cycle the gun using empty cases. According to verbal instructions given by Re8b, Bureau of Ordnance, the Belleville Washers at the rear of the feed sprocket were precompressed to 2-9/16". However, it was found that the driving springs would not return the slide to battery when the washers were compressed this much. It was determined

that 2-11/16" was the tightest that the Bellevilles could be compressed to permit the gun to be cycled by air, using the twisted wire driving springs as received with the gun. A calibration of these springs is given as Figures 8 and 9. 100 psi pressure was used on the feeder and 250 psi on the charger during these cycling operations. Several of the empty cases were damaged during these operations by the cam following roller on the center sprocket. It was found that the air pressure on the feeder was not sufficient to keep the third round in position against the force of the two spring loaded detents, and this round was hitting the cam following roller as it rotated. Increasing the feeder pressure to 250 psi corrected this difficulty.

Ammunition components had been received, and an attempt was made to assemble ten T217 proof rounds, using the following components:

Cartridge Case	Drawing 23D-1-200
Igniter Assembly	Drawing P-82070A
Launcher	Drawing P-82071A
Proof Slug	Drawing 23D-50-108
Gas Seal Ring	Drawing P-82224D

It was found that the shot start devices furnished with the Igniter Assemblies had 3/8" male threads on the forward end, while the proof slugs were tapped to receive a 1/2" male thread. Therefore, it was necessary to drill out the slugs, re-tap them, and manufacture an adapter to accommodate the 3/8" shot start devices. The Bureau of Ordnance was advised of this discrepancy, and Picatinny Arsenal Drawing PX-8-719 dated 10 August 1951 showing a shot start device with a 1/2" male thread for use with slugs was received shortly after, and 100 of the new shot start devices followed.

Further difficulty was encountered in assembling the rounds, when it was found that the rotating bands on slugs would not enter the cartridge case. A check of the drawings for these parts showed the diameter of the rotating bands should be 2.815 + .000-.001 while the I.D. of the case should be 2.816 + .001-.000. Actually, the diameter of the slugs was found to be as much as 2.818, and at least 30% of them measured 2.816 at some point. It was necessary to turn all slugs to the proper dimensions, after which another attempt was made to load the rounds. It was then found that there was a shoulder in each of the cases, 7-1/2" from the mouth, beyond which they were not ground, as the rotating band on the T131 or T132 Rockets does not pass beyond this point when the rockets are properly positioned in the cartridge cases.

2.75 Automatic Rocket Launcher T-110-E2B

The rotating band on the slugs is 4.225 from the base, while on the T131 or T132 Rocket, the band is 5.350 from the base. This difference in dimension prevented the slugs from being inserted in the cases far enough to engage the shot start device. To overcome this, seventeen of the cases were sent to the Naval Gun Factory, and ground to a depth of 9-1/2", to accommodate the slugs.

Complete T217 rounds were now assembled and two single rounds were fired and a burst of two rounds, in each case operation was normal and an empty case used as a dummy was fed into firing position. During this preliminary firing, the gas sealing rings were not fastened to the mouth of the cases, but were only inserted with the shoulder forward, as shown on Ordnance Corps, Department of the Army, Drawing Number P-83111. Six rounds were next loaded into the feeder, and on attempting to fire the burst, the ring on the fourth round moved forward as the round was moving into firing position, jamming against the rear face of the tube and the positioning collar, as shown in Figure 10. The slide was held out of battery, and the round did not fire. It was necessary to remove this round with a wrecking bar. On attempting to fire a three round burst later, the ring on the third round jammed as in the preceding burst, so that firing of rounds with the rings not held in place was discontinued.

A shipment of T132 Practice Rocket rounds, completely assembled, was received on 24 September 1951, and it was noted that the gas sealing rings were cemented in place. A number of these were fired, in bursts up to five rounds, to obtain cyclic rates and velocities. While all rounds fed normally, the rings were being carried forward unevenly and the most forward part was flowing into the barrel on firing, making it necessary for them to be torn loose on ejection (Figures 11 and 12). During the five round burst, one of cam following rollers on the sprocket came off, probably due to excessive strain caused by the obturating rings siezing against the barrel. These rollers are held in place by a wire retaining ring only, which fits in between a groove on the inside of the roller and a groove in the shaft. The roller, which came off, jammed between the feed sprocket and the cover, stopping the actuating slide in its forward motion, and breaking the driving spring rods. (Figure 34). It was noted that these rods had the threaded portion silver soldered to the rod, and they were replaced by one piece rods supplied by Re8b, Bureau of Ordnance. To prevent a recurrence of this trouble, one piece rollers were manufactured at the Naval Proving Ground (Figure 35), and substituted for the roller and roller pin (Drawing Numbers 22D1-404 and 5). These one piece rollers turned freely, and no further trouble was experienced after they were installed.

2.75 Automatic Rocket Launcher T-110-E2B

Several misfires were encountered during the early part of the firing, due to the breakdown of the Firing Pin Insulation Cone (Drawing Number 22D2-206) which was made of .005 Fishpaper. To overcome this shorting and arcing, three experimental Firing Pin Seats were made, one each of Nylon, Teflon and Synthane (Figure 35). Of the three, the seat made of Synthane was found to be the best, as both of the others tended to sieze the firing pin and hold it in.

On examining the fired cases, it was found that the entire shot start device on two rounds was still in the ignitor tube. (Figures 13 and 14). Apparently, on assembly by Picatinny Arsenal, the device was not screwed into the rocket projectile for more than 1/4 of a thread, but had screwed down into the ignitor tube. The small portion of the thread had stripped, rather than the necked down section breaking. The Bureau of Ordnance was advised of this condition by telephone, and Picatinny Arsenal was requested to cement or stake the shot start device to the ignitor tube, so that it would screw into the rocket on assembly. All other T132 rounds on hand were broken down and the shot start device properly positioned. Recorded velocities of the rounds where the shot start device remained intact did not vary to any large extent from those rounds on which the device functioned properly.

Further firing of the T132 Rockets was conducted to obtain peak velocity, burning time and burnt out velocities. Velocity vs. Time was recorded for six (6) rounds, and is given in Tables III through VIII, and plotted in Figure 15. From these, Velocity vs. Distance graphs were computed and are given as Figure 16. These measurements were made with a Sperry Radio Doppler Chronograph at intervals of about 75 feet along the trajectory.

To observe rocket stability and burning, high speed photographs of rockets in flight were obtained by two methods, High Speed Fastax Cameras with a frame rate of 3200 pictures per second, and a Ballistic-Synchro Camera. These photographs are given as Figures 17 and 18.

Firing of T217 proof (slug) rounds was resumed in an effort to determine the best method of holding the copper gas sealing rings in place, so as to permit high speed burst firing of the launcher without unnecessary strain on the slide, cam following rollers, and driving spring rods. Rounds were assembled with the rings held in by several different methods, which were as follows:

Scotch Tape Only
Miracle Cement Only
12 Stakes in Normal Case
4 Stakes in Normal Case
2 Stakes in Normal Case
12 Stakes in Case with Special 1/8" Diameter Groove Turned in Mouth
2 Stakes in Case as Above
Gas Sealing Ring Inverted, Scotch Tape
Gas Sealing Ring Inverted, 2 Stakes in Normal Case

It was found that by inverting the ring, i.e., placing it in the mouth of the case with the thin section forward, and by either staking the thick section lightly or using Scotch Tape, excellent sealing and operation was obtained. Photographs of the device used to stake the rings are shown in Figures 19 and 20. If staking was too deep, it was found that the ring was weakened, and, in one instance, a part of it was completely carried away, (Figure 21).

Five rounds of T217 ammunition were assembled with the shot start broken prior to assembly. These were fired in a velocity series with five standard rounds having the shot start device intact, to determine whether or not this connector increased the velocity. Average velocities were only slightly higher with the device in place.

At this point 1" spacers were made and installed at the ends of the driving springs to preload them approximately an additional 40# to facilitate loading. These are shown in Figure 22. On attempting a five round burst to determine whether this additional spring loading affected cyclic rate, a part of the obturating ring in the fourth round carried away, as mentioned above, jamming the sprocket.

Further work on the launcher was stopped when the Bureau of Ordnance requested that it be shipped to the Naval Gun Factory on 30 November 1951 for comparison with the drawings. This was accomplished on BOSO #395376 on 30 November 1951.

10. RESULTS AND DISCUSSION:

The results obtained from the tests of the 2.75 Rocket Launcher T-110-E2B conducted to date indicate the following.

a. The performance of the obturating or gas sealing ring seriously affects gun operation. If the ring is not held securely in place, it will move forward on feed and jam against the side of the barrel as a round is being moved into firing position. This is

a particularly dangerous malfunction, as a failure of one of the cam following rollers on the sprocket at this time will permit the slide to return to battery and fire a round when it is not aligned with the barrel. Three methods of holding the ring in place in the mouth of the case were tried, i.e., cementing, staking, and scotch taping, and all were satisfactory up to the time the round fired. However, on firing, considerable difficulty was encountered with the rings being upset and flowing into the barrel (see Figure 10). This prevents the empty case from being moved out of the firing position, and usually results in the cam following roller which is engaged jumping out of the slide camming slots, with damage to both the slide and roller. On the greater part of the rounds which had the rings cemented in place, it was found that the rings did not move forward uniformly. One side would flow into the barrel, while the other would not move at all and permit gas to escape. The rings staked or scotch taped usually moved forward uniformly, but when seizing did occur, it was greater than when the rings were cemented. By trial and error, it was determined that the best and only satisfactory performance was obtained with the rings placed in the mouth of the cartridge case in an inverted position, i.e., with the thick section toward the rear of the case. Either two pieces of scotch tape or two light stakes were used to hold the rings in place on feeding, and permitted them to move forward uniformly on firing. Only one ring failure occurred when the rings were inverted, that being caused by part of the ring being carried away. (Figure 21). Apparently this was caused by too heavy staking, as a number of single rounds were fired with perfect results with the rings inverted and not held in place.

b. The performance of the shot start device, except as a means of holding the rocket or slug in place during handling and feeding, does not seem to be critical. Firing of the three T132 inert rockets on which the shot start device was not screwed in place gave velocities at 62-1/2 feet of 1361, 1370 and 1301 fps for an average of 1344 fps, which may be compared to the velocities of three rounds where the device functioned properly, which were 1354, 1342 and 1349 for an average of 1348 fps. Additional tests, using T217 slug rounds, due to the shortage of rocket rounds, gave the following results:

2.75 Automatic Rocket Launcher T-110-E2B

Velocity at 62-1/2 feet, Shot Start Device Broken Prior to Firing	Velocity at 62-1/2 feet, Shot Start Device Normal
1128	1165
1113	1160
1030	1102
1060	1116
1113	1175
1085	1135
1088 Average fps	1142 Average fps

Although the average velocity with the shot start device in place was 54 fps greater than without it, no definite conclusions may be drawn as there was a difference of 73 fps in velocities obtained using the shot start device. Also, no record of the condition of the barrel prior to each shot was kept at this time, as the information given in paragraph (c) below had not transpired.

c. In firing a two round series at each temperature in a cold ammunition test, it was noted that the first round fired had a velocity considerably greater than the second round. There were no changes in the gun or ammunition, except that the barrel had been cleaned and oiled prior to firing the first round, but not the second. To determine whether or not the lubricated barrel affected velocities, six (6) additional rounds were fired at 0°F without lubricating the barrel, and none reached the velocity of the first round, when the barrel was oiled. Apparently the increasing twist rifling in the tube, with its resulting "X" engraving (Figure 23) of the rotating band will give greater velocities when lubricated.

d. The small amount of cold temperature work completed shows that the gun will cycle successfully at 0°F with an average velocity at 62-1/2 feet of 959 fps, when firing T217 (slug) rounds.

e. Velocities taken with the Sperry Radio Doppler Chronograph show the peak velocity occurring at from .5153 to .5742 seconds after primer ignition. These times are slightly longer than the actual burning time of the ballistite. Peak velocities were from 2822 to 2916 fps and velocities at 2000 feet (calculated) were from 2475 to 2600 fps. While the rocket could not be tracked for more than one second, the deceleration from the peak velocity to the extreme point recorded is uniform.

f. The accuracy of the T217 proof round at 1000" is much better than that of the T132 Rocket Round. (Figures 24 through 30). Apparently the ballistite does not burn uniformly and a different amount of gas is forced from each orifice, although this cannot be detected in the high speed photographs (Figures 17 and 18). Figures 28, 29 and 30 are a series of patterns obtained at 1000", 2000" and 3000" from one firing sequence, and from them it may be seen that the rockets are not traveling in a straight line. Variations in peak velocity and burning time as shown in Figure 15 may be due to uneven burning. It is possible that, due to the loose fit of the launcher propellant bag in the cartridge case, the position of the rocket orifices on firing may affect the ignition and burning of the ballistite. If they were in a vertical plane, the lower orifice would be directly against the launcher propellant, while the upper one would not, probably causing uneven ignition.

g. In order to reuse the cartridge cases, the Naval Proving Ground was advised by the Bureau of Ordnance to test them hydrostatically at 7500 psi before reloading. To accomplish this, a piston was made with a nylon cup type washer, Figures 31 and 32, that fitted snugly inside the case. This was put under a hydraulic press, and forced downward into a case filled with oil, until the desired pressure was obtained. It was noted that oil was flowing past the nylon washer and it was impossible to maintain pressure. To overcome this, several discs, 2.75 diameter, were cut from 1/2" gasket rubber. It was found that if one was placed on top of the oil in the case, and one placed inside the nylon cup, pressure could be maintained for an indefinite period. The Naval Gun Factory later manufactured an enclosed type of tester, shown in Figure 33 which was superior to the piston type, as a case could be tested in 5 minutes using it, compared to 15 minutes using the piston. During the testing of approximately 50 cases, some of which were fired as many as six times, only one showed a leak. This particular defective case had been fired only once, and the leak was between the base and the cylinder.

PART D

CONCLUSIONS

11. On the basis of the limited number of rounds fired in the one 2.75 T-110-E2B Rocket Launcher receiver by the Naval Proving Ground, it is concluded that:

a. The basic operating principles of this gun are sound.

b. It will perform at its designed rate of 800-900 rounds per minute.

c. The peak velocity of the T132 rocket exceeds 2800 fps at burn out.

d. Its accuracy is not equal to present service aircraft guns when firing T132 Practice Rockets as received. It is, however, when firing T217 slug rounds at 1000".

PART E

RECOMMENDATIONS

12. In view of the fact that the 2.75 Rocket Launcher, which weighs only 205 lbs, fires at roughly the same rate and velocity as an AN-M3 or Mark 12 20mm Aircraft Gun, but carries a bursting charge of 1 pound (7000 grains) compared to a 20mm projectile with .017 pounds (119 grains) it is recommended that:

a. An additional six launchers be obtained and delivered to the Naval Proving Ground for further development and testing.

b. At least 1500 rounds each of T132 (Practice Rocket) and T217 (slug) ammunition be provided for these tests.

c. A high priority be assigned to this work.

Certain minor modifications be made to the launcher and ammunition, as contained elsewhere in this report.

PART F

DISPOSITION OF MATERIAL

13. The 2"75 Automatic Rocket Launcher T-110-E2B, No. 2 with Tube No. 3, was shipped to the Naval Gun Factory 30 November 1951 on BOSO #395376 for inspection and check. Empty fired cartridge cases were tested and retained at the Naval Proving Ground for reloading.

The investigation upon which this report is based was conducted by:
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Aviation Ordnance Department

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By direction

CONFIDENTIAL

NPG REPORT NO. 973

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

First Partial Report

on

2.75 Automatic Rocket Launcher T-110-E2B

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Project No.: NPG-Re8b-119-1-52
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APR 28 1952

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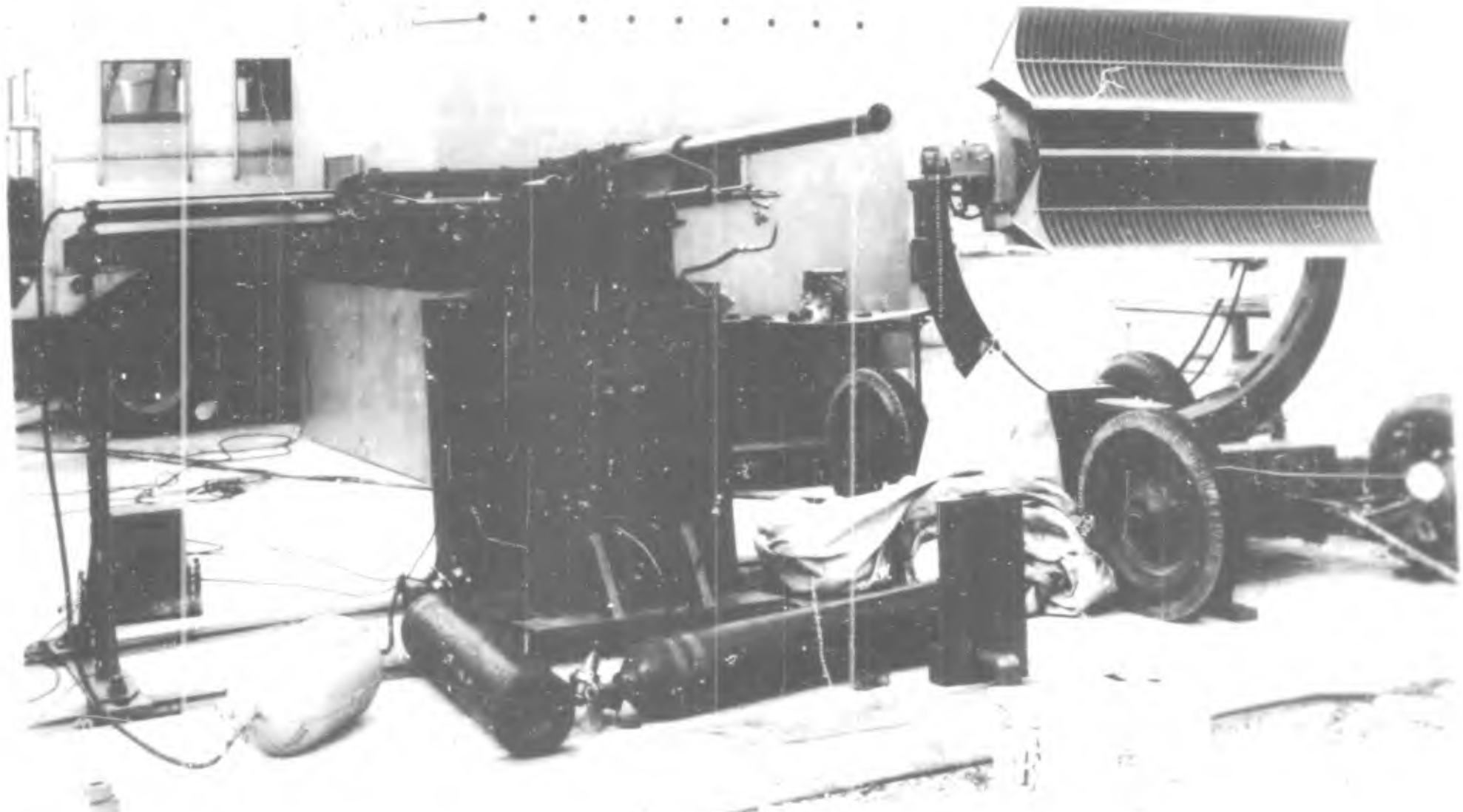
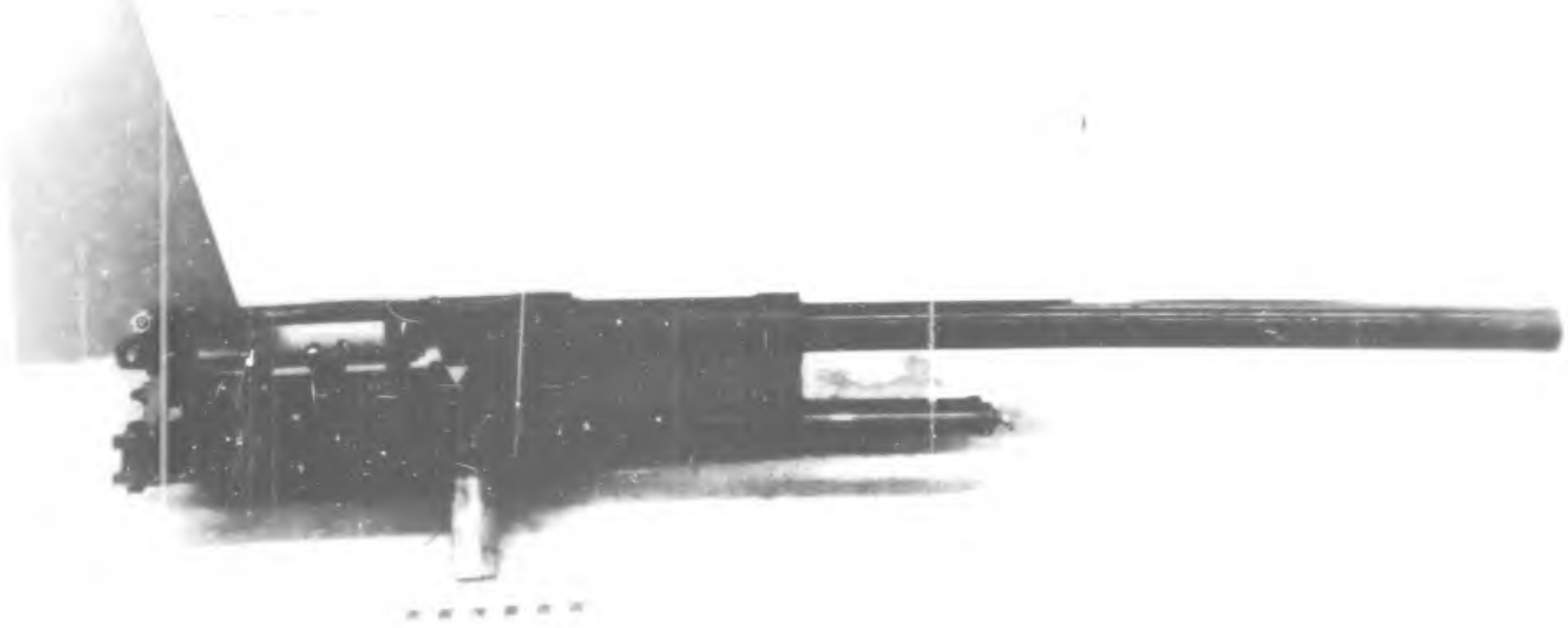
NP9 48467
Front view showing T11C Rocket Launcher on 1,000,000 pounds/inch mount with Sperry Radar Doppler.

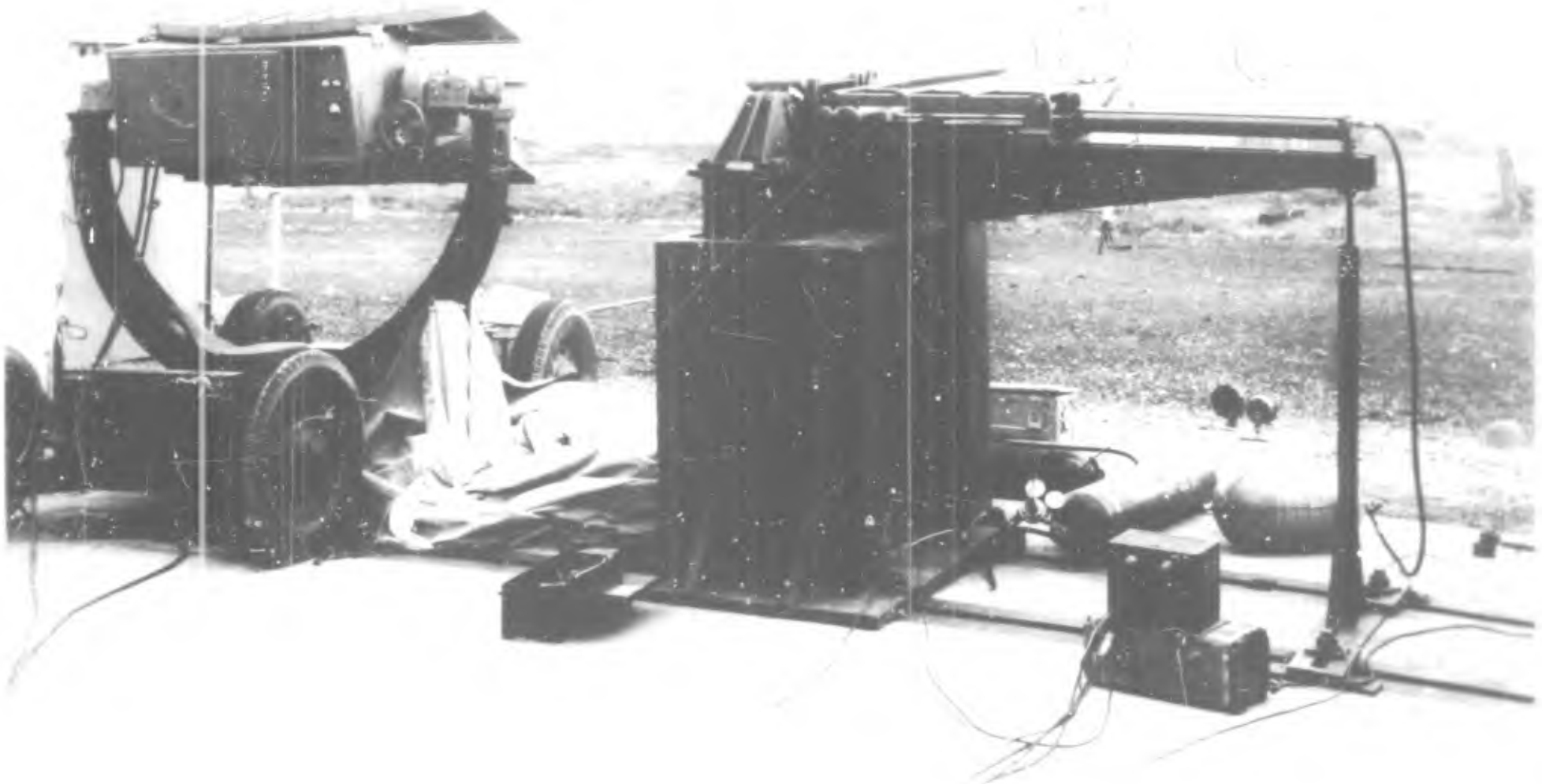
Figure 2



NPO 48466
View shown 2.75 Automatic Rocket Launcher T110-E2B No. 2 after assembly.
Figure 1



NP9 48468
Rear view of T110 Rocket Launcher mounted on gun mount have a rigidity of approximately 1,000,000 pounds/inch, with Sperry Radar Doppler.
Figure 3



NP9 48469
View of T132 practice rocket round and cartridge case.
Figure 4

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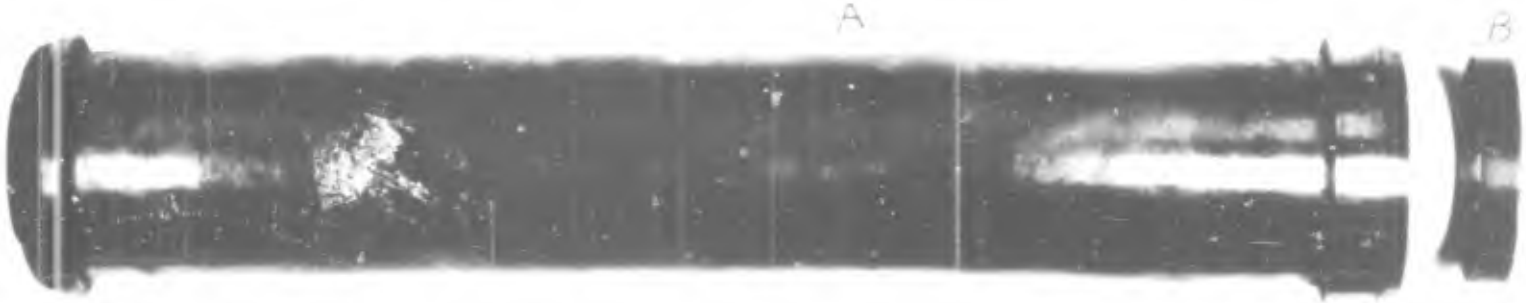
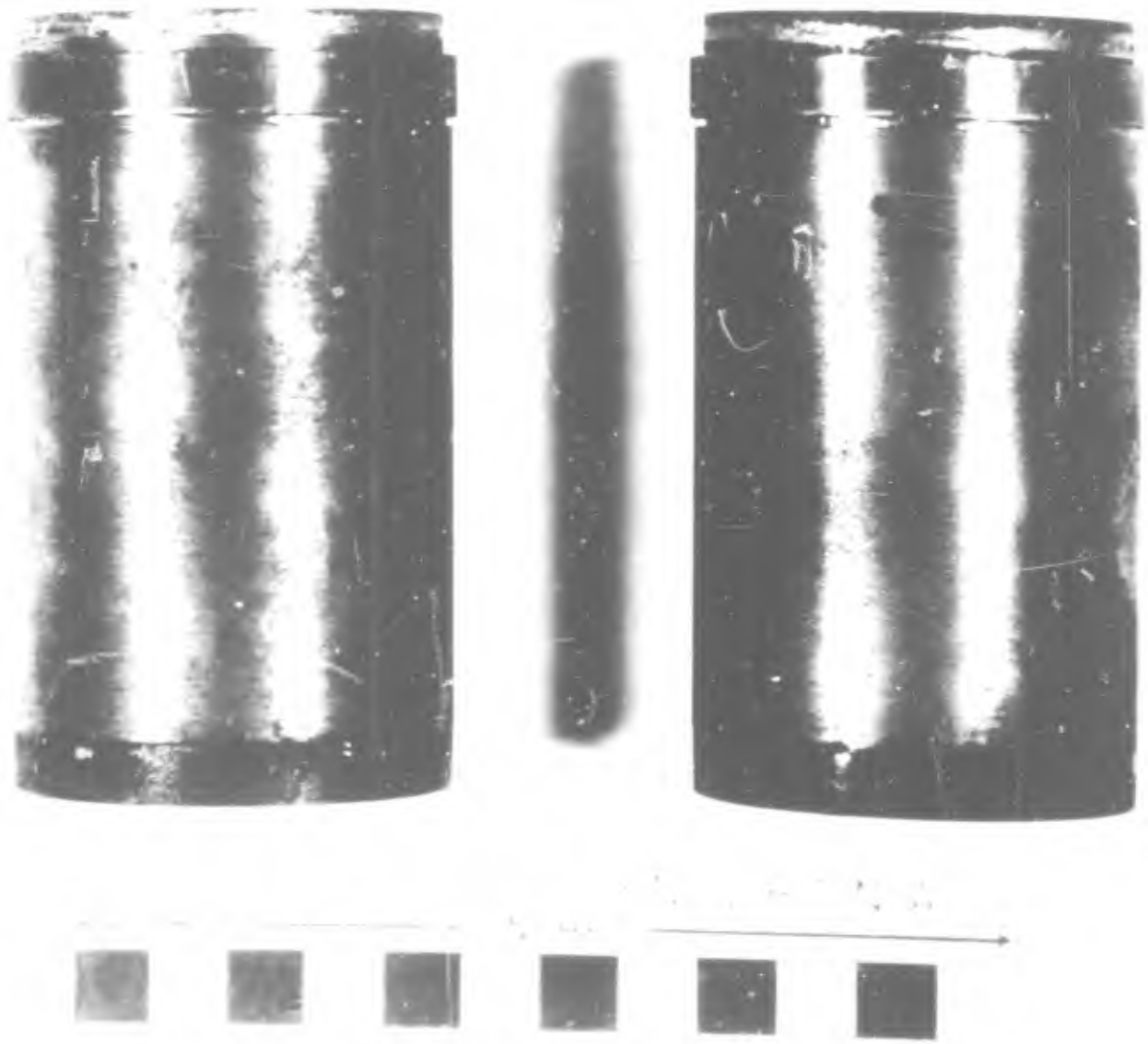
NP9 48470
View of T132 practice rocket showing (a) Cartridge Case, (b) Gas Sealing Ring, (c) Retaining Nut, (d) Ignitor Tube, (e) Shot Start Device, (f) Nozzle Plate, (g) Rocket Motor, (h) Rotating Band, (i) Head, (j) Fuze.

Figure 5



ORD 48471
View of two T217 proof (or slug) rounds, showing gap in rotating bands.
Figure 6



NP9 48472
View of forward end of two T217 proof (or slug) rounds showing gap in rotating band.
Figure 7

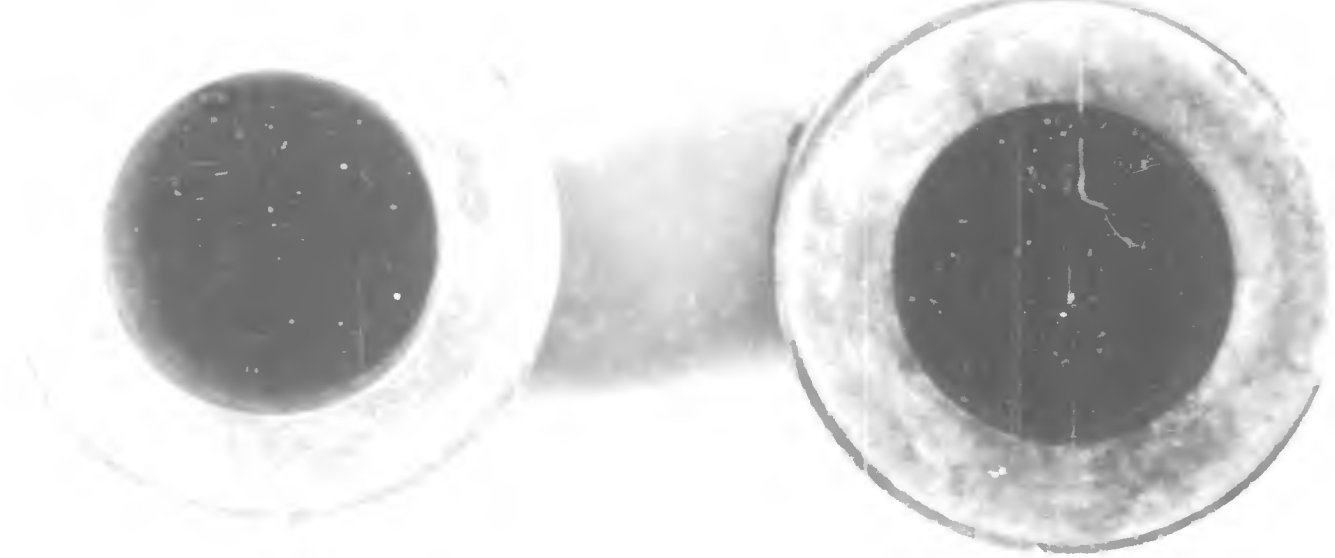


TABLE I

TABULATED FIRING DATA

2".75 Automatic Rocket Launcher, T-110-E2B, #2, Tube #3
Manufactured by Rock Island Arsenal
7 Development Rounds on Gun When Received

Date Fired 1951	Loaded, No. Rounds	Fired, No. Rounds	Type Round	Cyclic Rate Rounds Per Minute	Velocity, Feet Per Second	Number of Feet From Muzzle Velocity Taken	Dispersion 100% Mils, XA	YA	XB	YB	Shot Start Device, Before Firing	Shot Start Device, After Firing	Gas Sealing Ring Held In By	Gas Sealing Ring Condition After Firing	New Parts Installed	Remarks
8/30	1	1	T-217	---	----	--					Intact	Broken	Nothing	Good		Fed dummy, stable at 100'.
"	1	1	"	---	1016	15'	)				"	"	"	"		" " " " "
"	2	2	"	632	1198*	15'	) 3.25	1.25			"	"	"	"		" " " " "
"	6	3	"	640	Lost	15'	)				"	"	"	Torn		Ring jammed in feeding 4th round, which did not fire.
"	3	2	"	632	Lost	15'					"	"	"	Torn		Ring jammed 3rd round, as above.
9/27	1	1	T-132	---	1229	15'	)				"	"	Cement	Upset		Fed dummy.
"	1	1	"	---	1276	15'	) 3.00	2.05			"	"	& Scotch	"		" "
"	3	3	"	Lost	1298*	15'	)				"	"	Tape	"		" "
"	5	5	"	935	1340*	15'	4.97	5.66	-2.2	+3.6	"	"	"	"		One sprocket roller snapped off, damaging cover.
9/28	1	1	"	---	(1250	37 1/2')					"	Intact	"	"		Shot start device screwed too far into ignitor tube.
					(1361	62 1/2')										
"	1	1	"	---	(1249	37 1/2')					"	"	"	"		Same as above.
					(1570	62 1/2')										
"	1	1	"	---	(1304	37 1/2')					"	Broken	"	"		Shot start device functioned properly.
					(1354	62 1/2')										

TABLE I (Continued)

Date Fired 1951	Loaded, No. Rounds	Fired, No. Rounds	Type Round	Cyclic Rate Rounds Per Minute	Velocity, Feet Per Second	Number of Feet From Muzzle Velocity Taken	Dispersion 100% Mils. XA	YA	XB	YB	Shot Start Device, Before Firing	Shot Start Device, After Firing	Gas Sealing Ring Held In By	Gas Sealing Ring Condition After Firing	New Parts Installed	Remarks
10/12	1	1	T-132	---	(1253 (1301 (1425 (1571	41 1/2' 62 1/2' 125' 207 1/2')					Intact	Intact	Cement & Scotch Tape	Upset	2 new nuts rear buffer	Shot start device screwed too far into ignitor tube.
"	1	1	"	---	(1262 (1342 (1487 (1601	41 1/2' 62 1/2' 125' 207 1/2')					"	Broken	"	"		Shot start device functioned properly.
"	5	5	"	807	(1302 (1349 (Lost (1571	41 1/2' 62 1/2' 125' 207 1/2')	See Figs. 28, 29 & 30 for dispersion on this burst and the two preceding rounds.				"	"	"	"		Shot start device functioned properly.
11/2	1	1	"	---	----	---					"	"	Cement	"		For photographs.
"	2	2	"	---	----	---					"	"	"	"		" "
"	8	4	T-217	Lost	----	---					"	"	Staked	Good		Sprocket roller came off, jamming and damaging slide, and breaking driving spring rods.
11/5	1	1	T-132	---	----	---					"	"	Cement	Upset	New slide and 2 rods	For photographs.
"	1	1	"	---	----	---					"	"	"	"		" "
"	1	1	"	---	----	---					"	"	"	"		" "
"	1	1	T-217	---	----	---					"	"	Scotch Tape	"		Test.

TABLE I (Continued)

Date Fired 1951	Loaded, No. Rounds	Fired, No. Rounds	Type Round	Cyclic Rate Rounds Per Minute	Velocity, Feet Per Second	Number of Feet From Muzzle Velocity Taken	Dispersion 100% Mils. XA	YA	XB	YB	Shot Start Device, Before Firing	Shot Start Device, After Firing	Gas Sealing Ring Held In By	Gas Sealing Ring Condition After Firing	New Parts Installed	Remarks
11/5	7	3	T-217	686	----	---					Intact	Broken	Scotch Tape	Upset		Empty case jammed by ring, sprocket roller snapped off.
"	1	1	"	---	----	---					"	"	"	"	4 new roller retaining rings	New roller ring test.
"	1	1	T-132	---	Fig.#15	Fig.#15					"	"	Cement	"		For radar track.
"	1	1	"	---	Fig.#15	Fig.#15					"	"	"	"		For radar track.
"	3	3	T-217	914	----	---					"	"	No Rings	No Rings		Severe breech flaming.
11/6	1	1	T-132	---	Fig.#15	Fig.#15					"	"	Cement	Upset	Nylon Firing Pin Insulator	Sprocket roller thrown to roof of adjacent building.
"	1	1	"	---	Fig.#15	Fig.#15					"	"	"	"		For radar track.
11/9	1	1	T-217	---	----	---					"	"	Staked	"	4 NGF 1 piece rollers, Fig.#15	Ring jam.
11/15	1	1	T-132	---	Fig.#15	Fig.#15					"	"	Cement	"		For radar track.
"	1	1	"	---	Fig.#15	Fig.#15					"	"	"	"		" " "
"	1	1	"	---	Fig.#15	Fig.#15					"	"	"	"		" " "
"	1	1	"	---	Fig.#15	Fig.#15					"	"	"	"		" " "
11/17	5	1	T-217	---	----	---					"	"	Miracle Cement	Torn		Ring jam.
11/19	1	1	"	---	----	---					"	"	Staked	Good		Satisfactory.
"	3	3	"	---	----	---					"	"	"	Fair		Satisfactory.
11/20	2	2	"	---	1139*	52 1/2'					"	"	See Remarks		1" spacers behind spring	1st round staked and coated with liqui-moly - ring upset. 2nd round inverted and staked in 2 places - Excellent.

TABLE I (Continued)

Date Fired 1951	Loaded, No. Rounds	Fired, No. Rounds	Type Round	Cyclic Rate Rounds Per Minute	Velocity, Feet Per Second	Number of Feet From Muzzle Velocity Taken	Dispersion 100% Mils. XA	YA	XB	YB	Shot Start Device, Before Firing	Shot Start Device, After Firing	Gas Sealing Ring Held In By	Gas Sealing Ring Condition After Firing	New Parts Installed	Remarks
11/20	2	2	T-217	---	1122*	62 1/2'					Intact	Broken	See Remarks	Fair		1st round inverted and staked in 2 places - Excellent. 2nd round normal and staked in 2 places - Ring upset. Shoulders on inside of both rings machined off.
"	2	2	"	---	1131*	"					"	"	"	"		1st round scotch tape - Good. 2nd round 4 stakes - Good.
"	2	2	"	---	1124*	"					"	"	"	"		Both rings inverted and staked in two places - Excellent.
"	1	1	"	---	1128	"					Broken	"	Inverted Staked	Excellent		Shot start device test.
"	1	1	"	---	1165	"					Intact	"	"	"		" " " "
11/21	1	1	"	---	1160**	"					"	"	"	"		" " " "
"	1	1	"	---	1102	"					"	"	"	"		" " " "
"	1	1	"	---	1116	"					"	"	"	"		" " " "
"	1	1	"	---	1175	"					"	"	"	"		" " " "
"	1	1	"	---	1113	"					Broken	"	"	"		" " " "
"	1	1	"	---	1030	"					"	"	"	"		" " " "
"	1	1	"	---	1060	"					"	"	"	"		" " " "
"	1	1	"	---	1113	"					"	"	"	"		" " " "
"	1	1	"	---	1135	"					Intact	"	"	"		" " " "
"	1	1	"	---	1085	"					Broken	"	"	"		" " " "

TABLE I (Continued)

Date Fired 1951	Loaded, No. Rounds	Fired, No. Rounds	Type Round	Cyclic Rate Rounds Per Minute	Velocity, Feet Per Second	Number of Feet From Muzzle Velocity Taken	Dispersion 100% Mils. XA	YA	XB	YB	Shot Start Device, Before Firing	Shot Start Device After Firing	Gas Sealing Ring Held In By	Gas Sealing Ring Condition After Firing	New Parts Installed	Remarks
11/27	1	1	T-217	---	1047	62 1/2'					Intact	Broken	Inverted Staked	Excellent		Rounds conditioned 17 hrs. at +30°F, fed dummy.
"	1	1	"	---	1049	"					"	"	"	"		" " " "
"	1	1	"	---	1022)**	"					"	"	"	"		Rounds conditioned 7 hrs.
"	1	1	"	---	930)	"					"	"	"	"		at +20°F, fed dummy.
11/28	1	0	"	---	----	"					"	"	"	"		Misfire, shorted primer.
"	1	1	"	---	1022)**	"					"	"	"	"		Rounds conditioned 16 hrs.
"	1	1	"	---	925)	"					"	"	"	"		at 10°F, fed dummy.
"	1	1	"	---	1000)**	"	)				"	"	"	"		Rounds conditioned 6 hrs.
"	1	1	"	---	937)	"	)				"	"	"	"		at 0°F, fed dummy.
"	1	1	"	---	935)	"	)				"	"	"	"		" " " "
"	1	1	"	---	939)	"	)				"	"	"	"		" " " "
"	1	0	"	---	---)	"	)	1.5	1.0							Misfire, shorted primer:
"	1	1	"	---	964)	"	)				"	"	"	"		Rounds conditioned 6 hrs.
"	1	1	"	---	975)	"	)				"	"	"	"		at 0°F, fed dummy.
"	1	1	"	---	952)	"	)				"	"	"	"		" " " "
"	1	1	"	---	972)	"	)				"	"	"	"		" " " "
11/29	1	1	"	---	1102	"					"	"	"	"		Ambient temp., instrument
					1104***	65'										check.
"	1	1	"	---	1081	62 1/2'					"	"	"	"		" " "
"	1	1	"	---	1135	"					"	"	"	"		" " "
					1136***	65'										" " "
"	1	1	"	---	1117	62 1/2'					"	"	"	"		" " "
"	4	3	"	Lost	Lost	"					"	"	"	1 Ring torn		Ring on 3rd round failed, see Fig. 21.
"	1	1	"	---	1129	"					"	"	"	Excellent		Ambient, temp., instrument check.

* Velocities given for burst firing are for first round only.
** Tube cleaned and oiled prior to first round but not others.
*** Velocity taken with break screen to compare with lumiline screens.

TABLE II

2.75 T-110-E2B AUTOMATIC ROCKET LAUNCHER NO. 3, EQUIPPED WITH TUBE NO. 2

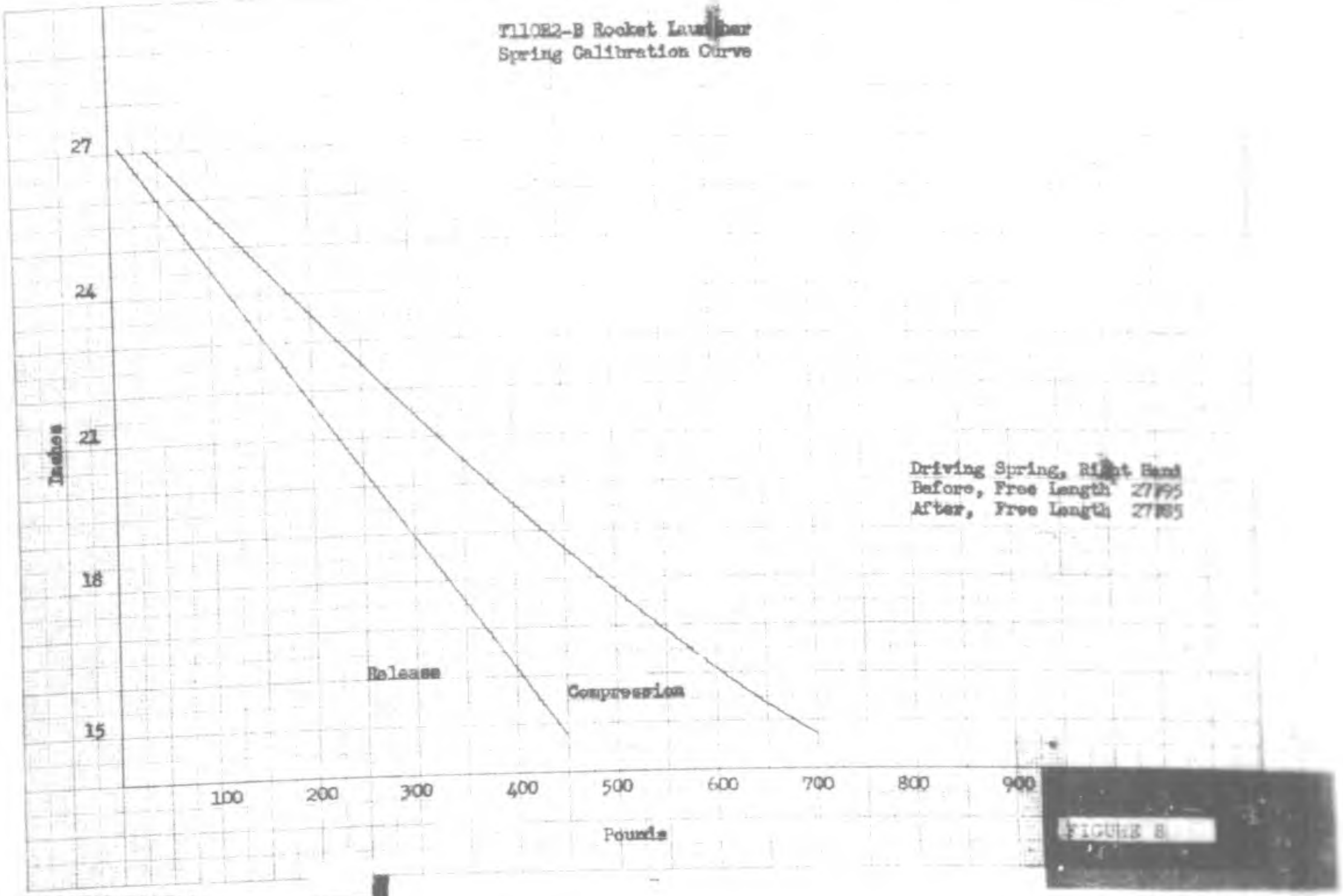
Stargage Readings Taken by Rock Island Arsenal after 7 Rounds

Distance from Muzzle	Gage Reading
2" to 28"	2.7513
28" to 52"	2.7514
52" to 72"	2.7513

Stargage Readings Taken by Naval Proving Ground after 20 T217 (Slug) Rounds and 14 T132 (Practice Rocket) Rounds

Distance	Gage Reading
Breech	2.755
1"	2.753
2"	.752
3"	.753
4"	.753
5"	.752
6"	.752
7"	.752
8"	.751
9"	.752
10"	.752
11"	.752
12"	.752
18"	.752
24"	.753
30"	.752
36"	.753
42"	.752
48"	.753
54"	.752
60"	.752
66"	.753
72"	

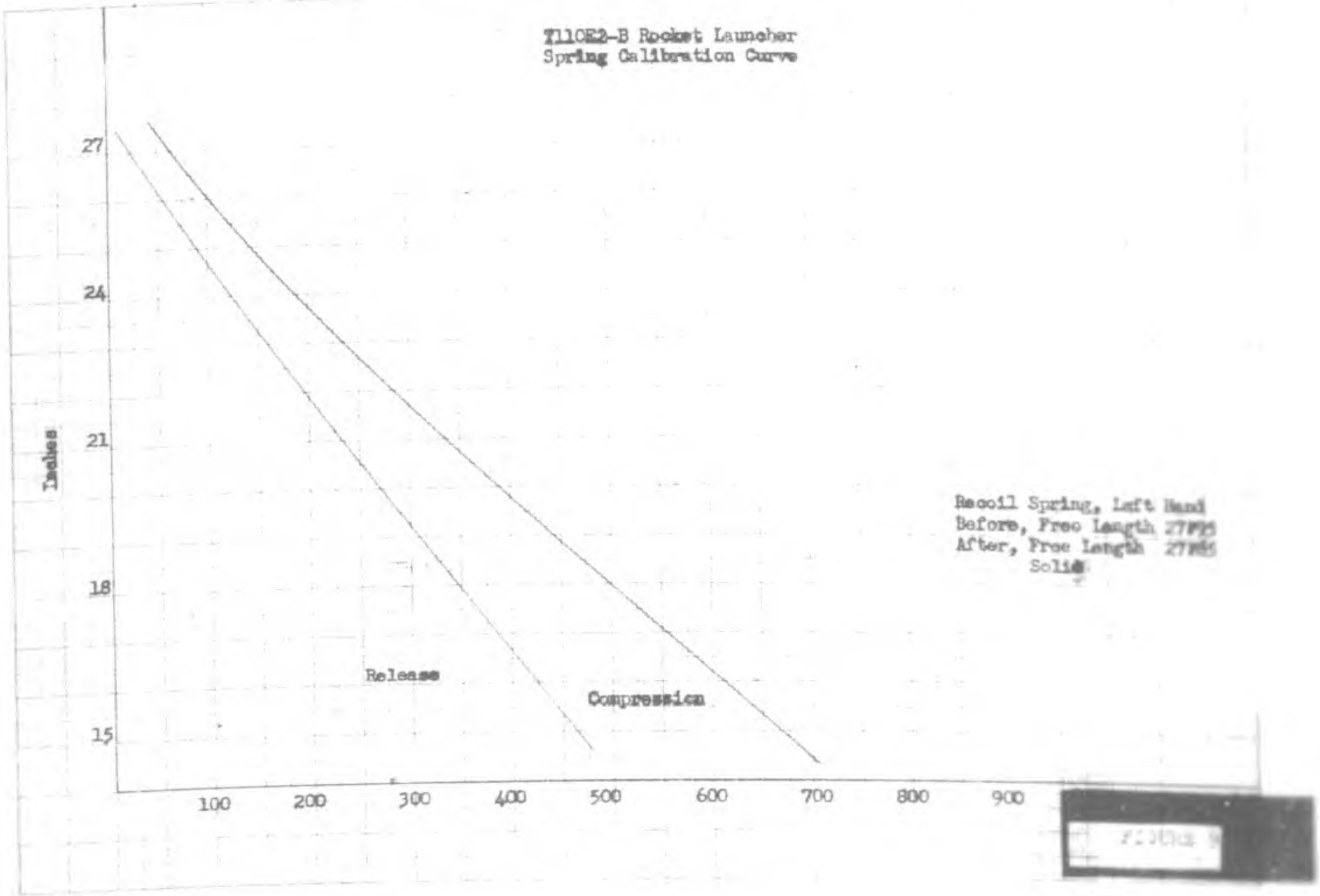
T11C82-B Rocket Launcher
Spring Calibration Curve



Driving Spring, Right Hand
Before, Free Length 27.95
After, Free Length 27.85

FIGURE 8

T110E2-B Rocket Launcher
Spring Calibration Curve



Recoil Spring, Left Hand
Before, Free Length 27[illegible]
After, Free Length 27[illegible]
Solid

[redacted]

NP9 48473
View showing obturating ring jamming against rear face of tube holding slide out of battery.
Figure 10

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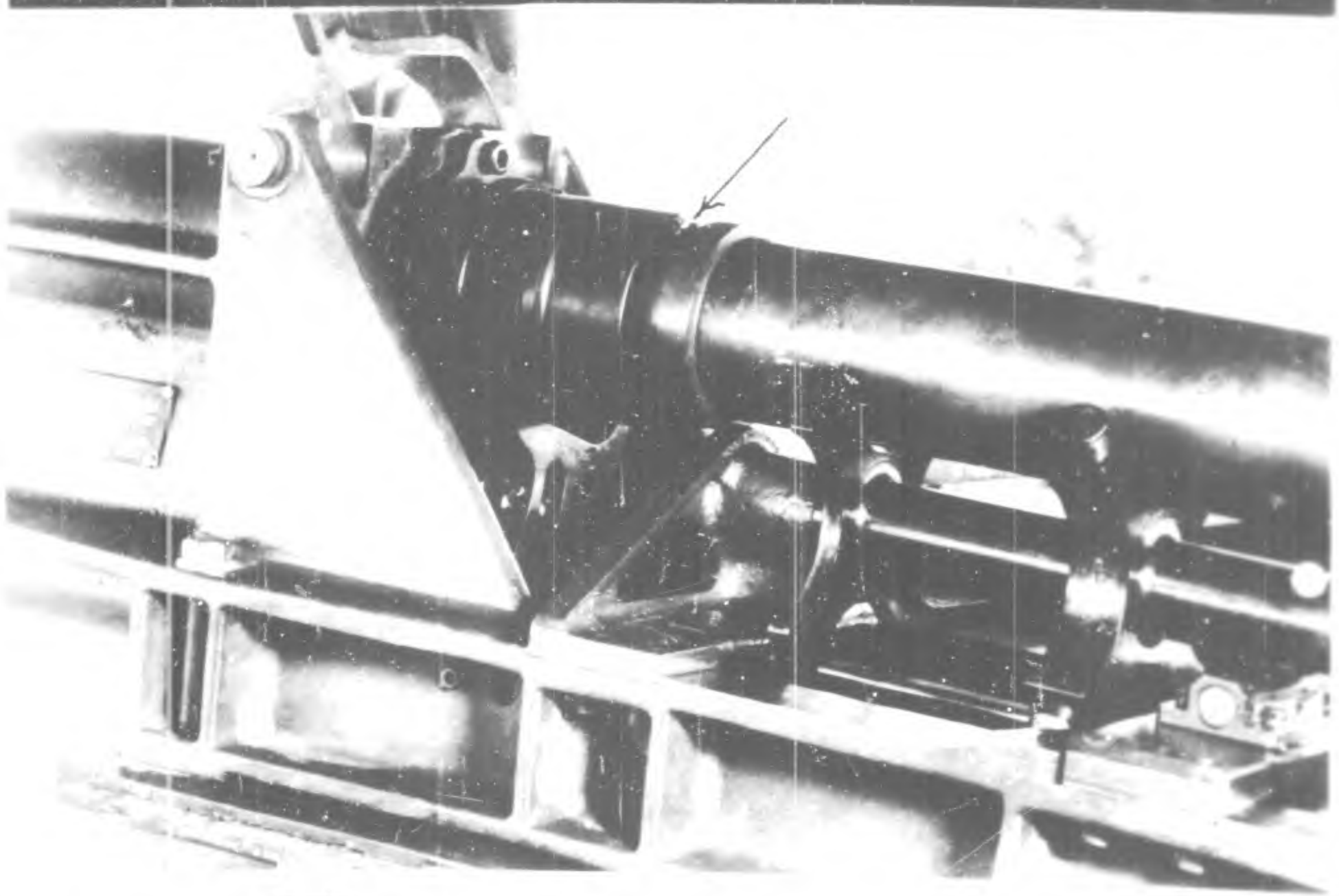
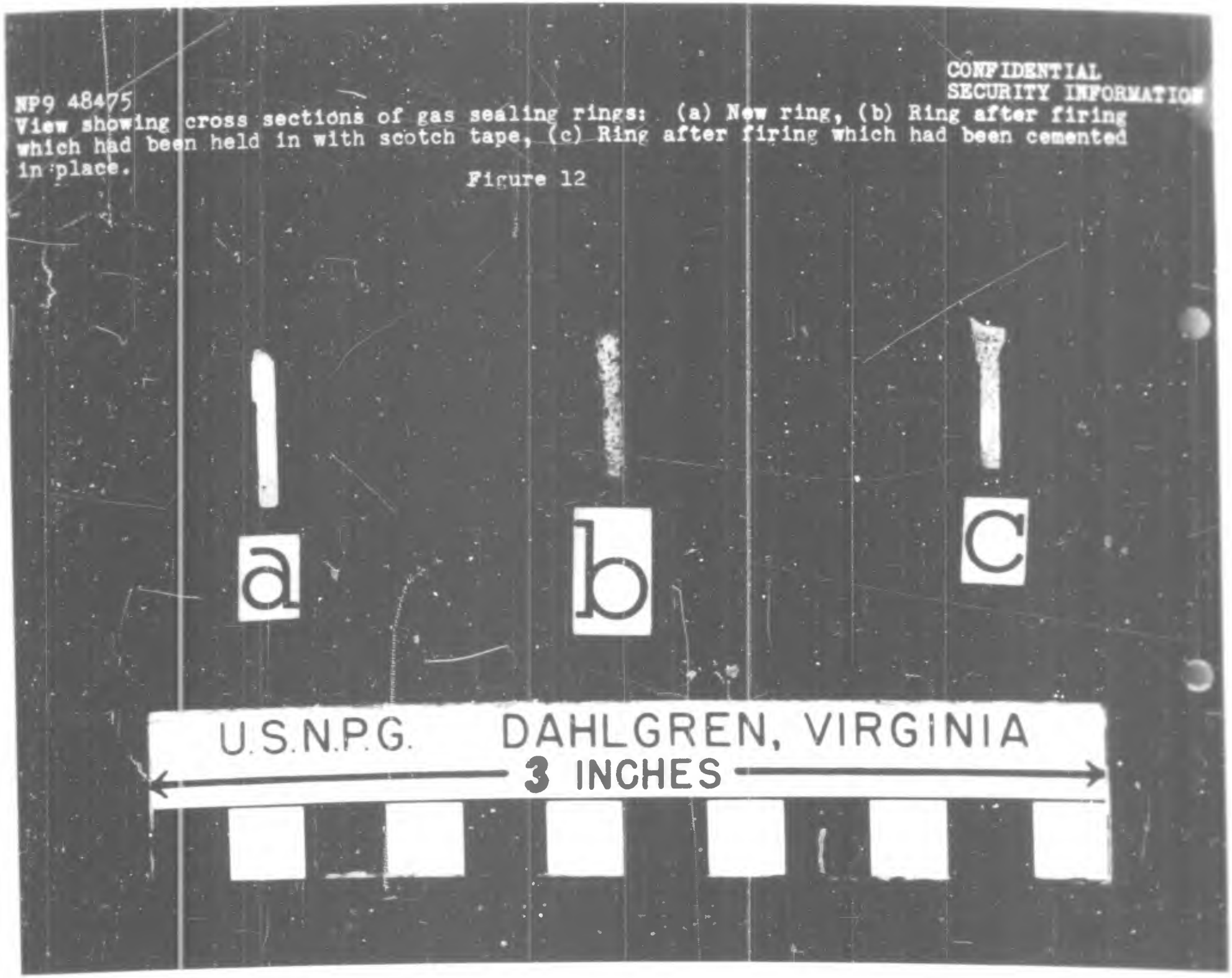


NPG 48474
View of gas sealing rings: (A) New ring, (b) Ring after firing which had been held in with scotch tape, (c) Ring after firing which had been cemented in place.
Figure 11

NP9 48475
View showing cross sections of gas sealing rings: (a) New ring, (b) Ring after firing which had been held in with scotch tape, (c) Ring after firing which had been cemented in place.

Figure 12



NP9 48476
Forward end view of shot start device left intact in ignitor tube after firing.
Figure 13

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NP9 48477
Side view of shot start device that remained intact in ignitor tube after firing.
Figure 14

TABLE III

VELOCITY MEASUREMENT DATA
FROM SPERRY RADIO DOPPLER CHRONOGRAPH
FOR 2.75 INCH ROCKET GUN T-110

Round 2, 5 November 1951, Ambient Temperature

Time Seconds	Velocity Ft/Sec.
.0293	1288
.0854	1438
.1359	1590
.1818	1722
.2242	1847
.2639	1972
.3011	2091
.3363	2211
.3696	2330
.4012	2449
.4314	2565
.4602	2674
.4881	2774
.5153	2822
.5421	2813
.5692	2791
.5964	2764
.6239	2736
.6516	2708
.6797	2679
.7081	2650
.7367	2621
.7657	2592
.7951	2564
.8262	2311
.0567	Distance Reference

TABLE IV

VELOCITY MEASUREMENT DATA
FROM SPERRY RADIO DOPPLER CHRONOGRAPH
FOR 2.75 INCH ROCKET GUN T-110

Round 3, 5 November 1951, Ambient Temperature

Time Seconds	Velocity Ft/Sec.
.0284	1331
.0833	1426
.1338	1525
.1799	1720
.2225	1839
.2626	1941
.3004	2061
.3362	2169
.3702	2277
.4026	2389
.4335	2501
.4631	2610
.4916	2718
.5190	2801
.5459	2830
.5727	2819
.5996	2793
.6268	2766
.6543	2737
.6820	2708
.7101	2680
.7385	2652
.7671	2623
.7961	2594
.8254	2566
.8552	2505
.0569	Distance Reference

TABLE V

VELOCITY MEASUREMENT DATA
FROM SPERRY RADIO DOPPLER CHRONOGRAPH
FOR 2.75 INCH ROCKET GUN T-110

Round 1, 15 November 1951, Ambient Temperature

Time Seconds	Velocity Ft/Sec.
.0285	1325
.0832	1444
.1325	1634
.1770	1765
.2185	1888
.2573	2008
.2939	2123
.3286	2237
.3616	2355
.3929	2468
.4229	2579
.4516	2690
.4792	2799
.5058	2883
.5318	2916
.5578	2906
.5839	2880
.6103	2853
.6369	2825
.6638	2797
.6910	2769
.7184	2741
.7401	2713
.7742	2685
.8025	2657
.8311	2629
.8600	2591
.8896	2521
.9205	2377
.	
.0526	Distance Reference (73.5 Feet from Muzzle)

2.75 Automatic Rocket Launcher T-110-E2B

TABLE VI

VELOCITY MEASUREMENT DATA
FROM SPERRY RADIO DOPPLER CHRONOGRAPH
FOR 2.75 INCH ROCKET GUN T-110

Round 2, 15 November 1951, Ambient Temperature

Time Seconds	Velocity Ft/Sec.
.0290	1305
.0846	1415
.1353	1576
.1815	1704
.2244	1822
.2647	1937
.3027	2050
.3386	2163
.3728	2250
.0567	Distance Reference (73.5 Feet from Muzzle)

TABLE VII

VELOCITY MEASUREMENT DATA
FROM SPERRY RADIO DOPPLER CHRONOGRAPH
FOR 2.75 INCH ROCKET GUN T-110

Round 3, 15 November 1951, Ambient Temperature

Time Seconds	Velocity Ft/Sec
.0287	1315
.0835	1454
.1328	1624
.1777	1744
.2199	1856
.2594	1961
.2970	2062
.3328	2166
.3669	2271
.3995	2370
.4412	1470
.4884	1762
.0520	Distance Reference (73.5 Feet from Muzzle)

TABLE VIII

VELOCITY MEASUREMENT DATA FROM SPERRY RADIO DOPPLER CHRONOGRAPH FOR 2.75 INCH ROCKET GUN T-110

Round 4, 15 November 1951, Ambient Temperature

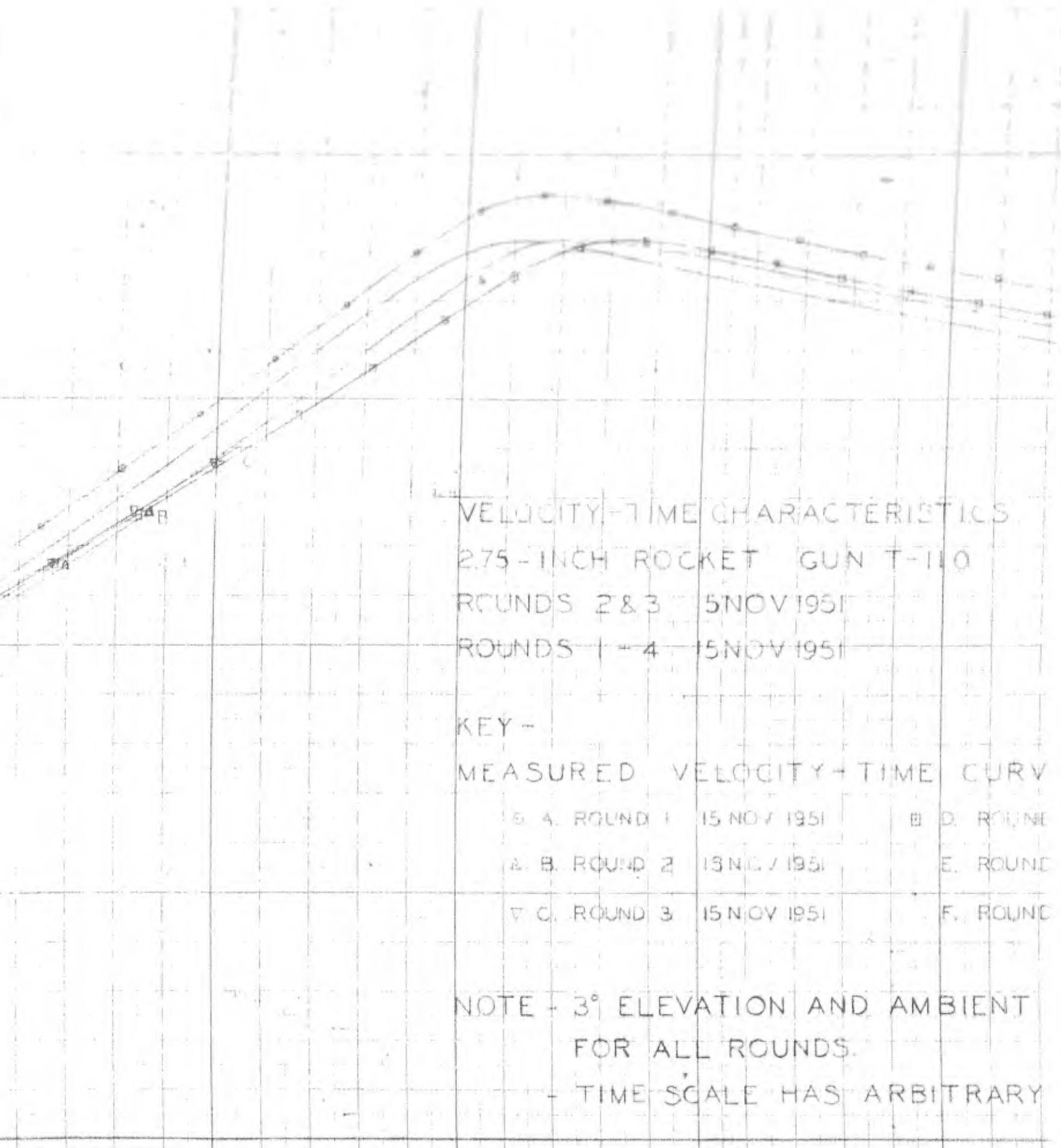
Time Seconds	Velocity Ft/Sec.
.0291	1300
.0845	1435
.1345	1615
.1794	1736
.2217	1846
.2615	1954
.2992	2059
.3350	2162
.2692	2264
.4019	2365
.4332	2465
.4633	2565
.4922	2663
.5201	2753
.5473	2814
.5742	2822
.6011	2801
.6282	2776
.6555	2750
.6832	2723
.7111	2696
.7392	2669
.7677	2642
.7965	2607
.8256	2589
.8549	2562
.8846	2532
.9148	2477
.9455	2457
.9787	2122
.0504	Distance Reference (73.5 Feet from Muzzle)

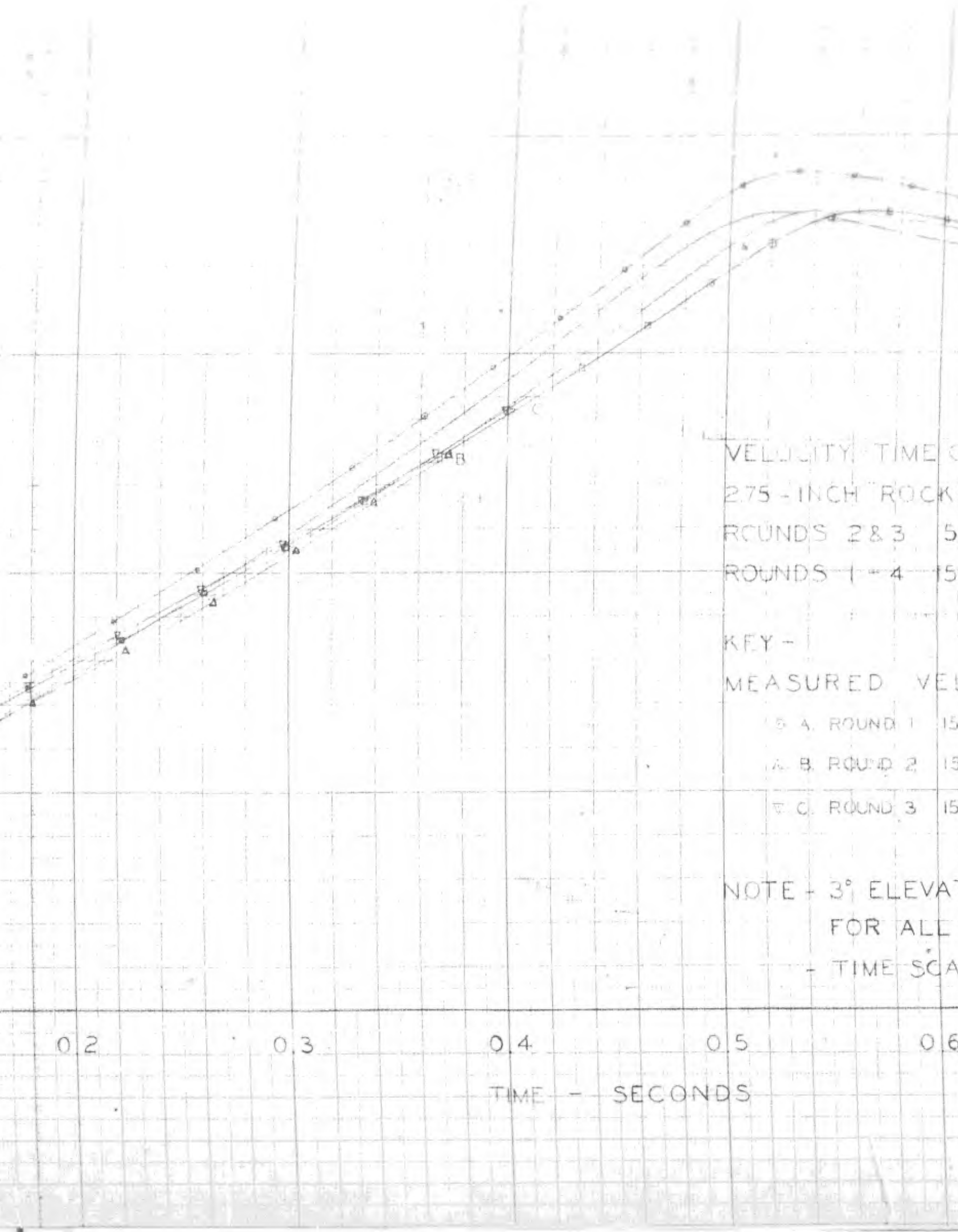
VELOCITY - FEET PER SECOND

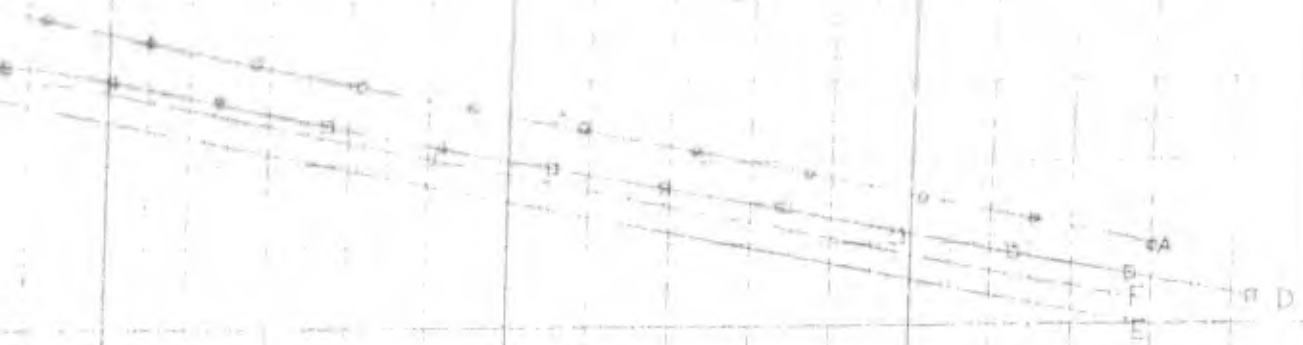
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000

0
0.1
0.2
0.3

1


A
B
VELOCITY-TIME CHARACTERISTICS
2.75-INCH ROCKET GUN T-110
ROUNDS 2&3 5NOV1951
ROUNDS 1-4 15NOV1951
KEY-
MEASURED VELOCITY-TIME CURV
A. ROUND 1 15 NOV 1951
B. ROUND 2 15 NOV 1951
C. ROUND 3 15 NOV 1951
D. ROUNE
E. ROUNE
F. ROUNE
NOTE - 3° ELEVATION AND AMBIENT
FOR ALL ROUNDS.
- TIME SCALE HAS ARBITRARY
0.4
0.5
0.6
0.7
TIME - SECONDS
CO
SE


VELOCITY - TIME C
2.75 - INCH ROCK
ROUNDS 2&3 5
ROUNDS 1 - 4 15
KEY -
MEASURED VE
A. ROUND 1 15
B. ROUND 2 15
C. ROUND 3 15
NOTE - 3° ELEVAT
FOR ALL
- TIME SCA
0.2
0.3
0.4
0.5
0.6
TIME - SECONDS



TIME CHARACTERISTICS

ROCKET GUN T-10

3 5NOV 1951

4 15NOV 1951

VELOCITY - TIME CURVES:

1	15 NOV 1951	D	ROUND 4	15 NOV 1951
2	15 NOV 1951	E	ROUND 2	5 NOV 1951
3	15 NOV 1951	F	ROUND 3	5 NOV 1951

2

LEVATION AND AMBIENT TEMPERATURE

ALL ROUNDS

SCALE HAS ARBITRARY ORIGIN

06 07 08 09

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FIGURE 15

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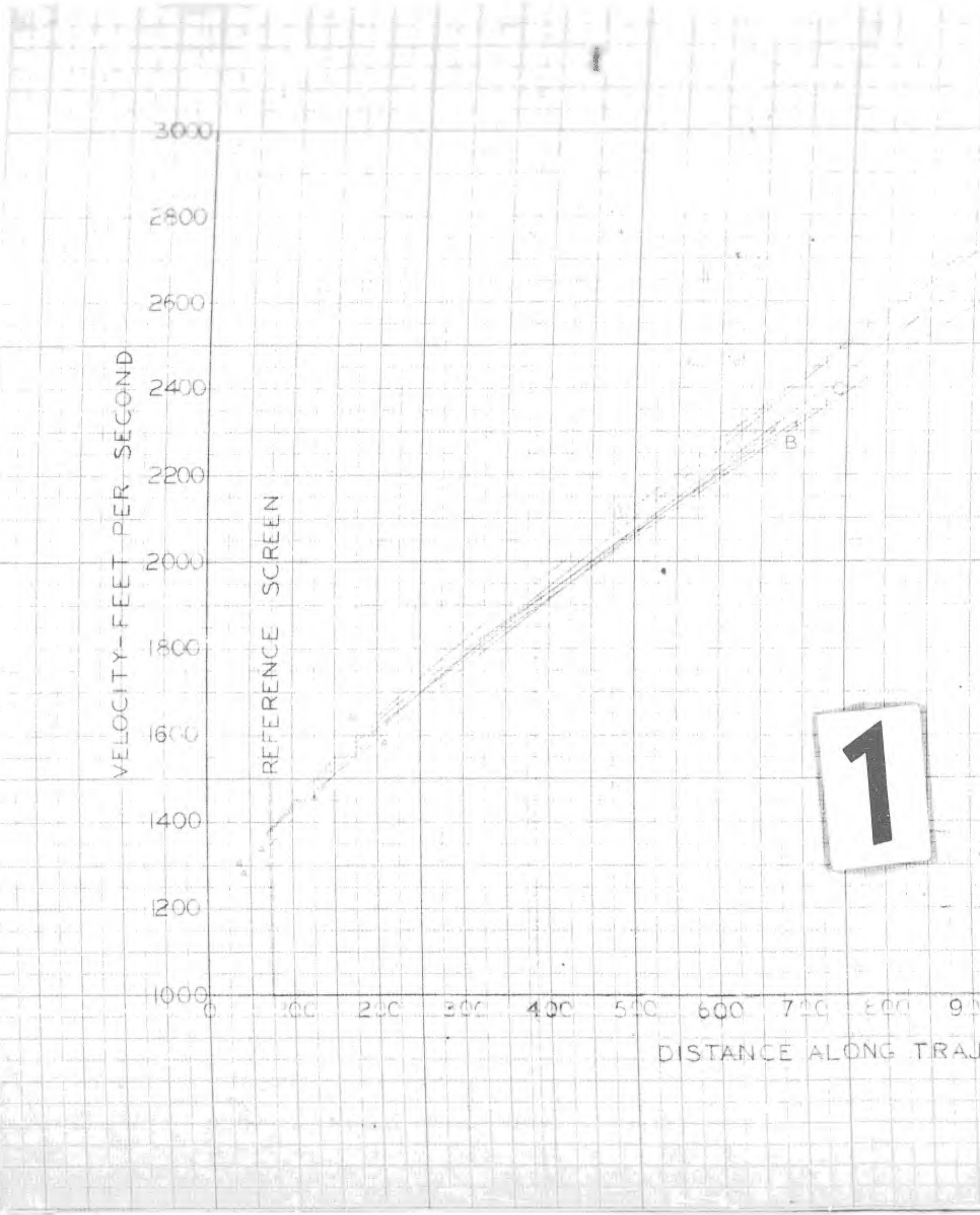
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
VELOCITY-FEET PER SECOND
REFERENCE SCREEN
B
1
0
DISTANCE ALONG TRAJ

VELOCITY DISTANCE CHARACTERISTICS

2.75 INCH ROCKET GUN T-11C

ROUNDS 2 & 3 5 NOV 1951

ROUNDS 1-4 15 NOV 1951

KEY -

DERIVED CURVES FROM VELOCITY-TIME CURVES:

A. ROUND 1 15 NOV 1951 D. ROUND 4 15 NOV 1951

B. ROUND 2 15 NOV 1951 E ROUND 2 5 NOV 1951

C. ROUND 3 15 NOV 1951 F ROUND 3 5 NOV 1951

Δ AVERAGE DATA FROM LUMILINE AND MICROPHONE SCREENS

NOTE - 3° ELEVATION AND AMBIENT TEMPERATURE FOR ALL ROUNDS.

9.0 1000 1100 1200 1300 1400 1500 1600 1700 1800 1

TRAJECTORY FROM MUZZLE - FEET

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B

E[illegible]Y DIST-NCE CHARACTERISTICS

2.75 INCH ROCKET GUN T-[illegible]

ROUNDS 2 & 3 15 NOV 1951

ROUNDS 1-4 15 NOV 1951

KEY

DERIVED CURVES FROM VELOCITY-TIME CURVES

A ROUND 1 15 NOV 1951 . D ROUND

B ROUND 2 15 NOV 1951 . E ROUND

C ROUND 3 15 NOV 1951 . F ROUND

Δ AVERAGE DATA FROM LUMILINE AND MICR

NOTE - 3° ELEVATION AND AMBIENT T

FOR ALL ROUNDS.

500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600

DISTANCE ALONG TRAJECTORY FROM MUZZLE - FEET

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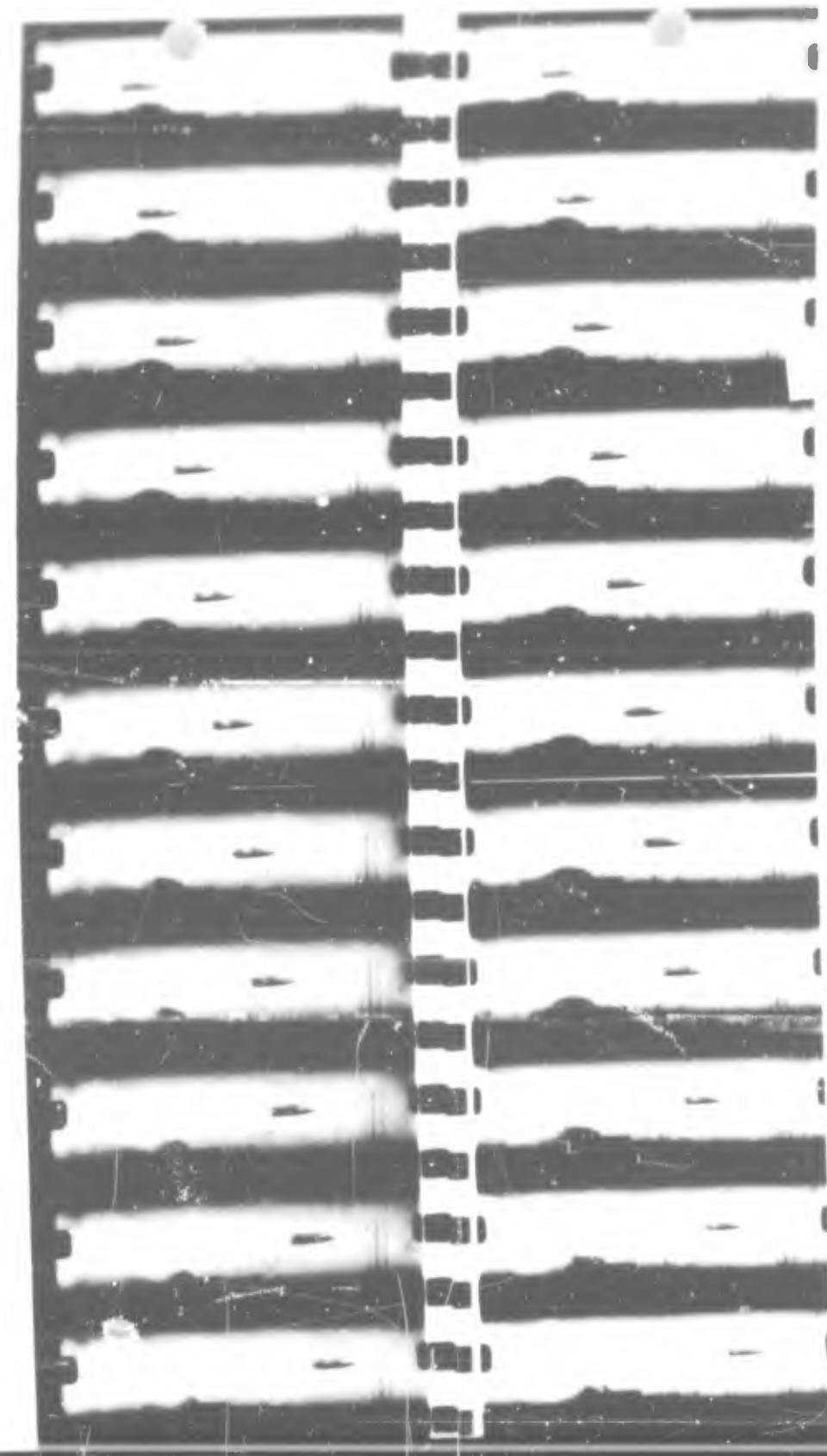
SECURIT

FIGURE 16



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NP9 48478

High speed photographs of T132 rockets in flight at 20' from muzzle, taken with Fastax Camera at 3200 frames/seconds.

Figure 17

NP9 48479
Ballistic Synchro Photograph of T132 Rocket in flight 25' from muzzle.
Figure 13

NP9 48480
View showing staking of gas seal ring in case using a special tool. Manufactured by Naval Proving Ground.

Figure 19

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NP9 48481
View of staking tool manufactured by Naval Proving Ground for staking 2.75 gas sealing rings.
Figure 20

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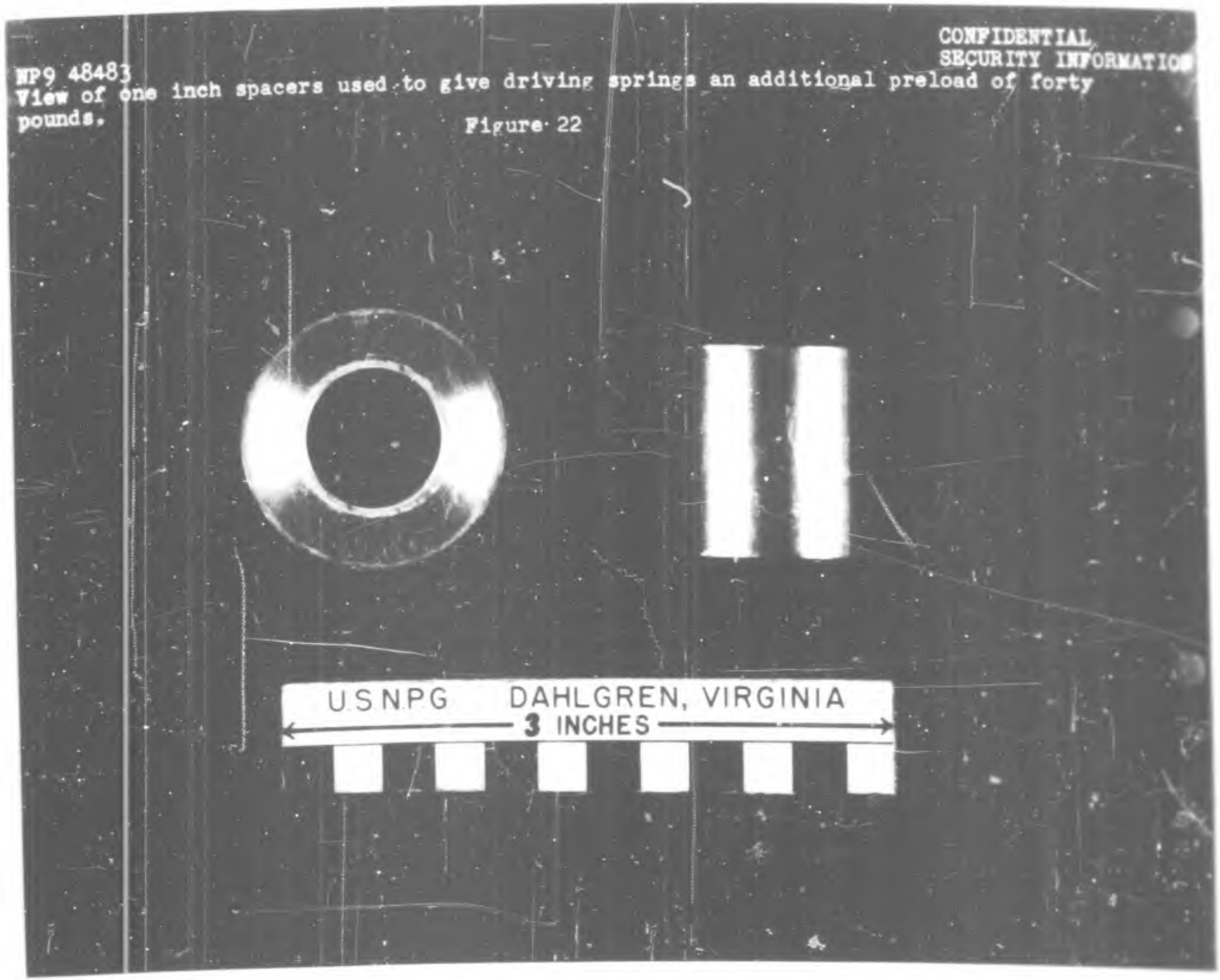
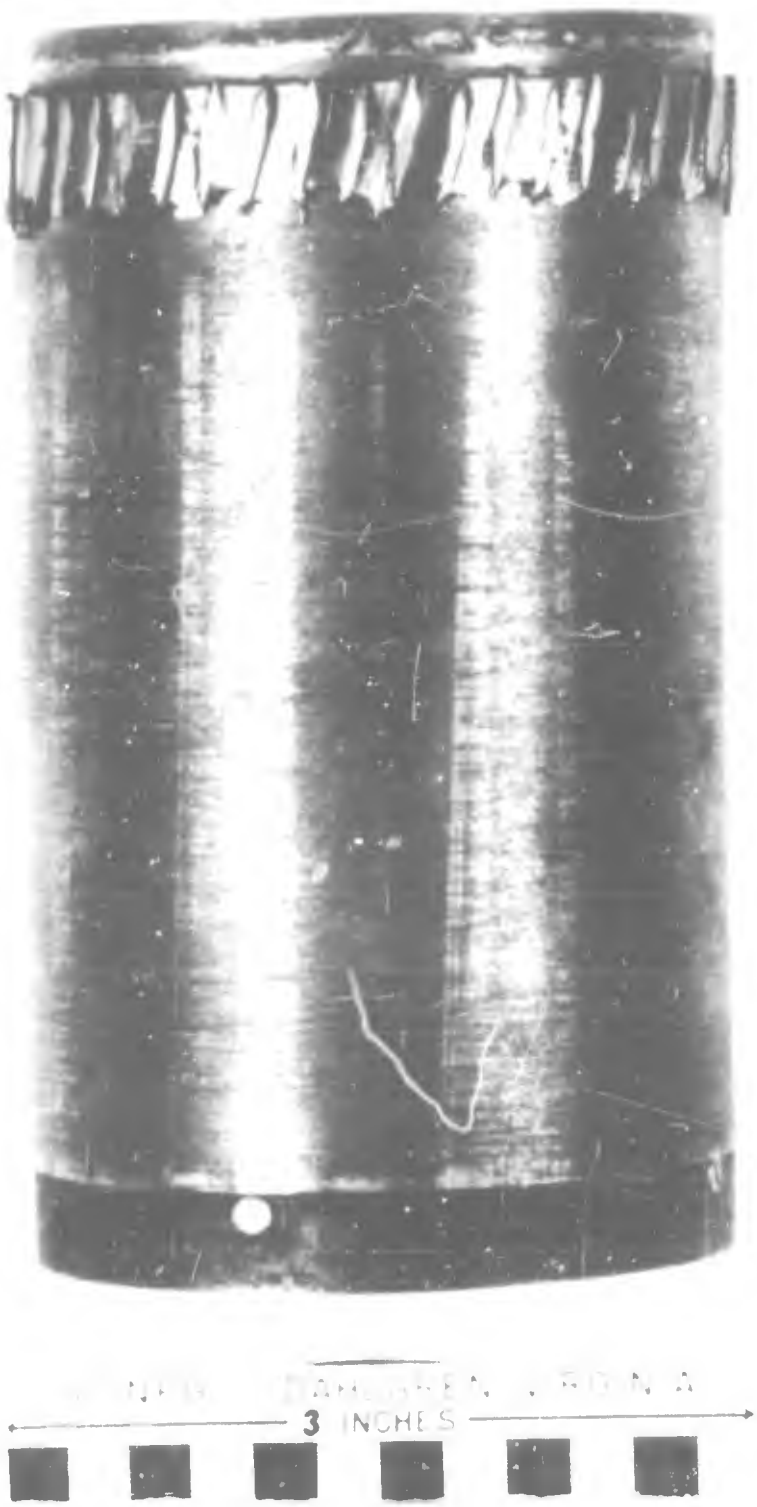
NP9 48482
View of gas sealing ring, part of which was carried away on firing.
Figure 21

NP9 48483
View of one inch spacers used to give driving springs an additional preload of forty pounds.

Figure 22





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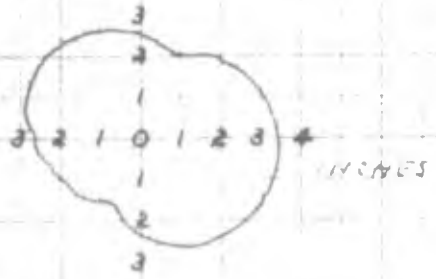
NP9 48484
View showing "X" engraving on rotating band of a T217 round which had been forced through the barrel.

Figure 23

NP9 48485
View of 1/4" Beaverboard Pattern at which 8 T217 rounds have been fired (3 single shots and a 5 round burst) from 1000". A T217 slug is shown for comparison.
Figure 24

Test of T110E2-B Rocket Launcher

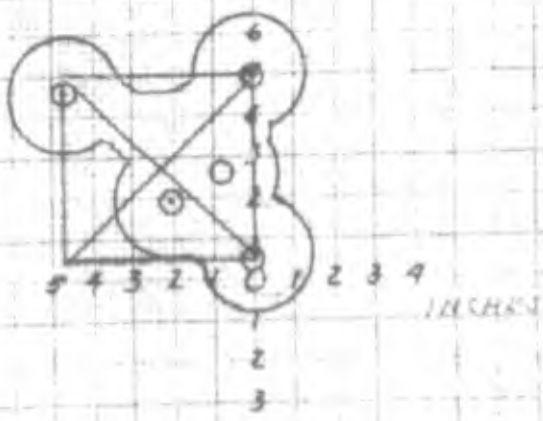


Date: 30 August 1951
2 Single Rounds
1 2 Round Burst
1 3 Round Burst
Type of Ammo. -(Slugs) T-217
Target 1000 Inches From Muzzle
Target, .25 Inch Beaver Board
Boresight at Intersection of
X and Y Axis

XA = 3.25 Mils
YA = 1.25 Mils

FIGURE 25

Test of T110E2-B Rocket Launcher



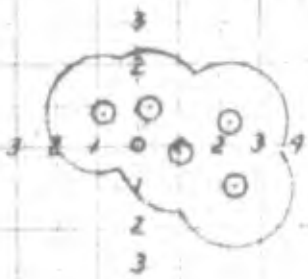
Date: 27 September 1951
5 Round Burst
Target 1000 Inch From Target
Target, .25 Inch Beaver Board
Boresight is at Intersection
of X and Y Axis
Type of Ammo. T-132

XA = 4.97 Mils
YA = 5.66 Mils
XB = 2.2 Mils
YB = 2.6 Mils

[redacted]

FIGURE 16

Test of T110E2-B Rocket Launcher



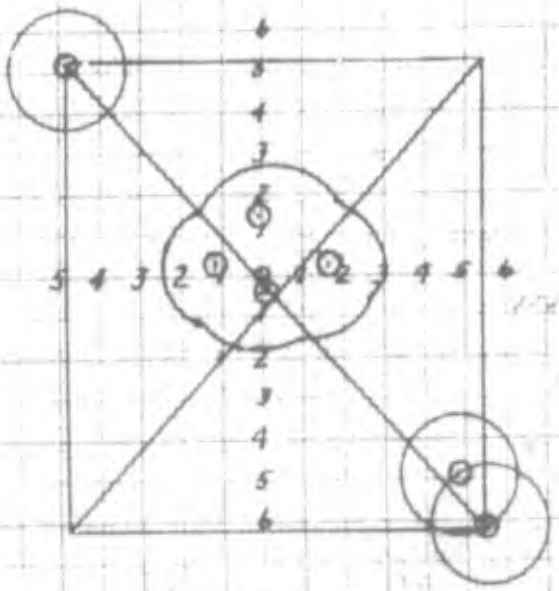
Date: 27 September 1951
2 Single Rounds
3 Round Burst
Target 1000 Inches From Muzzle
Target, .25 Inch Beaver Board
Boresight is at Intersection
of X and Y Axis
Type of Ammo. T-152

XA = 3.00 Mils
YA = 2.05 Mils

[redacted]

FIGURE 27

Test of T110E2-B Rocket Launcher

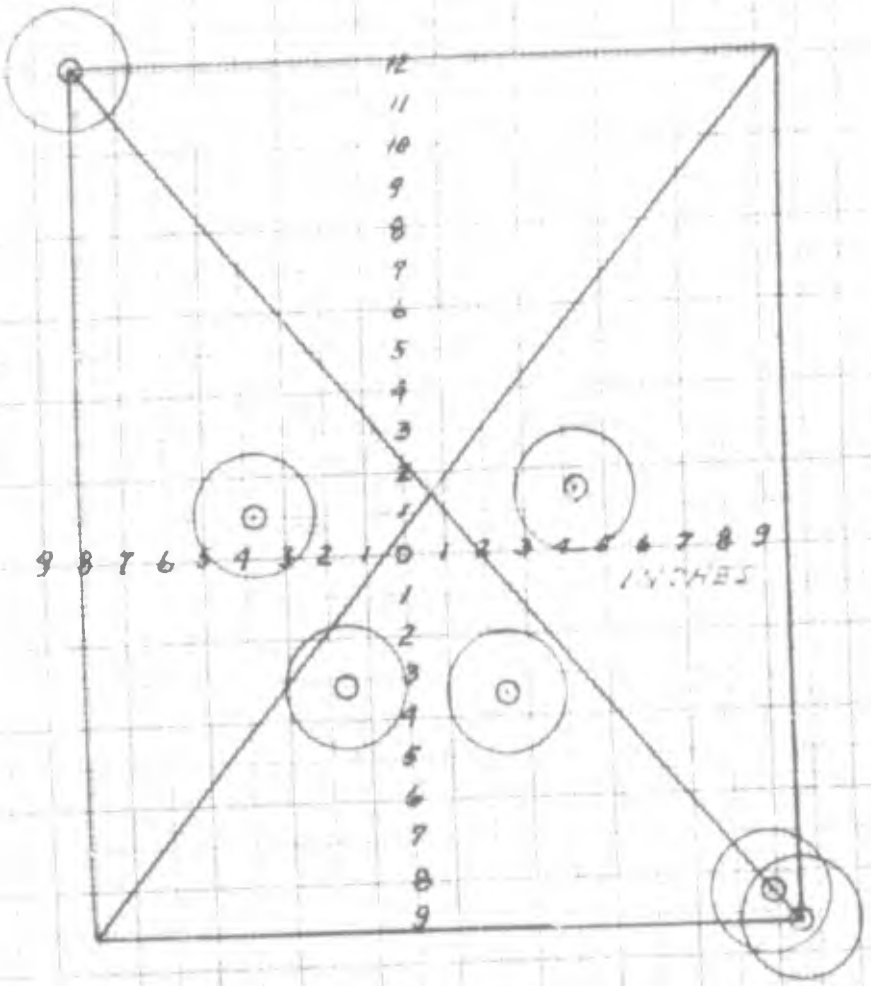


Date: 12 October 1951
2 Single Rounds
5 Round Burst
Target 1000 Inches
From Muzzle of Gun
Target, .25 Inch Beaver Board
Bore Sight is at Intersection
of X and Y Axis
Type of Ammo. T-132

XA = 10.25 Mils
YA = 11.38 Mils
XB = 4.50 Mils
YB = 7.56 Mils

FIGURE 28

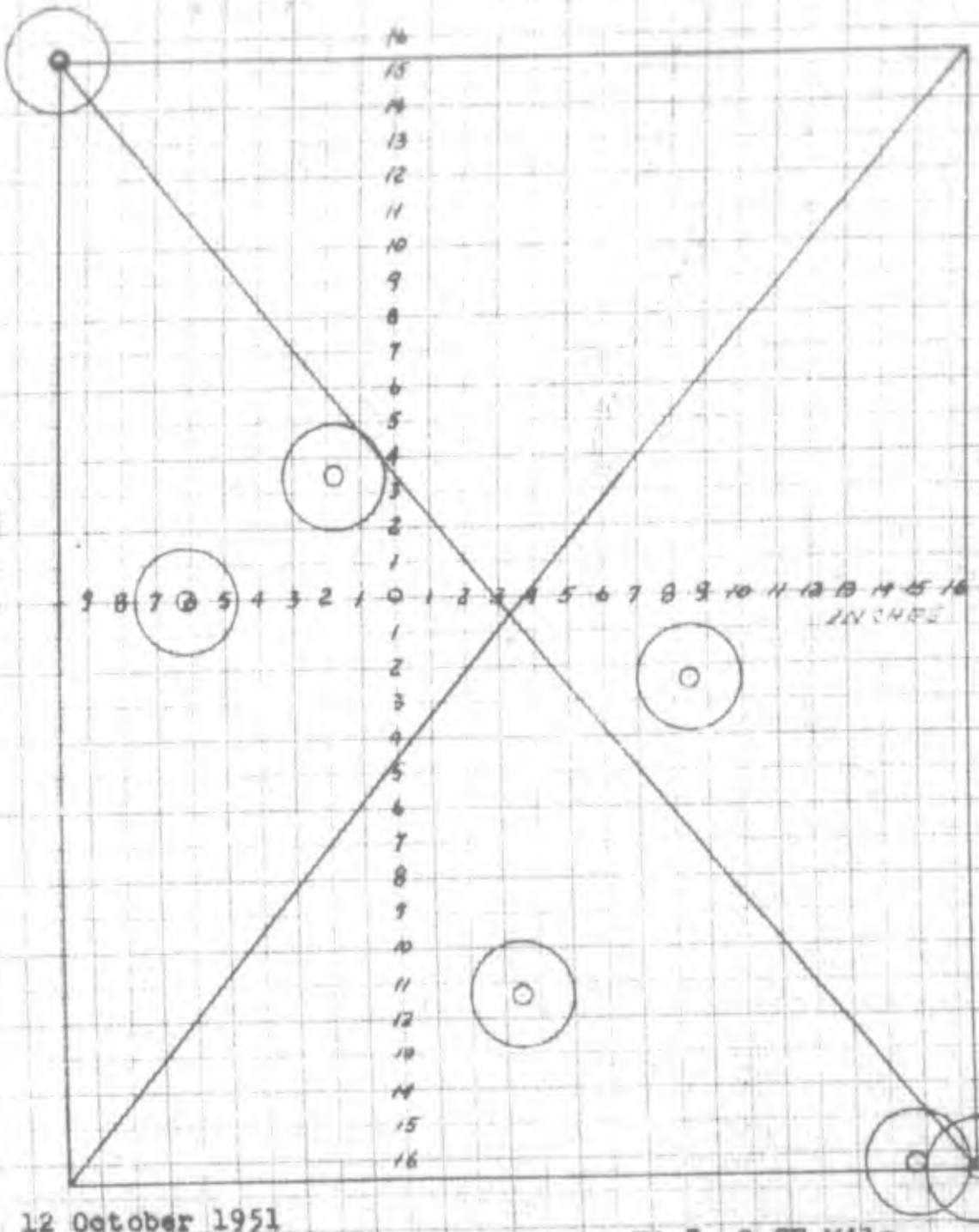
Test of T110E2-B Rocket Launcher



Date: 12 October 1951
2 Single Rounds
5 Round Burst
Target 2000 Inches From Muzzle
Target, .25 Inch Beaver Board
Boresight is at Intersection
of X and Y Axis
Type of Ammo. T-132

XA = 9.32 Mils
YA = 10.69 Mils
XB = .05 Mils
YB = .7 Mils

Test of T110E2-B Rocket Launcher



Date: 12 October 1951
2 Single Rounds
5 Round Burst
Target 3000 Inches
From Muzzle of Gun
Target .25 Inch Beaver Board
Boresight is at Intersection
of X and Y Axis Type of Ammo. T-132

XA = 9.77 Mils
YA = 10.31 Mils
XB = 1.1 Mils
YB = .07 Mils

FIGURE 30

NP9 48486
View of piston, washers and gauge fabricated by the Naval Proving Ground to test used cartridge cases hydrostatically at 7500 p.s.i.
Figure 31

NP9 48487
View showing Naval Proving Ground cartridge case tester in use.
Figure 32

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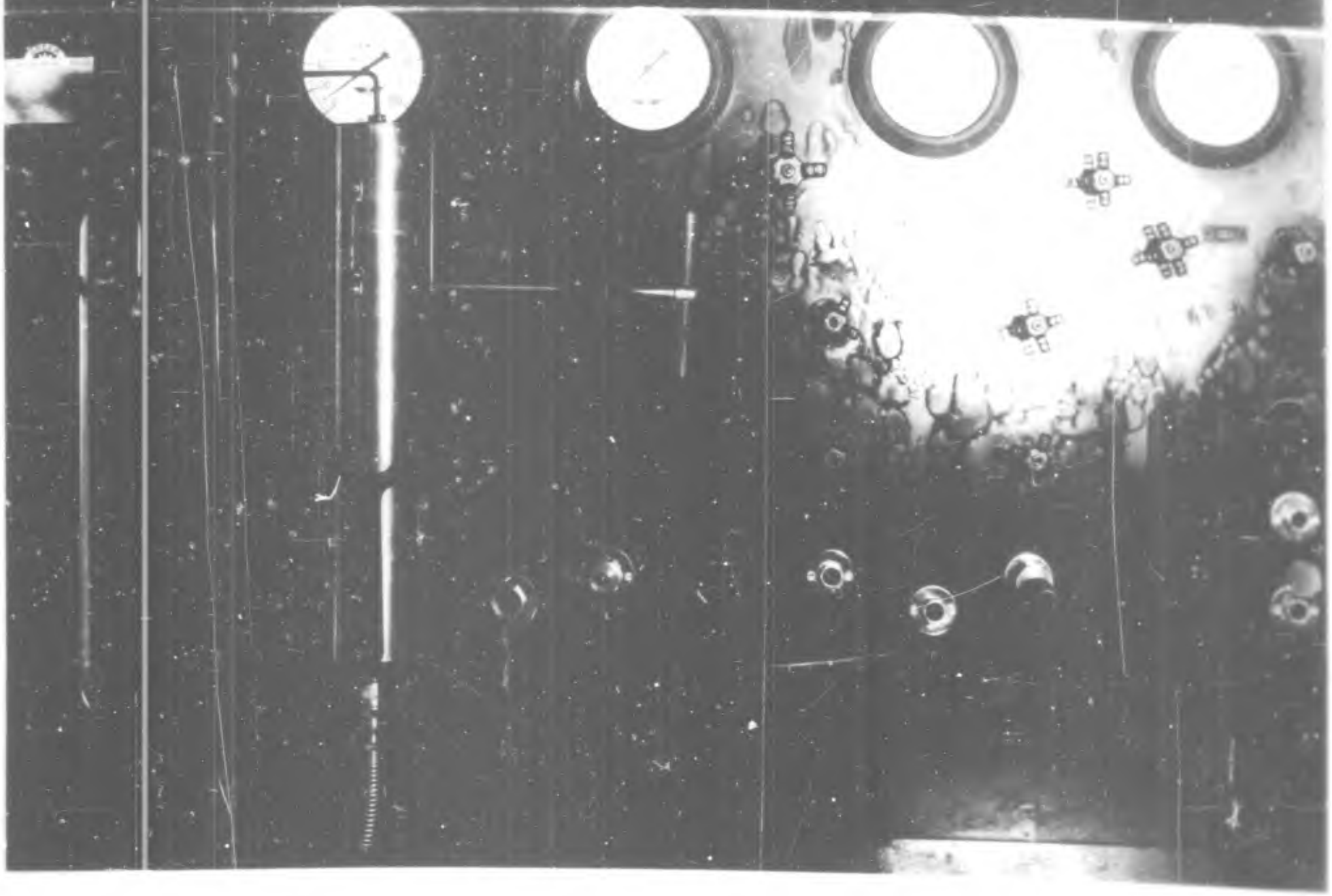

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NP9 48488
View of enclosed type cartridge case tester manufactured by the Naval Gun Factory.

Figure 33

NP9 48489
View showing failure of T110 driving spring rods with threaded portion silver soldered to the rods.

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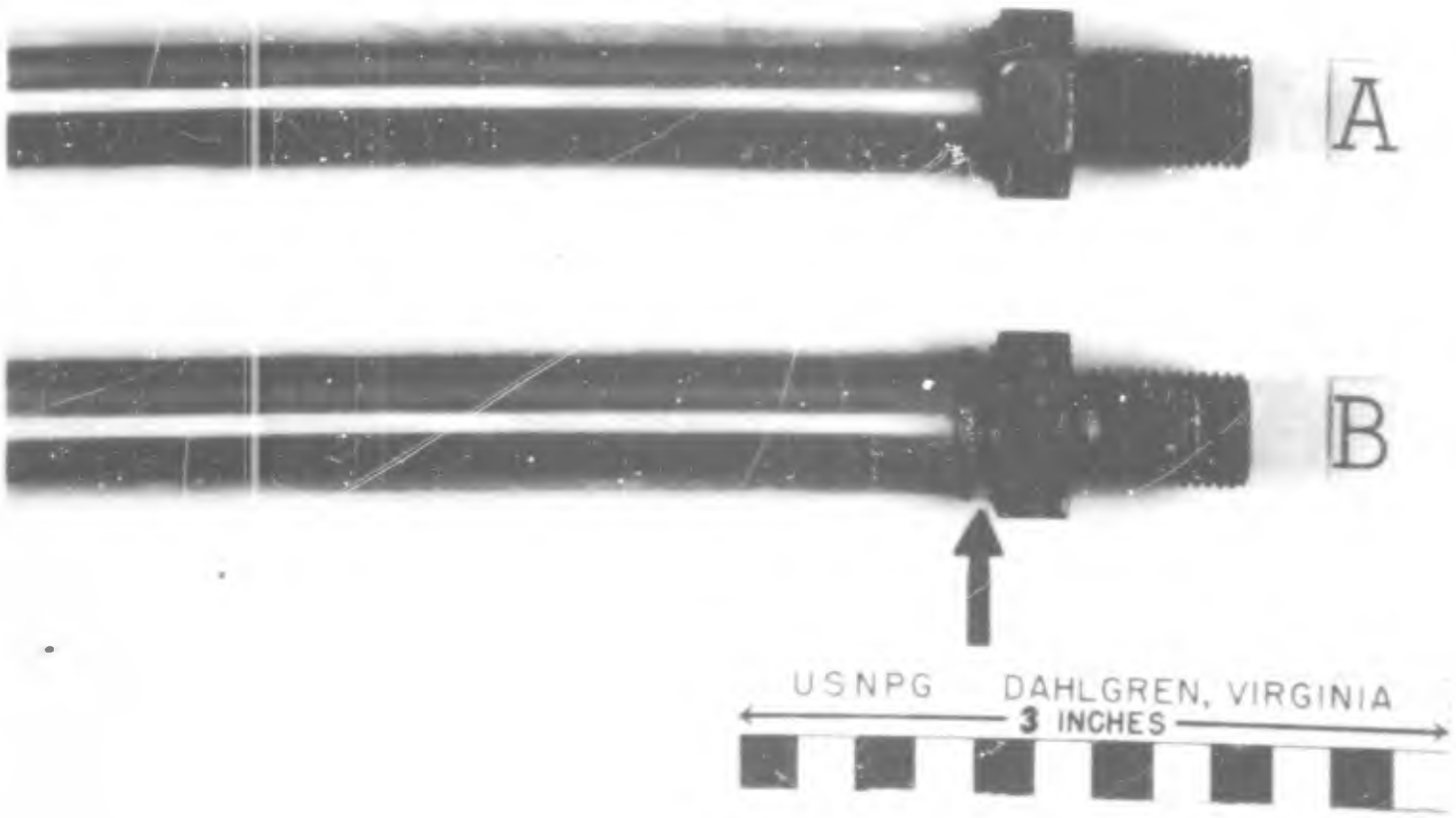
Figure 34



NP9 48490 CONFIDENTIAL
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View of Naval Proving Ground designed and manufactured replacement parts (a) One piece cam following roller and shaft, (b) Teflon firing pin insulator.

Figure 35

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