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# DEVELOPMENT AND TEST OF NYLON ROTATING BAND FOR 20MM HIGH VELOCITY PROJECTILE

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Rotating Band

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Date 10 March 1955

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U. S. Naval Proving Ground
Dahlgren, Virginia

# Development and Test of Nylon Rotating Band for 20mm High Velocity Projectile

by

R. B. Butler
Terminal Ballistics Department

NPG REPORT NO. 1342
NAVORD REPORT NO. 1339

Task Assignment No.
NPG-B-3b-225-1-54

10 March 1955

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D. Accuracy Data (Tables 5-7)
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H. Distribution

## ABSTRACT

Previously reported work on the development of a nylon rotating band for the 20mm aircraft gun Mk 12 had shown that the band as developed imparted full spin to the projectile, obturated satisfactorily, and did not fringe noticeably or produce unacceptable yaw, in slow fire at muzzle velocities up to 3500 ft/sec and at temperatures from -65° to 160°F. On the basis of a relatively small amount of firing, the band appeared to be completely retained in flight even at the temperature extremes. This report continues the account of the development work on this band, including additional extreme temperature firing, firing for ballistic accuracy, and rapid-fire tests.

The extreme temperature firing indicated that a band design and a method of molding have been achieved which produce a band that is retained in flight at all firing conditions.

The rapid fire results showed that very satisfactory performance of the band is obtained even in a very hot gun. In chromium-plated barrels the nylon bands produce a spectacular increase in gun life. One barrel has been fired for over 2400 rounds on a severe schedule with practically no wear, while a similar barrel fired on the same schedule with gilding-metal bands was worn out after 1000 rounds. Unplated barrels also show an increase in life with nylon bands, but not to a similar extent. No evidence of band loss in rapid fire has been observed. Yaw performance in rapid fire has been in some cases inferior to that observed with gilding-metal bands, but none of these cases having occurred at less than 150 rounds of burst firing, they are not considered to be of importance in service use. The short-range dispersion obtained in rapid fire is generally comparable with that obtained with gilding-metal bands.

In accuracy firing (slow fire in a Mann barrel) acceptable dispersion at long range is obtained.

A report bearing on the storage life of nylon bands is in preparation.

## FOREWORD

The work described in this report was conducted by authority of reference (a) under Task Assignment NPG-B-3b-225-1-54, during the period 1 February 1953 to 1 May 1954. This is the twentieth partial report submitted under this task assignment, "Projectile Rotating Bands and Components".

The nylon bands injection molded on the projectiles and fired in these tests were produced by Nylon Molded Products Corporation, Garrettsville, Ohio, (commercial molders) or by the Naval Ordnance Laboratory. The Naval Ordnance Laboratory molding was done under the technical supervision of S. Prosen of the Plastics Division. Chromium plating of Mk 11 gun barrels was accomplished at the National Bureau of Standards, under the technical supervision of J. Young.

The tests upon which this report is based were conducted by:

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## INTRODUCTION

Reference (b) reported the original design and development work on a nylon rotating band for the 20mm Mk 12 aircraft gun, as well as the results of the evaluation in slow fire of relatively small samples of band models for spin, obturation, fringing, yaw near the muzzle, degree of band retention in flight, and performance at extreme temperatures. It was found that the bands developed imparted full spin to the projectile, obturated satisfactorily, and did not fringe noticeably or produce unacceptable yaw, in slow fire from a Mk 12 gun at muzzle velocities up to 3500 ft/sec and at temperatures from -65° to 160°F. On the basis of a relatively small amount of firing, the bands appeared to be completely retained in flight even at the temperature extremes.

This report continues the account of the development work on this band, including more extreme temperature firing, accuracy firings, and rapid-fire tests.

## PROCEDURE AND RESULTS

### Recovery Firing to Determine Band Retention

The bands under evaluation in this phase were of two NOL lots, previous tests of which, as well as manufacturing details, were reported in reference (b). Briefly, the two lots were the same except that Lot 4A was molded at a mold temperature of 190°F and a projectile temperature of 160°F, while for Lot 4B the mold was at 60°F and the projectile at 75°F. Both lots were of 0.3 long bands, molded on Type 2 Mod 2 projectiles, as shown in Figure 1, left.

Projectiles from each lot were subjected to temperature conditioning as follows:

| No. of Rounds | | |
|---|---|---|
| Lot 4A | Lot 4B | Conditioning |
| 10 | 10 | Dry at 160°F for 7 days, ambient for 24 hours, -65°F for 4 hours, fired at -65°F. |
| 10 | 10 | -65°F for 4 hours, +160°F (dry) for 4 hours, ambient for 16 hours, this cycle repeated 7 times. Projectiles brought to -65°F for 4 hours and fired. |
| 7 | 10 | 160°F and 100% relative humidity for 7 days, fired at 160°F. |

The projectiles were fired for recovery from a new Mk 11 Mod 2 barrel. Microflash photographs (Figure 2 shows typical examples) were taken of all rounds in flight at 100 feet from the muzzle and spin was determined for some of the rounds on each test. The results are shown in detail in Tables 1, 2, and 3 (Appendix B). Except for band retention in the case of the lot 4A projectiles fired at -65°F, both lots performed satisfactorily in every regard at both high and low temperature. Out of 20 projectiles from lot 4A fired at -65°F, six showed some band loss. Results of the initial test of these lots (reported in reference (b)) also indicated that lot 4A bands would not be uniformly retained when fired at -65°F. Counting both tests, a total of 83 rounds have been fired at high, low and ambient temperatures. At -65°F lot 4A showed incomplete band retention on 8 out of 25 projectiles fired. Eight projectiles at ambient and seven projectiles at +160°F showed no loss. On the other hand no loss for lot B was shown for 25 projectiles fired at -65°F, 8 at ambient and 10 at +160°F.

Neither lot showed any detectable deterioration in performance after a week's temperature cycling, nor after a week's exposure to 160°F and 100% humidity, which produces a soft band by reason of temperature softening and softening by moisture absorption. It is interesting to observe, in view of the fears which have sometimes been expressed of rapid and excessive dimensional changes of FM 10001 nylon, either by thermal expansion or moisture absorption, that in a week's exposure to such extreme conditions these latter bands increased in diameter by about 0".004, which is not enough to cause any interference with the gun chamber.

In view of the better band retention of Lot 4B, all nylon-banded 20mm projectiles subsequently procured, except a few for mold temperature studies, have been molded under similar conditions of mold and projectile temperature.

Development of Special Crimp

An attempt was now made to fire a powder charge determination, preparatory to conducting standard rapid-fire tests to determine gun life and projectile performance with 0".3 long nylon bands. In the 15-round bursts, which are a part of the charge determination, and which were the first bursts fired with 20mm nylon-banded projectiles, numerous small pieces of nylon were observed to be emitted from the breech of the gun.

This caused alarm, and the phenomenon was investigated by making up 15-round belts of standard ammunition with all rounds live except the last, which had an inert powder charge and a nylon band. When the belt was burst-fired, the nylon-banded round came to rest in the chamber, after going through the normal loading cycle, and was extracted and examined. It was found that the nylon bands were chipping and losing pieces by reason of the forward motion of the case over the projectile upon impact of the belt mechanism on the base of the case. This forward motion is not a new phenomenon since it is commonly observed with

standard gilding-metal-banded rounds, but while the gilding-metal band is sufficiently strong to act as a stop for the case without damage to itself, the nylon band is not. One of the rounds loaded in the fashion described is shown after extraction in Figure 3, left. High-speed motion pictures of the loading process confirmed that the band damage was occurring in this manner.

It was thus necessary either to improve the strength of the crimp, or to provide a stop other than the band for the forward motion of the case. Several attempts to improve the crimp strength were made, involving a deeper crimping groove, a double groove, or a more favorably shaped groove, but none of these was fully successful. Crimping the case with its forward edge as far back of the band as practicable, so as to permit a maximum forward motion before the band was contacted, was also unsuccessful. The problem was finally solved by cutting a notch, between the standard crimping groove and the after edge of the band, to hold the mouth of the case and prevent its touching the band. The mouth of the case is forced into this notch by a special jig during the operation of assembling projectile and case. The round is then rubber-crimped in the standard manner. This procedure, as compared with the standard assembly, involves no additional trouble or expense other than the cost of the special jig, and has been in use on all nylon-banded rounds fired subsequent to its development, with only a few exceptions when slow fire tests were conducted. Figure 4 shows the contour of the notch, and Figure 3, right, shows a round with the modified crimping groove after loading and extraction.

The deformation of the case mouth into the notch has caused no appreciable case damage on firing in slow fire or in bursts.

Abandonment of the 0.2 Band

About the same time, burst firing in a standard-twist unplated barrel was attempted with bands 0.2 long, earlier work on which has been described in reference (b). Some doubts had previously been felt about the adequacy of this design, which were justified when on the burst firing the

majority failed badly to impart the required spin. In view of this result, the 0".2 band was abandoned, and no further work on it attempted. All projectiles fired subsequently have been of the Type 2 Mod 2 design, with bands 0".3 long and 0".828 in diameter (Figure 5), with the exception of some projectiles, as described later, with variations in diameter.

Determination of Pressure-Time Data

Pressure time data were obtained for nylon- and gilding-metal-banded projectiles fired from a Mann barrel fitted with a piezoelectric pressure gauge. Two different nylon bands were employed in this work, both 0".3 long, one 0".828 and the other 0".834 in diameter. The detailed results are given in Appendix C.

In brief, the results indicated little difference among the three types of projectile, except for a tendency for the nylon-banded projectiles to give a peak pressure one to two tons lower for about the same muzzle velocity and muzzle pressure. This is in line with what has been observed for nylon bands in other calibers, and is attributed to the lower engraving force and diminished bore friction characteristic of nylon.

Accuracy Tests

Three accuracy tests were fired from Mann barrels to determine the performance of the nylon-banded projectiles. In the first of these, six ten-round groups were fired at a vertical target 600' from the gun. One group consisted of reference rounds (standard gilding-metal-banded Mk 11 Mod 0 projectiles); one of Type 2 Mod 2 projectiles; one of Type 2 Mod 2 projectiles crimped in the case with the same crimp as the standard gilding-metal-banded projectiles, that is, without the additional crimping notch used with the other nylon-banded projectiles; one of Type 2 Mod 2 projectiles at -65°F; and one each of Type 2 projectiles at band diameters of 0".823 and 0".834. The projectiles with 0".834 bands were not crimped at all, since it was discovered too late that they could not be crimped without modifying the equipment.

In the second test, 25 or 26-round groups were fired at 1500 yards range, comparing standard projectiles, Type 2 Mod 2 projectiles, and Type 2 projectiles with band diameter of 0".834 and 0".836 diameters.

In the third test, ten-round groups were fired at 600' range, comparing reference projectiles, Type 2 Mod 2 projectiles, and Type 2 Mod 6 projectiles, the latter being identical to the Type 2 Mod 2 projectiles except for the provision of an after bourrelet behind the band of 0".784 diameter (an increase in diameter of 0".014).

The detailed results are given in Appendix D, and are summarized in the following table, which gives for each group the horizontal and vertical standard deviations in mils, and the RMS average of these two quantities. If horizontal and vertical dispersions are equal, the RMS average gives the best estimate of a figure of merit for the accuracy of the round.

Standard Deviations (Mils) of Points of Impact of
Nylon-banded 20mm Mk 11-0 Projectiles Fired from Accuracy Barrels

| Projectile Type | Horizontal | Vertical | RMS Average |
|---|---|---|---|
| Test of 10-round groups at 600' range on 7 August 1953 | | | |
| Standard | 0.40 | 0.20 | 0.31 |
| T2-2 | 0.50 | 0.79 | 0.66 |
| T2-2 (Service Crimp) | 0.87 | 0.74 | 0.80 |
| T2-2 (at -65°F) | 0.52 | 0.35 | 0.44 |
| T2 at 0".823 diameter | 0.54 | 0.44 | 0.49 |
| T2 at 0".834 diameter (Not crimped) | 0.36 | 0.53 | 0.46 |
| Test of 25-26-round groups at 1500 yd. range on 22-26 August 1953 | | | |
| Standard | 0.41 | 0.40 | 0.40 |
| T2-2 | 0.62 | 0.90 | 0.77 |
| T2 at 0".834 diameter | 0.57 | 0.63 | 0.60 |
| T2 at 0".836 diameter | 0.60 | 0.67 | 0.64 |
| Test of 10-round groups at 600' range on 11 March 1954 | | | |
| Standard | 0.34 | 0.21 | 0.28 |
| T2-2 | 0.36 | 0.45 | 0.41 |
| T2-6 | 0.77 | 0.66 | 0.72 |

These results show a general increase in standard deviation for nylon over gilding metal. For the Type 2 Mod 2 projectile this increase is by a factor of 1.5 to 2. Firing the nylon band cold (-65°F) or at large or small diameter appears to improve the accuracy somewhat, although it does not bring it up to the level of the gilding metal band. There was initially considerable doubt whether the greater dispersion with nylon was to be attributed to a less firm centering of the projectile in the gun, particularly at exit, or to a small amount of fringing. The diminished dispersion with cold bands and with bands of altered diameters could support either hypothesis. In an effort to distinguish, the Type 2 Mod 6 projectiles were made up and fired in the third test. That this projectile, with a larger body diameter aft of the band, showed greater dispersion is considered to support the idea that there is some degree of fringing which causes the increased dispersion.

The actual amount of dispersion for the nylon-banded projectile is not great, and it is considered that in service the increase over the metal-banded projectile would be completely masked by dispersion attributable to the gun, the fire control system, and the aircraft.

Rapid-Fire Tests

The standard firing cycle for rapid-fire barrel life tests with the 20mm Mk 12 gun consists of twelve 50-round bursts (fired at a rate of about 1000 rounds per minute), with two minutes between bursts, and with complete cooling following the end of the cycle (600 rounds). In some cases, cold erosion checks are also fired. The criteria for end of life of the barrel, arrived at from experience with gilding-metal bands, are a 200 ft/sec loss in velocity averaged over a 50-round burst, or occurrence of yaw greater than 15° on 20% or more of the rounds in a burst, whichever occurs first.

In the rapid-fire tests, velocity, yaw, and dispersion are measured, and star-gauging of the barrel is conducted. Details of these measurements, as well as data on the ammunition components and assembly, will be found in Appendix E.

Retention of nylon bands in rapid-fire was judged either by a thorough search of the ground in front of the gun for band fragments, or by firing through a wire-screen enclosure 30" x 30" x 48' long and checking for the presence of band fragments after each burst. No nylon band fragments were found in any test.

All nylon bands used in the rapid-fire tests were molded by Nylon Molded Products Corporation, and while all were molded under the same conditions so far as these could be controlled, the projectiles will be identified by lot numbers. A lot is defined as a set of projectiles whose bands have been molded in one mold, on one machine, and in the same run.

The barrels employed were either standard Mk 11 Mod 2 barrels (unplated), or Mk 11 Mod 2 barrels modified at the Bureau of Standards by electropolishing and plating chamber and bore with 0".006 of hard chromium.

The detailed data obtained in all the rapid-fire tests are contained in Appendices F (plated barrels) and G (unplated barrels). For convenience, the velocity data and barrel erosion results are summarized graphically in Figures 6 to 11, Appendix A, and the yaw and dispersion data are summarized in the table on the following page.

The first barrel tested with nylon bands was No. EX-184, a plated barrel. On the first two erosion cycles in this barrel, although gun wear was negligible, velocity maintenance excellent, and dispersion acceptable, a large number of yawed rounds were encountered.

With nylon bands, the first round in each burst in a well-heated gun, being charged into the chamber and remaining there for ten or fifteen seconds before firing, usually shows a large yaw. This is to be attributed to band failure as a result of heating the band, and it is not considered entirely fair to count this round in applying the yaw criterion stated above. The effect is of little service importance, since it does not occur until 150-200 rounds have been fired.

## SUMMARY OF YAW AND DISPERSION DATA

| Barrel No. | Erosion Cycle | Band | Percentage of Rounds with Yaw in the Range 0-5° | 6-10° | 11-15° | Over 15° | Measured Rds. | Rds. in Cycle | Average Pattern Size for 50-round Burst (91' Muzzle Distance) (ins.) Horiz. | Vert. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | **Plated Barrels** | | | | | | | |
| EX-184 | 1 | Nylon Lot S2A | 40.6 | 16.2 | 18.2 | 24.9 | 598 | 598 | 22.4 | 23.6 |
| | 2 | Nylon Lot S2B | 43.5 | 18.0 | 21.1 | 17.4 | 596 | 596 | 20.8 | 20.7 |
| | 3 | Nylon Lot S9 | 80.8 | 13.5 | 4.7 | 1.0 | 598 | 613 | 17.4 | 17.5 |
| | 4 | Nylon Lot S10, S10M, S9 | 93.6 | 2.9 | 2.1 | 1.3 | 595 | 607 | 19.4 | 18.0 |
| 855108 | 1 | Nylon Lot S10M | 77.0 | 10.5 | 8.6 | 3.8 | 572 | 613 | 17.9 | 16.7 |
| 854254 | 1 | Nylon Lot S9 | 86.1 | 9.7 | 3.0 | 1.2 | 402 | 402 | 15.2 | 14.4 |
| EX-183 | 1 | Gilding Metal | 56.2 | 32.2 | 10.9 | .7 | 681 | 681 | 16.7 | 16.2 |
| | 2 | Gilding Metal | 57.8 | 26.9 | 12.8 | 2.5 | 483 | 496 | 14.4 | 15.5 |
| EX-182 | 1 | Gilding Metal | 40.6 | 24.5 | 31.9 | 3.0 | 470 | 615 | 15.3 | 15.2 |
| | 2 | Gilding Metal | 47.8 | 25.5 | 17.6 | 9.1 | 427 | 469 | 13.4 | 14.2 |
| | | | **Unplated Barrels** | | | | | | | |
| 854342 | 1 | Nylon Lot S2B | 75.1 | 14.1 | 6.1 | 4.7 | 594 | 599 | 17.1 | 16.8 |
| | 2 | Nylon Lot S9 | 67.0 | 9.5 | 9.5 | 14.0 | 399 | 407 | 16.6 | 14.9 |
| 856686 | 1 | Gilding Metal | 46.9 | 34.1 | 15.3 | 3.7 | 510 | 513 | 15.3 | 14.1 |
| 855119 | 1 | Gilding Metal | 76.2 | 15.7 | 7.2 | .8 | 235 | 436 | Not Taken | |

Omitting from the count the first round of each burst after the third, one finds that the bursts in the first cycle which failed the yaw criterion were the third through the eighth, and the tenth. In the second cycle, the fifth, sixth, tenth, eleventh, and twelfth bursts failed the yaw criterion. The failure to pass the conventional yaw criterion was not taken very seriously, since there appeared to be no very definite trend toward deterioration of performance, successive bursts in the same cycle passing or failing in quite an arbitrary way. (This is not the case for barrels fired with gilding-metal bands, where shortly after the first burst to fail on yaw, the accuracy of the gun declines precipitously.) Furthermore, the negligible amount of wear of the gun indicated no reason to believe that the barrel performance should be deteriorating.

It was accordingly decided to continue testing this barrel, and two more cycles were fired. As shown in Figures 6 and 9, in the summary table above, and in Appendix F, the results of these two cycles were completely satisfactory. After 2464 rounds, the barrel showed practically no wear, the velocity drop was negligible, and the yaw performance was somewhat better than expected with gilding-metal bands.

In the fourth cycle of this barrel, the bands fired in the first, fourth, and eighth bursts were of a diameter reduced to 0".823. This experiment was made for two reasons: (1) work in other gun calibers had indicated a possible improvement in range accuracy by reduction of band diameter, and (2) investigations of artificial aging of nylon had disclosed the possibility that under prolonged storage under very humid and hot conditions, nylon bands at 0".828 diameter might increase in size just enough to be troublesome in seating in the chamber of the gun. The 0".823 diameter bands showed no detectable difference in performance.

One more plated barrel has been fired for one cycle with 0".828 nylon bands, and a third has been fired for one cycle with 0".823 nylon bands. Both, as the data in Figures 7 and 10, in the summary table, and in Appendix F show, gave excellent performance, similar to that shown in the third and fourth cycles of the first barrel. Two plated

barrels have been fired to end of life with standard gilding-metal bands, for comparison. Both had a velocity life (to 200 ft/sec drop) of about 1000 rounds, and an accuracy life of about 1150 rounds (see Appendix F).

One unplated barrel has been fired to end of life with 0".828 diameter nylon bands, and two for comparison with standard gilding-metal bands. The results are given in detail in Appendix G, and are summarized as regards yaw and dispersion in the summary table above, and as regards velocity and barrel wear in Figures 8 and 11.

The unplated barrel with nylon bands began with excellent yaw performance, which declined suddenly on the last burst of the first cycle to an extent sufficient to fail the burst by the yaw criterion. This performance was checked by firing a second cycle, during which there was a rather similar decline at the eighth burst. The accuracy life of this barrel is therefore conservatively set at 550 rounds. The two comparison barrels indicated an end of velocity life at about 550 rounds, with the accuracy still acceptable.

Bore photographs of plated and unplated barrels having fired nylon or gilding-metal bands are shown in Figures 12 to 15, Appendix A. It is interesting to note in Figure 13, the photograph of the unplated barrel fired with nylon bands, the rather large wear of the driving edge producing a tapered top of the land. This type of wear does not produce very much effect on the star-gauge readings, but may well be expected to promote failure of the nylon band. The photograph of the plated barrel fired with nylon bands shows no such effect.

## DISCUSSION

It is gratifying that the problem of obtaining acceptable performance of nylon bands in a very hot gun presented no more difficulty than it did. Apparently the poor heat conductivity of the nylon, and the short time it remains in the barrel, prevent any appreciable heat softening of the material except in the case of the first round in a burst, as mentioned above.

The phenomenal increase in life observed with nylon bands in plated barrels is in line with results in other calibers. As a general rule, in plated guns the chromium prolongs the life of the gun essentially by the number of rounds it manages to stay intact. After the plating is breached, which occurs in the region of the origin, the gun wears at the same rate as an unplated gun. A nylon band, being considerably softer than a metal band, inflicts much less damage on the chromium in the process of engraving, and the chromium thus lasts for a number of rounds at present indeterminately large.

The reasons for the occurrence of numerous yawed rounds in two rapid-fire cycles with nylon bands, and their absence in four other cycles, is not understood at present, and must be investigated further. There appears to be some chance that this phenomenon is connected with the action of the gun and feeder, and that nylon is more sensitive to variations in such action than is gilding metal. Variations in ballistic conditions or in quality of nylon do not seem capable of yielding an explanation. At any rate, since the phenomenon does not occur in the first 100 or 150 rounds fired in a cycle, it may be of little consequence in service.

That the increased long-range dispersion observed with nylon bands in slow fire in a Mann barrel is not of serious consequence is supported by a comparison of the short-range dispersion patterns in rapid-fire given by nylon and gilding-metal bands, which are considerably closer together.

A comparison of the pattern sizes shown by the two band materials, from the summary table, indicates no appreciable difference, except for the two cycles which had the numerous yawed rounds. Inspection of the detailed tables in the Appendices shows that even for these two cycles the pattern sizes for the first two or three bursts are close to those characteristic of gilding metal.

A report is in preparation dealing with accelerating aging tests, which bear on the problem of storage life of nylon bands, with some data on the effect of molding conditions on the quality of nylon.

## CONCLUSIONS

The extreme temperature firing indicated that a band design and a method of molding have been achieved which produce a band that is retained in flight at all firing conditions.

The rapid-fire results showed that very satisfactory performance of the band is obtained even in a very hot gun. In chromium-plated barrels the nylon bands produce a spectacular increase in gun life. One barrel has been fired for over 2400 rounds on a severe schedule with practically no wear while a similar barrel fired on the same schedule with gilding-metal bands is worn out after 1000 rounds. Unplated barrels also show an increase in life with nylon bands, but not to a similar extent. No evidence of band loss in rapid-fire has been observed. Yaw performance in rapid-fire has been in some cases inferior to that observed with gilding-metal bands, but none of these cases having occurred at less than 150 rounds of burst firing, they are not considered to be of importance in service use. The short-range dispersion obtained in rapid-fire is generally comparable with that obtained with gilding-metal bands.

In accuracy firing (slow fire in a Mann barrel) acceptable dispersion at long range is obtained.

## REFERENCES

(a) BUORD Conf ltr NP9 Re3b:CFJ:mt Ser 63652 of 24 September 1953
(b) NPG Conf Report No. 1099 of 28 February 1953
(c) NPG Conf Report No. 845 of 3 September 1951

# APPENDIX A

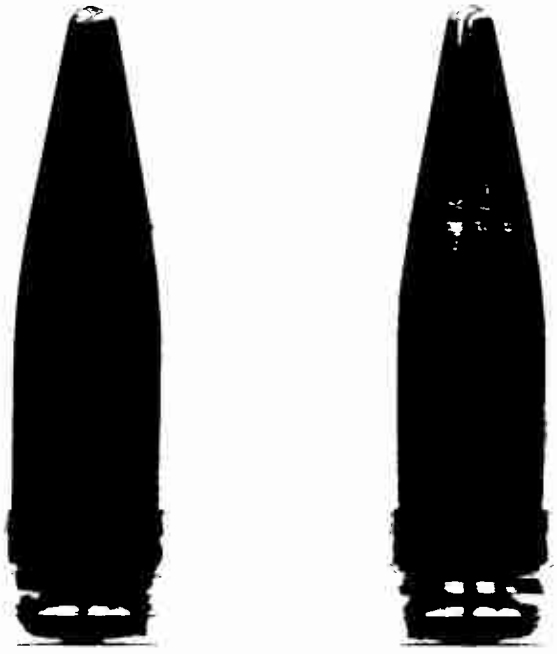

**Figure 1**

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Typical 20mm Type 2 Mod 2 projectiles before firing. View on right has modified crimping groove.

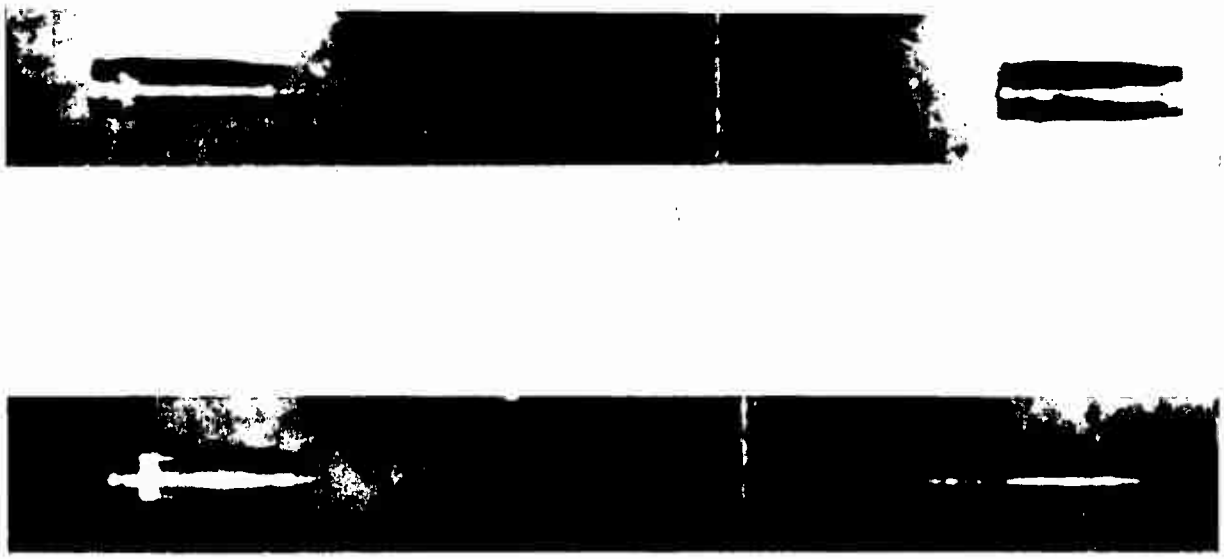

Figure 2

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Microflash photographs, 100 ft. from muzzle, of 20 mm projectiles. Top view shows band retained and lower view illustrates typical band loss if loss did occur.

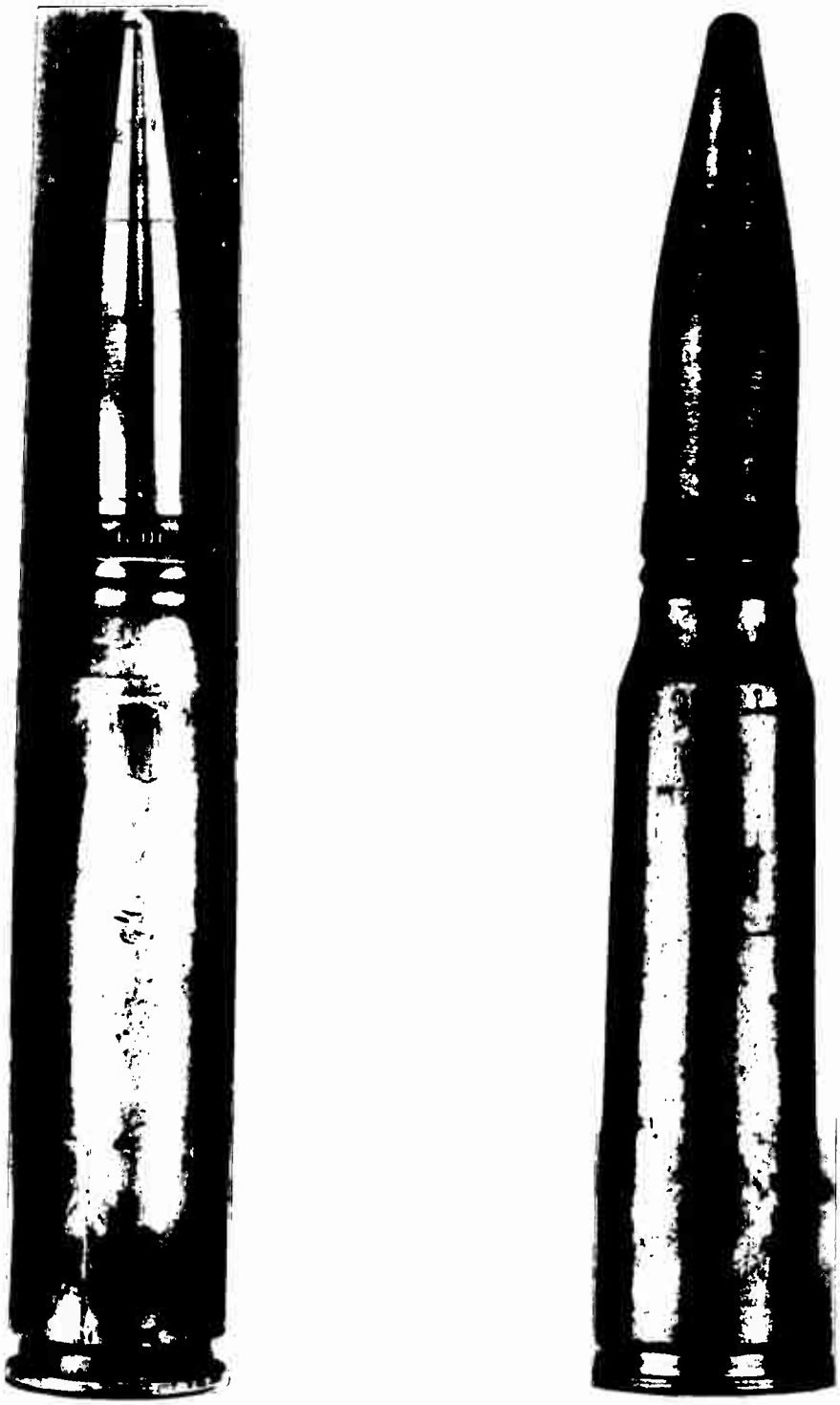

**Figure 3**

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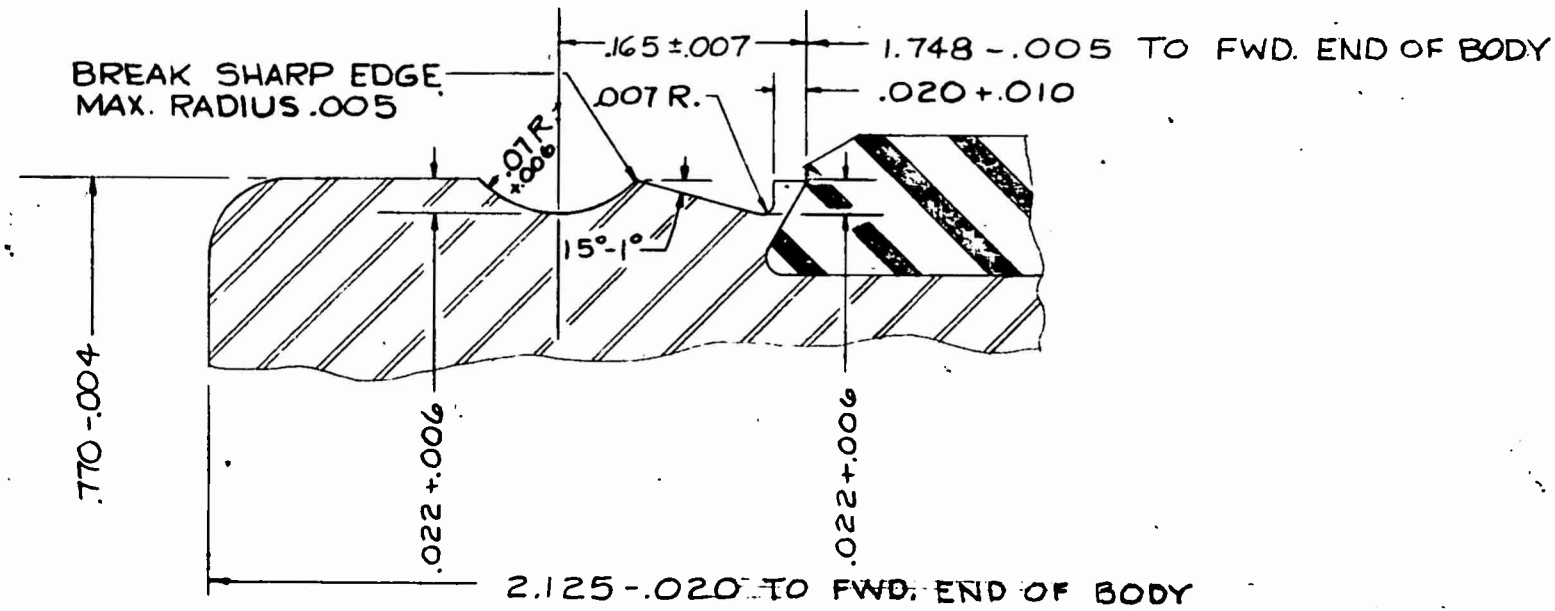
**20mm Type 2 Mod 2 Projectile assemblies after subjection to normal loading cycle showing ramming effect on standard crimp (left) and on modified crimp (right).**




MODIFIED CRIMPING GROOVE

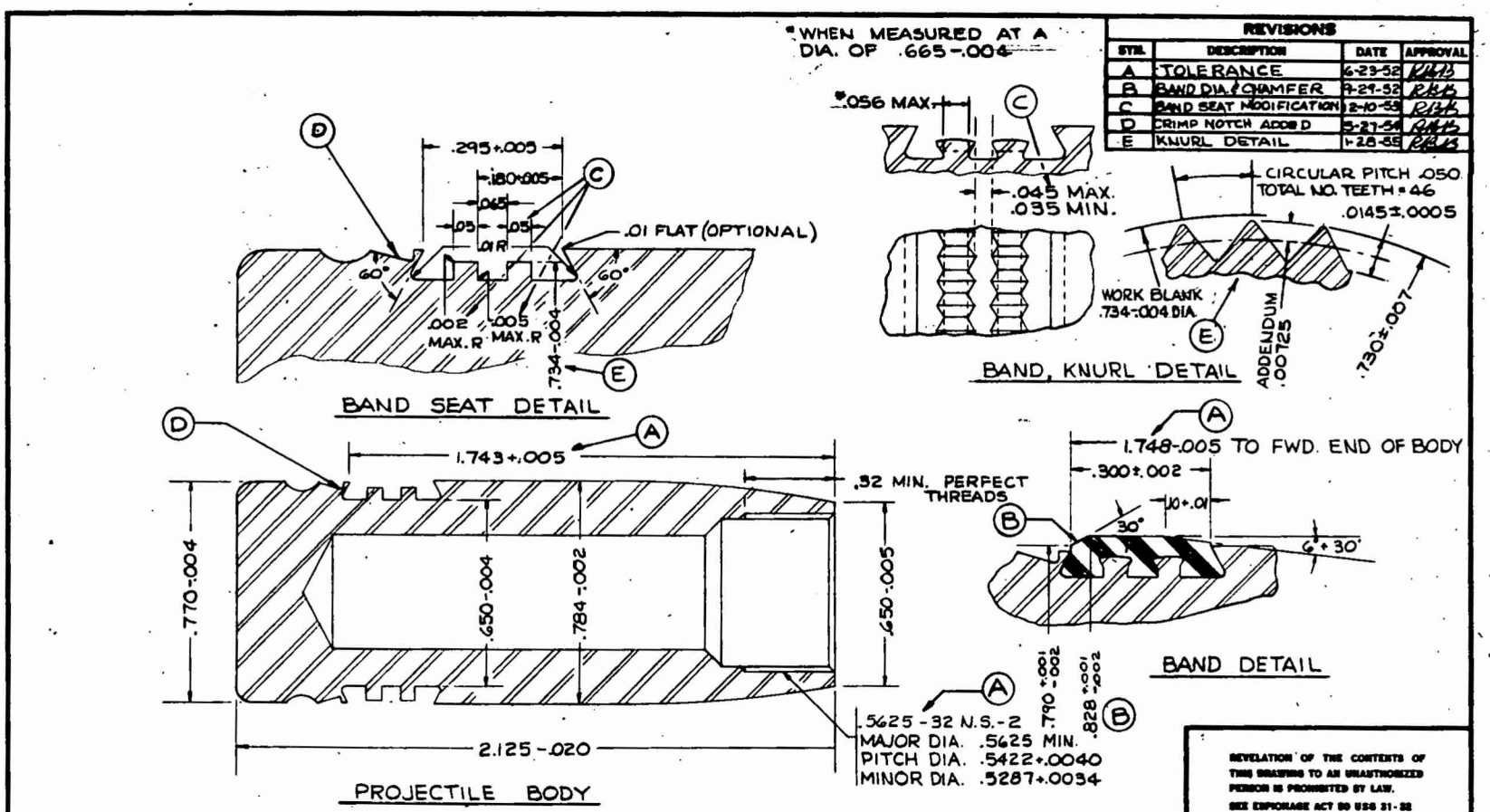
FOR 20MM PROJECTILE TYPE 2 MOD 2

SCALE : 10-1
4/20/53 LEW

DRAWING NO.
APL -452

FIGURE 4

NPG 67026




NOTE:
FOR ALL OTHER APPLICABLE DIMENSIONS AND NOTES SEE BUORD DWG. NO. 982323 (20 MM PROJECTILE MK.11 MOD 0 (TARGET)) AND DWG. NO. APL-452

FIGURE 5

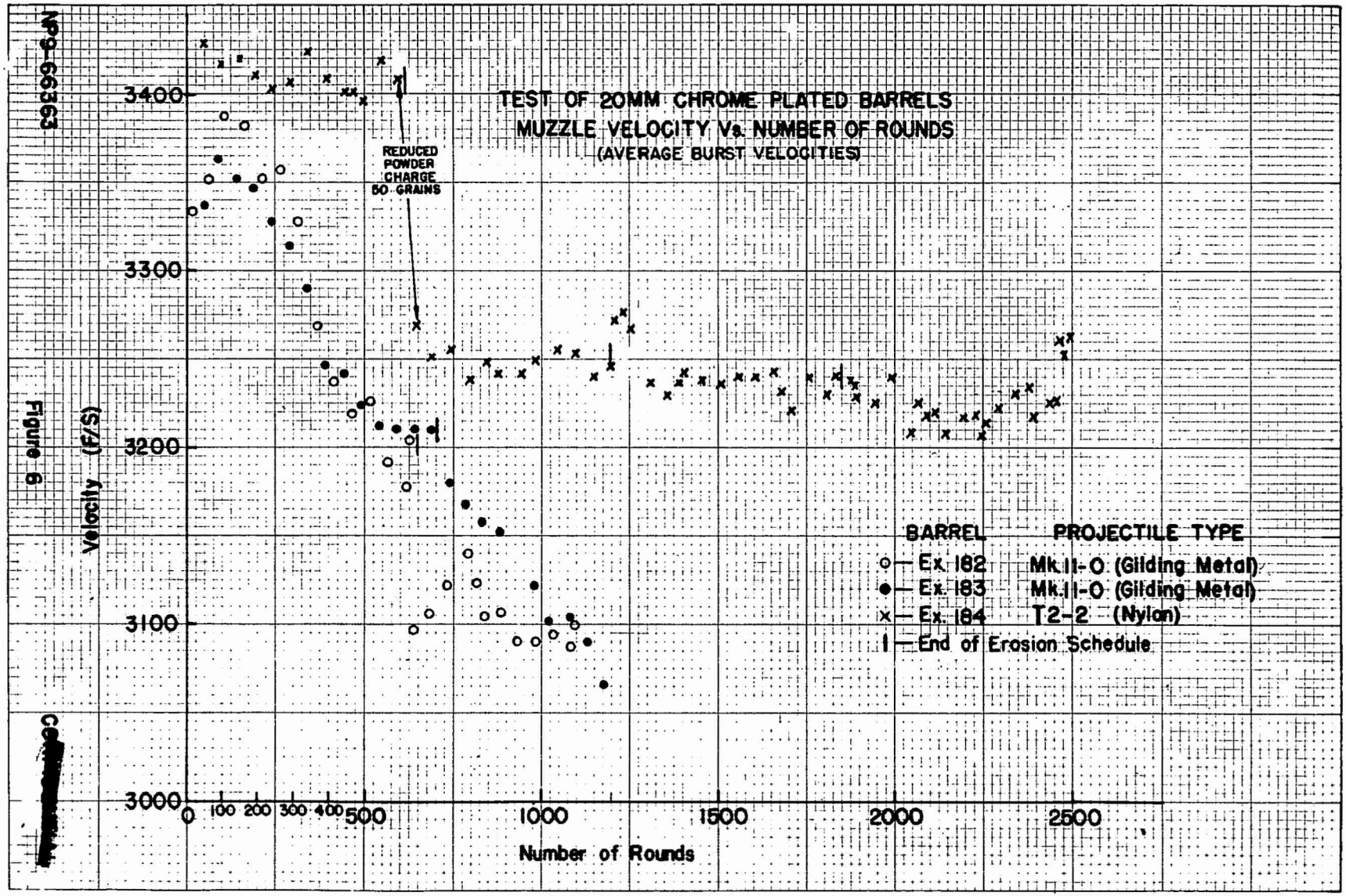



Figure 6

NP9-66363

[redacted]

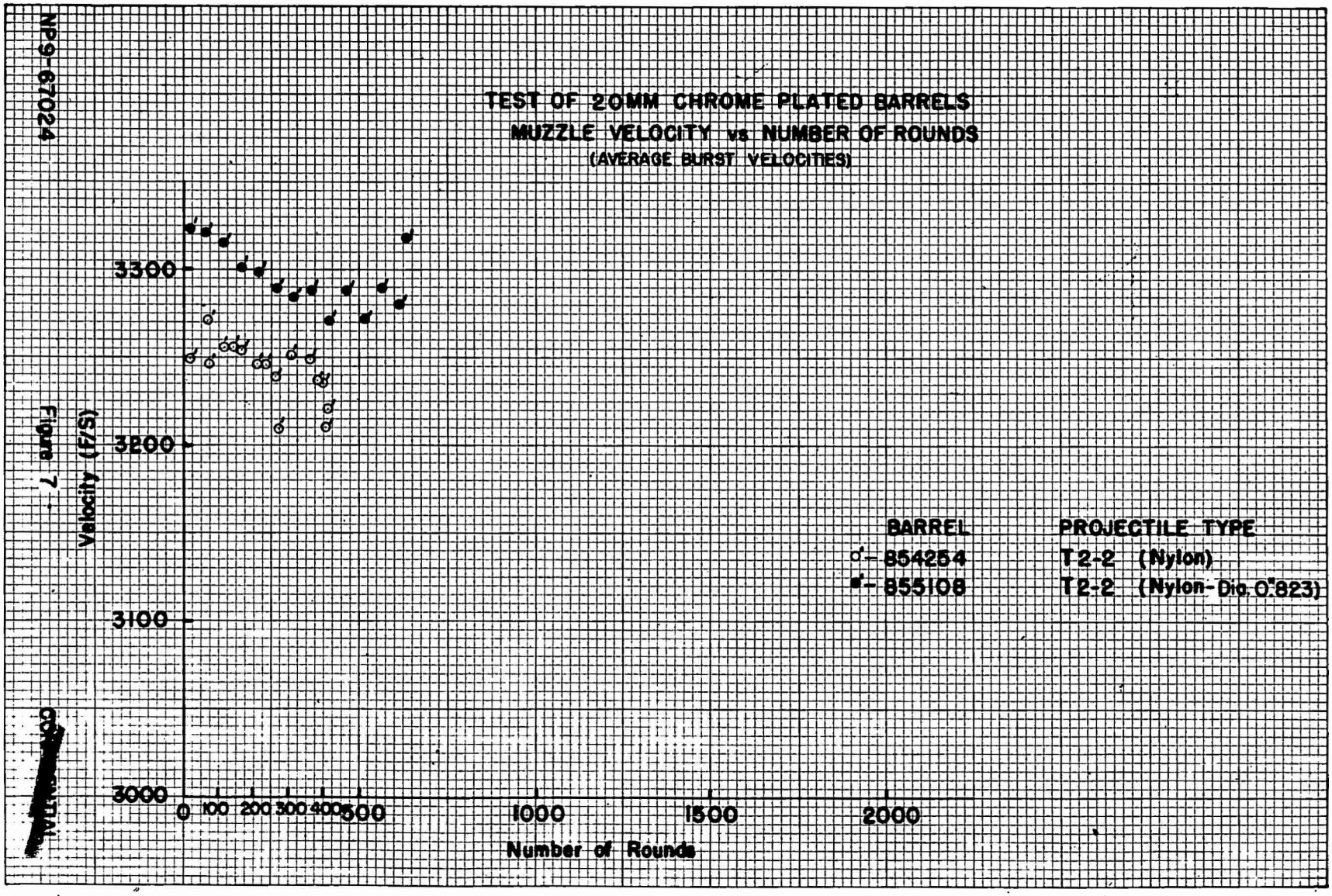



Figure 7

NP9-67024

[redacted]

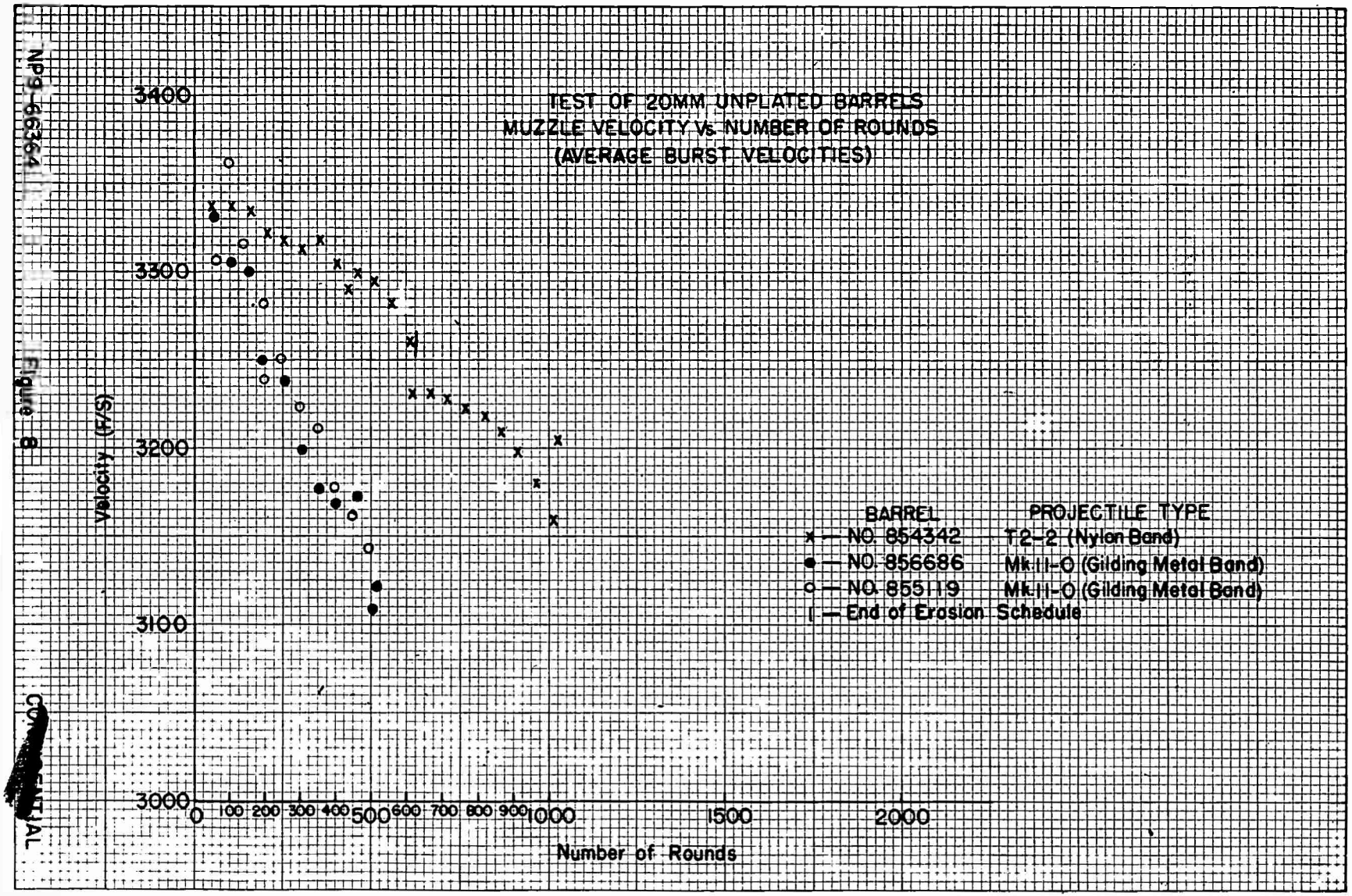



Figure 8

NPG-66364

CONFIDENTIAL

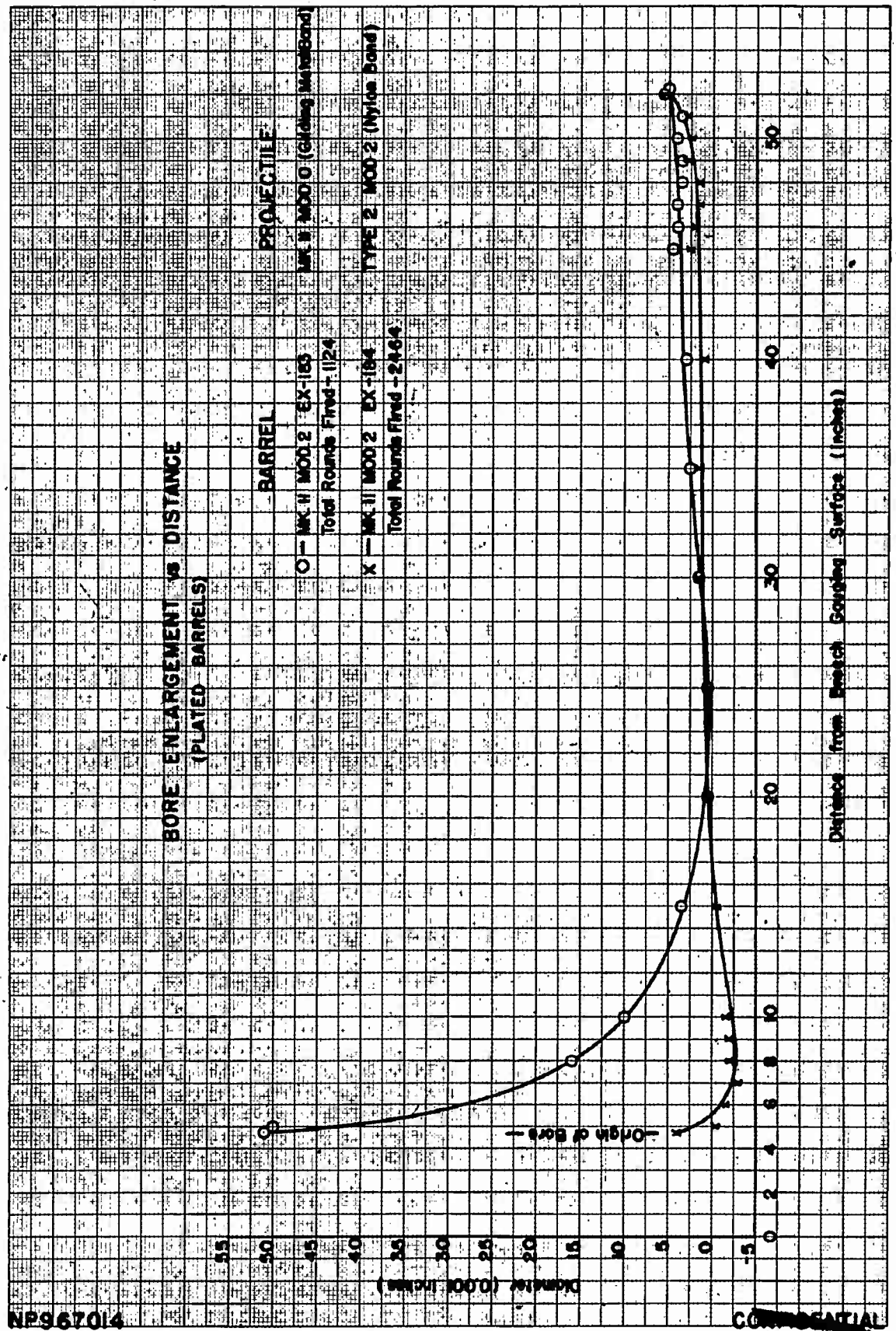

BORE ENLARGEMENT vs DISTANCE
(PLATED BARRELS)
BARREL
PROJECTILE
O — MK II MOD 2 EX-185 MK II MOD 0 (Gliding Metal Band)
Total Rounds Fired - 1124
X — MK II MOD 2 EX-184 TYPE 2 MOD 2 (Nylon Band)
Total Rounds Fired - 2464
Diameter (0.001 inches)
55
50
45
40
35
30
25
20
15
10
5
0
-5
0
2
4
6
8
10
20
30
40
50
Distance from Breech Gauging Surface (Inches)
Origin of Bore
NPS67014
CONFIDENTIAL

Figure 9

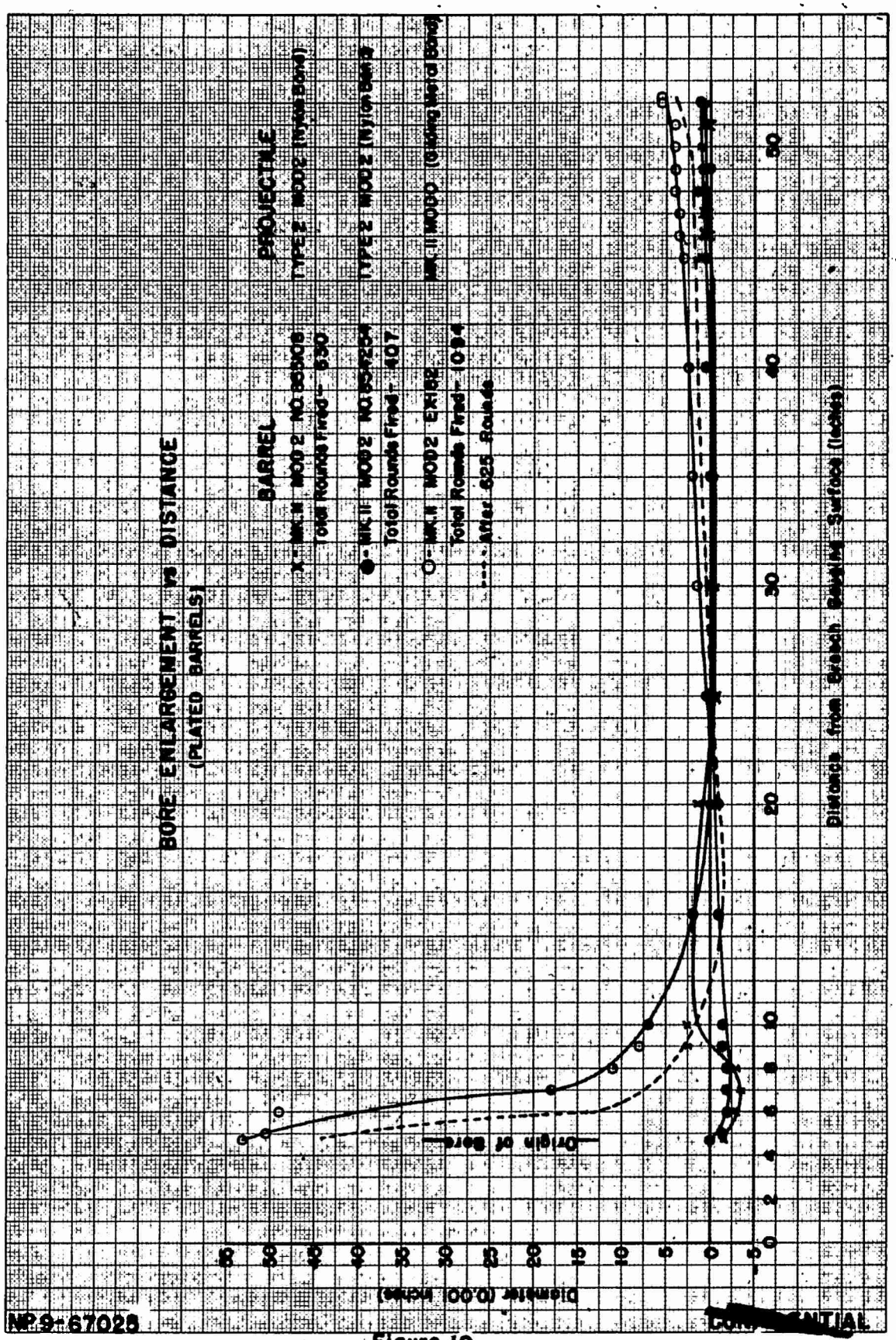

BORE ENLARGEMENT vs DISTANCE
(PLATED BARRELS)
BARREL
PROJECTILE
X - MK.II MOD 2 NO.353108 TYPE 2 MOD 2 (Nylon Band)
Total Rounds Fired - 630
● - MK.II MOD 2 NO.354254 TYPE 2 MOD 2 (Nylon Band)
Total Rounds Fired - 407
O - MK.II MOD 2 EX162 MK.II MOD 0 (Gliding Metal Band)
Total Rounds Fired - 1094
After 625 Rounds
Origin of Bore
Distance from Breech Bearing Surface (Inches)
Diameter (0.001 Inches)
NP 9-67025
CONFIDENTIAL

Figure 10

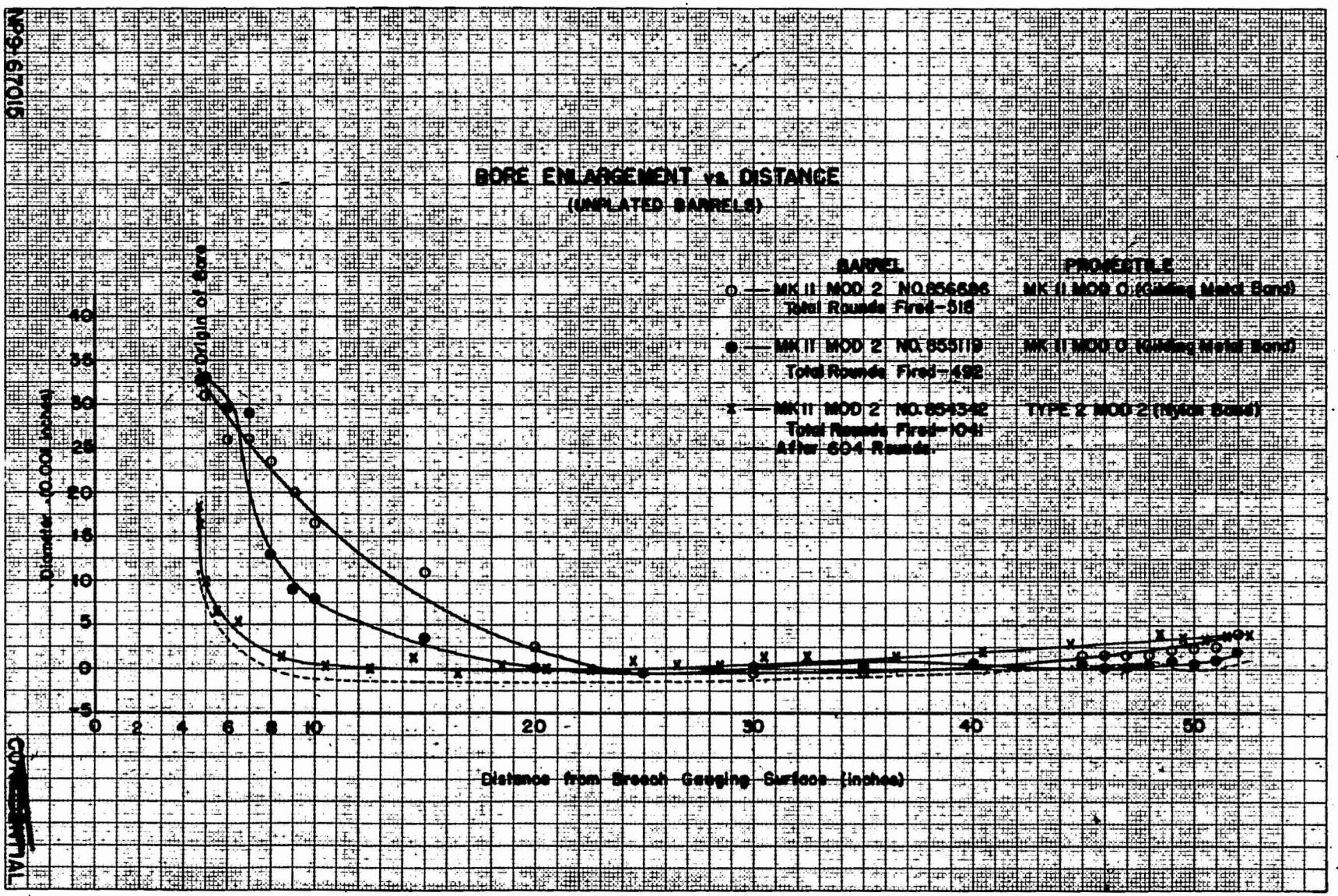
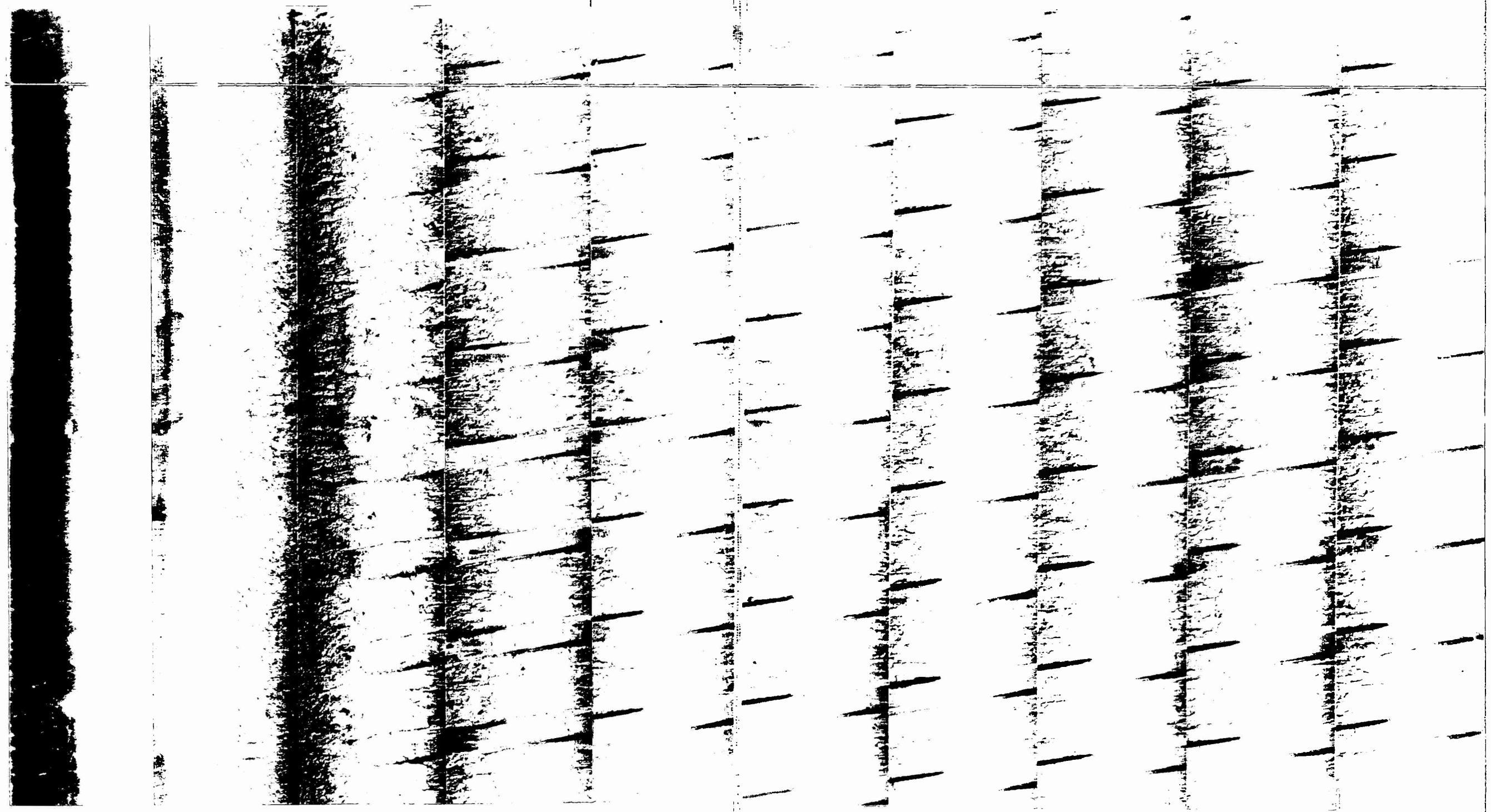



Figure 11



CONFIDENTIAL

KEUFFEL & ESSER CO.



Distance from Breech

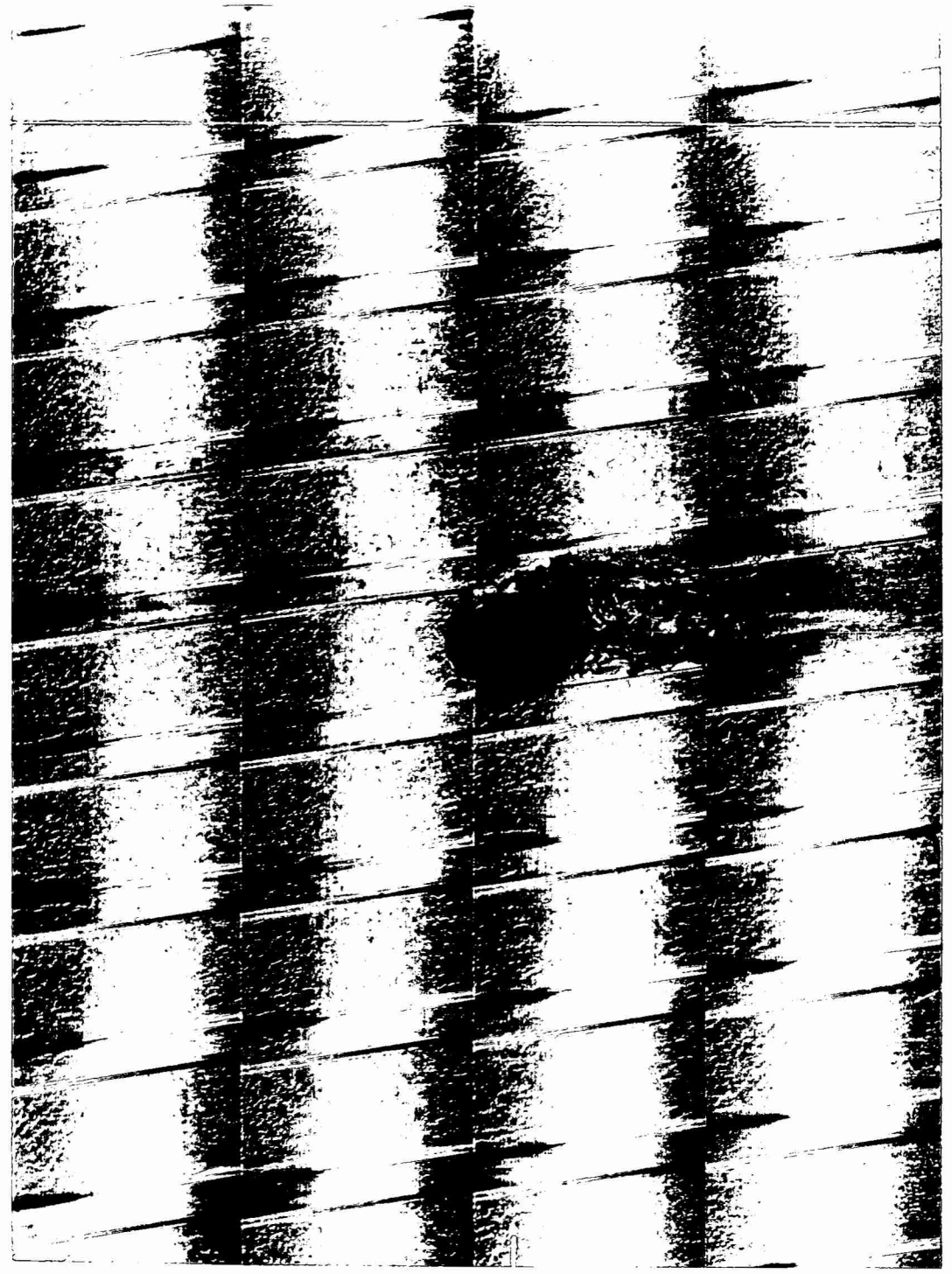
4".7
Origin
of Bore

5".0

6".0

7".0

7".5

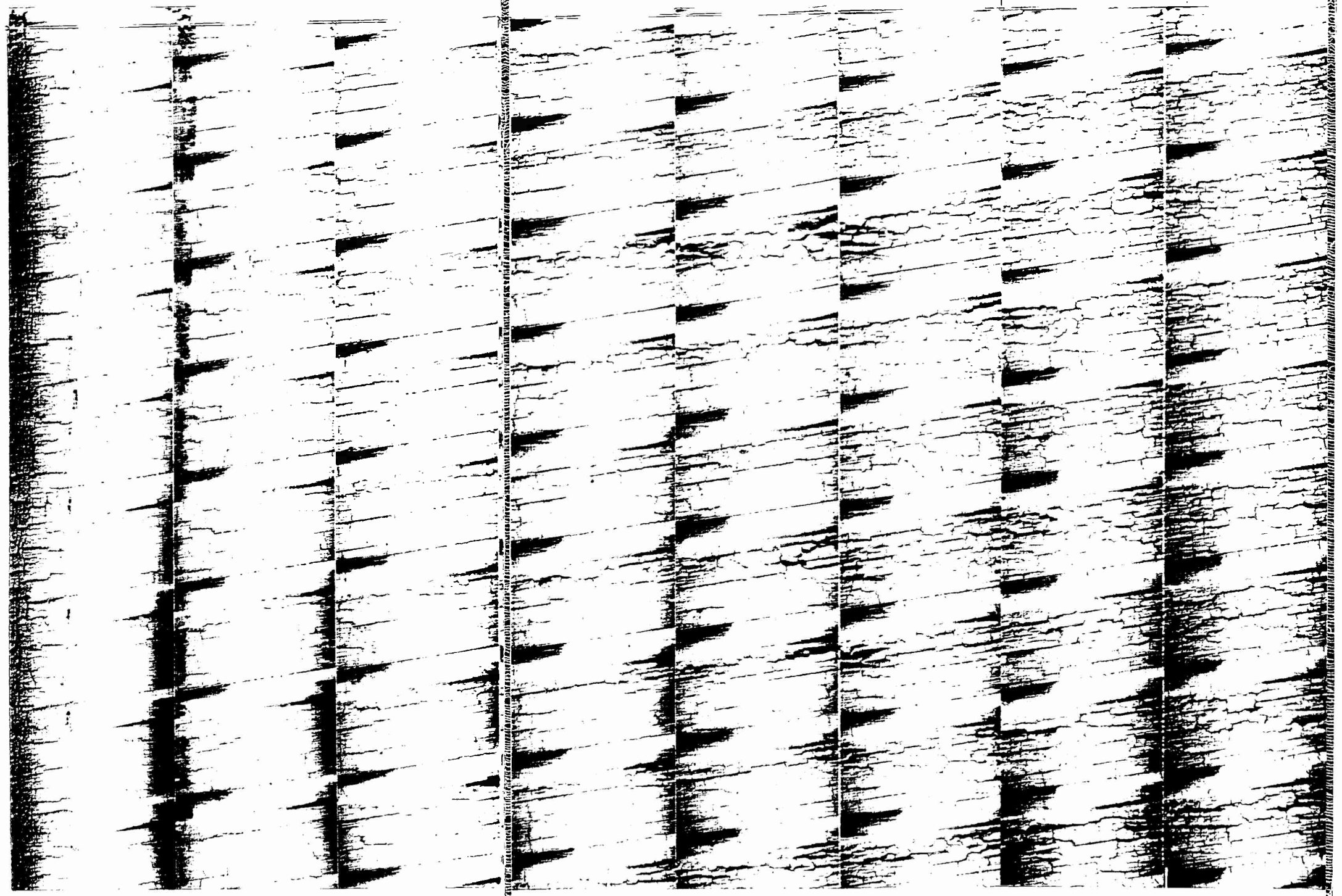


23".9
Gas Port

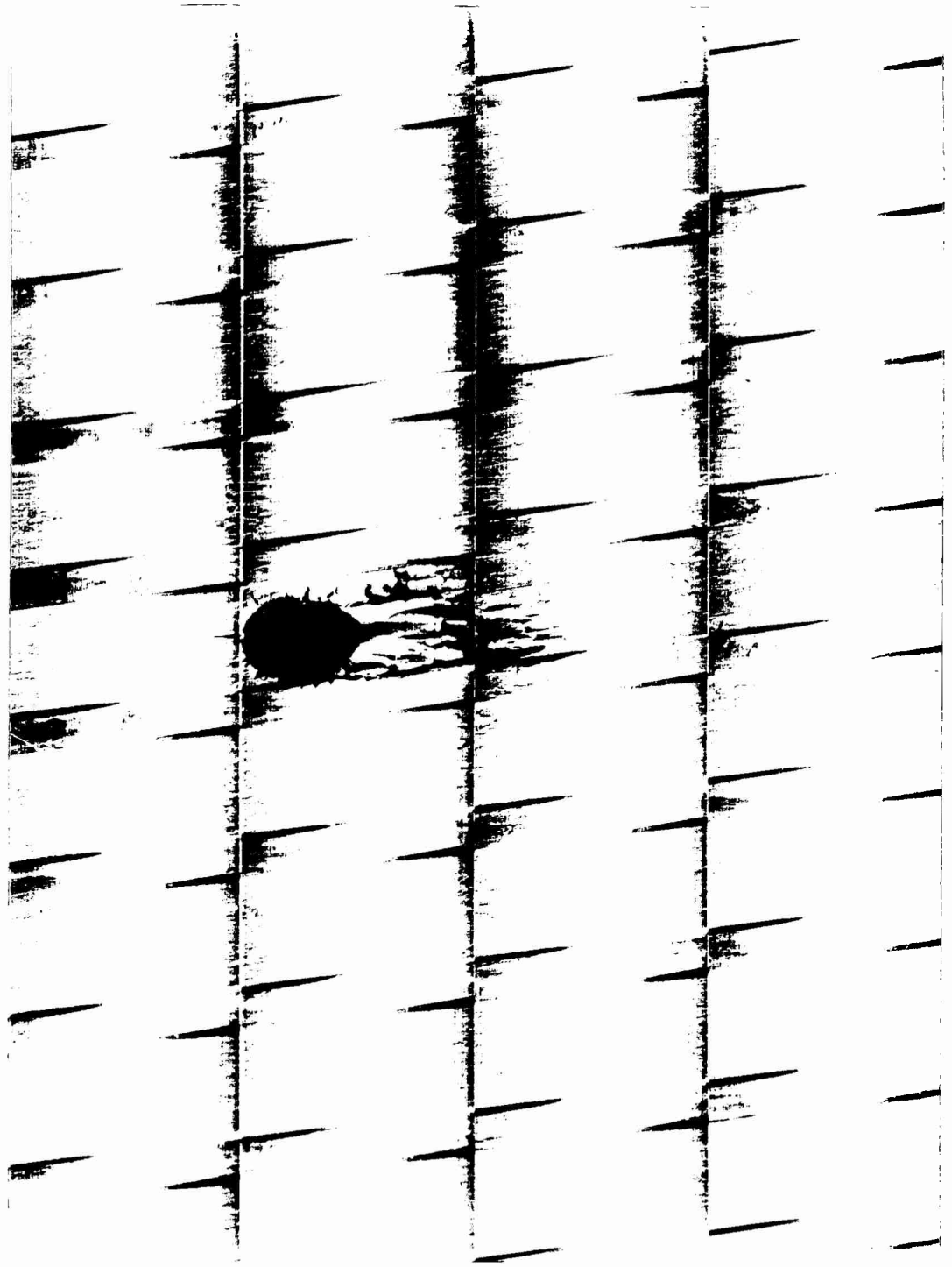
Figure 12

NP9-67027
[redacted]

Bore Photograph of Chrome Plated 20mm Gun Barrel No. FX 184 after firing 2464 rounds of Type 2 Mod 2 (nylon banded) projectiles.



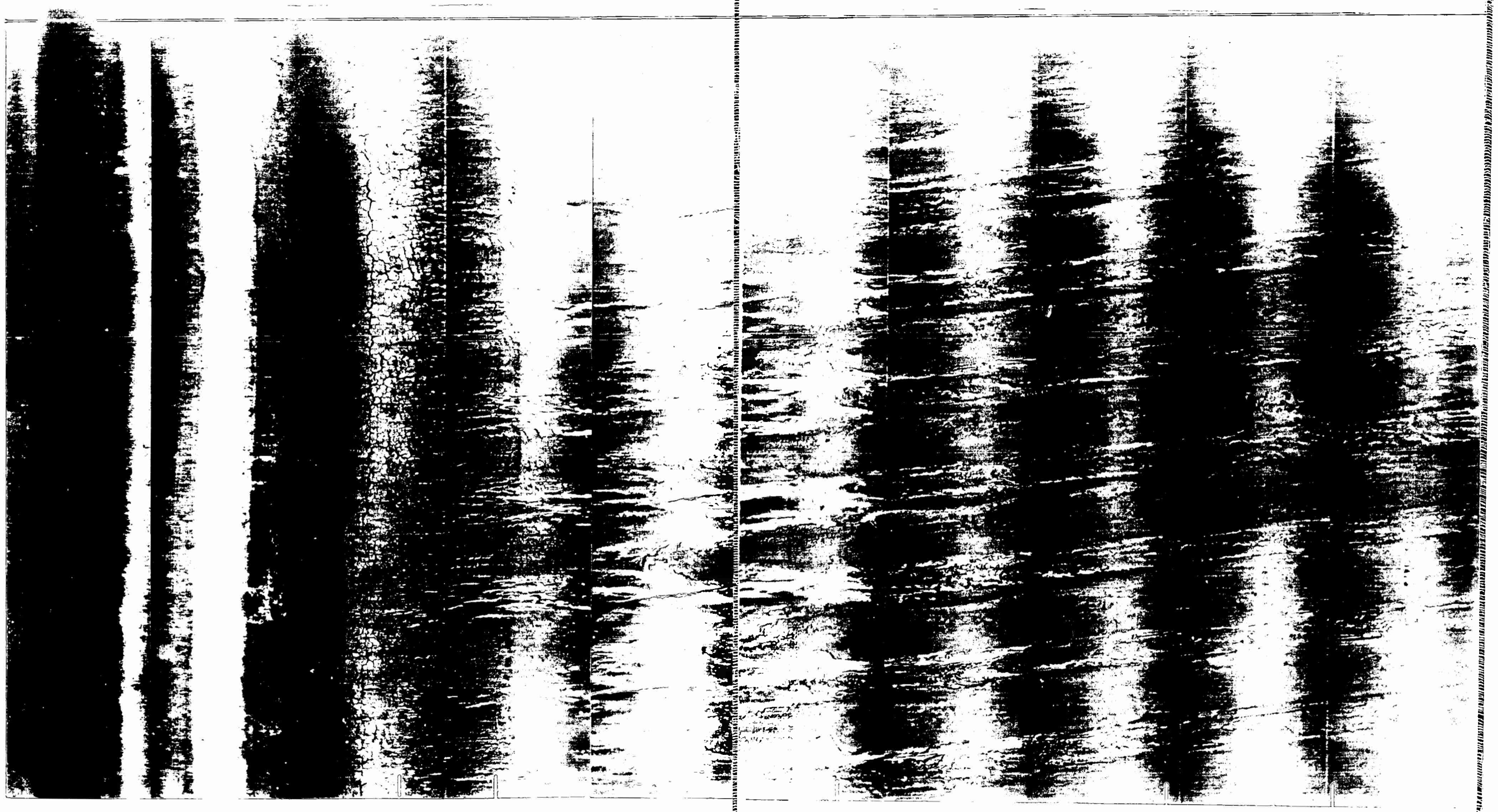
Distance from Breech 4".7 Origin of Bore 5".0 6".0 7".0 7".5



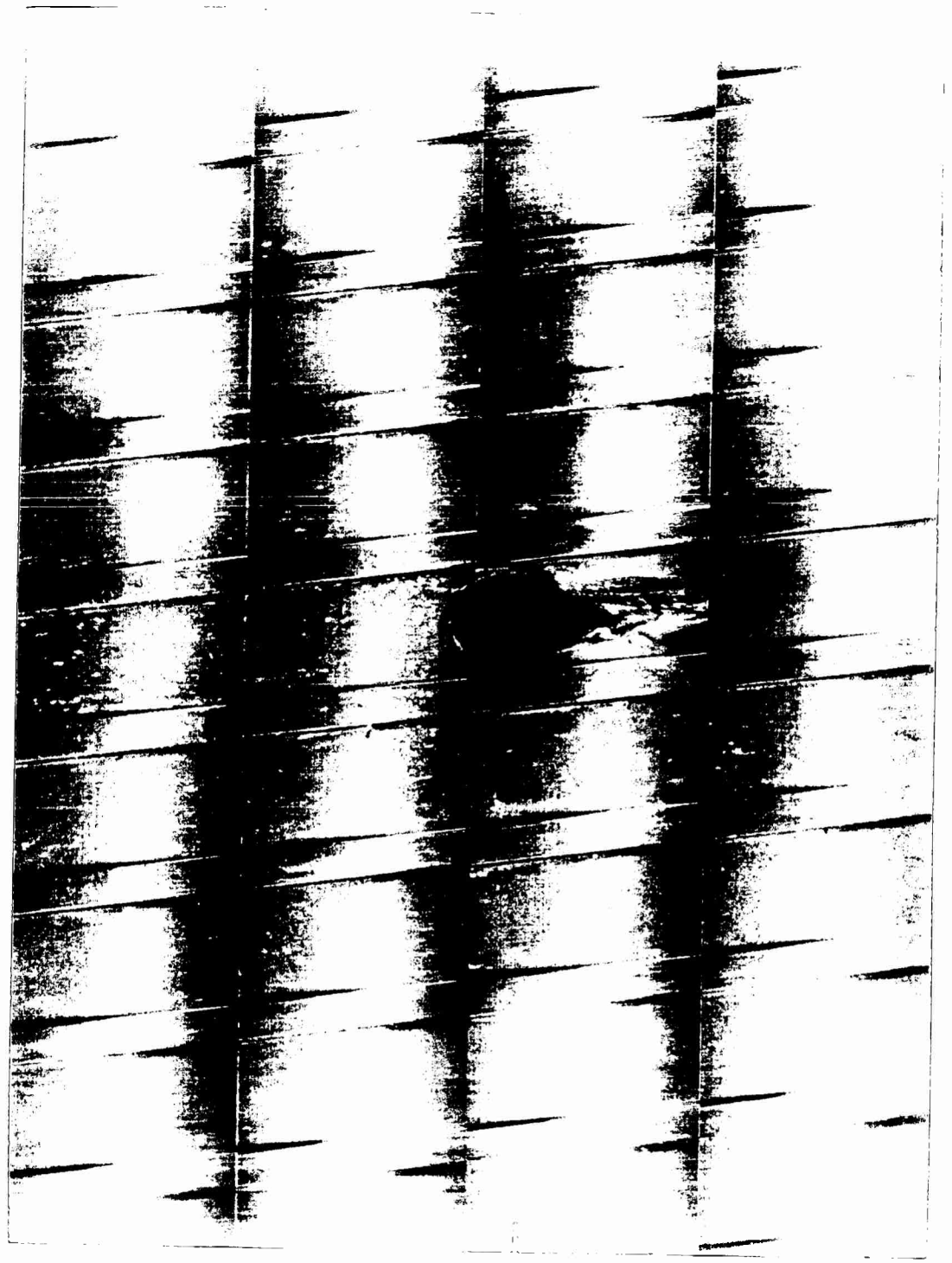
23".9 Gas Port

Figure 13

NP9-67029 ~~CONFIDENTIAL~~ Bore Photograph of Unplated 20mm Gun Barrel No. 854342 after firing 1041 rounds of Type 2 Mod 2 (nylon banded) projectiles.



Distance from Breech 4"7 Origin of Bore 5"0 6"0 7"0 7"5

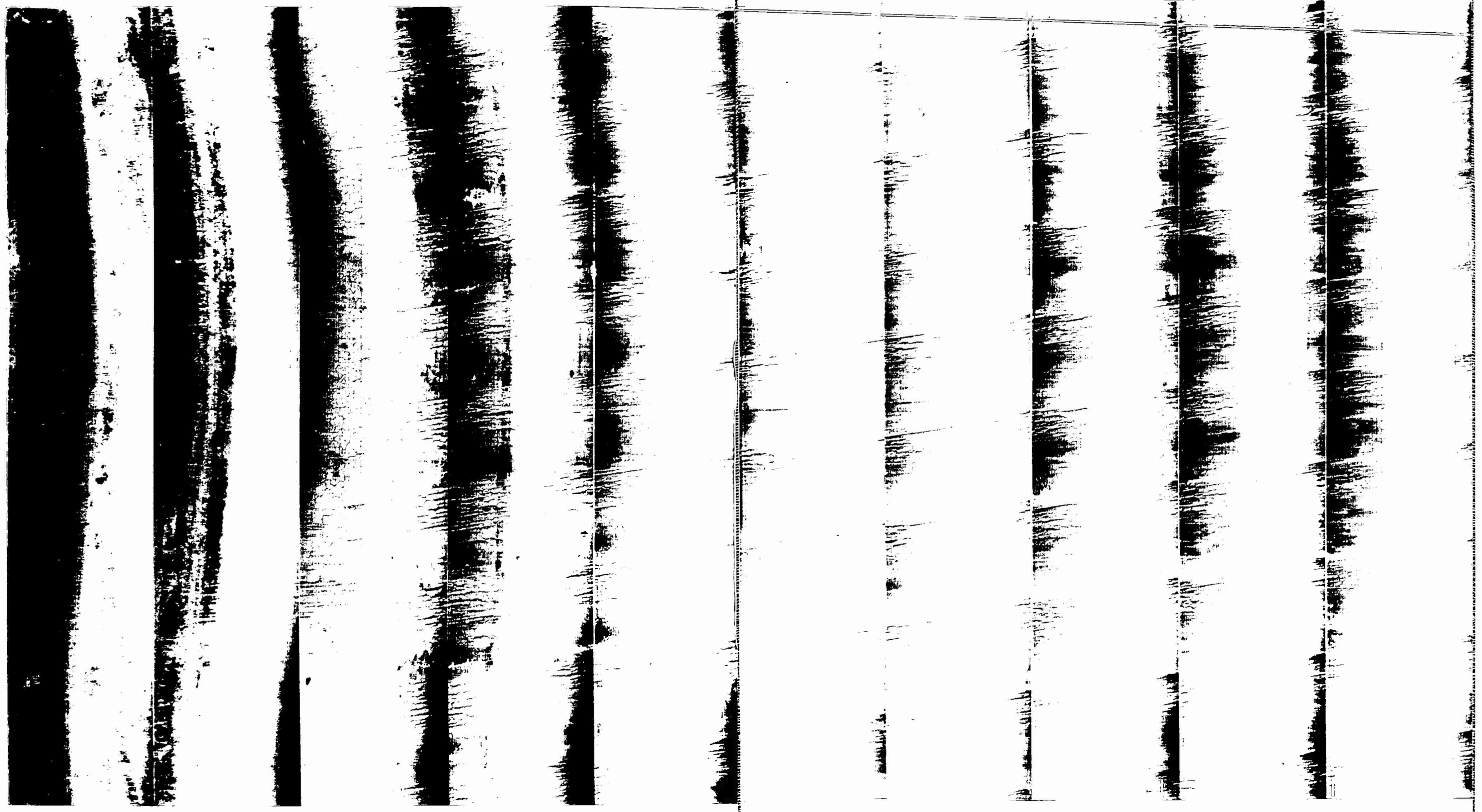


23"9
Gas Port

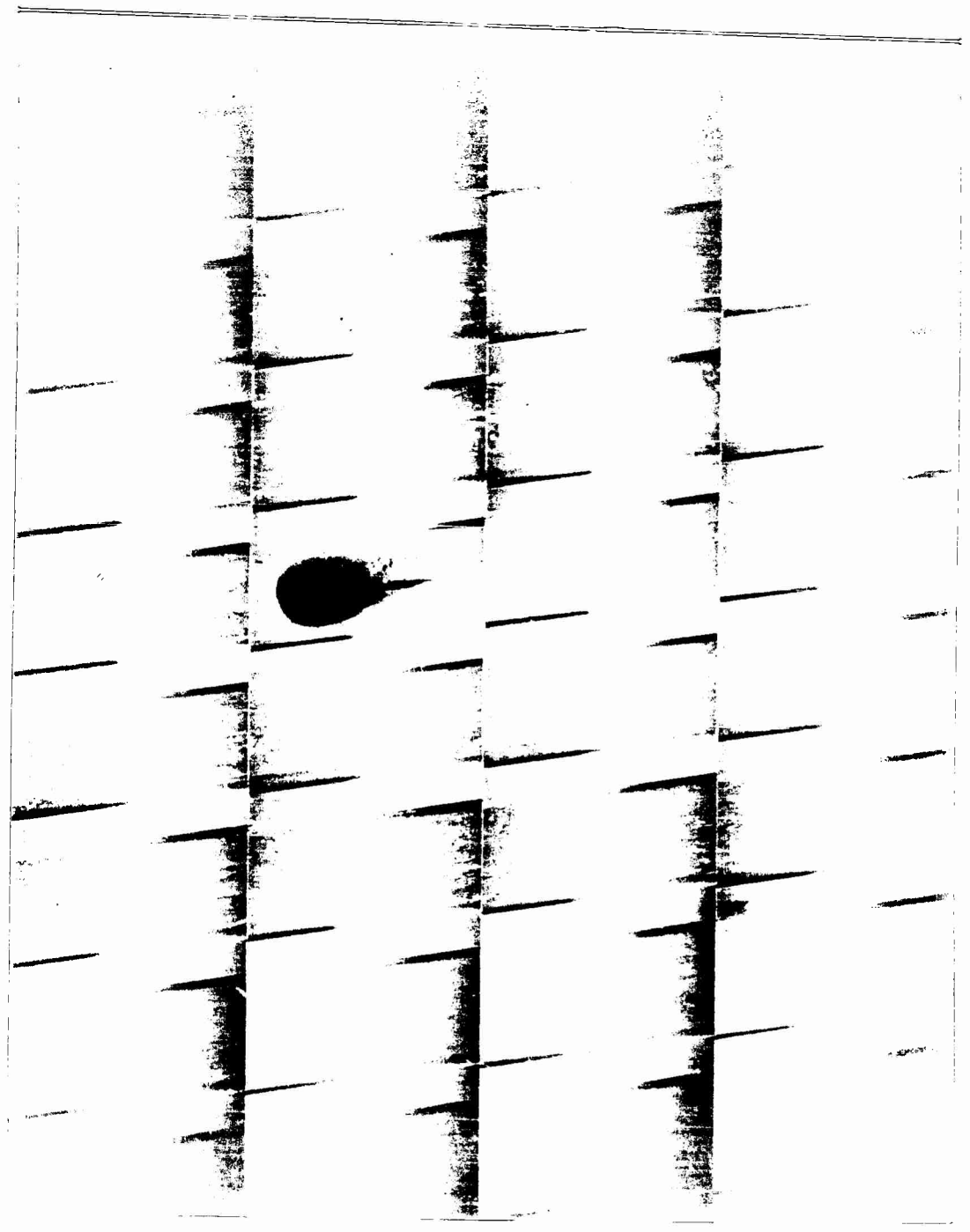
Figure 14

NP9-67028
CONFIDENTIAL

Bore Photograph of Chrome Plated 20mm Gun Barrel No. FX 183 after firing 1177 rounds of Mk 11 Mod 0 (gilding metal bands) projectiles.



Distance from Breech 4".7 Origin of Bore 5".0 6".0 7".0 7".5



23".9
Gas Port

Figure 15

NP9-67030
~~CONFIDENTIAL~~

Bore Photograph of Unplated 20mm Gun Barrel No. 856686 after firing 518 rounds of Mk 11 Mod 0 (gilding metal bands) projectiles.

# APPENDIX B

TABLE 1

COMPLETE BEFORE AND AFTER FIRING DATA

Recovery Test of 20mm Mk 11 (Target) Projectiles with Nylon Bands fired in Mk 11 Mod 2 Barrel No. 854063

| Proj. No. | Firing Order 1/30/53 | Lot No. | Firing Temp. (°F) | Powder Charge (grs.) IMR 6962 | Muzzle Velocity (ft./sec.) | % Nominal Spin | Average Band Hardness $R_R$ Before Conditioning | Average Band Hardness $R_R$ After Conditioning at +160°F | Band Diameter O.D. (ins.) Before Conditioning | Band Diameter O.D. (ins.) After Conditioning at +160°F | ° Yaw 95' From Muzzle | ° Yaw 115' From Muzzle | ° Yaw 130' From Muzzle | % Band on in Flight |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2056 | 1 | 4A | -65 | 685 | 3251 | 104.73 | 103 | 107 | .8278 | .8285 | 5 | 2-1/2 | 3 | 100 |
| 2057 | 2 | 4A | -65 | 685 | 3251 | 104.73 | 104 | 108 | .8276 | .8285 | 0 | 0 | 0 | 100 |
| 2058 | 3 | 4A | -65 | 685 | 3262 | 105.34 | 103 | 107 | .8276 | .8282 | 0 | 4 | 4 | 90 |
| 2059 | 4 | 4A | -65 | 685 | 3252 | 105.34 | 102 | 108 | .8275 | .8288 | 4 | 0 | 0 | 100 |
| 2060 | 5 | 4A | -65 | 685 | 3249 | 104.57 | 103 | 107 | .8275 | .8287 | 3 | 3-1/2 | 2-1/2 | 100 |
| 2061 | 6 | 4A | -65 | 685 | 3238 | -- | 105 | 107 | .8275 | .8285 | 3 | 3 | 2-1/2 | 100 |
| 2062 | 7 | 4A | -65 | 685 | 3292 | -- | 102 | 106 | .8275 | .8283 | 0 | 0 | 0 | 100 |
| 2063 | 8 | 4A | -65 | 685 | 3212 | -- | 103 | 108 | .8276 | .8286 | 0 | 0 | 0 | 100 |
| 2064 | 9 | 4A | -65 | 685 | 3249 | -- | 102 | 108 | .8275 | .8286 | 2-1/2 | 2-1/2 | 0 | 100 |
| 2065 | 10 | 4A | -65 | 685 | 3232 | -- | 102 | 106 | .8275 | .8287 | 0 | 0 | 0 | 90 |
| 2066 | 11 | 4B | -65 | 685 | 3243 | 105.01 | 102 | 108 | .8272 | .8280 | 0 | 0 | 0 | 100 |
| 2067 | 12 | 4B | -65 | 685 | 3238 | 104.70 | 102 | 104 | .8271 | .8282 | 0 | 0 | 0 | 100 |
| 2068 | 13 | 4B | -65 | 685 | 3290 | 104.75 | 102 | 106 | .8277 | .8286 | 4 | 4 | 2-1/2 | Missed Picture |
| 2069 | 14 | 4B | -65 | 685 | 3232 | 104.76 | 102 | 108 | .8279 | .8288 | 4 | 4 | 2-1/2 | 100 |
| 2070 | 15 | 4B | -65 | 685 | 3246 | 104.97 | 104 | 107 | .8273 | .8283 | 0 | 0 | 0 | 100 |
| 2071 | 16 | 4B | -65 | 685 | 3246 | -- | 102 | 108 | .8279 | .8290 | 3 | 2-1/2 | 0 | 100 |
| 2072 | 17 | 4B | -65 | 685 | 3298 | -- | 102 | 108 | .8272 | .8280 | 5 | 5 | 4 | Missed Picture |
| 2073 | 18 | 4B | -65 | 685 | 3240 | -- | 103 | 107 | .8273 | .8281 | 0 | 0 | 0 | 100 |
| 2074 | 19 | 4B | -65 | 685 | 3226 | -- | 103 | 107 | .8278 | .8287 | 0 | 0 | 0 | 100 |
| 2075 | 20 | 4B | -65 | 685 | 3238 | -- | 103 | 107 | .8279 | .8290 | 2-1/2 | 2 | 2 | 100 |

Lot 4A Projectiles Type 2 Mod 2 according to APL 355B (Temp.: Mold +190°F, Proj. +160°F).

Lot 4B Projectiles Type 2 Mod 2 according to APL 355B (Temp.: Mold +60°F, Proj. +75°F).

Both lots of projectiles in temperature control at +160°F for 7 days, ambient 24 hours, and -65°F for a minimum of 4 hours. Approximately 30-45 seconds time out of cold box before firing.

TABLE 2

## COMPLETE BEFORE AND AFTER FIRING DATA

Recovery Test of 20mm Mk 11 (Target) Projectiles with Nylon Bands in Mk 11 Mod 2 Barrel No. 854063

| Proj. No. | Firing Order 2/19/53 | Lot No. | Firing Temp. (°F) | Powder Charge (grs.) IMR-6962 | Muzzle Velocity (ft./sec.) | % Nominal Spin | Average Band Hardness $R_R$ Before Conditioning | Average Band Hardness $R_R$ Ambient Temp. Before Test | Band Diameter O.D. (ins.) Before Conditioning | Band Diameter O.D. (ins.) After Conditioning | ° Yaw 115' From Muzzle | ° Yaw 130' From Muzzle | % Band on in Flight |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2095 | 1 | 4A | -65 | 685 | 3334 | 98.43 | 102 | -- | .8277 | .8277 | 4 | 0 | 40 |
| 2096 | 3 | 4A | -65 | 685 | 3369 | 98.52 | 102 | 105 | .8277 | .8277 | 0 | 0 | 100 |
| 2097 | 5 | 4A | -65 | 685 | 3361 | 98.72 | 105 | -- | .8277 | .8277 | 0 | 0 | 80 |
| 2098 | 7 | 4A | -65 | 685 | 3364 | 99.02 | 103 | -- | .8277 | .8277 | 2-1/2 | 2-1/2 | 100 |
| 2099 | 9 | 4A | -65 | 685 | 3358 | -- | 104 | -- | .8277 | .8277 | 0 | 0 | 100 |
| 2100 | 11 | 4A | -65 | 685 | 3357 | -- | 103 | -- | .8277 | .8277 | 0 | 0 | 90 |
| 2101 | 13 | 4A | -65 | 685 | 3362 | -- | 105 | -- | .8278 | .8278 | 1 | 1 | 100 |
| 2102 | 15 | 4A | -65 | 685 | 3368 | -- | 102 | -- | .8277 | .8277 | 0 | 0 | 100 |
| 2103 | 17 | 4A | -65 | 685 | 3366 | -- | 101 | -- | .8277 | .8277 | 2-1/2 | 2-1/2 | 95 |
| 2104 | 19 | 4A | -65 | 685 | 3462 | -- | 103 | 104 | .8276 | .8276 | 0 | 0 | 100 |
| 2105 | 2 | 4B | -65 | 685 | 3382 | 98.55 | 104 | -- | .8277 | -- | 0 | 0 | 100 |
| 2106 | 4 | 4B | -65 | 685 | 3372 | 98.52 | 104 | -- | .8278 | -- | 0 | 0 | 100 |
| 2107 | 6 | 4B | -65 | 685 | 3369 | 98.42 | 103 | -- | .8278 | -- | 0 | 0 | 100 |
| 2108 | 8 | 4B | -65 | 685 | 3394 | 97.19 | 104 | -- | .8278 | .8278 | 2-1/2 | 1 | 100 |
| 2109 | 10 | 4B | -65 | 685 | 3358 | -- | 101 | -- | .8287 | .8286 | 2 | 0 | 100 |
| 2110 | 12 | 4B | -65 | 685 | 3374 | -- | 100 | -- | .8282 | -- | 0 | 0 | 100 |
| 2111 | 14 | 4B | -65 | 685 | 3358 | -- | 101 | -- | .8278 | -- | 2-1/2 | 1 | 100 |
| 2112 | 16 | 4B | -65 | 685 | 3368 | -- | 102 | -- | .8278 | -- | 0 | 0 | 100 |
| 2113 | 18 | 4B | -65 | 685 | 3353 | -- | 101 | 105 | .8278 | -- | 0 | 0 | 100 |
| 2114 | 20 | 4B | -65 | 685 | 3273 | -- | 101 | 105 | .8282 | -- | 0 | 0 | 100 |

Lot 4A Projectiles Type 2 Mod 2 according to APL 355B (Temp.: Mold +190°F, Proj. +160°F).
Lot 4B Projectiles Type 2 Mod 2 according to APL 355B (Temp.: Mold +60°F, Proj. +75°F).

Both lots of projectiles in temperature control at -65°F for 4 hours, +160°F for 4 hours, ambient temperature for 16 hours. This cycle was repeated for 7 days. The projectiles were again subjected to -65°F for 4 hours and fired at that temperature.

TABLE 3

## COMPLETE BEFORE AND AFTER FIRING DATA

Recovery Test of 20mm Mk 11 (Target) Projectiles with Nylon Bands Fired in Mk 11 Mod 2 Barrel No. 854063

| Proj. No. | Firing Order 3/17/53 | Lot No. | Firing Temp. (°F) | Powder Charge (grs.) SPDN 10285 | Muzzle Velocity (ft./sec.) | % Nominal Spin | Average Band Hardness $R_R$ Before Conditioning (Ambient) | Average Band Hardness $R_R$ After Conditioning (+160°F) | Band Diameter (ins.) Before Conditioning (Ambient) | Band Diameter (ins.) After Conditioning (+160°F) | Band Diameter (ins.) Difference of Diameters after Temp. Control | °Yaw 115' From Muzzle | °Yaw 130' From Muzzle | % Band on After Recovery | % Band on In Flight |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2145 | 2 | 4A | +160 | 685 | 3388 | 96.8 | 102 | 89 | .8277 | .8314 | +.0037 | 3 | 3 | 100 | 100 |
| 2146 | 4 | 4A | +160 | 685 | 3362 | 98.9 | 101 | -- | .8277 | .8320 | +.043 | 0 | 0 | 100 | 100 |
| 2147 | 6 | 4A | +160 | 685 | 3367 | 98.5 | 102 | 86 | .8277 | .8316 | +.0039 | 2 | 2 | 100 | 100 |
| 2148 | 8 | 4A | +160 | 685 | 3373 | -- | 102 | 90 | .8280 | .8318 | +.0038 | 5 | 3 | 100 | 100 |
| 2149 | 10 | 4A | +160 | 685 | 3321 | -- | 102 | -- | .8277 | .8310 | +.0033 | 2-1/2 | 3 | 100 | 100 |
| 2150 | 12 | 4A | +160 | 685 | 3352 | -- | -- | -- | -- | -- | -- | 2-1/2 | 2-1/2 | 100 | 100 |
| 2151 | 14 | 4A | +160 | 685 | 3352 | -- | -- | 85 | -- | -- | -- | 4 | 2-1/2 | 100 | 100 |
| 2152 | 1 | 4B | +160 | 685 | 3361 | 95.0 | 102 | 80 | .8272 | .8320 | +.0048 | 6 | 2-1/2 | 100 | 100 |
| 2153 | 3 | 4B | +160 | 685 | 3362 | 98.6 | 93 | -- | .8278 | .8316 | +.0038 | 3 | 0 | 100 | 100 |
| 2154 | 5 | 4B | +160 | 685 | 3352 | 98.5 | 103 | -- | .8281 | .8322 | +.0041 | 2-1/2 | 2-1/2 | 100 | 100 |
| 2155 | 7 | 4B | +160 | 685 | 3367 | -- | 102 | -- | .8277 | .8320 | +.0043 | 5 | 3 | 100 | 100 |
| 2156 | 9 | 4B | +160 | 685 | 3326 | -- | 101 | 85 | .8277 | .8320 | +.0043 | 2-1/2 | 0 | 100 | 100 |
| 2157 | 11 | 4B | +160 | 685 | 3356 | -- | 102 | 88 | -- | -- | -- | 2-1/2 | 3 | 100 | 100 |
| 2158 | 13 | 4B | +160 | 685 | 3352 | -- | 102 | -- | -- | -- | -- | 3 | 3 | 100 | 100 |
| 2159 | 15 | 4B | +160 | 685 | 3359 | -- | 101 | -- | -- | -- | -- | 5 | 3 | 100 | 100 |
| 2160 | 16 | 4B | +160 | 685 | 3351 | -- | 102 | -- | -- | -- | -- | 3 | 2-1/2 | 100 | 100 |
| 2161 | 17 | 4B | +160 | 685 | 3354 | -- | 102 | -- | -- | -- | -- | 1 | 0 | 100 | 100 |

Lot 4A Projectiles Type 2 Mod 2 according to APL 355B (Temp.: Mold +190°F, Proj. +160°F).

Lot 4B Projectiles Type 2 Mod 2 according to APL 355B (Temp.: Mold +60°F, Proj. +75°F).

Projectiles subjected to +160°F temperature and 100% humidity for 7 days.

# APPENDIX C

## DESCRIPTION OF VELOCITY AND PRESSURE-TIME TEST

Ref: (c) NPG Conf Report No. 845 of 3 September 1951

1. Pressure-time curves were taken on rounds assembled with projectiles Type 2 Mod 2 (Nylon 0".3 band 0".828 diameter) and projectiles with Nylon 0".3 band 0".834 diameter (marked "SP"). Rounds assembled with projectiles Mk 11 Mod 0 were used for control.

2. All rounds were assembled as indicated in Table 4 from components on hand with the exception of the nylon projectiles. The nylon-banded projectiles were crimped in the case with the special crimp devised for these projectiles; the crimp for the gilding-metal-banded projectiles was standard. When fired, the projectile emergence was missed on the original projectiles with nylon rotating bands because the nylon was insulating the projectile from the barrel. Three more projectiles of each type were furnished and the muzzle exit recorded by the breaking of the muzzle wire. It will be noted that the rounds of one group of projectiles with nylon bands were fired alternately with those of the other group having nylon bands. Neither group was alternated with the group having copper bands. This was felt desirable to avoid any additional coppering of the barrel while these rounds were fired. All data were recorded by procedures covered in reference (c) except the projectile emergence times. All results are tabulated in Table 4. Typical pressure-time curves and a calibration are included as Figures 16 to 18 inclusive.

TABLE 4

## TABULATED VELOCITY AND PRESSURE-TIME DATA

Nylon and Gilding Metal Band Comparison
Piezo Gauge 13, Cell 4
Barrel No. 862897 Chemically Decoppered
672 Previous Rounds

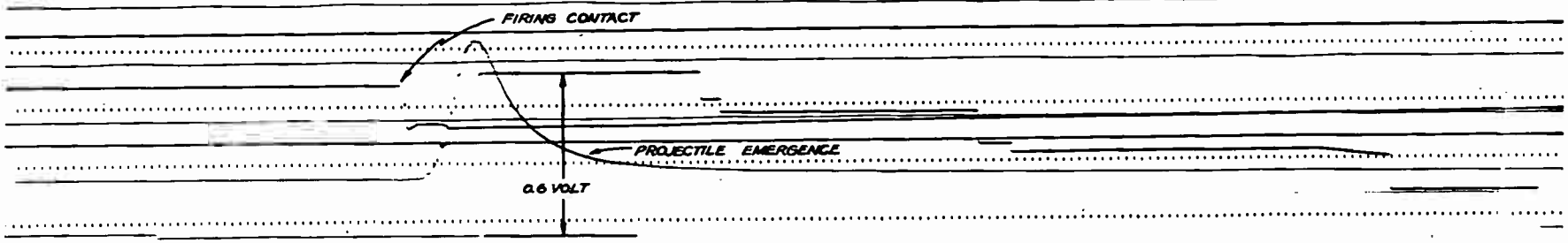
| Date 1953 | Time | Rd. | Powder Type | Powder Lot | Powder Weight (Grains) | Projectile Type | Projectile Weight (Grains) | Crimp (Tons) | Times (ms) Ignition | Times (ms) Emergence | Muzzle Velocity (ft./sec.) | Piezo Pressure (psi) Peak | Piezo Pressure (psi) Muzzle Exit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10-23 | | 1 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | | 15 | | | *3268 | | |
| 10-23 | 1457 | 2 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | | 15 | .53 | 2.02 | *3346 | *63,100 | *11,200 |
| 10-23 | 1502 | 3 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | 1690.7 | 15 | | | 3340 | | |
| 10-23 | 1506 | 4 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | 1688.8 | 15 | .51 | 2.04 | 3340 | 62,050 | 11,550 |
| 10-23 | 1510 | 5 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | 1685.0 | 15 | .47 | 2.05 | 3338 | 59,900 | 10,900 |
| 10-23 | 1513 | 6 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | 1685.9 | 15 | .50 | 2.03 | | 60,050 | 11,400 |
| 10-23 | 1516 | 7 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | 1687.1 | 15 | .50 | 2.03 | | 59,550 | 10,250 |
| 10-23 | 1519 | 8 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | 1679.4 | 15 | .49 | 2.01 | 3357 | 60,550 | 10,900 |
| 10-23 | 1523 | 9 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | 1686.1 | 15 | .47 | 2.05 | 3333 | 59,800 | 10,850 |
| | | | | Averages | | | 1686.1 | | .49 | 2.04 | 3342 | 60,317 | 10,975 |
| 10-23 | 1527 | 10 | IMR 7013 | 1A40302 | 620 | T2-2 (Nylon | 1607.6 | 20 | .47 | | 3346 | 59,450 | 10,650 |
| 10-23 | 1536 | 12 | IMR 7013 | 1A40302 | 620 | Rotating Band | 1608.5 | 20 | | | | | |
| 10-23 | 1557 | 14 | IMR 7013 | 1A40302 | 620 | 0.834 Dia.) | 1606.2 | 20 | .50 | 1.99 | 3314 | 56,150 | 11,100 |
| 10-23 | 1604 | 16 | IMR 7013 | 1A40302 | 620 | | 1606.0 | 20 | .47 | | 3292 | 54,050 | |
| 10-23 | 1612 | 18 | IMR 7013 | 1A40302 | 620 | | 1601.2 | 20 | .49 | | 3316 | 56,775 | |
| 10-23 | 1625 | 20 | IMR 7013 | 1A40302 | 620 | | 1610.0 | 20 | .48 | | 3331 | 57,000 | |
| 10-23 | 1637 | 22 | IMR 7013 | 1A40302 | 620 | | 1610.6 | 20 | .50 | | 3362 | 62,350 | |
| | | | | Averages | | | 1606.9 | | .49 | 1.99 | 3327 | 57,629 | 10,875 |
| 10-23 | 1532 | 11 | IMR 7013 | 1A40302 | 620 | T2-2 (Nylon | 1606.2 | 20 | .42 | | | 55,600 | |
| 10-23 | 1555 | 13 | IMR 7013 | 1A40302 | 620 | Rotating Band) | 1597.6 | 20 | .47 | | 3316 | 55,550 | |
| 10-23 | 1600 | 15 | IMR 7013 | 1A40302 | 620 | | 1605.8 | 20 | .50 | | 3305 | 55,500 | |
| 10-23 | 1608 | 17 | IMR 7013 | 1A40302 | 620 | | 1591.7 | 20 | .48 | | 3318 | 55,550 | |
| 10-23 | 1618 | 19 | IMR 7013 | 1A40302 | 620 | | 1611.0 | 20 | .49 | | 3329 | 57,850 | |
| 10-23 | 1631 | 21 | IMR 7013 | 1A40302 | 620 | | 1604.0 | 20 | .44 | | 3322 | 56,550 | |
| 10-23 | 1643 | 23 | IMR 7013 | 1A40302 | 620 | | 1602.5 | 20 | .51 | | 3344 | 59,600 | |
| | | | | Averages | | | 1602.7 | | .47 | | 3322 | 56,600 | |

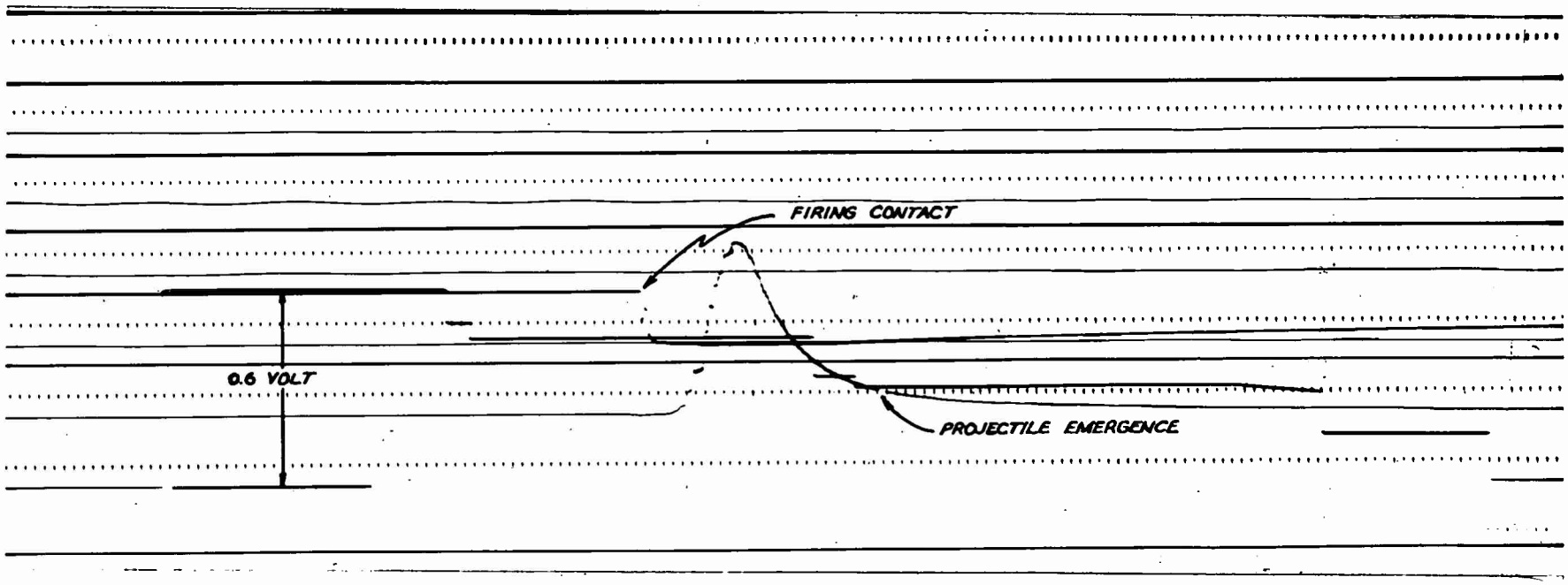
* Not included in average.

TABLE 4 (Continued)

Barrel No. 862904 Chemically Decoppered
717 Previous Rounds

| Date 1953 | Time | Rd. | Powder Type | Powder Lot | Powder Weight (Grains) | Projectile Type | Projectile Weight (Grains) | Crimp (Tons) | Times (ms) Ignition | Times (ms) Emergence | Muzzle Velocity (ft./sec.) | Piezo Pressure (psi) Peak | Piezo Pressure (psi) Muzzle Exit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11-24 | 1321 | 1 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | | 15 | Warm-up | Warm-up | | | |
| 11-24 | 1333 | 2 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | | 15 | Warm-up | Warm-up | | | |
| 11-24 | 1345 | 3 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | | 15 | Warm-up | Warm-up | | | |
| 11-24 | 1352 | 4 | IMR 7013 | 1A40302 | 620 | T2-2 (Nylon | 1600.1 | 20 | .45 | | 3346 | 62,500 | 1,500 |
| 11-24 | 1412 | 6 | IMR 7013 | 1A40302 | 620 | Rotating Band | 1596.1 | 20 | .41 | | 3329 | 61,000 | 10,000 |
| 11-25 | 1342 | 7 | IMR 7013 | 1A40302 | 620 | 0.834 Dia.) | 1601.8 | 20 | | 2.21 | 3320 | 58,750 | 9,900 |
| | | | | Averages | | | 1599.3 | | .43 | 2.21 | 3332 | 60,750 | 9,800 |
| 11-24 | 1405 | 5 | IMR 7013 | 1A40302 | 620 | T2-2 (Nylon | 1600.8 | 20 | .40 | 2.11 | 3286 | 57,800 | 10,300 |
| 11-24 | 1420 | 7 | IMR 7013 | 1A40302 | 620 | Rotating Band) | 1598.3 | 20 | .40 | 2.10 | 3270 | 56,200 | 10,475 |
| 11-25 | 1338 | 6 | IMR 7013 | 1A40302 | 620 | | 1602.8 | 20 | | 2.22 | 3281 | 55,850 | 9,750 |
| | | | | Averages | | | 1600.6 | | .40 | 2.14 | 3279 | 56,617 | 10,175 |
| 11-25 | 1345 | 8 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | 1695.5 | 15 | .45 | 2.17 | 3342 | 63,650 | 10,200 |
| 11-25 | 1354 | 9 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | 1700.2 | 15 | .45 | 2.17 | 3336 | 63,350 | 10,200 |
| 11-25 | 1357 | 10 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | 1699.2 | 15 | .49 | 2.15 | 3318 | 60,850 | 10,150 |
| 11-25 | 1400 | 11 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | 1696.0 | 15 | .49 | 2.16 | 3325 | 62,200 | 10,350 |
| 11-25 | 1404 | 12 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | 1695.2 | 15 | .45 | 2.16 | 3336 | 62,750 | 10,350 |
| 11-25 | 1407 | 13 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | 1697.5 | 15 | .50 | 2.10 | 3338 | 62,900 | 10,650 |
| 11-25 | 1411 | 14 | IMR 6962 | DSZA-8 | 662 | Mk 11 Mod 0 | 1702.5 | 15 | .44 | 2.16 | 3314 | 61,250 | 10,500 |
| | | | | Averages | | | 1698.0 | | .47 | 2.15 | 3330 | 62,421 | 10,343 |


FIRING CONTACT
PROJECTILE EMERGENCE
0.6 VOLT

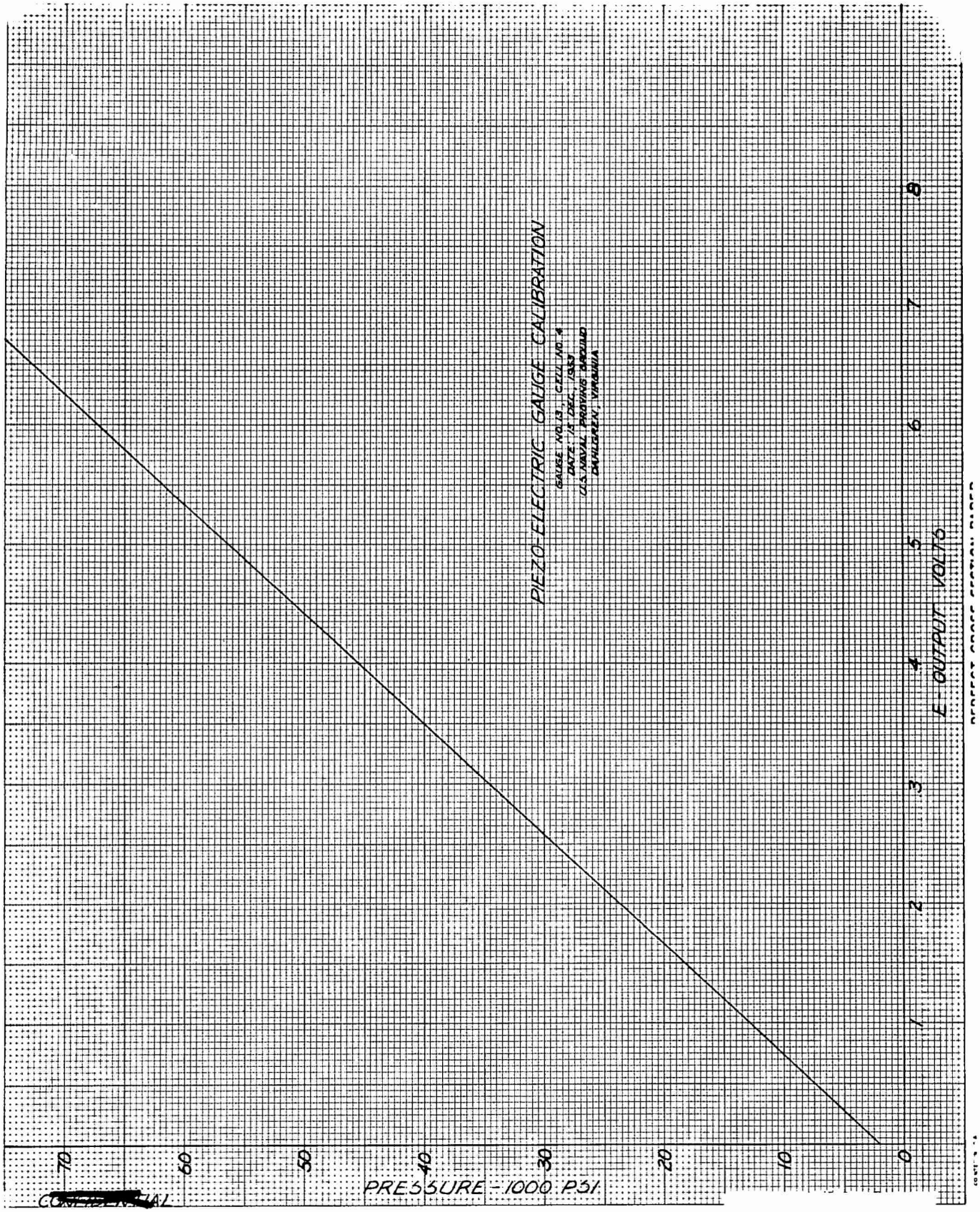



NP9-64994 CONFIDENTIAL

Typical piezo pressure record of 20mm round assembled with Type 2 Mod 2 Modified Projectiles (band diameter 0".834). Time in 0.1 milliseconds.

Figure 17

APPENDIX C

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NP9 64995

Figure 18

APPENDIX C

# APPENDIX D

[redacted]

TABLE 5

ACCURACY TEST, 600 FOOT RANGE FIRED IN NEW ACCURACY BARREL

7 August 1953

| Rd. No. | Projectile Type | Powder Charge IMR 7013 (Grains) | Corrected Muzzle Velocity (ft./sec.) | Yaw at 38 Feet (Degrees) | Width of Pattern (ins.) | Height of Pattern (ins.) | Distance from Center of Impact Area (ins.) X | Distance from Center of Impact Area (ins.) Y | Distance of Center of Impact Area from Boresight (ins.) X | Distance of Center of Impact Area from Boresight (ins.) Y | Standard Deviation at 600 Feet (ins.) X | Standard Deviation at 600 Feet (ins.) Y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | T2-2 (Nylon Rotating Band) | 620 | 3297 | 3 | | | +8.3 | +2.7 | | | | |
| 2 | (Standard Crimp) | 620 | 3302 | 5 | | | +2.1 | -6.6 | | | | |
| 3 | | 620 | 3266 | 2 | | | -1.3 | -4.7 | | | | |
| 4 | | 620 | 3327 | 4 | | | -8.4 | -2.9 | | | | |
| 5 | | 620 | 3320 | 2 | | | +2.1 | -5.2 | | | | |
| 6 | | 620 | 3290 | 5 | | | -6.5 | +6.7 | | | | |
| 7 | | 620 | 3331 | 5 | | | +7.7 | +5.3 | | | | |
| 8 | | 620 | 3292 | 4 | | | -8.2 | -5.9 | | | | |
| 9 | | 620 | 3299 | 4 | | | -6.7 | +3.3 | | | | |
| 10 | | 620 | 3314 | 2 | | | -1.8 | -6.8 | | | | |
| Average | | | 3304 | | 16.7 | 13.4 | | | -3.3 | -3.9 | 6.13 | 5.25 |
| 11 | T2-2 (Nylon Rotating Band | 620 | 3320 | 4 | | | -2.9 | -3.8 | | | | |
| 12 | 0.823 Diameter) | 620 | 3327 | 2 | | | -2.9 | +2.5 | | | | |
| 13 | (Special Crimp) | 620 | 3316 | 5 | | | +6.6 | -1.4 | | | | |
| 14 | | 620 | 3336 | 1 | | | -4.4 | +2.5 | | | | |
| 15 | | 620 | 3336 | 2 | | | -4.5 | +1.9 | | | | |
| 16 | | 620 | 3331 | 1 | | | -6.6 | +1.1 | | | | |
| 17 | | 620 | 3318 | 1 | | | -3.6 | +3.1 | | | | |
| 18 | | 620 | 3320 | 2 | | | -3.3 | +1.5 | | | | |
| 19 | | 620 | 3340 | 3 | | | -3.1 | -4.7 | | | | |
| 20 | | 620 | 3353 | 1 | | | -2.9 | +4.8 | | | | |
| Average | | | 3330 | | 13.1 | 9.5 | | | +0.4 | -12.9 | 4.33 | 3.04 |
| 21 | T2-2 (Nylon Rotating Band) | 620 | 3375 | 1 | | | -4.1 | -4.5 | | | | |
| 22 | (Special Crimp) | 620 | 3349 | 1 | | | +1.0 | -0.1 | | | | |
| 23 | | 620 | 3355 | 2 | | | -3.5 | -2.7 | | | | |
| 24 | | 620 | 3355 | 3 | | | +3.9 | -5.5 | | | | |
| 25 | | 620 | 3342 | 3 | | | +1.2 | -3.3 | | | | |
| 26 | | 620 | 3377 | 3 | | | -5.4 | -5.0 | | | | |
| 27 | | 620 | 3336 | 3 | | | +0.7 | -9.2 | | | | |
| 28 | | 620 | 3338 | 3 | | | +3.4 | +7.5 | | | | |
| 29 | | 620 | 3353 | 2 | | | -1.0 | +6.0 | | | | |
| 30 | | 620 | 3349 | 4 | | | +5.4 | +9.2 | | | | |
| Average | | | 3353 | | 10.7 | 18.4 | | | -1.9 | -10.0 | 3.34 | 6.03 |

TABLE 5 (Continued)

| Rd. No. | Projectile Type | Powder Charge IMR 7013 (Grains) | Corrected Muzzle Velocity (ft./sec.) | Yaw at 38 Feet (Degrees) | Width of Pattern (ins.) | Height of Pattern (ins.) | Distance from Center of Impact Area (ins.) X | Distance from Center of Impact Area (ins.) Y | Distance of Center of Impact Area from Boresight (ins.) X | Distance of Center of Impact Area from Boresight (ins.) Y | Standard Deviation at 600 Feet (ins.) X | Standard Deviation at 600 Feet (ins.) Y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31 | T2-2 (Nylon Rotating Band) | 620 | -- | 2 | | | +2.1 | -1.4 | | | | |
| 32 | (Fired at -65°F) | 620 | 3217 | 2 | | | +5.8 | -1.6 | | | | |
| 33 | (Special Crimp) | 620 | -- | 3 | | | +0.2 | -4.1 | | | | |
| 34 | | 620 | -- | 1 | | | -4.1 | -0.7 | | | | |
| 35 | | 620 | -- | 2 | | | -5.7 | -1.8 | | | | |
| 36 | | 620 | 3163 | 3 | | | -4.6 | +4.5 | | | | |
| 37 | | 620 | 3161 | 2 | | | -3.5 | -2.0 | | | | |
| 38 | | 620 | -- | 2 | | | -4.1 | -3.2 | | | | |
| 39 | | 620 | -- | 2 | | | -0.8 | -4.5 | | | | |
| 40 | | 620 | -- | 2 | | | -2.5 | -2.4 | | | | |
| Average | | | 3180 | | 11.5 | 9.0 | | | -3.2 | -9.1 | 3.85 | 2.96 |
| 41 | T2-2 (Nylon Rotating Band) | 620 | 3279 | 3 | | | -3.3 | -5.9 | | | | |
| 42 | 0.834 Diameter) | 620 | -- | 3 | | | +2.7 | -3.5 | | | | |
| 43 | (Special Crimp) | 620 | 3264 | 1 | | | +4.0 | +3.8 | | | | |
| 44 | | 620 | 3264 | 2 | | | +0.9 | +2.5 | | | | |
| 45 | | 620 | 3295 | 2 | | | -2.0 | -1.3 | | | | |
| 46 | | 620 | 3270 | 1 | | | +1.5 | -1.4 | | | | |
| 47 | | 620 | 3275 | 3 | | | +1.8 | -2.7 | | | | |
| 48 | | 620 | 3275 | 1 | | | -0.5 | +0.7 | | | | |
| 49 | | 620 | 3286 | 3 | | | -4.0 | +6.9 | | | | |
| 50 | | 620 | 3288 | 3 | | | -1.9 | -4.8 | | | | |
| Average | | | 3277 | | 8.0 | 11.8 | | | -6.9 | -10.0 | 2.57 | 3.92 |
| 51 | Reference Rounds, Mk 11 | 633 | 3373 | 3 | | | +1.7 | -0.8 | | | | |
| 52 | Mod 0 | 633 | 3351 | 3 | | | -2.2 | +0.5 | | | | |
| 53 | (Standard Crimp) | 633 | 3377 | 3 | | | -2.2 | +0.7 | | | | |
| 54 | | 633 | 3344 | 4 | | | +2.8 | +0.3 | | | | |
| 55 | | 633 | 3362 | 2 | | | -4.0 | -2.5 | | | | |
| 56 | | 633 | 3366 | 3 | | | -1.7 | -1.5 | | | | |
| 57 | | 633 | 3353 | 2 | | | -2.6 | 0.0 | | | | |
| 58 | | 633 | 3371 | 3 | | | -2.4 | +0.3 | | | | |
| 59 | | 633 | 3353 | 3 | | | +0.7 | -1.4 | | | | |
| 60 | | 633 | 3357 | 2 | | | +4.0 | +2.5 | | | | |
| Average | | | 3361 | | 8.0 | 5.1 | | | -4.0 | -9.5 | 2.63 | 1.38 |

TABLE 6 — ACCURACY TEST, 600 FOOT RANGE FIRED IN NEW ACCURACY BARREL — 11 March 1954

| Rd. No. | Projectile Type | Powder Charge IMR 7013 (Grains) | Corrected Muzzle Velocity (ft./sec.) | Yaw at 38 Feet (Degrees) | Yaw at 600 Feet (Degrees) | Distance from Center of Impact Area (ins.) X | Distance from Center of Impact Area (ins.) Y | Distance of Center of Impact Area from Boresight (ins.) X | Distance of Center of Impact Area from Boresight (ins.) Y | Total Group Dispersion at 600 Feet (ins.) X | Total Group Dispersion at 600 Feet (ins.) Y | Standard Deviation at 600 Feet (ins.) X | Standard Deviation at 600 Feet (ins.) Y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Reference Rounds, | 633 | 3324 | 1 | 0 | -2.73 | -0.60 | | | | | | |
| 2 | 20mm Projectile | 633 | 3299 | 0 | 0 | +2.17 | +0.47 | | | | | | |
| 3 | Mk 11 Mod 0 | 633 | -- | 0 | 0 | +1.33 | -2.31 | | | | | | |
| 4 | | 633 | 3295 | 0 | 0 | -3.84 | -1.28 | | | | | | |
| 5 | | 633 | 3323 | 2 | 0 | +3.32 | +1.52 | | | | | | |
| 6 | | 633 | 3323 | 1 | 0 | +3.84 | +2.23 | | | | | | |
| 7 | | 633 | 3306 | 1 | 0 | +1.58 | +0.12 | | | | | | |
| 8 | | 633 | 3286 | 1 | 0 | -0.16 | -0.98 | | | | | | |
| 9 | | 633 | 3301 | 0 | 0 | -0.65 | +2.31 | | | | | | |
| 10 | | 633 | 3299 | 0 | 0 | +0.78 | +0.12 | | | | | | |
| Average | | | 3306 | 0.6 | | | | +2.35 | -2.28 | 7.68 | 4.62 | 2.468 | 1.524 |
| 11 | T2-Mod 2 (Nylon | 620 | 3255 | 1 | 0 | +1.30 | +0.10 | | | | | | |
| 12 | Rotating Band) | 620 | 3267 | 0 | 0 | -1.88 | +2.18 | | | | | | |
| 13 | | 620 | 3263 | 0 | 0 | -1.32 | -2.15 | | | | | | |
| 14 | | 620 | 3263 | 0 | 0 | -3.86 | -0.22 | | | | | | |
| 15 | | 620 | 3293 | 2 | 0 | +3.86 | -5.63 | | | | | | |
| 16 | | 620 | 3265 | 0 | 0 | -2.12 | +4.34 | | | | | | |
| 17 | | 620 | 3257 | 0 | 0 | -3.50 | +0.90 | | | | | | |
| 18 | | 620 | 3265 | 2 | 0 | -3.75 | +2.42 | | | | | | |
| 19 | | 620 | 3274 | 2 | 0 | +1.33 | +5.63 | | | | | | |
| 20 | | 620 | 3255 | 0 | 0 | -3.00 | +2.17 | | | | | | |
| Average | | | 3266 | 0.7 | | | | +5.75 | -0.63 | 11.26 | 7.72 | 2.616 | 3.224 |
| 21 | T2-Mod 6 (Nylon | 620 | 3308 | 0 | 0 | -1.23 | -4.25 | | | | | | |
| 22 | Rotating Band) | 620 | 3308 | 1 | 0 | -6.42 | -2.14 | | | | | | |
| 23 | 0".784 Diameter | 620 | 3299 | 2 | 0 | +1.87 | +7.95 | | | | | | |
| 24 | Aft of Band | 620 | 3282 | 1 | 0 | -3.67 | -0.23 | | | | | | |
| 25 | | 620 | 3291 | 2 | 0 | +6.62 | +1.80 | | | | | | |
| 26 | | 620 | 3280 | 1 | 0 | +8.73 | -3.17 | | | | | | |
| 27 | | 620 | 3295 | 2 | 0 | +4.40 | -7.95 | | | | | | |
| 28 | | 620 | 3274 | 1 | 0 | +1.22 | +4.12 | | | | | | |
| 29 | | 620 | 3288 | 1 | 0 | -8.73 | -5.20 | | | | | | |
| 30 | | 620 | 3286 | 2 | 0 | +2.02 | +1.30 | | | | | | |
| Average | | | 3291 | 1.3 | | | | +3.90 | -3.75 | 17.46 | 15.90 | 5.563 | 4.738 |

TABLE 7

ACCURACY TEST, 1500 YARD RANGE FIRED IN NEW ACCURACY BARREL

22 and 26 August 1953

| Date 1953 | Time | Rd. No. | Ammunition Lot Number and/or Projectile Type | Powder Charge IMR 7013 (Grains) | Air Temp. °F | Relative Humidity (%) | Wind Direction From Line of Fire | Wind Velocity (knots) | Barometric Press at 21 Feet Above Sea Level (millibars) | Ammunition Temp. °F | Gun Elevation | Muzzle to First Screen (Feet) | Distance Between Screens (Feet) | Instrumental Velocity (ft./sec.) | Time of Flight Muzzle to Target (Seconds) | Diagional Distance From Microphone to Projectile Location (Feet) | Projectile Weight (Grains) | Hit Position (Feet) Horizontal | Hit Position (Feet) Vertical | Standard Deviation at 1500 Yards (Feet) X | Standard Deviation at 1500 Yards (Feet) Y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-22 | 1413 | 1 | Reference | 633 | 80 | 48 | -- | 0 | 1024.2 | 76 | 54'06" | 30.095 | 49.965 | 3333 | 2.186 | 7.29 | 1702.3 | 10.92 | 4.36 | | |
| 8-22 | 1415 | 2 | Rounds, 20mm | 633 | 78 1/2 | | -- | 0 | | 76 1/2 | 54'06" | | | 3331 | 2.182 | 5.58 | 1704.3 | 11.97 | 6.04 | | |
| 8-22 | 1416 | 3 | Projectile | 633 | 78 1/2 | | 340 | 2 | | 76 | 54'06" | | | 3318 | 2.188 | 6.59 | 1695.5 | 10.94 | 5.09 | | |
| 8-22 | 1421 | 4 | Mk 11 Mod 0 | 633 | 78 | | 5 | 2 | | 77 | 54'06" | | | 3333 | 2.190 | 6.74 | 1700.4 | 10.20 | 5.04 | | |
| 8-22 | 1425 | 5 | | 633 | 78 | | 320 | 3 | | 76 1/2 | 54'24" | | | 3351 | 2.179 | 9.02 | 1700.0 | 4.90 | 5.75 | | |
| 8-22 | 1427 | 6 | | 633 | 78 | | 325 | 1 | | 77 | 54'24" | | | 3316 | 2.203 | 9.31 | 1699.0 | 10.03 | 2.44 | | |
| 8-22 | 1428 | 7 | | 633 | 78 | 48 | 330 | 5 | 1024.2 | 77 | 54'24" | | | 3327 | 2.216 | 11.10 | 1700.5 | 9.56 | 0.75 | | |
| 8-22 | 1430 | 8 | | 633 | 78 | | 305 | 3 | | 77 | 54'24" | | | 3329 | 2.190 | 6.21 | 1699.8 | 13.34 | 5.62 | | |
| 8-22 | 1442 | 9 | | 633 | 80 | | -- | 0 | | 77 | 54'24" | | | 3329 | 2.207 | 10.07 | 1698.5 | 12.00 | 1.56 | | |
| 8-22 | 1444 | 10 | | 633 | 78 1/2 | | 335 | 3 | | 77 | 54'24" | | | 3318 | -- | 5.99 | 1702.9 | 10.19 | 5.85 | | |
| 8-22 | 1448 | 11 | | 633 | 78 1/2 | | 355 | 1 | | 77 1/2 | 54'24" | | | 3313 | 2.212 | 7.08 | 1697.1 | 9.95 | 4.76 | | |
| 8-22 | 1449 | 12 | | 633 | 78 1/2 | | 330 | 2 | | 77 1/2 | 54'24" | | | 3340 | 2.200 | 8.17 | 1694.9 | 9.28 | 3.85 | | |
| 8-22 | 1456 | 13 | | 633 | 79 1/2 | | -- | 0 | | 78 | 54'24" | | | 3320 | 2.222 | 11.01 | 1696.9 | 8.99 | 0.96 | | |
| 8-22 | 1458 | 14 | | 633 | 79 1/2 | | 65 | 1 | | 78 | 54'24" | | | 3324 | 2.203 | 6.54 | 1705.6 | 12.64 | 5.13 | | |
| 8-22 | 1459 | 15 | | 633 | 80 | | 0 | 1 | | 78 | 54'24" | | | 3324 | 2.206 | 7.39 | 1703.5 | 10.89 | 4.28 | | |
| 8-22 | 1501 | 16 | | 633 | 78 1/2 | 49 | 5 | 3 | 1023.3 | 78 | 54'24" | | | 3289 | 2.239 | 7.70 | 1697.4 | 11.40 | 3.92 | | |
| 8-22 | 1502 | 17 | | 633 | 79 | | 345 | 3 | | 78 | 54'24" | | | 3316 | 2.205 | 7.82 | 1699.8 | 8.97 | 4.30 | | |
| 8-22 | 1503 | 18 | | 633 | 78 | | 320 | 2 | | 78 | 54'24" | | | 3333 | 2.206 | 8.76 | 1699.2 | 11.19 | 2.87 | | |
| 8-22 | 1505 | 19 | | 633 | 79 1/2 | | 10 | 1 | | 78 | 54'24" | | | 3309 | 2.200 | 9.32 | 1701.5 | 6.78 | 3.71 | | |
| 8-22 | 1506 | 20 | | 633 | 80 | | 50 | 2 | | 78 | 54'24" | | | 3324 | 2.190 | 10.91 | 1698.7 | 10.79 | 0.77 | | |
| 8-22 | 1508 | 21 | | 633 | 80 | | 30 | 1 | | 78 | 54'24" | | | 3324 | 2.185 | 7.96 | 1701.7 | 7.60 | 4.87 | | |
| 8-22 | 1509 | 22 | | 633 | 79 1/2 | | 30 | 2 | | 78 | 54'24" | | | 3324 | 2.192 | 8.21 | 1696.9 | 7.60 | 4.54 | | |
| 8-22 | 1510 | 23 | | 633 | 80 | | -- | 0 | | 78 | 54'24" | | | 3333 | 2.185 | 6.67 | 1702.2 | 9.84 | 5.23 | | |
| 8-22 | 1512 | 24 | | 633 | 79 | | -- | 0 | | 78 | 54'24" | | | 3313 | 2.202 | 10.57 | 1705.3 | 10.60 | 1.11 | | |
| 8-22 | 1513 | 25 | | 633 | 79 | | 10 | 3 | | 78 | 54'24" | | | 3316 | 2.218 | 11.12 | 1696.9 | 11.11 | 0.51 | | |
| 8-22 | 1515 | 26 | | 633 | 79 | | -- | 0 | | 79 | 54'24" | | | 3324 | 2.165 | 6.48 | 1702.1 | 10.00 | 5.37 | 1.842 | 1.806 |
| 8-26 | 1035 | 1 | | 620 | 82 1/2 | 55 | -- | 0 | 1021.9 | 79 | 56'00" | 30.030 | 50.025 | 3293 | 2.242 | 9.60 | 1607 | 5.68 | 18.63 | | |
| 8-26 | 1039 | 2 | | 620 | 82 1/2 | | 210 | 2 | | 79 | 56'00" | | | 3300 | 2.278 | 10.36 | 1607 | 1.85 | 7.99 | | |
| 8-26 | 1043 | 3 | | 620 | 83 | | -- | 0 | | 79 | 56'00" | | | 3306 | 2.192 | 7.53 | 1593 | 6.88 | 5.41 | | |
| 8-26 | 1046 | 4 | T2-2 | 620 | 83 | | 165 | 2 | | 79 | 56'00" | | | 3291 | 2.223 | 7.01 | 1604 | 8.08 | 5.18 | | |
| 8-26 | 1048 | 5 | (Nylon Rotat- | 620 | 83 | | -- | 0 | | 79 | 56'36" | | | 3298 | 2.220 | 7.26 | 1606 | 6.14 | 15.79 | | |
| 8-26 | 1051 | 6 | ing Band, | 620 | 84 | | -- | 0 | | 79 | 56'36" | | | 3302 | 2.260 | 5.84 | 1607 | 6.46 | 13.76 | | |
| 8-26 | 1053 | 7 | 0.828 Diam- | 620 | 84 | | -- | 0 | | 79 | 56'36" | | | 3306 | 2.213 | 10.12 | 1607 | 2.27 | 7.47 | | |
| 8-26 | 1055 | 8 | eter) | 620 | 83 1/2 | | 320 | 2 | | 80 | 56'36" | | | 3315 | 2.177 | 2.31 | 1598 | 9.46 | 10.69 | | |
| 8-26 | 1057 | 9 | | 620 | 83 1/2 | | 230 | 1 | | 80 | 56'36" | | | 3317 | 2.169 | 8.85 | 1602 | 4.05 | 15.64 | | |
| 8-26 | 1059 | 10 | | 620 | 84 | | -- | 0 | | 80 | 56'46" | | | 3324 | 2.219 | 7.82 | 1607 | 6.23 | 5.59 | | |
| 8-26 | 1113 | 11 | | 620 | 84 | 55 | -- | 0 | 1021.9 | 80 | 56'46" | | | 3293 | 2.260 | 6.62 | 1598 | 11.01 | 4.61 | | |
| 8-26 | 1115 | 12 | | 620 | 85 | | 230 | 1 | | 80 | 56'46" | | | 3315 | -- | 2.69 | 1605 | 9.31 | 12.38 | | |
| 8-26 | 1117 | 13 | | 620 | 84 | | -- | 0 | | 80 | 56'46" | | | 3309 | 2.190 | 4.43 | 1602 | 8.52 | 14.25 | | |
| 8-26 | 1119 | 14 | | 620 | 84 1/2 | | -- | 0 | | 80 | 56'46" | | | 3309 | 2.198 | 5.58 | 1602 | 10.30 | 5.78 | | |
| 8-26 | 1120 | 15 | | 620 | 85 | | -- | 0 | | 80 | 56'46" | | | 3322 | 2.191 | 5.58 | 1602 | 6.22 | 12.14 | | |
| 8-26 | 1122 | 16 | | 620 | 85 | | -- | 0 | | 80 | 56'46" | | | 3326 | 2.167 | 6.22 | 1609 | 6.75 | 7.44 | | |
| 8-26 | 1125 | 17 | | 620 | 85 | | -- | 0 | | 80 1/2 | 56'46" | | | 3298 | 2.258 | 3.14 | 1607 | 14.13 | 9.18 | | |
| 8-26 | 1127 | 18 | | 620 | 86 | | 160 | 1 | | 81 | 56'46" | | | 3291 | 2.193 | 4.69 | 1598 | 7.28 | 12.73 | | |
| 8-26 | 1130 | 19 | | 620 | 86 1/2 | | 230 | 2 | | 81 1/2 | 56'46" | | | 3313 | 2.190 | 7.05 | 1605 | 4.93 | 9.23 | | |
| 8-26 | 1133 | 20 | | 620 | 86 1/2 | | -- | 0 | | 82 | 56'46" | | | 3322 | 2.193 | 5.70 | 1607 | 7.94 | 15.43 | | |
| 8-26 | 1135 | 21 | | 620 | 86 1/2 | | -- | 0 | | 82 | 56'46" | | | 3320 | 2.172 | 9.36 | 1607 | 2.77 | 13.79 | | |
| 8-26 | 1137 | 22 | | 620 | 86 | | 210 | 2 | | 82 | 56'46" | | | 3387 | 2.238 | 7.26 | 1595 | 5.24 | 14.50 | | |
| 8-26 | 1139 | 23 | | 620 | 86 1/2 | | -- | 0 | | 82 | 56'46" | | | 3289 | 2.219 | 3.50 | 1607 | 8.25 | 10.58 | | |
| 8-26 | 1141 | 24 | | 620 | 86 | | -- | 0 | | 82 | 56'46" | | | 3304 | 2.188 | 5.16 | 1605 | 7.79 | 7.84 | | |
| 8-26 | 1142 | 25 | | 620 | 86 1/2 | | -- | 0 | | 82 1/2 | 57'06" | | | 3315 | 2.159 | 9.12 | 1600 | 3.83 | 15.75 | | |
| 8-26 | 1151 | 26 | | 620 | 87 | 59 | -- | 0 | 1021.5 | 83 | 57'06" | | | 3291 | 2.207 | 6.28 | 1605 | 6.36 | 7.88 | 2.771 | 4.054 |

TABLE 7 (Continued)

| Date 1953 | Time | Rd. No. | Ammunition Lot Number and/or Projectile Type | Powder Charge IMR 7013 (Grains) | Air Temp. °F | Relative Humidity (%) | Wind Direction From Line of Fire | Wind Velocity (knots) | Barometric Press at 21 Feet Above Sea Level (millibars) | Ammunition Temp. °F | Gun Elevation | Muzzle to First Screen (Feet) | Distance Between Screens (Feet) | Instrumental Velocity (ft./sec.) | Time of Flight Muzzle to Target (Seconds) | Diagional Distance From Microphone to Projectile Location (Feet) | Projectile Weight (Grains) | Hit Position (Feet) Horizontal | Hit Position (Feet) Vertical | Standard Deviation at 1500 Yards (Feet) X | Standard Deviation at 1500 Yards (Feet) Y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-26 | 1239 | 1 | T2-2 (Nylon | 620 | 88 1/2 | 47 | -- | 0 | 1021.2 | 83 1/2 | 57'06" | 30.030 | 50.025 | 3278 | 2.300 | 7.88 | 1605 | 5.09 | 6.93 | | |
| 8-26 | 1241 | 2 | Rotating Band, | 620 | 88 1/2 | | -- | 0 | | 84 | 57'06" | | | 3287 | 2.247 | 7.15 | 1608 | 7.62 | 5.33 | | |
| 8-26 | 1243 | 3 | 0.834 Diam- | 620 | 88 | | 335 | 2 | | 84 | 57'06" | | | 3274 | 2.275 | 8.71 | 1604 | 9.16 | 2.87 | | |
| 8-26 | 1245 | 4 | ster) | 620 | 88 1/2 | | 315 | 2 | | 84 | 57'06" | | | 3298 | 2.218 | 6.41 | 1604 | 6.43 | 7.52 | | |
| 8-26 | 1246 | 5 | | 620 | 88 1/2 | | 310 | 4 | | 84 | 57'06" | | | 3257 | 2.286 | 2.48 | 1600 | 13.57 | 9.56 | | |
| 8-26 | 1248 | 6 | | 620 | 88 1/2 | | 315 | 4 | | 84 1/2 | 57'06" | | | 3263 | 2.253 | 5.48 | 1607 | 7.86 | 7.29 | | |
| 8-26 | 1250 | 7 | | 620 | 88 1/2 | | 335 | 2 | | 84 1/2 | 57'06" | | | 3295 | 2.230 | 1.70 | 1605 | 10.04 | 10.75 | | |
| 8-26 | 1251 | 8 | | 620 | 88 1/2 | 47 | 305 | 4 | 1021.2 | 84 1/2 | 57'06" | | | 3263 | 2.289 | 6.32 | 1602 | 8.22 | 5.90 | | |
| 8-26 | 1252 | 9 | | 620 | 87 1/2 | | 305 | 4 | | 84 1/2 | 57'06" | | | 3276 | 2.238 | 5.01 | 1605 | 6.83 | 9.94 | | |
| 8-26 | 1255 | 10 | | 620 | 87 | | 300 | 4 | | 84 1/2 | 57'06" | | | 3280 | 2.279 | 8.72 | 1605 | 4.08 | 6.96 | | |
| 8-26 | 1257 | 11 | | 620 | 87 | | 335 | 3 | | 84 1/2 | 57'06" | | | 3291 | 2.218 | 4.53 | 1605 | 7.96 | 8.64 | | |
| 8-26 | 1259 | 12 | | 620 | 87 1/2 | | 320 | 2 | | 84 1/2 | 57'06" | | | 3274 | 2.240 | 6.36 | 1604 | 5.35 | 11.43 | | |
| 8-26 | 1301 | 13 | | 620 | 88 | 47 | 330 | 3 | 1021.2 | 84 1/2 | 57'06" | | | 3287 | 2.271 | 3.79 | 1600 | 13.64 | 14.39 | | |
| 8-26 | 1303 | 14 | | 620 | 88 1/2 | | 325 | 2 | | 85 | 57'06" | | | 3272 | 2.321 | 5.86 | 1602 | 5.95 | 10.22 | | |
| 8-26 | 1305 | 15 | | 620 | 88 1/2 | | 340 | 3 | | 85 | 57'06" | | | 3295 | 2.252 | 4.30 | 1594 | 9.49 | 7.49 | | |
| 8-26 | 1306 | 16 | | 620 | 88 1/2 | | -- | 0 | | 85 | 57'06" | | | 3293 | 2.247 | 6.19 | 1610 | 6.43 | 7.94 | | |
| 8-26 | 1308 | 17 | | 620 | 89 | | 340 | 2 | | 85 | 57'06" | | | 3304 | 2.229 | 7.78 | 1595 | 3.96 | 12.04 | | |
| 8-26 | 1310 | 18 | | 620 | 88 1/2 | | 320 | 4 | | 85 | 57'06" | | | 3293 | 2.287 | 3.59 | 1602 | 10.01 | 8.01 | | |
| 8-26 | 1312 | 19 | | 620 | 88 | | 310 | 3 | | 85 | 57'06" | | | 3291 | 2.311 | 10.12 | 1595 | 5.13 | 3.50 | | |
| 8-26 | 1314 | 20 | | 620 | 88 1/2 | | 325 | 4 | | 85 | 57'06" | | | 3295 | 2.256 | 6.81 | 1606 | 6.00 | 7.47 | | |
| 8-26 | 1316 | 21 | | 620 | 88 1/2 | | 330 | 2 | | 85 | 57'06" | | | 3285 | 2.263 | 2.68 | 1605 | 9.95 | 13.18 | | |
| 8-26 | 1317 | 22 | | 620 | 88 | | 350 | 3 | | 85 | 57'06" | | | 3282 | 2.249 | 6.52 | 1600 | 5.27 | 10.07 | | |
| 8-26 | 1319 | 23 | | 620 | 88 1/2 | | 305 | 3 | | 85 | 57'06" | | | 3289 | 2.244 | 4.91 | 1600 | 8.00 | 7.96 | | |
| 8-26 | 1321 | 24 | | 620 | 88 | | 290 | 4 | | 85 | 57'06" | | | 3304 | 2.229 | 3.49 | 1597 | 8.70 | 12.96 | | |
| 8-26 | 1322 | 25 | | 620 | 88 | | 290 | 4 | | 85 | 57'06" | | | 3302 | 2.211 | 6.01 | 1604 | 6.09 | 9.04 | 2.556 | 2.846 |
| 8-26 | 1357 | 1 | T2-2 (Nylon | 620 | 89 | | 330 | 3 | | 87 | 56'36" | 30.030 | 50.025 | 3326 | 2.170 | 3.50 | 1602 | 8.27 | 10.37 | | |
| 8-26 | 1402 | 2 | Rotating Band, | 620 | 88 1/2 | 41 | 320 | 4 | 1020.8 | 87 1/2 | 56'36" | | | 3278 | 2.227 | 8.06 | 1602 | 3.67 | 11.25 | | |
| 8-26 | 1404 | 3 | 0.836 Diam- | 620 | 89 | | 305 | 4 | | 87 1/2 | 56'36" | | | 3346 | 2.160 | 6.18 | 1603 | 6.35 | 14.25 | | |
| 8-26 | 1406 | 4 | ster) | 620 | 89 | | 305 | 6 | | 87 1/2 | 56'36" | | | 3355 | 2.150 | 7.81 | 1607 | 5.60 | 16.05 | | |
| 8-26 | 1409 | 5 | | 620 | 90 | | 325 | 1 | | 87 1/2 | 56'36" | | | 3346 | 2.160 | 4.04 | 1600 | 10.88 | 15.09 | | |
| 8-26 | 1411 | 6 | | 620 | 89 1/2 | | 320 | 4 | | 87 1/2 | 56'36" | | | 3293 | 2.222 | 5.80 | 1595 | 7.95 | 6.76 | | |
| 8-26 | 1414 | 7 | | 620 | 89 | | 20 | 2 | | 87 1/2 | 56'36" | | | 3342 | 2.180 | 3.86 | 1600 | 8.00 | 10.10 | | |
| 8-26 | 1418 | 8 | | 620 | 89 | | 20 | 3 | | 88 | 56'36" | | | 3295 | 2.224 | 1.85 | 1602 | 9.98 | 10.55 | | |
| 8-26 | 1420 | 9 | | 620 | 89 1/2 | | 5 | 4 | | 88 | 56'36" | | | 3353 | 2.141 | 6.05 | 1598 | 6.31 | 13.94 | | |
| 8-26 | 1422 | 10 | | 620 | 90 | | 325 | 2 | | 88 | 56'36" | | | 3339 | 2.172 | 9.16 | 1604 | 3.07 | 14.22 | | |
| 8-26 | 1425 | 11 | | 620 | 90 | | 320 | 4 | | 88 | 56'36" | | | 3331 | 2.151 | 3.74 | 1600 | 7.98 | 11.47 | | |
| 8-26 | 1428 | 12 | | 620 | 89 1/2 | | 320 | 2 | | 88 | 56'36" | | | 3326 | 2.189 | 7.63 | 1602 | 4.30 | 13.01 | | |
| 8-26 | 1430 | 13 | | 620 | 90 | | 355 | 3 | | 88 | 56'36" | | | 3348 | 2.160 | 8.96 | 1602 | 3.12 | 13.70 | | |
| 8-26 | 1455 | 14 | | 620 | 90 | | 0 | 4 | | 89 | 56'36" | | | 3360 | 2.145 | 5.54 | 1605 | 6.24 | 10.16 | | |
| 8-26 | 1457 | 15 | | 620 | 90 | | 0 | 4 | | 89 | 56'36" | | | 3328 | 2.194 | 10.62 | 1610 | 1.08 | 11.13 | | |
| 8-26 | 1459 | 16 | | 620 | 91 | | 25 | 1 | | 89 | 56'36" | | | 3342 | 2.172 | 3.07 | 1602 | 10.24 | 8.49 | | |
| 8-26 | 1502 | 17 | | 620 | 91 | 47 | 340 | 3 | 1020.3 | 89 | 56'36" | | | 3346 | 2.169 | 9.19 | 1605 | 2.57 | 11.94 | | |
| 8-26 | 1504 | 18 | | 620 | 91 | | 5 | 3 | | 89 | 56'36" | | | 3355 | 2.150 | 4.95 | 1595 | 7.00 | 12.72 | | |
| 8-26 | 1505 | 19 | | 620 | 90 1/2 | | 5 | 4 | | 89 | 56'36" | | | 3355 | 2.151 | 8.45 | 1602 | 5.35 | 16.71 | | |
| 8-26 | 1510 | 20 | | 620 | 90 | | 355 | 2 | | 89 1/2 | 56'36" | | | -- | 2.144 | 7.92 | 1603 | 5.98 | 16.63 | | |
| 8-26 | 1514 | 21 | | 620 | 90 1/2 | | 330 | 2 | | 89 1/2 | 56'36" | | | 3348 | 2.174 | 6.64 | 1597 | 7.76 | 16.49 | | |
| 8-26 | 1517 | 22 | | 620 | 90 | | 335 | 5 | | 90 | 56'36" | | | 3339 | 2.205 | 7.89 | 1597 | 3.82 | 10.81 | | |
| 8-26 | 1525 | 23 | | 620 | 90 1/2 | | 0 | 5 | | 90 | 56'36" | | | 3274 | 2.245 | 5.52 | 1604 | 8.17 | 6.95 | | |
| 8-26 | 1528 | 24 | | 620 | 90 1/2 | | 5 | 2 | | 90 | 56'36" | | | 3369 | 2.137 | 9.13 | 1602 | 4.76 | 17.10 | | |
| 8-26 | 1531 | 25 | | 620 | 90 | | 310 | 3 | | 90 | 56'36" | | | 3346 | 2.158 | 2.06 | 1598 | 11.29 | 9.16 | 2.707 | 3.019 |

# APPENDIX E

## DATA PERTAINING TO THE RAPID-FIRE GUN LIFE TESTS

### Gun

The 20mm aircraft gun Mk 12 Mod 0 used in these tests, which fires at a rate of approximately 1000 rounds per minute, was mounted on a stationary mount for normal rapid-fire operation.

### Barrel

The 20mm Mk 11 Mod 2 barrels fired in these tests were either chrome plated with 0".006 hard chrome, chamber and bore, or unplated. The rifling had uniform twist of 1 turn in 25.587 calibers, and a uniform depth of ".015.

### Round Assembly

The 20mm Mk 11 Mod 0 (Target) projectiles, both standard and modified (nylon band and extra crimping groove) were assembled in Mk 5 steel cases with Mk 47 primers (with one exception; the primer Mk 4 was used in Barrel No. 856686). The standard projectiles were rubber crimped at a pressure of 15 tsi and the modified projectiles at 20 tsi pressure. The nose plugs were standard pointed dummy nose plugs.

### Powder

The propellant, IMR 7013 Lots CDZA-1 and CDZA-3 (the latter also designated as 1A-40302), was a 20mm NH production powder. The two lots were of the same series, having the same nominal composition and granulation and the same approximate flame temperature (2880°K).

### Yaw

The projectile yaw in degrees was measured at 1000 inches from the gun by means of a traveling paper screen. Actual degrees of yaw for each round was determined by measuring the maximum diameter of the hole cut in this screen.

## Dispersion

The dispersion was measured at 1092 inches from the gun by means of a stationary cardboard target, and is expressed in terms of the horizontal and vertical dimensions in inches of the rectangle on the target enclosing all the impacts in one burst (approximately 50 rounds).

## Velocity

The velocity measurements were taken for each round by means of a Potter recording counter chronograph. The magnetizing coil was placed at the muzzle of the gun and the velocity measured by means of coils placed at 30 and 80 feet from the muzzle.

## Barrel Inspection

The barrels were inspected by observing the rifling and chamber before and after each cycle was fired with a borescope. Photographs were taken at points of interest, before and after firing each cycle, of the barrels firing nylon bands and after each cycle of some of the barrels firing gilding metal bands. The barrels, rifling and chamber, were gauged before and after firing each cycle. Each diameter at a dimension from the gauging plane was gauged three times on three different sets of lands or grooves.

# APPENDIX F

TABLE 8

## TABULATED FIRING DATA

Date Fired: 21 May 1953
20mm Aircraft Gun Mk 12 Mod 0 Serial No. 500056
20mm Barrel Mk 11 Mod 2 Serial No. EX-184 Chrome Plated (No Previous Rounds)
Projectiles: Type 2 Mod 2 (Nylon Bands Lot S2A)
Propellant: 670 grains of IMR 7013, Lot 1A40302 Powder

| Burst | Time | Belted | Fired | Rds. on Barrel | Cyclic Rate (rpm) | Muzzle Velocity (ft./sec.) | Yaw (Degrees)* 0-5 No. Rds. | 6-10 No. Rds. | 11-15 No. Rds. | Over 15 No. Rds. | Dispersion 100% Pattern (ins.) X | Y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1111 | 50 | 50 | 50 | 1041 | 3428±13 | 31 | 12 | 4 | 3 | ( | |
| 2 | 1113 | 50 | 50 | 100 | 1037 | 3416±13 | 30 | 10 | 6 | 4 | **(21.9 | 23.0 |
| 3 | 1115 | 50 | 50 | 150 | 1034 | 3420±15 | 14 | 13 | 12 | 11 | ( | |
| 4 | | 50 | 1) | | -- | | | | | | -- | -- |
| 4 | 1117 | 47 | 47) | 198 | 1030 | 3410±17 | 14 | 12 | 9 | 13 | -- | -- |
| 5 | 1119 | 50 | 50 | 248 | 1029 | 3403±15 | 10 | 8 | 11 | 21 | -- | -- |
| 6 | 1121 | 50 | 50 | 298 | 1028 | 3406±19 | 11 | 6 | 15 | 18 | -- | -- |
| 7 | 1123 | 50 | 50 | 348 | 1021 | 3424±26 | 15 | 10 | 12 | 13 | 22.1 | 26.9 |
| 8 | 1125 | 50 | 50 | 398 | 1010 | 3408±19 | 16 | 8 | 6 | 20 | 26.5 | 27.0 |
| 9 | 1128 | 50 | 50 | 448 | 1014 | 3401±19 | 25 | 4 | 10 | 11 | 25.2 | 24.2 |
| 10 | 1130 | 50 | 17) | | | | | | | | 21.2 | 26.1 |
| 10 | 1130 | 33 | 33) | 498 | 998 | 3398±26 | 21 | 4 | 10 | 15 | 25.9 | 24.6 |
| 11 | 1132 | 50 | 50 | 548 | 1015 | 3419±20 | 33 | 5 | 3 | 8 | ( | |
| 12 | 1134 | 50 | 50 | 598 | 1004 | 3407±20 | 23 | 5 | 11 | 11 | **(26.1 | 27.3 |

NOTES: Gun stoppage Bursts 4 and 10 due to feeder failure.

* Rounds omitted could not be measured.
** An average single-burst-pattern size was calculated statistically from the total pattern size.
The statistical average for first three bursts - Horizontal 18.6, Vertical 19.5.
The statistical average for last two bursts - Horizontal 23.4, Vertical 24.5.

TABLE 9

## TABULATED FIRING DATA

Date Fired: 18 September 1953
20mm Aircraft Gun Mk 12 Mod 0 Serial No. 501151
20mm Barrel Mk 11 Mod 2 Serial No. EX-184 Chrome Plated (598 Previous Rounds)
Projectiles: Type 2 Mod 2 (Nylon Bands Lot S2B)
Propellant: 620 grains IMR 7013, Lot 1A-40302 Powder

| Burst | Time | Belted | Fired | Rds. on Barrel | Cyclic Rate (rpm) | Average Velocity (ft./sec.) | Yaw (Degrees) 0-5 No. Rds. | 6-10 No. Rds. | 11-15 No. Rds. | 16-35 No. Rds. | Dispersion 100% Pattern (ins.) X | Y | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1427 | 50 | 46 | 644 | 967 | 3270±13 | 33 | 8 | 3 | 2 | 18.3 | 16.3 | Slow feed. |
| 2 | 1429 | 50 | 50 | 694 | 976 | 3253±10 | 36 | 3 | 11 | | 16.8 | 17.1 | |
| 3 | 1431 | 50 | 43) | | 978 | | | | | | | | Slow feed. |
| 3 | 1432 | 7 | 7) | 744 | -- | 3256±14 | 19 | 11 | 13 | 7 | 19.4 | 20.1 | |
| 4 | 1434 | 50 | 50 | 794 | 971 | 3238±17 | 19 | 13 | 7 | 11 | 19.7 | 23.0 | |
| 5 | 1436 | 50 | 50 | 844 | 976 | 3249±15 | 15 | 8 | 13 | 14 | 23.0 | 23.8 | |
| 6 | 1438 | 50 | 31) | | 976 | | | | | | | | Slow feed. |
| 6 | 1439 | 19 | 7) | | -- | | | | | | | | Slow feed. |
| 6 | 1439 | 11 | 11) | 893 | -- | 3241±18 | 16 | 10 | 10 | 13 | 19.8 | 21.2 | |
| 7 | 1441 | 50 | 50 | 943 | 958 | 3242±15 | 19 | 13 | 12 | 6 | 19.5 | 20.6 | |
| 8 | 1445 | 50 | 35) | | 952 | | | | | | | | Shorted primer. |
| 8 | 1445 | 13 | 13) | 991 | | 3248±17 | 22 | 11 | 11 | 4 | 21.3 | 21.9 | |
| 9 | 1446 | 50 | 50 | 1041 | 952 | 3255±17 | 22 | 7 | 15 | 6 | 22.1 | 19.7 | |
| 10 | 1448 | 50 | 50 | 1091 | 950 | 3252±15 | 16 | 8 | 11 | 15 | 24.8 | 23.1 | |
| 11 | 1450 | 53 | 52 | 1143 | 948 | 3240±18 | 18 | 10 | 12 | 12 | 22.7 | 20.6 | Defective end link. |
| 12 | 1452 | 51 | 51 | 1194 | 943 | 3245±20 | 24 | 5 | 8 | 14 | 22.7 | 21.6 | |

TABLE 10

## TABULATED FIRING DATA

Date Fired: 23 April 1954
20mm Aircraft Gun Mk 12 Mod 0 Serial No. 500201
20mm Barrel Mk 11 Mod 2 Serial No. EX-184 Chrome Plated (1194 Previous Rounds)
Projectiles: Type 2 Mod 2 (Nylon Bands Lot S9)
Propellant: 620 grains IMR 7013, Lot 1A-40302 Powder

| Burst | Time | Belted | Fired | Rds. on Barrel | Cyclic Rate (rpm) | Average Velocity (ft./sec.) | Yaw (Degrees) 0-5 No. Rds. | 6-10 No. Rds. | 11-15 No. Rds. | Over 15 No. Rds. | Dispersion 100% Pattern (ins.) X | Y | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1102 | 15 | 15 | 1209 | 1014 | 3272±10 | | | | | | | Cold velocity. Last 10 rounds of burst figured for average. |
| 1 | 1415 | 50 | 18 | 1227 | 1025 | 3276±12 | | | | | | | Broken firing pin. |
| | 1417 | 31 | 31 | 1258 | 1016 | 3266±14 | 49 | | | | 11.5 | 16.4 | |
| 2 | 1419 | 50 | 50 | 1308 | 1037 | 3236±15 | 32 | 9 | 8 | 1 | 15.4 | 14.5 | |
| 3 | 1421 | 50 | 50 | 1358 | 1032 | 3230±14 | 28 | 19 | 3 | | 12.1 | 15.9 | |
| 4 | 1423 | 50 | 34 | 1392 | 1023 | 3236±20 | | | | | | | Breech block out of battery. |
| 4 | 1424 | 15 | 15 | 1407 | 1019 | 3241±17 | 46 | 1 | 1 | 1 | 19.0 | 17.4 | |
| 5 | 1426 | 50 | 50 | 1457 | 1014 | 3237±19 | 46 | 3 | 1 | | 13.8 | 16.8 | |
| 6 | 1428 | 50 | 50 | 1507 | 1005 | 3235±17 | 38 | 11 | 1 | | 21.1 | 16.6 | |
| 7 | 1430 | 50 | 50 | 1557 | 997 | 3239±19 | 41 | 5 | 3 | **1 | 18.1 | 20.1 | |
| 8 | 1432 | 50 | 50 | 1607 | 987 | 3240±18 | 39 | 8 | 3 | | 17.6 | 16.0 | |
| 9 | 1434 | 50 | 50 | 1657 | 977 | 3243±18 | 37 | 10 | 3 | | 20.3 | 17.2 | |
| 10 | 1436 | 50 | 23 | 1680 | 985 | 3231±23 | | | | | | | Belt separation. |
| 10 | 1438 | 27 | 27 | 1707 | 965 | 3220±19 | 41 | 7 | 1 | 1 | 21.6 | 19.3 | |
| 11 | 1440 | 50 | 50 | 1757 | 960 | 3238±19 | 43 | 5 | 1 | 1 | 21.4 | 17.1 | |
| 12 | 1442 | 50 | 50 | 1807 | 960 | 3240±20 | 43 | 3 | 3 | **1 | 17.0 | 23.1 | |
| | | *15 | 15 | 1822 | 977 | 3241±10 | | | | | | | Cold velocity. Last 10 rounds of burst figured for average. |

* Gun at Ambient Temperature.
** 1st round in burst.

TABLE 11

## TABULATED FIRING DATA

Date Fired: 16 July 1954
20mm Aircraft Gun Mk 12 Mod 0 Serial No. 501152
20mm Barrel Mk 11 Mod 2 Serial No. EX-184 Chrome Plated (1832 Previous Rounds)
Projectiles: Type 2 Mod 2 (Nylon Bands, Lots S9, S10, and S10M)
Propellant: 620 grains IMR 7013, Lot 1A-4C302 Powder

| Burst | Time | Belted | Fired | Rds. on Barrel | Cyclic Rate (rpm) | Average Velocity (ft./sec.) | Rotating Band Lot | Yaw (Degrees)* 0-5 No. Rds. | 6-10 No. Rds. | 11-15 No. Rds. | Over 15 No. Rds. | Dispersion 100% Pattern (ins.) X | Y | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0950 | 10 | 10 | 1842 | 1023(5 rds) | 3238±8 | S10 | | | | | | | |
| | | | | | (5 rds) | 3236±7 | S10M | 10 | | | | | | |
| 1 | 0959 | 50 | 50 | 1892 | 1049 | 3228±12 | S10M | 38 | 1 | 2 | 1 | 11.1 | 14.2 | |
| 2 | 1023 | 50 | 50 | 1942 | 1058 | 3225±16 | S10 | 45 | 3 | 1 | | 16.7 | 14.3 | |
| 3 | 1025 | 50 | 50 | 1992 | 1012 | 3237±13 | S10 | 50 | | | | 15.3 | 18.5 | |
| 4 | 1027 | 50 | 50 | 2042 | 1041 | 3209±20 | S10M | 48 | 1 | 1 | | 21.4 | 19.1 | |
| 5 | 1029 | 50 | 31 | 2073 | 1025 | 3224±19 | | | | | | | | Rd. in chamber - bolt out of battery. |
| 5 | 1030 | 18 | 18 | 2091 | 1016 | 3219±18 | S10 | 47 | 1 | 1 | | 17.9 | 18.0 | |
| 6 | 1031 | 50 | 36 | 2127 | 1017 | 3220±14 | | | | | | | | Rd. in chamber - bolt out of battery. |
| 6 | | 13 | 13 | 2141 | 1000 | 3208±22 | S10 | 45 | 1 | | 3 | 19.8 | 17.3 | |
| 7 | 1034 | 50 | 50 | 2191 | 1003 | 3216±20 | S10 | 44 | 3 | 3 | | 23.1 | 20.0 | |
| 8 | 1036 | 50 | 37 | 2228 | 996 | 3219±20 | | | | | | | | Rd. in chamber - bolt out of battery. |
| 8 | | 12 | 12 | 2241 | 994 | 3207±8 | S10M | 45 | 2 | 1 | 1 | 23.3 | 18.3 | |
| 9 | 1037 | 50 | 11 | 2252 | 1000 | 3213±25 | | | | | | | | Rd. in chamber - bolt out of battery. |
| 9 | 1039 | 38 | 38 | 2290 | 984 | 3223±17 | S9 | 47 | 2 | | | 17.6 | 19.9 | |
| 10 | 1041 | 50 | 50 | 2340 | 980 | 3230±18 | S10 | 45 | 1 | 1 | 1 | 21.4 | 19.8 | |
| 11 | 1043 | 50 | 40 | 2380 | 973 | 3235±13 | | | | | | | | Rd. in chamber - bolt out of battery. |
| 11 | | 9 | 9 | 2389 | 984 | 3217±15 | S10 | 46 | 2 | | 2 | 22.2 | 16.7 | |
| 12 | 1056 | 50 | 24 | 2413 | 965 | 3225±19 | | | | | | | | |
| 12 | 1060 | 26 | 26 | 2439 | 965 | 3226±20 | S10 | 47 | | 3 | | 23.1 | 20.2 | |
| | | **25 | 25 | 2464 | 984(10 rds) | 3260±14 | S9 | | | | | | | |
| | | | | | (10 rds) | 3251±6 | S10M | | | | | | | |
| | | | | | (5 rds) | 3261±13 | S10 | | | | | | | |

NOTE: Bands of Lot S10M were machined to 0".823 diameter, others as molded at 0".828.

* Rounds omitted could not be measured.
** Gun at Ambient Temperature.

TABLE 12

BARREL MEASUREMENT DATA

20mm Barrel Mk 11 Mod 2 Serial EX-184 Chrome Plated.

| Distance from Breech Surface (ins.) | Diameters (ins.) Bore (0".787+0".002-0".000) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Prior to Firing | After Firing 598 Rds. | After Firing 1194 Rds. | After Firing 1822 Rds. | After Firing 2464 Rds. | Prior to Firing | After Firing 598 Rds. | After Firing 1194 Rds. | After Firing 1822 Rds. | After Firing 2464 Rds. | Prior to Firing | After Firing 598 Rds. | After Firing 1194 Rds. | After Firing 1822 Rds. | After Firing 2464 Rds. |
| 4.75 | .7875 | .789 | .789 | .791 | .791 | .788 | .7885 | .789 | .792 | .792 | .7875 | .7895 | .790 | .7915 | .7915 |
| 5.00 | .787 | .786 | .787 | .787 | .787 | .788 | .786 | .7865 | .787 | .787 | .7875 | .786 | .7865 | .787 | .787 |
| 6.00 | .787 | .785 | .7855 | .7855 | .7855 | .7875 | .785 | .7845 | .7855 | .7855 | .787 | .7845 | .785 | .786 | .786 |
| 7.00 | .7875 | .7845 | .7845 | .7845 | .7845 | .787 | .7845 | .785 | .7845 | .7845 | .7875 | .785 | .785 | .7845 | .7845 |
| 8.00 | .7875 | .785 | .785 | .785 | .785 | .787 | .785 | .7845 | .785 | .785 | .787 | .784 | .7845 | .785 | .785 |
| 9.00 | .7875 | .785 | .785 | .785 | .785 | .787 | .7845 | .7845 | .785 | .785 | .787 | .7845 | .7845 | .785 | .785 |
| 10.00 | .7875 | .785 | .785 | .7855 | .7855 | .787 | .7845 | .7855 | .7855 | .7855 | .787 | .7845 | .785 | .785 | .785 |
| 15.00 | .787 | .786 | .7865 | .7865 | .7865 | .787 | .7855 | .786 | .7865 | .7865 | .787 | .7855 | .786 | .787 | .787 |
| 20.00 | .787 | .7865 | .787 | .7875 | .7875 | .787 | .786 | .787 | .7875 | .7875 | .787 | .7865 | .787 | .7875 | .7875 |
| 25.00 | .787 | .787 | .787 | .7875 | .7875 | .787 | .787 | .787 | .7875 | .7875 | .787 | .7865 | .7865 | .7875 | .7875 |
| 30.00 | .787 | .787 | .7875 | .788 | .788 | .787 | .7875 | .788 | .7885 | .7885 | .787 | .7875 | .7875 | .7885 | .7885 |
| 35.00 | .787 | .787 | .788 | .7885 | .7885 | .787 | .7875 | .787 | .7885 | .7885 | .787 | .7875 | .788 | .7885 | .7885 |
| 40.00 | .7865 | .7865 | .7875 | .788 | .788 | .7865 | .7865 | .7865 | .7875 | .7875 | .786 | .786 | .7865 | .7875 | .7875 |
| 45.00 | .787 | .788 | .789 | .7895 | .7895 | .787 | .788 | .788 | .789 | .789 | .787 | .7875 | .788 | .7895 | .7895 |
| 46.00 | .787 | .788 | .7885 | .789 | .789 | .787 | .7875 | .7875 | .789 | .789 | .787 | .7875 | .7875 | .7885 | .7885 |
| 47.00 | .7865 | .7875 | .788 | .7885 | .7885 | .7865 | .787 | .7875 | .789 | .789 | .7875 | .7875 | .7875 | .788 | .788 |
| 48.00 | .7865 | .7875 | .7875 | .7885 | .7885 | .7865 | .7875 | .7875 | .789 | .789 | .7875 | .7875 | .7875 | .7885 | .7885 |
| 49.00 | .786 | .7875 | .7875 | .7885 | .7885 | .786 | .7875 | .7875 | .789 | .789 | .786 | .7875 | .7875 | .789 | .789 |
| 50.00 | .786 | .787 | .787 | .7885 | .7885 | .786 | .787 | .787 | .788 | .788 | .7855 | .7875 | .7875 | .7885 | .7885 |
| 51.00 | .786 | .7875 | .787 | .788 | .788 | .7855 | .7865 | .787 | .788 | .788 | .7855 | .787 | .787 | .788 | .788 |
| 52.00 | .7855 | .789 | .789 | .7905 | .7905 | .7855 | .789 | .7895 | .791 | .791 | .7855 | .789 | .7895 | .791 | .791 |
| 52.25 | .7855 | .7895 | .789 | .791 | .791 | .7855 | .7895 | .7895 | .791 | .791 | .7855 | .7895 | .7895 | .791 | .791 |
| | Diameters (ins.) Grooves (0".817+0".004-0".000) | | | | | | | | | | | | | | |
| 4.75 | .821 | .817 | .817 | .8175 | .8175 | .821 | .817 | .817 | .8175 | .8175 | .822 | .817 | .8165 | .817 | .817 |
| 5.00 | .821 | .818 | .8165 | .817 | .817 | .821 | .817 | .817 | .8175 | .8175 | .821 | .817 | .8165 | .817 | .817 |
| 6.00 | .8205 | .8175 | .817 | .817 | .817 | .8205 | .8175 | .817 | .817 | .817 | .821 | .817 | .8175 | .817 | .817 |
| 7.00 | .8205 | .8175 | .817 | .817 | .817 | .8205 | .8175 | .817 | .817 | .817 | .8205 | .817 | .817 | .817 | .817 |
| 8.00 | .8205 | .818 | .817 | .817 | .817 | .8205 | .8175 | .817 | .817 | .817 | .8205 | .817 | .817 | .8165 | .8165 |
| 9.00 | .8205 | .818 | .8175 | .8175 | .8175 | .8205 | .8175 | .817 | .817 | .817 | .8205 | .817 | .817 | .817 | .817 |
| 10.00 | .8205 | .818 | .8175 | .8175 | .8175 | .8205 | .818 | .817 | .817 | .817 | .8205 | .817 | .817 | .817 | .817 |
| 15.00 | .8205 | .8185 | .8175 | .8185 | .8185 | .8205 | .818 | .8175 | .8175 | .8175 | .8205 | .818 | .8175 | .818 | .818 |
| 20.00 | .8205 | .8185 | .818 | .8185 | .8185 | .8205 | .8185 | .8175 | .8185 | .8185 | .8205 | .8185 | .8185 | .8185 | .8185 |
| 25.00 | .8205 | .8185 | .818 | .819 | .819 | .8205 | .819 | .818 | .8185 | .8185 | .8205 | .819 | .818 | .8185 | .8185 |
| 30.00 | .8205 | .819 | .819 | .8195 | .8195 | .8205 | .8195 | .8185 | .8195 | .8195 | .8205 | .8195 | .8185 | .819 | .819 |
| 35.00 | .8205 | .8195 | .819 | .8195 | .8195 | .8205 | .8195 | .819 | .8195 | .8195 | .8205 | .8195 | .8185 | .819 | .819 |
| 40.00 | .820 | .819 | .8185 | .819 | .819 | .820 | .819 | .818 | .8185 | .8185 | .820 | .819 | .8185 | .8185 | .8185 |
| 45.00 | .821 | .820 | .8195 | .820 | .820 | .821 | .820 | .8195 | .820 | .820 | .821 | .820 | .819 | .820 | .820 |
| 46.00 | .821 | .820 | .8195 | .820 | .820 | .821 | .820 | .8195 | .820 | .820 | .821 | .820 | .819 | .820 | .820 |
| 47.00 | .8205 | .8195 | .819 | .8195 | .8195 | .8205 | .820 | .819 | .8195 | .8195 | .8205 | .820 | .819 | .8195 | .8195 |
| 48.00 | .8205 | .8195 | .819 | .8195 | .8195 | .8205 | .8195 | .819 | .819 | .8195 | .8205 | .820 | .819 | .8195 | .8195 |
| 49.00 | .8205 | .8195 | .819 | .819 | .819 | .820 | .8195 | .819 | .8195 | .819 | .820 | .8195 | .819 | .819 | .819 |
| 50.00 | .820 | .8195 | .819 | .819 | .819 | .820 | .8195 | .819 | .819 | .819 | .820 | .8195 | .819 | .819 | .819 |
| 51.00 | .8195 | .819 | .8185 | .8185 | .8185 | .8195 | .819 | .8185 | .8185 | .8185 | .8195 | .8195 | .8185 | .8185 | .8185 |
| 52.00 | .819 | .8195 | .819 | .819 | .819 | .819 | .820 | .819 | .819 | .819 | .819 | .8195 | .819 | .819 | .819 |
| 52.25 | .8195 | .820 | .819 | .8185 | .8185 | .820 | .820 | .819 | .819 | .8185 | .820 | .821 | .819 | .819 | .819 |

TABLE 13 CHAMBER MEASUREMENT DATA

Barrel No. EX-184, 20mm Mk 11 Mod 2

| Distance from Breech Surface (ins.) | Chamber Diameter (ins.) | | | | | |
|---|---|---|---|---|---|---|
| | Drawing Dimensions | Prior to Firing | After Firing 598 Rds. | After Firing 1194 Rds. | After Firing 1822 Rds. | After Firing 2464 Rds. |
| .359 | 1.1531+.002 | 1.1567 | 1.1570 | 1.1570 | 1.1570 | 1.1570 |
| 1.209 | 1.1233+.002 | 1.1255 | 1.1256 | 1.1257 | 1.1258 | 1.1258 |
| 1.739 | 1.1048+.002 | 1.1059 | 1.1060 | 1.1061 | 1.1062 | 1.1062 |
| 2.239 | 1.0873+.002 | 1.0885 | 1.0887 | 1.0888 | 1.0888 | 1.0888 |
| 2.739 | 1.0698+.002 | 1.0720 | 1.0722 | 1.0724 | 1.0724 | 1.0724 |
| 3.039 | 1.0593+.002 | 1.0611 | 1.0613 | 1.0615 | 1.0615 | 1.0615 |
| Specs. 3.693±.005 | .942 | .9433 | .9433 | .9439 | .9444 | .9444 |
| Actual 3.695 | | .942 | .942 | .9426 | .9431 | .9431 |
| 4.100 | .834+.003 | .847 | .8468 | .8470 | .8472 | .8472 |
| 4.200 | .834+.003 | .8437 | .8428 | .8422 | .8421 | .8421 |
| 4.300 | .834+.003 | .8431 | .8414 | .8410 | .8403 | .8403 |
| 4.330 | .834+.003 | .8439 | .8413 | .8415 | .8411 | .8411 |
| 4.370 | .834+.003 | .8448 | .8426 | .8428 | .8416 | .8416 |
| 4.380 | .834+.003 | .8448 | .8423 | .8428 | .842 | .842 |
| Specs. 4.458+.020 | .828 | .8403 | .8377 | .8374 | .8363 | .8363 |
| 4.523 | | .828 | .8236 | .8226 | .8237 | .8237 |
| 4.563 | | .821 | .8188 | .8172 | .8169 | .8169 |

TABLE 14

## TABULATED FIRING DATA

Date Fired: 29 May 1953
20mm Aircraft Gun Mk 12 Mod 0 Serial No. 5C0056
20mm Barrel Mk 11 Mod 2 Serial No. EX-183 Chrome Plated (No Previous Rounds)
Ammunition: Production Lot ZS-68-HMC-53 - Standard 20mm Mk 11 Mod 0 Target Projectiles
- 629 grains IMR 7013, Lot CDZA-1 Propellant Powder

| Burst | Time | Belted | Fired | Rds. on Barrel | Cyclic Rate (rpm) | Average Velocity (ft./sec.) | Yaw (Degrees) 0-5 No. Rds. | 6-10 No. Rds. | 11-15 No. Rds. | Over 15 No. Rds. | Dispersion 100% Pattern (ins.) X | Y | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1118 | 50 | 50 | 50 | 974 | 3337±25 | 45 | 5 | | | 13.4 | 13.6 | |
| 2 | 1120 | 50 | 47 | 97 | 987 | 3362±24 | 41 | 6 | | | 10.6 | 11.5 | Stubbed round possibly due to defective end link. |
| 3 | 1122 | 50 | 50 | 147 | 985 | 3352±20 | 41 | 8 | 1 | | 21.0 | 15.6 | |
| 4 | 1124 | 50 | 4 | 151 | -- | -- | 2 | 2 | | | | | Failure to extract. |
| 5 | 1126 | 45 | 4 | 155 | -- | -- | 3 | 1 | | | | | Failure to extract. |
| 6 | 1128 | 40 | 4 | 159 | -- | -- | 3 | 1 | | | | | Failure to extract. |
| 7 | 1130 | 35 | 35 | 194 | 983 | *3346±23 | 30 | 5 | | | 15.5 | 14.4 | |
| 8 | 1132 | 50 | 50 | 244 | 981 | 3329±15 | 28 | 18 | 3 | 1 | 20.3 | 14.3 | |
| 9 | 1134 | 50 | 50 | 294 | 971 | 3314±18 | 22 | 24 | 2 | 2 | 16.1 | 18.5 | |
| 10 | 1136 | 50 | 50 | 344 | 961 | 3290±14 | 24 | 21 | 5 | | 17.3 | 17.5 | |
| 11 | 1138 | 50 | 50 | 394 | 955 | 3247±12 | 18 | 25 | 7 | | 15.8 | 13.8 | |
| 12 | 1140 | 50 | 50 | 444 | 947 | 3242±17 | 18 | 21 | 11 | | 17.5 | 20.9 | |
| 13 | 1142 | 50 | 50 | 494 | 945 | 3224±14 | 26 | 15 | 9 | | 18.1 | 16.9 | |
| 14 | 1144 | 49 | 49 | 543 | 938 | 3212±16 | 18 | 13 | 18 | | 15.0 | 19.8 | |
| 15 | 1146 | 50 | 50 | 593 | 949 | 3210±17 | 18 | 24 | 7 | 1 | 21.1 | 16.3 | |
| 16 | 1148 | 50 | 34 | 627 | 938 | | 16 | 13 | 5 | | | | Round in chamber but failed to fire. |
| 17 | 1150 | 14 | 14 | 641 | 933 | **3211±23 | 7 | 6 | 1 | | 18.9 | 16.1 | |
| 18 | 1152 | 40 | 40 | 681 | 923 | 3209±23 | 23 | 11 | 5 | 1 | 13.50 | 17.4 | |

* Average of Bursts 4-7.
** Average of Bursts 16-17.

TABLE 15

TABULATED FIRING DATA

Date Fired: 24 September 1953
20mm Aircraft Gun Mk 12 Mod 0 Serial No. 501151
20mm Barrel Mk 11 Mod 2 Serial No. EX-183 Chrome Plated (681 Previous Rounds)
Ammunition: Production Lot ZS-69-HMC-53 - Standard 20mm Mk 11 Mod 0 Target Projectiles
- 629 grains IMR 7013, Lot CDZA-1 Propellant Powder

| Burst | Time | Belted | Fired | Rds. on Barrel | Cyclic Rate (rpm) | Average Velocity (ft./sec.) | Yaw (Degrees)* 0-5 No. Rds. | 6-10 No. Rds. | 11-15 No. Rds. | Over 15 No. Rds. | Dispersion 100% Pattern (ins.) X | Y | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1255 | 50 | 50 | 731 | 1028 | 3180 | 50 | | | | 9.6 | 9.8 | |
| 2 | 1257 | 50 | 49 | 780 | 1020 | 3167 | 39 | 9 | 1 | | 11.7 | 14.4 | Broken end links. |
| 3 | 1301 | 50 | 50 | 830 | 1019 | 3158 | 34 | 13 | 2 | | 12.3 | 13.1 | |
| 4 | 1304 | 50 | 2 | 832 | -- | -- | | | | | | | Slow feed. |
| 4 | 1304 | 47 | 47 | 879 | 1010 | 3152 | 37 | 11 | 1 | | 13.5 | 11.3 | |
| 5 | 1306 | 50 | 50 | 929 | 1005 | Missed | 22 | 19 | 8 | | 15.6 | 15.2 | |
| 6 | 1307 | 50 | 50 | 979 | 989 | 3121 | 18 | 23 | 9 | | 15.3 | 19.5 | |
| 7 | 1310 | 50 | 43 | 1022 | | | | | | | | | Slow feed. |
| 7 | 1310 | 7 | 7 | 1029 | 995 | 3101 | 21 | 10 | 9 | | 16.3 | 14.0 | |
| 8 | 1312 | 49 | 49 | 1078 | 986 | 3109 | 28 | 18 | 3 | | 14.5 | 21.8 | End link jammed on stripper. |
| 9 | 1314 | 49 | 49 | 1127 | 982 | 3090 | 22 | 15 | 12 | | 17.9 | 15.8 | |
| 10 | 1315 | 50 | 50 | 1177 | 972 | 3066 | 8 | 12 | 17 | 12 | 17.2 | 19.6 | |

* Rounds omitted could not be measured.

TABLE 16

BARREL MEASUREMENT DATA

Date Fired: 29 May 1953
Barrel No. EX-183, 20mm Mk 11 Mod 2 (No Previous Rounds)

| Distance from Breech Surface (ins.) | Diameters (ins.) Bore (0".787+0".002-0".000) Prior to Firing | After Firing 681 Rds. | Prior to Firing | After Firing 681 Rds. | Prior to Firing | After Firing 681 Rds. | Grooves (0".817+0".004-0".000) Prior to Firing | After Firing 681 Rds. | Prior to Firing | After Firing 681 Rds. | Prior to Firing | After Firing 681 Rds. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.69 Bore-4.63 Rifling | 0.788 | | 0.7875 | 0.8295 | 0.788 | | 0.820 | | 0.820 | 0.831 | 0.8195 | |
| | | | | 0.809 ) | | | | | | | | |
| 5.0 | 0.787 | | 0.787 | 0.811 ) | 0.7875 | | 0.820 | | 0.820 | 0.827 | 0.8195 | |
| 6.0 | 0.7875 | | 0.787 | 0.794 | 0.7870 | | 0.820 | | 0.820 | 0.8155 | 0.8195 | |
| 7.0 | 0.787 | | 0.787 | 0.7965 | 0.7870 | | 0.820 | | 0.8195 | 0.8165 | 0.8195 | |
| 8.0 | 0.787 | 0.793 | 0.787 | 0.7925 | 0.7870 | 0.7925 | 0.820 | 0.817 | 0.8195 | 0.8170 | 0.8195 | 0.817 |
| 9.0 | 0.787 | 0.792 | 0.787 | 0.792 | 0.7870 | 0.792 | 0.820 | 0.8175 | 0.8195 | 0.8175 | 0.8195 | 0.8175 |
| 10.0 | 0.7875 | 0.791 | 0.7875 | 0.7905 | 0.7870 | 0.7915 | 0.820 | 0.8185 | 0.8195 | 0.8175 | 0.8195 | 0.818 |
| 15.0 | 0.787 | 0.7855 | 0.787 | 0.7855 | 0.7870 | 0.7855 | 0.8195 | 0.8185 | 0.8195 | 0.8180 | 0.8195 | 0.818 |
| 20.0 | 0.787 | 0.7865 | 0.787 | 0.786 | 0.7865 | 0.786 | 0.8195 | 0.8185 | 0.8195 | 0.8185 | 0.819 | 0.8185 |
| 25.0 | 0.787 | 0.7885 | 0.7865 | 0.787 | 0.787 | 0.787 | 0.8195 | 0.8185 | 0.8195 | 0.8180 | 0.819 | 0.8185 |
| 30.0 | 0.7865 | 0.788 | 0.787 | 0.7885 | 0.7865 | 0.787 | 0.8195 | 0.8185 | 0.8195 | 0.8185 | 0.8195 | 0.8185 |
| 35.0 | 0.7865 | 0.7885 | 0.7865 | 0.788 | 0.7865 | 0.7875 | 0.8195 | 0.819 | 0.8195 | 0.8185 | 0.8195 | 0.8185 |
| 40.0 | 0.786 | 0.788 | 0.7865 | 0.788 | 0.786 | 0.7875 | 0.8195 | 0.8185 | 0.819 | 0.8185 | 0.819 | 0.8185 |
| 45.0 | 0.786 | 0.789 | 0.7865 | 0.7885 | 0.786 | 0.789 | 0.8195 | 0.819 | 0.819 | 0.8185 | 0.819 | 0.819 |
| 46.0 | 0.786 | 0.789 | 0.786 | 0.789 | 0.786 | 0.7885 | 0.819 | 0.819 | 0.819 | 0.8185 | 0.819 | 0.819 |
| 47.0 | 0.786 | 0.789 | 0.786 | 0.7885 | 0.786 | 0.7885 | 0.819 | 0.8185 | 0.819 | 0.8185 | 0.8185 | 0.819 |
| 48.0 | 0.7855 | 0.789 | 0.7855 | 0.789 | 0.7855 | 0.7885 | 0.8185 | 0.8185 | 0.8185 | 0.8185 | 0.8185 | 0.819 |
| 49.0 | 0.7855 | 0.789 | 0.7855 | 0.789 | 0.7855 | 0.789 | 0.8185 | 0.8185 | 0.8185 | 0.8185 | 0.8185 | 0.819 |
| 50.0 | 0.7855 | 0.7885 | 0.7855 | 0.7885 | 0.7855 | 0.788 | 0.8185 | 0.8185 | 0.818 | 0.8185 | 0.818 | 0.819 |
| 51.0 | 0.7855 | 0.7885 | 0.7855 | 0.788 | 0.7855 | 0.7875 | 0.8185 | 0.8185 | 0.818 | 0.819 | 0.818 | 0.819 |
| 52.0 | 0.786 | 0.7895 | 0.7855 | 0.7895 | 0.7855 | 0.7895 | 0.8185 | 0.819 | 0.8185 | 0.8195 | 0.8185 | 0.8195 |
| 52.25 | 0.786 | 0.7895 | 0.786 | 0.7895 | 0.7865 | 0.7895 | -- | -- | -- | -- | -- | -- |
| 52.40 | -- | -- | -- | -- | -- | -- | 0.820 | 0.8205 | 0.820 | 0.820 | 0.820 | 0.8205 |

TABLE 16 (Continued)

Barrel No. EX-183, 20mm Mk 11 Mod 2 (681 Previous Rounds)

| Distance from Breech Surface (ins.) | Diameters (ins.) Bore (0".787+0".002-0".000) Prior to Firing | After Firing 1177 Rds. | Prior to Firing | After Firing 1177 Rds. | Prior to Firing | After Firing 1177 Rds. | Grooves (0".817+0".004-0".000) Prior to Firing | After Firing 1177 Rds. | Prior to Firing | After Firing 1177 Rds. | Prior to Firing | After Firing 1177 Rds. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.70 | | | 0.8295 | 0.839 | | | | | | 0.839 | | |
| 5.00 | | | -- | 0.837 | | | | | | 0.839 | | |
| 6.00 | | | 0.794 | -- | | | | | | -- | | |
| 7.00 | | | 0.7965 | -- | | | | | | -- | | |
| 8.00 | 0.793 | | 0.7925 | 0.803 | 0.7925 | | 0.817 | | 0.8170 | 0.815 | 0.817 | |
| 9.00 | 0.792 | | 0.792 | -- | 0.792 | | 0.8175 | | 0.8175 | 0.816 | 0.8175 | |
| 10.00 | 0.791 | 0.797 | 0.7915 | 0.796 | 0.7915 | 0.7965 | 0.8185 | 0.8165 | 0.8175 | 0.8165 | 0.818 | 0.8165 |
| 15.00 | 0.7855 | 0.790 | 0.7855 | 0.7915 | 0.7855 | 0.7905 | 0.8185 | 0.8175 | 0.8180 | 0.8175 | 0.818 | 0.8175 |
| 20.00 | 0.7865 | 0.787 | 0.786 | 0.788 | 0.786 | 0.7875 | 0.8185 | 0.817 | 0.8185 | 0.817 | 0.8185 | 0.8175 |
| 25.00 | 0.7885 | 0.787 | 0.787 | 0.7875 | 0.787 | 0.788 | 0.8185 | 0.8175 | 0.8180 | 0.8175 | 0.8185 | 0.8175 |
| 30.00 | 0.788 | 0.7885 | 0.787 | 0.788 | 0.787 | 0.788 | 0.8185 | 0.818 | 0.8185 | 0.818 | 0.8185 | 0.818 |
| 35.00 | 0.7885 | 0.789 | 0.7875 | 0.789 | 0.7875 | 0.7885 | 0.819 | 0.8185 | 0.8185 | 0.818 | 0.8185 | 0.8185 |
| 40.00 | 0.788 | 0.789 | 0.7875 | 0.789 | 0.7875 | 0.7885 | 0.8185 | 0.818 | 0.8185 | 0.818 | 0.8185 | 0.818 |
| 45.00 | 0.789 | 0.791 | 0.789 | 0.7905 | 0.789 | 0.789 | 0.819 | 0.8185 | 0.8185 | 0.819 | 0.819 | 0.8185 |
| 46.00 | 0.789 | 0.7905 | 0.7885 | 0.790 | 0.7885 | 0.790 | 0.819 | 0.8185 | 0.8185 | 0.819 | 0.819 | 0.8185 |
| 47.00 | 0.789 | 0.7905 | 0.7885 | 0.790 | 0.7885 | 0.790 | 0.8185 | 0.818 | 0.8185 | 0.818 | 0.819 | 0.8185 |
| 48.00 | 0.789 | 0.790 | 0.7885 | 0.790 | 0.7885 | 0.7895 | 0.8185 | 0.818 | 0.8185 | 0.818 | 0.819 | 0.818 |
| 49.00 | 0.789 | 0.790 | 0.789 | 0.790 | 0.789 | 0.790 | 0.8185 | 0.818 | 0.8185 | 0.818 | 0.819 | 0.818 |
| 50.00 | 0.7885 | 0.790 | 0.788 | 0.7895 | 0.788 | 0.7895 | 0.8185 | 0.818 | 0.8185 | 0.818 | 0.819 | 0.818 |
| 51.00 | 0.7885 | 0.7895 | 0.7875 | 0.789 | 0.7875 | 0.789 | 0.8185 | 0.818 | 0.819 | 0.8185 | 0.819 | 0.818 |
| 52.00 | 0.7895 | 0.791 | 0.7895 | 0.791 | 0.7895 | 0.791 | 0.819 | 0.819 | 0.8195 | 0.819 | 0.8195 | 0.819 |
| 52.25 | 0.7895 | 0.791 | 0.7895 | 0.791 | 0.7895 | 0.791 | 0.8205 | 0.819 | 0.820 | 0.819 | 0.8205 | 0.819 |

TABLE 17 CHAMBER MEASUREMENT DATA

Barrel No. EX-183, 20mm Mk 11 Mod 2

| Distance from Breech Surface (ins.) | Chamber Diameter (ins.) Drawing Dimensions | Prior to Firing | After Firing 681 Rds. | After Firing 1177 Rds. |
|---|---|---|---|---|
| .359 | 1.1531+.002 | 1.1548 | 1.1550 | 1.1551 |
| 1.209 | 1.1233+.002 | 1.1248 | 1.1255 | 1.1256 |
| 1.739 | 1.1048+.002 | 1.1044 | 1.1054 | 1.1055 |
| 2.239 | 1.0873+.002 | 1.0871 | 1.0882 | 1.0883 |
| 2.739 | 1.0698+.002 | 1.0708 | 1.0717 | 1.0719 |
| 3.039 | 1.0593+.002 | 1.0608 | 1.0616 | 1.0618 |
| Specs. 3.693±.005 | .942 | .9453 | .9457 | .9462 |
| 3.6975 | | .942 | .9424 | .9429 |
| 4.100 | .834+.003 | .8431 | .8433 | .8434 |
| 4.200 | .834+.003 | .8414 | .8397 | .8404 |
| 4.300 | .834+.003 | .8406 | .8375 | .8385 |
| 4.320 | .834+.003 | .8401 | .8375 | .8375 |
| 4.360 | .834+.003 | .8432 | .8405 | .8408 |
| 4.370 | .834+.003 | .8432 | .8404 | .8408 |
| Specs. 4.458+.020 | .828 | .8346 | .8315 | .8315 |
| 4.489 | | .828 | .8285 | .8287 |
| 4.530 | | .821 | .8327 | .8358 |

Note: Barrel Chamber Surface Finish Prior to Firing 6-21 Microinches.

TABLE 18 TABULATED FIRING DATA

Date Fired: 3 February 1954
20mm Aircraft Gun Mk 12 Mod 0 Serial No. 500243
20mm Barrel Mk 11 Mod 2 Serial No. EX-182 Chrome Plated (5 Previous Rounds)
Ammunition: Production Lot ZS-69-HMC-53 - Standard 20mm Mk 11 Mod 0 Target Projectiles
- 629 grains IMR 7013, Lot CDZA-1 Propellant Powder

| Burst | Time | Belted | Fired | Rds. on Barrel | Cyclic Rate (rpm) | Average Velocity (ft./sec.) | Yaw Degrees)* 0-5 No. Rds. | 6-10 No. Rds. | 11-15 No. Rds. | Over 15 No. Rds. | Dispersion 100% Pattern (ins.) X | Y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0955 | 10 | 10 | 15 | 918 | 3332±36 | 10 | | | | | |
| 2 | 1038 | 50 | 50 | 65 | 985 | 3351±31 | 21 | 9 | 2 | | 9.9 | 8.1 |
| 3 | 1041 | 50 | 50 | 115 | 992 | 3387±24 | 14 | 9 | 11 | | 11.4 | 16.7 |
| 4 | 1043 | 50 | 50 | 165 | 996 | 3381±27 | 14 | 7 | 18 | 2 | 17.5 | 19.1 |
| 5 | 1045 | 50 | 50 | 215 | 983 | 3352±28 | 14 | 11 | 12 | 1 | 18.7 | 17.4 |
| 6 | 1047 | 50 | 50 | 265 | 1006 | 3356±19 | 18 | 7 | 13 | 2 | 12.7 | 14.3 |
| 7 | 1049 | 50 | 50 | 315 | 993 | 3327±15 | 22 | 9 | 6 | 2 | 15.7 | 15.4 |
| 8 | 1051 | 50 | 50 | 365 | 970 | 3269±12 | 19 | 13 | 13 | 1 | 17.2 | 13.0 |
| 9 | 1053 | 50 | 50 | 415 | 958 | 3236±15 | 18 | 11 | 16 | 1 | 18.9 | 15.4 |
| 10 | 1055 | 50 | 50 | 465 | 952 | 3218±18 | 13 | 13 | 20 | 1 | 13.9 | 16.8 |
| 11 | 1057 | 50 | 50 | 515 | 947 | 3225±16 | 11 | 14 | 19 | | 15.6 | 14.8 |
| 12 | 1100 | 50 | 50 | 565 | 939 | 3190±21 | 13 | 7 | 10 | 2 | 16.2 | 17.4 |
| 13 | 1102 | 50 | 50 | 615 | 936 | 3177±22 | 4 | 5 | 10 | 2 | 16.4 | 14.3 |
| | | **10 | 10 | 625 | 931 | 3204±26 | | | | | | |

* Rounds omitted could not be measured.
** Gun at Ambient Temperature.

TABLE 19 — TABULATED FIRING DATA

Date Fired: 12 February 1954
20mm Aircraft Gun Mk 12 Mod 0 Serial No. 500243
20mm Barrel Mk 11 Mod 2 Serial No. EX-182 Chrome Plated (625 Previous Rounds)
Ammunition: Production Lot ZS-69-HMC-53 - Standard 20mm Mk 11 Mod 0 Target Projectiles
- 629 grains IMR 7013, Lot CDZA-1 Propellant Powder

| Burst | Time | Belted | Fired | Rds. on Barrel | Cyclic Rate (rpm) | Average Velocity (ft./sec.) | Yaw (Degrees)* 0-5 No. Rds. | 6-10 No. Rds. | 11-15 No. Rds. | Over 15 No. Rds. | Dispersion 100% Pattern (ins.) X | Y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1107 | 10 | 10 | 635 | 918 | 3096±13 | | | | | -- | -- |
| 2 | 1109 | 50 | 50 | 685 | 971 | 3106±17 | 29 | 18 | 1 | | 9.5 | 10.7 |
| 3 | 1111 | 50 | 50 | 735 | 970 | 3122±18 | 21 | 15 | 8 | 1 | 10.1 | 11.3 |
| 4 | 1113 | 50 | 50 | 785 | 977 | 3139±21 | 23 | 12 | 11 | | 13.5 | 11.7 |
| 5 | 1115 | 50 | 29 | 814 | 965 | 3122±24 | 15 | 7 | 3 | | -- | -- |
| 6 | 1116 | 22 | 21 | 835 | 968 | 3104±21 | 12 | 6 | 2 | | 10.6 | 13.7 |
| 7 | 1118 | 50 | 50 | 885 | 957 | 3107±21 | 29 | 9 | 8 | 4 | 14.3 | 14.3 |
| 8 | 1120 | 50 | 50 | 935 | 957 | 3090±23 | 18 | 8 | 11 | 7 | 18.4 | 16.6 |
| 9 | 1122 | 50 | 50 | 985 | 952 | 3090±20 | 17 | 11 | 13 | 9 | 14.6 | 14.6 |
| 10 | 1124 | 50 | 49 | 1034 | 945 | 3093±23 | 23 | 11 | 11 | 5 | 13.7 | 14.6 |
| 11 | 1126 | 50 | 50 | 1084 | 936 | 3087±29 | 17 | 12 | 7 | 13 | 16.2 | 19.9 |
| | | **10 | 10 | 1094 | 926 | 3099±15 | | | | | | |

Notes: Gun stoppage on Burst 5 due to bolt stopping 1".5 out of battery.

* Rounds omitted could not be measured.
** Gun at Ambient Temperature.

TABLE 20

BARREL MEASUREMENT DATA

Barrel No. EX-182, 20mm Mk 11 Mod 2

| Distance from Breech Surface (ins.) | Diameters (ins.) Bore (0".787+0".002-0".000) Prior to Firing | After Firing 625 Rds. | After Firing 1095 Rds. | Prior to Firing | After Firing 625 Rds. | After Firing 1095 Rds. | Prior to Firing | After Firing 625 Rds. | After Firing 1095 Rds. | Grooves (0".817+0".004-0".000) Prior to Firing | After Firing 625 Rds. | After Firing 1095 Rds. | Prior to Firing | After Firing 625 Rds. | After Firing 1095 Rds. | Prior to Firing | After Firing 625 Rds. | After Firing 1095 Rds. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.69 | .7875 | Note 1 | Note 1 | .7880 | Note 1 | Note 1 | .7880 | Note 1 | Note 1 | .8195 | Note 2 | Note 3 | .8195 | Note 2 | Note 3 | .8195 | Note 2 | Note 3 |
| 5.00 | .7870 | Note 1 | Note 1 | .7875 | Note 1 | Note 1 | .7885 | Note 1 | Note 1 | .8195 | Note 2 | Note 3 | .8195 | Note 2 | Note 3 | .8195 | Note 2 | Note 3 |
| 6.00 | .7870 | .7960 | Note 1 | .7870 | .8040 | Note 1 | .7880 | .8050 | Note 1 | .8195 | .8165 | .8150 | .8195 | .8160 | .8155 | .8195 | .8165 | .8155 |
| 7.00 | .7870 | .7960 | .8050 | .7870 | .7940 | .8045 | .7875 | .7965 | .8050 | .8195 | .8165 | .8155 | .8190 | .8160 | .8160 | .8190 | .8160 | .8155 |
| 8.00 | .7875 | .7955 | .7985 | .7875 | .7920 | .7990 | .7870 | .7915 | .7985 | .8195 | .8170 | .8165 | .8195 | .8165 | .8160 | .8190 | .8160 | .8150 |
| 9.00 | .7870 | .7890 | .7960 | .7870 | .7900 | .7950 | .7870 | .7895 | .8000 | .8195 | .8170 | .8170 | .8195 | .8170 | .8175 | .8190 | .8165 | .8165 |
| 10.00 | .7870 | .7875 | .7940 | .7870 | .7885 | .7935 | .7870 | .7870 | .7940 | .8195 | .8175 | .8170 | .8195 | .8170 | .8170 | .8195 | .8170 | .8175 |
| 15.00 | .7870 | .7860 | .7875 | .7870 | .7860 | .7870 | .7870 | .7860 | .7940 | .8195 | .8175 | .8175 | .8195 | .8175 | .8175 | .8190 | .8170 | .8180 |
| 20.00 | .7865 | .7860 | .7870 | .7865 | .7865 | .7870 | .7870 | .7860 | .7870 | .8195 | .8175 | .8175 | .8190 | .8175 | .8175 | .8190 | .8175 | .8175 |
| 25.00 | .7865 | .7865 | .7880 | .7865 | .7865 | .7875 | .7865 | .7865 | .7865 | .8190 | .8175 | .8175 | .8190 | .8175 | .8175 | .8185 | .8175 | .8175 |
| 30.00 | .7865 | .7870 | .7880 | .7865 | .7870 | .7880 | .7865 | .7865 | .7875 | .8190 | .8175 | .8175 | .8190 | .8175 | .8175 | .8185 | .8175 | .8175 |
| 35.00 | .7865 | .7880 | .7885 | .7865 | .7870 | .7885 | .7865 | .7870 | .7885 | .8190 | .8180 | .8180 | .8185 | .8175 | .8175 | .8185 | .8175 | .8175 |
| 40.00 | .7860 | .7875 | .7885 | .7860 | .7875 | .7885 | .7860 | .7875 | .7885 | .8190 | .8175 | .8180 | .8185 | .8180 | -- | .8185 | .8175 | .8175 |
| 45.00 | .7865 | .7885 | .7895 | .7865 | .7885 | .7895 | .7860 | .7885 | .7900 | .8185 | .8185 | .8185 | .8185 | .8175 | .8185 | .8185 | .8180 | .8180 |
| 46.00 | .7865 | .7885 | .7895 | .7860 | .7885 | .7895 | .7860 | .7890 | .7895 | .8185 | .8185 | .8185 | .8185 | .8185 | .8180 | .8185 | .8180 | .8180 |
| 47.00 | .7860 | .7885 | .7895 | .7860 | .7880 | .7895 | .8760 | .7880 | .7895 | .8185 | .8185 | .8180 | .8185 | .8185 | -- | .8185 | .8180 | .8180 |
| 48.00 | .7860 | .7885 | .7895 | .7860 | .7880 | .7900 | .7860 | .7880 | .7900 | .8185 | .8180 | .8180 | .8185 | .8185 | -- | .8185 | .8180 | .8180 |
| 49.00 | .7860 | .7885 | .7900 | .7860 | .7880 | .7905 | .7860 | .7880 | .7900 | .8185 | .8180 | .8180 | .8185 | .8180 | -- | .8185 | .8180 | .8180 |
| 50.00 | .7860 | .7880 | .7895 | .7860 | .7880 | .7900 | .7860 | .7880 | .7900 | .8185 | .8180 | .8180 | .8185 | .8180 | -- | .8185 | .8180 | .8180 |
| 51.00 | .7860 | .7880 | .7895 | .8760 | .7880 | .7905 | .7860 | .7880 | .7900 | .8185 | .8185 | .8185 | .8185 | .8185 | -- | .8185 | .8185 | .8185 |
| 52.00 | .7860 | .7895 | .7910 | .8760 | .7895 | .7920 | .7860 | .7895 | .7915 | .8190 | .8195 | .8195 | .8190 | .8195 | .8195 | .8210 | .8185 | .8190 |
| 52.25 | .7860 | .7900 | .7910 | .7860 | .7905 | .7920 | .7865 | .7905 | .7920 | -- | -- | -- | -- | -- | -- | -- | .8190 | -- |
| 52.40 | .7870 | -- | -- | .7870 | -- | -- | .7870 | -- | -- | .8210 | .8215 | .8220 | .8210 | .8215 | .8210 | -- | .8215 | .8210 |

Note 1: Unable to gauge lands - Nons at that point; worn off to ".832 - ".836 Dia. after 625 rds. and ".836 - ".841 Dia. after 1095 rds.

Note 2: Gauging Distance
4.63 Diameter from ".834 to ".835
4.69 Diameter from ".832 to ".836 (Origin of Bore)
5.00 Diameter from ".8195 to ".8335

Note 3: 4.63 Diameter from ".8385 to ".840
4.69 Diameter from ".838 to ".841 (Origin of Bore)
5.00 Diameter from ".8315 to ".8385
6.00 Diameter from ".811 to ".824

TABLE 21 CHAMBER MEASUREMENT DATA

Barrel No. EX-182, 20mm Mk 11 Mod 2

| Distance from Breech Surface (ins.) | Chamber Diameter (ins.) | | | |
|---|---|---|---|---|
| | Drawing Dimensions | Prior to Firing | After Firing 625 Rds. | After Firing 1095 Rds. |
| .359 | 1.1531+.002 | 1.1537 | 1.1540 | 1.1540 |
| 1.209 | 1.1233+.002 | 1.1233 | 1.1236 | 1.1237 |
| 1.739 | 1.1048+.002 | 1.1041 | 1.1046 | 1.1046 |
| 2.239 | 1.0873+.002 | 1.0865 | 1.0872 | 1.0872 |
| 2.739 | 1.0698+.002 | 1.0704 | 1.0710 | 1.0710 |
| 3.039 | 1.0593+.002 | 1.0598 | 1.0603 | 1.0604 |
| Specs. 3.693±.005 | .942 | .9464 | .9471 | .9474 |
| 3.6991 | | .9420 | .9426 | .9430 |
| 4.100 | .834+.003 | .8414 | .8413 | .8413 |
| 4.200 | .834+.003 | .8411 | .8402 | .8404 |
| 4.300 | .834+.003 | .8409 | .8379 | .8382 |
| 4.320 | .834+.003 | .8399 | .8364 | .8373 |
| 4.330 | .834+.003 | .8399 | .8369 | .8377 |
| 4.370 | .834+.003 | .8420 | .8381 | .8391 |
| 4.380 | .834+.003 | .8420 | .8381 | .8391 |
| Specs. 4.458+.020 | .828 | .8342 | .8318 | .8322 |
| 4.489 | | .8280 | .8286 | .8327 |
| 4.531 | | .8210 | .8335 | .8380 |
| | | See Note 1 | See Not 2 | See Note 2 |

Note 1: Circumferential Tool Marks 3".12 From Breech Face, Body of Chember Pitted, Small Pitts in Shoulder and Neck Area.

Note 2: Some accumulation of Matter in Rifling, causing an irregular finish appearance, also some build up of substance in the Neck Area of Chamber having a Carbonized appearance. Small section of one land torn away approximately 23".37 from breech face.

TABLE 22

## TABULATED FIRING DATA

Date Fired: 10 September 1954
20mm Aircraft Gun Mk 12 Mod 0 Serial No. 506103
20mm Barrel Mk 11 Mod 2 Serial No. 855108 Chrome Plated (5 Previous Rounds)
Projectiles: Type 2 Mod 2 (Nylon Bands Lot S10M)
Propellant: 630 grains IMR 7013, Lot 1A-40302 Powder

| Burst | Time | Belted | Fired | Rds. on Barrel | Cyclic Rate (rpm) | Average Velocity (ft./sec.) | Yaw (Degrees)* 0-5 No. Rds. | 6-10 No. Rds. | 11-15 No. Rds. | Over 15 No. Rds. | Dispersion 100% Pattern (ins.) X | Y | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1120 | 13 | 13 | 18 | 957 | 3323±10 | 13 | | | | | | |
| 2 | 1307 | 50 | 50 | 68 | 963 | 3321±13 | 16 | | | | 9.1 | 11.0 | Yaw machine stopped therefore very few individual yaws were obtained. |
| 3 | 1309 | 50 | 50 | 118 | 984 | 3315±17 | 48 | 1 | 1 | | 13.8 | 12.0 | |
| 4 | 1311 | 50 | 50 | 168 | 1007 | 3301±22 | 43 | 5 | 2 | | 12.6 | 14.2 | |
| 5 | 1313 | 50 | 50 | 218 | 1011 | 3298±22 | 41 | 4 | 4 | 1 | 19.6 | 16.0 | |
| 6 | 1315 | 50 | 50 | 268 | 997 | 3289±23 | 40 | 5 | 2 | 3 | 20.1 | 13.6 | |
| 7 | 1317 | 50 | 50 | 318 | 995 | 3284±24 | 27 | 13 | 5 | 3 | 20.4 | 15.4 | |
| 8 | 1319 | 50 | 50 | 368 | 996 | 3287±29 | 34 | 6 | 8 | 2 | 18.0 | 21.5 | |
| 9 | 1321 | 50 | 50 | 418 | 991 | 3271±19 | 39 | 3 | 7 | 2 | 22.7 | 16.7 | |
| 10 | 1323 | 50 | 50 | 468 | 976 | 3288±16 | 33 | 7 | 6 | 3 | 20.4 | 21.2 | |
| 11 | 1325 | 50 | 50 | 518 | 960 | 3272±17 | 36 | 4 | 6 | 2 | 20.5 | 17.4 | |
| 12 | 1327 | 50 | 50 | 568 | 956 | 3289±19 | 37 | 4 | 3 | 3 | 19.6 | 18.6 | |
| 13 | 1329 | 50 | 50 | 618 | 946 | 3280±20 | 34 | 8 | 5 | 3 | 18.6 | 22.3 | |
| | | **12 | 12 | 630 | 938 | 3318±9 | 12 | | | | | | |

* Rounds omitted could not be measured.
** Gun at Ambient Temperature.

TABLE 23

## BARREL MEASUREMENT DATA

20mm Barrel Mk 11 Mod 2 Serial No. 855108 Chrome Plated

| Distance from Breech Surface (ins.) | Diameters (ins.) Bore (0".787+0".002-0".000) Prior to Firing | After Firing 630 Rds. | Prior to Firing | After Firing 630 Rds. | Prior to Firing | After Firing 630 Rds. | Grooves (0".817+0".004-0".000) Prior to Firing | After Firing 630 Rds. | Prior to Firing | After Firing 630 Rds. | Prior to Firing | After Firing 630 Rds. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.75 | .789 | .7875 | .789 | .7875 | .789 | .7875 | .820 | .8155 | .820 | .8155 | .820 | .8155 |
| 5.00 | .789 | .7865 | .789 | .787 | .789 | .787 | .820 | .8155 | .820 | .816 | .8205 | .816 |
| 6.00 | .789 | .7855 | .789 | .786 | .789 | .786 | .8205 | .816 | .820 | .816 | .820 | .816 |
| 7.00 | .789 | .785 | .789 | .7855 | .789 | .7855 | .820 | .816 | .820 | .8155 | .820 | .8165 |
| 8.00 | .7885 | .7855 | .7885 | .785 | .7885 | .785 | .820 | .816 | .820 | .816 | .820 | .8165 |
| 9.00 | .7885 | .786 | .7885 | .786 | .7885 | .786 | .820 | .816 | .820 | .816 | .820 | .816 |
| 10.00 | .7885 | .786 | .7885 | .7855 | .7885 | .7855 | .820 | .8165 | .820 | .817 | .8205 | .8165 |
| 15.00 | .7885 | .7865 | .7885 | .7865 | .7885 | .786 | .820 | .817 | .8205 | .817 | .8205 | .817 |
| 20.00 | .7885 | .787 | .7885 | .7865 | .7885 | .787 | .8205 | .8175 | .820 | .818 | .8205 | .8185 |
| 25.00 | .7885 | .788 | .7885 | .788 | .7885 | .788 | .8205 | .818 | .8205 | .8185 | .8205 | .819 |
| 30.00 | .7885 | .788 | .7885 | .788 | .7885 | .788 | .8205 | .8185 | .821 | .819 | .8205 | .8195 |
| 35.00 | .789 | .7885 | .7885 | .7885 | .789 | .7885 | .821 | .819 | .821 | .8195 | .821 | .8195 |
| 40.00 | .789 | .789 | .789 | .7895 | .789 | .789 | .821 | .8195 | .821 | .8195 | .821 | .8195 |
| 45.00 | .789 | .7895 | .789 | .790 | .789 | .790 | .821 | .8195 | .821 | .820 | .821 | .820 |
| 46.00 | .789 | .7895 | .789 | .7895 | .789 | .7895 | .821 | .8195 | .821 | .820 | .821 | .820 |
| 47.00 | .789 | .7895 | .789 | .7895 | .789 | .7895 | .821 | .820 | .821 | .820 | .821 | .820 |
| 48.00 | .789 | .790 | .789 | .790 | .789 | .790 | .821 | .820 | .821 | .820 | .821 | .820 |
| 49.00 | .789 | .790 | .789 | .790 | .789 | .790 | .821 | .820 | .821 | .8205 | .821 | .820 |
| 50.00 | .789 | .7895 | .789 | .7895 | .789 | .7895 | .821 | .820 | .821 | .8205 | .821 | .820 |
| 51.00 | .789 | .7895 | .789 | .7895 | .789 | .7895 | .821 | .820 | .821 | .8205 | .821 | .820 |
| 52.00 | .7895 | .7895 | .7895 | .7915 | .7895 | .7915 | .8215 | .821 | .8215 | .822 | .8215 | .821 |

TABLE 24 CHAMBER MEASUREMENT DATA

Barrel No. 855108, 20mm Mk 11 Mod 2

| Distance from Breech Surface (ins.) | Chamber Diameter (ins.) Drawing Dimensions | Prior to Firing | After Firing 630 Rds. |
|---|---|---|---|
| .359 | 1.1531+.002 | 1.1593 | 1.1595 |
| 1.209 | 1.1233+.002 | 1.1287 | 1.1288 |
| 1.739 | 1.1048+.002 | 1.1104 | 1.1105 |
| 2.239 | 1.0873+.002 | 1.0928 | 1.0929 |
| 2.734 | 1.0698+.002 | 1.0749 | 1.0750 |
| 3.039 | 1.0593+.002 | 1.0643 | 1.0645 |
| Specs. 3.693±.005 | .942 | .9406 | .9405 |
| Actual 3.691 | | .942 | .9418 |
| 4.100 | .834+.003 | .8364 | .8361 |
| 4.200 | .834+.003 | .8364 | .8361 |
| 4.300 | .834+.003 | .8364 | .8334 |
| 4.400 | .834+.003 | .8315 | .8313 |
| Specs. 4.458+.020 | .828 | .828 | .8262 |
| Actual 4.4751 | | | .8229 |

Note: Post Firing Inspection: There is an irregular build up of matter on the rifling and in the neck area of chamber near the origin of rifling. The build up on the rifling is greater near the origin of rifling and gradually diminishes in quantity toward the muzzle.

TABLE 25

TABULATED FIRING DATA

Date Fired: 4 June 1954
20mm Aircraft Gun Mk 12 Mod 0 Serial No. 5C0614
20mm Barrel Mk 11 Mod 2 Serial No. 854254 Chrome Plated (5 Previous Rounds)
Projectiles: Type 2 Mod 2 (Nylon Bands Lot S9)
Propellant: 62C grains IMR 7013, Lot 1A-40302 Powder

| Burst | Time | Belted | Fired | Rds. on Barrel | Cyclic Rate (rpm) | Average Velocity (ft./sec.) | Yaw (Degrees) 0-5 No. Rds. | 6-10 No. Rds. | 11-15 No. Rds. | Over 15 No. Rds. | Dispersion 100% Pattern (ins.) X | Y | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1333 | 15 | 15 | 20 | 1005 | 3249±15 | 15 | | | | | | |
| 2 | 1341 | 50 | 50 | 70 | 1027 | 3271±13 | 50 | | | | 8.2 | 9.0 | |
| 3 | 1343 | 50 | 3 | 73 | | 3246±18 | 3 | | | | | | Slow feeder. |
| 4 | 1344 | 46 | 46 | 119 | 1023 | 3256±18 | 44 | 2 | | | 15.6 | 11.6 | |
| 5 | 1346 | 50 | 2 | 121 | | | 2 | | | | | | Slow feeder. |
| 6 | 1347 | 49 | 17 | 138 | 1005 | 3256±14 | 17 | | | | 13.7 | 10.1 | Failed to extract. |
| 7 | 1349 | 31 | 29 | 167 | 1000 | 3254±15 | 28 | | 1 | | | | Slow feeder. |
| 8 | 1351 | 50 | 50 | 217 | 1004 | 3246±12 | 43 | 6 | 1 | | 13.3 | 13.9 | |
| 9 | 1353 | 50 | 15 | 232 | | 3246±16 | 13 | 1 | 1 | | | | Slow feeder. |
| 10 | 1355 | 33 | 33 | 265 | 992 | 3238±16 | 22 | 7 | 4 | | 18.6 | 16.6 | |
| 11 | 1357 | 50 | 9 | 274 | | 3209±34 | 7 | 2 | | | | | Failed to extract. |
| 12 | 1359 | 40 | 40 | 314 | 990 | 3251±16 | 36 | 2 | 1 | 1 | 14.7 | 18.6 | |
| 13 | 1400 | 50 | 48 | 362 | 982 | 3248±13 | 34 | 9 | 4 | 1 | 19.6 | 19.0 | Slight pause during burst. |
| 14 | 1402 | 50 | 17 | 379 | | 3237±14 | 13 | 3 | | 1 | | | Ammunition chute broken. |
| 15 | 1406 | 33 | 20 | 399 | | 3235±14 | 12 | 7 | | 1 | | | Bolt out of battery. |
| 16 | 1409 | 13 | 1 | 400 | | | 1 | | | | | | Bolt out of battery. |
| 17 | 1410 | 12 | 3 | 403 | | 3210±43 | 3 | | | | | | Bolt out of battery. |
| 18* | 1411 | 9 | 4 | 407 | | 3221±37 | 3 | | | 1 | 17.6 | 16.1 | Gun failed to extract expended case. Also had a broken lock and bad extractor spring. |

* The test was halted at this point because of the numerous gun stoppages.

TABLE 26

BARREL MEASUREMENT DATA

20mm Barrel Mk 11 Mod 2 Serial No. 854254 Chrome Plated

| Distance from Breech Surface (ins.) | Diameters (ins.) Bore (0".787+0".002-0".000) Prior to Firing | After Firing 407 Rds. | Prior to Firing | After Firing 407 Rds. | Prior to Firing | After Firing 407 Rds. | Grooves (0".817+0".004-0".000) Prior to Firing | After Firing 407 Rds. | Prior to Firing | After Firing 407 Rds. | Prior to Firing | After Firing 407 Rds. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.75 | .790 | .790 | .790 | .789 | .7905 | .790 | .822 | .819 | .822 | .819 | .822 | .819 |
| 5.00 | .790 | .7885 | .790 | .7885 | .790 | .7885 | .822 | .8195 | .822 | .819 | .822 | .819 |
| 6.00 | .790 | .788 | .790 | .7885 | .790 | .788 | .822 | .819 | .822 | .820 | .822 | .820 |
| 7.00 | .790 | .788 | .790 | .7885 | .790 | .788 | .822 | .819 | .822 | .8195 | .822 | .8195 |
| 8.00 | .790 | .788 | .790 | .7885 | .790 | .788 | .822 | .819 | .822 | .8195 | .822 | .8195 |
| 9.00 | .7895 | .788 | .7895 | .788 | .7895 | .788 | .822 | .8195 | .822 | .819 | .822 | .820 |
| 10.00 | .7895 | .788 | .7895 | .788 | .7895 | .789 | .822 | .820 | .822 | .8195 | .822 | .8195 |
| 15.00 | .789 | .788 | .789 | .788 | .789 | .788 | .8215 | .819 | .8215 | .819 | .8215 | .819 |
| 20.00 | .789 | .788 | .789 | .788 | .789 | .788 | .8215 | .820 | .8215 | .820 | .8215 | .820 |
| 25.00 | .7885 | .788 | .7885 | .788 | .7885 | .788 | .821 | .820 | .821 | .820 | .821 | .820 |
| 30.00 | .788 | .788 | .7885 | .788 | .788 | .788 | .821 | .820 | .821 | .8195 | .821 | .8195 |
| 35.00 | .788 | .788 | .788 | .788 | .788 | .788 | .8205 | .820 | .8205 | .8195 | .8205 | .8195 |
| 40.00 | .7875 | .788 | .7875 | .788 | .7875 | .788 | .8205 | .819 | .8205 | .8195 | .8205 | .820 |
| 45.00 | .7875 | .7885 | .7875 | .788 | .7875 | .788 | .8205 | .820 | .8205 | .820 | .8205 | .8205 |
| 46.00 | .7875 | .7885 | .7875 | .788 | .7875 | .788 | .8205 | .820 | .8205 | .820 | .8205 | .820 |
| 47.00 | .7875 | .788 | .7875 | .788 | .7875 | .7885 | .8205 | .8205 | .8205 | .820 | .8205 | .820 |
| 48.00 | .7875 | .788 | .7875 | .7885 | .7875 | .789 | .8205 | .8205 | .8205 | .820 | .8205 | .820 |
| 49.00 | .7875 | .7875 | .7875 | .787 | .7875 | .788 | .8205 | .8205 | .8205 | .820 | .8205 | .820 |
| 51.00 | .7875 | .788 | .7875 | .7875 | .7875 | .788 | .8205 | .820 | .8205 | .820 | .8205 | .820 |
| 52.00 | .7875 | .7885 | .7875 | .788 | .7875 | .7885 | .8205 | .820 | .8205 | .8205 | .8205 | .820 |

TABLE 27 CHAMBER MEASUREMENT DATA

Barrel No. 854254, 20mm Mk 11 Mod 2

| Distance from Breech Surface (ins.) | Chamber Diameter (ins.) Drawing Dimensions | Prior to Firing | After Firing 407 Rds. |
|---|---|---|---|
| .359 | 1.1531+.002 | 1.1588 | 1.1589 |
| 1.209 | 1.1233+.002 | 1.1286 | 1.1286 |
| 1.739 | 1.1048+.002 | 1.1096 | 1.1077 |
| 2.239 | 1.0873+.002 | 1.0918 | 1.0919 |
| 2.739 | 1.0698+.002 | 1.0744 | 1.0745 |
| 3.039 | 1.0593+.002 | 1.0642 | 1.0642 |
| Specs. 3.693±.005 | .942 | .9386 | .9386 |
| Actual 3.6885 | | .942 | .942 |
| 4.100 | .834+.003 | .8385 | .8384 |
| 4.200 | .834+.003 | .8383 | .8378 |
| 4.300 | .834+.003 | .8383 | .8364 |
| Specs. 4.458+.020 | .828 | .8321 | .8287 |
| Actual 4.4771 | | .828 | .8236 |

Notes: R.M.S. value of chamber surface finish in microinches - chamber to front slope 8 to 21, chamber neck area 12-14. Front slope pitted, pitts scattered around chamber body, non-concentric ring or raised surface around front slope chamber not within tolerances.

After firing there is a build up of matter on lands and grooves forming a rough crackle type finish similar to barrel EX-184. Fine heat cracks at origin of lands.

# APPENDIX G

TABLE 28

TABULATED FIRING DATA

Date Fired: 11 September 1953
20mm Aircraft Gun Mk 12 Mod C Serial No. 501151
20mm Barrel Mk 11 Mod 2 Serial No. 854342 Unplated (5 Previous Rounds)
Projectiles: Type 2 Mod 2 (Nylon Bands Lot S2B)
Propellant: 620 grains IMR 7013, Lot 1A-40302 Powder

| Burst | Time | Belted | Fired | Rds. on Barrel | Cyclic Rate (rpm) | Average Velocity (ft./sec.) | Yaw (Degrees)* 0-5 No. Rds. | 6-10 No. Rds. | 11-15 No. Rds. | Over 15 No. Rds. | Dispersion 100% Pattern (ins.) X | Y | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1406 | 50 | 48 | 53 | 976 | 3336±13 | 42 | 6 | | | 11.5 | 8.5 | Ammunition belt separation. |
| 2 | 1408 | 50 | 50 | 103 | 996 | 3337±7 | 44 | 6 | | | 12.5 | 13.0 | |
| 3 | 1410 | 50 | 50 | 153 | 1021 | 3335±9 | 39 | 6 | 2 | 1 | 14.0 | 15.5 | |
| 4 | 1412 | 48 | 48 | 201 | 1028 | 3323±16 | 38 | 7 | | 1 | 16.0 | 15.0 | |
| 5 | 1414 | 50 | 50 | 251 | 1024 | 3318±9 | 39 | 7 | 3 | 1 | 18.0 | 20.5 | |
| 6 | 1416 | 50 | 50 | 301 | 1010 | 3314±9 | 36 | 9 | 4 | 1 | 17.5 | 15.0 | |
| 7 | 1419 | 50 | 50 | 351 | 1007 | 3318±9 | 39 | 9 | 1 | 1 | 17.0 | 16.5 | |
| 8 | 1421 | 50 | 50 | 401 | 1001 | 3305±10 | 34 | 5 | 7 | 4 | 22.0 | 15.5 | |
| 9 | 1424 | 53 | 31 | 432 | 989 | 3290±10 | 16 | 5 | 7 | 2 | | | Broken feeder anchor arms. |
| | 1429 | 22 | 22 | 454 | 991 | 3298±9 | 19 | 2 | | 1 | 19.0 | 22.0 | |
| 10 | 1431 | 50 | 50 | 504 | 997 | 3295±10 | 30 | 15 | 4 | 1 | 17.0 | 17.0 | |
| 11 | 1433 | 50 | 48 | 552 | 987 | 3282±14 | 42 | 3 | 2 | 1 | 19.5 | 20.5 | Defective end link. |
| 12 | 1435 | 52 | 52 | 604 | 991 | 3260±11 | 28 | 4 | 6 | 14 | 21.5 | 23.0 | |

* Rounds omitted could not be measured.

TABLE 29 TABULATED FIRING DATA

Date Fired: 20 May 1954
20mm Aircraft Gun Mk 12 Mod 0 Serial No. 501614
20mm Barrel Mk 11 Mod 2 Serial No. 854342 Unplated (604 Previous Rounds)
Projectiles: Type 2 Mod 2 (Nylon Bands Lot S9)
Propellant: 620 grains IMR 7013, Lot 1A-40302 Powder

| Burst | Time | Belted | Fired | Rds. on Barrel | Cyclic Rate (rpm) | Average Velocity (ft./sec.) | Yaw (Degrees)* 0-5 No. Rds. | 6-10 No. Rds. | 11-15 No. Rds. | Over 15 No. Rds. | Dispersion 100% Pattern (ins.) X | Y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1420 | 15 | 15 | 619 | 1040 | 3233±8 | 15 | | | | | |
| 2 | 1431 | 50 | 50 | 669 | 1059 | 3232±7 | 44 | 6 | | | 11.0 | 7.8 |
| 3 | 1433 | 50 | 50 | 719 | 1059 | 3227±12 | 42 | 6 | 2 | | 13.0 | 10.8 |
| 4 | 1435 | 50 | 50 | 769 | 1057 | 3222±11 | 38 | 6 | 4 | 2 | 13.1 | 13.1 |
| 5 | 1442 | 50 | 50 | 819 | 1029 | 3219±13 | 41 | 4 | 4 | 1 | 15.1 | 11.8 |
| 6 | 1445 | 50 | 50 | 869 | 989 | 3210±14 | 41 | 3 | 3 | 3 | 12.6 | 12.4 |
| 7 | 1447 | 50 | 42 | 911 | 1013 | 3198±14 | 14 | 2 | 12 | 9 | 18.9 | 19.3 |
| 8 | 1449 | 50 | 50 | 961 | 991 | 3176±18 | 20 | 4 | 5 | 17 | 24.0 | 22.4 |
| 9 | 1451 | 50 | 50 | 1011 | 996 | 3158±20 | 12 | 7 | 8 | 24 | 23.3 | 21.3 |
| | | **15 | 15 | 1026 | | 3204±15 | | | | | | |
| 21 May | | **15 | 15 | 1041 | | 3201±10 | 7 | 2 | 6 | | | |

* Rounds omitted could not be measured.
** Gun at Ambient Temperature.

TABLE 30

BARREL MEASUREMENT DATA

20mm Barrel Mk 11 Mod 2 Serial No. 854342 Unplated

| Distance from Muzzle Surface (ins.) | Diameters (ins.) Bore (0".787+0".002-0".000) Prior to Firing | After Firing 604 Rds. | After Firing 1041 Rds. | Prior to Firing | After Firing 604 Rds. | After Firing 1041 Rds. | Prior to Firing | After Firing 604 Rds. | After Firing 1041 Rds. | Grooves (0".817+0".004-0".000) Prior to Firing | After Firing 604 Rds. | After Firing 1041 Rds. | Prior to Firing | After Firing 604 Rds. | After Firing 1041 Rds. | Prior to Firing | After Firing 604 Rds. | After Firing 1041 Rds. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | .788 | .789 | .792 | .7875 | .789 | .7915 | .7875 | .7885 | .791 | .818 | .818 | .817 | .818 | .818 | .8175 | .818 | .818 | .817 |
| 1.00 | .788 | .7885 | .7915 | .788 | .7885 | .7905 | .788 | .788 | .790 | .818 | .817 | .817 | .818 | .818 | .817 | .818 | .818 | .817 |
| 2.00 | .788 | .788 | .791 | .787 | .788 | .790 | .7875 | .788 | .790 | .818 | .817 | .817 | .818 | .817 | .817 | .818 | .8175 | .817 |
| 3.00 | .788 | .788 | .7915 | .7875 | .788 | .791 | .788 | .788 | .7915 | .818 | .817 | .817 | .818 | .817 | .817 | .818 | .818 | .817 |
| 4.00 | .788 | .7885 | .792 | .7875 | .788 | .792 | .7875 | .788 | .7915 | .818 | .817 | .817 | .818 | .817 | .817 | .818 | .817 | .817 |
| 8.00 | .7875 | .788 | .7905 | .7875 | .788 | .7905 | .7875 | .788 | .790 | .818 | .817 | .817 | .818 | .817 | .817 | .818 | .817 | .817 |
| 12.00 | .788 | .7875 | .790 | .7875 | .7875 | .790 | .7875 | .7875 | .7895 | .818 | .8175 | .817 | .818 | .8175 | .817 | .818 | .8175 | .817 |
| 16.00 | .788 | .7875 | .7895 | .7875 | .7875 | .7895 | .7875 | .7875 | .7895 | .818 | .817 | .8165 | .818 | .817 | .817 | .818 | .817 | .817 |
| 20.00 | .788 | .787 | .7895 | .7875 | .787 | .7895 | .7875 | .7875 | .7895 | .818 | .817 | .8165 | .818 | .817 | .817 | .818 | .817 | .8165 |
| 22.00 | .788 | .787 | .7895 | .7875 | .787 | .789 | .7895 | .787 | .7895 | .818 | .817 | .816 | .818 | .817 | .817 | .818 | .817 | .8165 |
| 24.00 | .788 | .787 | .7885 | .7875 | .787 | .7885 | .7875 | .787 | .7885 | .818 | .817 | .816 | .818 | .817 | .817 | .818 | .817 | .816 |
| 26.00 | .788 | .787 | .7885 | .7875 | .787 | .7885 | .788 | .7865 | .789 | .818 | .817 | .8165 | .818 | .8165 | .8165 | .818 | .817 | .815 |
| 28.00 | .788 | .787 | .789 | .788 | .7865 | .7885 | .788 | .7865 | .7885 | .818 | .8165 | .8165 | .818 | .817 | .8165 | .818 | .817 | .816 |
| 30.00 | .788 | .7865 | .788 | .788 | .7865 | .7885 | .788 | .7865 | .789 | .818 | .817 | .816 | .818 | .8165 | .816 | .818 | .8165 | .816 |
| 32.00 | .788 | .7865 | .788 | .788 | .7865 | .7885 | .788 | .7865 | .7885 | .818 | .8165 | .816 | .818 | .8165 | .816 | .818 | .8165 | .8145 |
| 34.00 | .788 | .7865 | .7885 | .788 | .787 | .789 | .788 | .7865 | .7885 | .818 | .816 | .815 | .818 | .816 | .815 | .818 | .816 | .8145 |
| 36.00 | .788 | .7865 | .7875 | .788 | .787 | .788 | .788 | .7865 | .7885 | .818 | .816 | .815 | .818 | .816 | .8155 | .818 | .816 | .8145 |
| 38.00 | .788 | .7865 | .7895 | .788 | .787 | .789 | .788 | .787 | .789 | .818 | .8155 | .8145 | .818 | .8155 | .8145 | .818 | .8155 | .8145 |
| 40.00 | .788 | .787 | .788 | .788 | .787 | .788 | .788 | .7875 | .788 | .818 | .8155 | .8135 | .818 | .8155 | .814 | .818 | .8155 | .8135 |
| 42.00 | .788 | .787 | .7885 | .788 | .787 | .7885 | .788 | .787 | .7885 | .818 | .8155 | .8145 | .818 | .8155 | .814 | .818 | .8155 | .814 |
| 44.00 | .788 | .7875 | .7895 | .788 | .788 | .790 | .788 | .788 | .790 | .818 | .8165 | .815 | .818 | .815 | .8135 | .818 | .815 | .814 |
| 46.00 | .7885 | .7905 | .794 | .7885 | .7895 | .794 | .7885 | .790 | .793 | .818 | .8165 | .820 | .818 | .8165 | .818 | .818 | .8165 | .817 |
| 47.00 | .7885 | .7935 | .795 | .7885 | .793 | .796 | .7885 | .793 | .7945 | .818 | .8165 | .817 | .818 | .8165 | .817 | .818 | .817 | .817 |
| 47.50 | .7885 | .795 to .7955 | .7985 | .7885 | .795 to .7955 | .798 | .7885 | .795 to .7955 | .798 | .818 | .816 | .8165 | .818 | .816 | .816 | .818 | .816 | .816 |
| 47.75 | .789 | .800 to .8005 | .8055 | .789 | .800 to .8005 | .806 | .789 | .800 to .8005 | .8055 | .818 | .815 | .816 | .818 | .815 | .816 | .818 | .815 | .816 |
| 47.81 | .790 | .8035 to .804 | .8085 | .790 | .8035 to .804 | .809 | .790 | .8035 to .804 | .8095 | .818 | .815 | .816 | .818 | .815 | .816 | .818 | .815 | .816 |

TABLE 31 CHAMBER MEASUREMENT DATA

Barrel No. 854342, 20mm Mk 11 Mod 2

| Distance from Breech Surface (ins.) | Chamber Diameters (ins.) Drawing Dimensions | Prior to Firing | After Firing 604 Rds. | After Firing 1041 Rds. |
|---|---|---|---|---|
| .359 | 1.1531+.002 | 1.1535 | 1.1536 | 1.537 |
| 1.209 | 1.1233+.002 | 1.1240 | 1.1241 | 1.1242 |
| 1.739 | 1.1048+.002 | 1.1053 | 1.1054 | 1.1056 |
| 2.239 | 1.0873+.002 | 1.0877 | 1.0879 | 1.0878 |
| 2.739 | 1.0698+.002 | 1.0703 | 1.0705 | 1.0706 |
| 3.039 | 1.0593+.002 | 1.0598 | 1.0600 | 1.0606 |
| Specs. 3.693±.005 | .942 | .9418 | .9425 | .9427 |
| Actual 3.698 | | | | |
| 4.100 | .834+.003 | .8365 | .8364 | .8366 |
| 4.150 | .834+.003 | .8365 | .8364 | |
| 4.200 | .834+.003 | .8364 | .8351 | .8355 |
| 4.250 | .834+.003 | .8364 | .8353 | |
| 4.300 | .834+.003 | .8363 | .8369 | .8390 |
| 4.350 | .834+.003 | .8360 | .8333 | .8345 |
| 4.400 | .834+.003 | .8352 | .8324 | .8328 |
| Specs. 4.458+.020 | .828 | .8293 | .8300 | .8319 |
| 4.478 | | .8252 | .8268 | .8305 |
| 4.500 | | .8209 | .8236 | .8264 |
| 4.515 | | .8180 | .8214 | .824 |

Note: Driving edge of lands noticeably worn after 1041 rounds for approximately 9" from origin, severe in intensity at origin and gradually diminishing toward muzzle, severe erosion at gas port, heat check marks in rifling varying from severe in intensity at approximately 2"0 from origin and diminishing to mild intensity 16" from origin.

TABLE 32

TABULATED FIRING DATA

Date Fired: 9 November 1953
20mm Aircraft Gun Mk 12 Mod 0 Serial No. 500899
20mm Barrel Mk 11 Mod 2 Serial No. 856686 Unplated (5 Previous Rounds)
Ammunition: Local Assembly - Standard 20mm Mk 11 Mod 0 Target Projectiles
- 633 grains IMR 7013, Lot 1A-40302 Propellant Powder

| Burst | Time | Belted | Fired | Rds. on Barrel | Cyclic Rate (rpm) | Average Velocity (ft./sec.) | Yaw (Degrees)* 0-5 No. Rds. | 6-10 No. Rds. | 11-15 No. Rds. | 16-20 No. Rds. | Dispersion 100% Pattern (ins.) X | Y | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1536 | 50 | 50 | 55 | 975 | 3331 | 32 | 18 | -- | -- | 7.9 | 9.6 | |
| 2 | 1530 | 51 | 51 | 106 | 960 | 3304 | 33 | 17 | -- | -- | 12.5 | 10.2 | |
| 3 | 1540 | 49 | 49 | 155 | 992 | 3299 | 28 | 19 | 2 | -- | 15.8 | 10.0 | |
| 4 | 1542 | 50 | 39 | 194 | 950 | | 21 | 10 | 6 | 2 | | | |
| 4 | 1543 | 11 | 11 | 205 | 893 | 3248 | 1 | 5 | 4 | -- | 14.5 | 17.5 | Chamber empty. |
| 5 | 1545 | 50 | 50 | 255 | 976 | 3238 | 21 | 18 | 9 | 1 | 14.7 | 16.3 | |
| 6 | 1548 | 50 | 50 | 305 | 1019 | 3198 | 22 | 20 | 4 | 4 | 17.8 | 13.2 | |
| 7 | 1550 | 50 | 50 | 355 | 1004 | 3176 | 21 | 18 | 11 | -- | 14.7 | 16.4 | |
| 8 | 1552 | 50 | 31 | 386 | 1001 | | 12 | 5 | 7 | 7 | | | |
| 8 | 1554 | 18 | 18 | 404 | 1002 | 3168 | 1 | 5 | 10 | 2 | 20.3 | 19.5 | Defective Primer. |
| 9 | 1555 | 50 | 50 | 454 | 1008 | 3171 | 23 | 12 | 14 | 1 | 18.0 | 11.9 | |
| 10 | 1557 | 50 | 30 | 484 | 986 | | 6 | 14 | 8 | 2 | | | Broken feeder |
| 10 | 1558 | 19 | 19 | 503 | 975 | 3107 | 8 | 9 | 2 | -- | 16.3 | 16.5 | anchor arm. |
| 11 | 1600 | 50 | 15 | 518 | -- | 3122 | 10 | 4 | 1 | -- | | | |

Test discontinued due to broken feed mechanism.

* Rounds omitted could not be measured.

TABLE 33

## BARREL MEASUREMENT DATA

Barrel No. 856686, 20mm Mk 11 Mod 2 (5 Previous Rounds)

| Distance from Breech Surface (ins.) | Diameters (ins.) Bore (0".787+0".002-0".000) Prior to Firing | After Firing 518 Rds. | Prior to Firing | After Firing 518 Rds. | Prior to Firing | After Firing 518 Rds. | Grooves (0".817+0".004-0".000) Prior to Firing | After Firing 518 Rds. | Prior to Firing | After Firing 518 Rds. | Prior to Firing | After Firing 518 Rds. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.75 | 0.790 | 0.8215 | 0.789 | 0.8215 | 0.789 | 0.8215 | 0.8195 | 0.8255 | 0.8195 | 0.8255 | 0.8195 | 0.8255 |
| 5.00 | 0.789 | 0.820 | 0.7885 | 0.820 | 0.788 | 0.820 | 0.8195 | 0.827 | 0.8195 | 0.8275 | 0.8195 | 0.827 |
| 6.00 | 0.788 | 0.814 | 0.788 | 0.814 | 0.788 | 0.814 | 0.8195 | 0.825 | 0.8195 | 0.8225 | 0.8195 | 0.8225 |
| 7.00 | 0.788 | 0.814 | 0.788 | 0.814 | 0.788 | 0.814 | 0.8195 | 0.820 | 0.8195 | 0.820 | 0.8195 | 0.820 |
| 8.00 | 0.788 | 0.8115 | 0.788 | 0.8115 | 0.7875 | 0.8115 | 0.8195 | 0.8185 | 0.8195 | 0.8185 | 0.8195 | 0.8185 |
| 9.00 | 0.788 | 0.808 | 0.788 | 0.808 | 0.7875 | 0.808 | 0.8195 | 0.8175 | 0.8195 | 0.8175 | 0.8195 | 0.8175 |
| 10.00 | 0.788 | 0.8045 | 0.788 | 0.8045 | 0.7875 | 0.8045 | 0.8195 | 0.8175 | 0.8195 | 0.8175 | 0.8195 | 0.8175 |
| 15.00 | 0.788 | 0.799 | 0.788 | 0.799 | 0.788 | 0.799 | 0.8195 | 0.8175 | 0.8195 | 0.8175 | 0.8195 | 0.8175 |
| 20.00 | 0.7875 | 0.790 | 0.7875 | 0.790 | 0.7875 | 0.790 | 0.8195 | 0.8175 | 0.8195 | 0.8175 | 0.8195 | 0.8175 |
| 25.00 | 0.788 | 0.7875 | 0.7875 | 0.7885 | 0.7875 | 0.789 | 0.8195 | 0.8175 | 0.8195 | 0.818 | 0.8195 | 0.8175 |
| 30.00 | 0.788 | 0.7875 | 0.7875 | 0.7875 | 0.7875 | 0.787 | 0.819 | 0.8175 | 0.819 | 0.8185 | 0.8195 | 0.818 |
| 35.00 | 0.788 | 0.7875 | 0.7875 | 0.7880 | 0.7875 | 0.7875 | 0.819 | 0.8175 | 0.819 | 0.8175 | 0.8195 | 0.818 |
| 40.00 | 0.7875 | 0.788 | 0.7875 | 0.7885 | 0.7875 | 0.788 | 0.819 | 0.818 | 0.819 | 0.8175 | 0.819 | 0.818 |
| 45.00 | 0.7875 | 0.789 | 0.7875 | 0.789 | 0.7875 | 0.790 | 0.819 | 0.818 | 0.819 | 0.8175 | 0.819 | 0.8175 |
| 46.00 | 0.7875 | 0.789 | 0.7875 | 0.789 | 0.7875 | 0.789 | 0.819 | 0.817 | 0.819 | 0.817 | 0.819 | 0.817 |
| 47.00 | 0.7875 | 0.789 | 0.7875 | 0.7885 | 0.7875 | 0.789 | 0.819 | 0.817 | 0.819 | 0.817 | 0.819 | 0.817 |
| 48.00 | 0.7875 | 0.789 | 0.7875 | 0.7895 | 0.7875 | 0.7895 | 0.819 | 0.817 | 0.819 | 0.817 | 0.819 | 0.817 |
| 49.00 | 0.7875 | 0.7895 | 0.7875 | 0.790 | 0.7875 | 0.790 | 0.819 | 0.817 | 0.819 | 0.817 | 0.819 | 0.817 |
| 50.00 | 0.7875 | 0.790 | 0.7875 | 0.790 | 0.7875 | 0.790 | 0.819 | 0.817 | 0.819 | 0.817 | 0.819 | 0.817 |
| 51.00 | 0.7875 | 0.790 | 0.7875 | 0.791 | 0.7875 | 0.790 | 0.819 | 0.818 | 0.819 | 0.818 | 0.819 | 0.818 |
| 52.00 | 0.7875 | 0.7915 | 0.7875 | 0.793 | 0.7875 | 0.792 | 0.819 | 0.818 | 0.819 | 0.818 | 0.819 | 0.818 |

TABLE 34 CHAMBER MEASUREMENT DATA

Barrel No. 856686, 20mm Mk 11 Mod 2

| Distance from Breech Surface (ins.) | Chamber Diameter (ins.) Drawing Dimensions | Prior to Firing | After Firing 518 Rds. |
|---|---|---|---|
| .359 | 1.1531+.002 | 1.1558 | 1.1558 |
| 1.209 | 1.1233+.002 | 1.1263 | 1.1263 |
| 1.739 | 1.1048+.002 | 1.1072 | 1.1072 |
| 2.239 | 1.0873+.002 | 1.0900 | 1.0901 |
| 2.739 | 1.0698+.002 | 1.0727 | 1.0727 |
| 3.039 | 1.0593+.002 | 1.0619 | 1.0619 |
| Specs. 3.693±.005 | .942 | .9436 | .9437 |
| 4.100 | .834+.003 | .8401 | .8401 |
| 4.200 | .834+.003 | .8383 | .8376 |
| 4.300 | .834+.003 | .8371 | .8368 |
| 4.400 | .834+.003 | .8355 | .8342 |
| Specs. 4.458+.020 | .828 | .8316 | .8324 |
| Actual 4.4755 | | .828 | .8307 |

TABLE 35

## TABULATED FIRING DATA

Date Fired: 12 May 1953
20mm Aircraft Gun Mk 12 Mod 0 Serial No. 5C0832
20mm Barrel Mk 11 Mod 2 Serial No. 855119 Unplated (56 Previous Rounds)
Ammunition: Production Lot ZS-7-HMC-53 - Standard 20mm Mk 11 Mod 0 Target Projectiles
- 661 grains IMR 6962 Lot DSZA-5 Propellant Powder

| Burst | Time | Belted | Fired | Rds. on Barrel | Cyclic Rate (rpm) | Average Velocity (ft./sec.) | Yaw (Degrees)* 0-5 No. Rds. | 6-10 No. Rds. | 11-15 No. Rds. | 16-20 No. Rds. | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1050 | 50 | 6 | 62 | 974 | 3305 | 6 | | | | Rounds in chamber, firing pin mark. |
| 2 | 1052 | 44 | 37 | 99 | 985 | 3361 | 36 | 1 | | | Round in chamber, firing pin mark, hesitation in burst. |
| 3 | 1055 | 50 | 44 | 143 | 1024 | 3315 | 34 | 6 | 3 | 1 | Round in chamber, firing pin mark. |
| Note: Above 3 stoppages due to defective synchronizing switch, new synchronizing switch installed. | | | | | | | | | | | |
| 4 | 1058 | 50 | 50 | 193 | 1008 | 3282 | 35 | 9 | 5 | 1 | |
| 5 | 1100 | 50 | 7 | 200 | 1000 | 3237 | 5 | 2 | | | Stubbed round. |
| Note: Feed mechanism EX-259 right hand removed and EX-214 right hand installed. | | | | | | | | | | | |
| 6 | 1102 | 42 | 42 | 242 | 995 | 3250 | 26 | 10 | 6 | | |
| 7 | 1104 | 50 | 50 | 292 | 983 | 3222 | 37 | 9 | 3 | | |
| Note: Paper in yaw machine broke, therefore, yaw not measured on remaining bursts. | | | | | | | | | | | |
| 8 | 1106 | 50 | 50 | 342 | 975 | 3210 | | | | | |
| 9 | 1108 | 50 | 50 | 392 | 972 | 3175 | | | | | |
| 10 | 1111 | 50 | 50 | 442 | 968 | 3163 | | | | | |
| 11 | 1115 | 50 | 50 | 492 | 955 | 3142 | | | | | |

* Rounds omitted could not be measured.

TABLE 36

## BARREL MEASUREMENT DATA

20mm Barrel Mk 11 Mod 2 Serial No. 855119 (56 Previous Rounds)

| Distance from Muzzle Surface (ins.) | Diameters (ins.) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bore (0".787+0".002-0".000) | | | | | | Grooves (0".817+0".004-0".000) | | | | | |
| | Prior to Firing | After Firing 492 Rds. | Prior to Firing | After Firing 492 Rds. | Prior to Firing | After Firing 492 Rds. | Prior to Firing | After Firing 492 Rds. | Prior to Firing | After Firing 492 Rds. | Prior to Firing | After Firing 492 Rds. |
| 4.75 | 0.7915 | 0.824 | 0.7915 | 0.824 | 0.7915 | 0.824 | 0.818 | 0.8255 | 0.818 | 0.8255 | 0.818 | 0.8255 |
| 5.00 | 0.790 | 0.8195 | 0.7905 | 0.824 | 0.790 | 0.825 | 0.818 | 0.824 | 0.818 | 0.8255 | 0.818 | 0.8255 |
| 6.00 | 0.7895 | 0.809 | 0.7895 | 0.824 | 0.789 | 0.824 | 0.818 | 0.819 | 0.818 | 0.819 | 0.818 | 0.819 |
| 7.00 | 0.789 | 0.805 | 0.789 | 0.824 | 0.789 | 0.824 | 0.818 | 0.8155 | 0.818 | 0.8155 | 0.818 | 0.816 |
| 8.00 | 0.789 | 0.801 | 0.789 | 0.803 | 0.789 | 0.803 | 0.818 | 0.816 | 0.818 | 0.816 | 0.818 | 0.815 |
| 9.00 | 0.7885 | 0.789 | 0.7885 | 0.798 | 0.789 | 0.798 | 0.818 | 0.816 | 0.818 | 0.816 | 0.818 | 0.816 |
| 10.00 | 0.7885 | 0.7965 | 0.7885 | 0.796 | 0.789 | 0.796 | 0.818 | 0.816 | 0.818 | 0.8165 | 0.818 | 0.8165 |
| 15.00 | 0.788 | 0.7915 | 0.788 | 0.792 | 0.788 | 0.7915 | 0.818 | 0.8165 | 0.818 | 0.8165 | 0.818 | 0.817 |
| 20.00 | 0.7875 | 0.788 | 0.7875 | 0.7875 | 0.7875 | 0.7885 | 0.818 | 0.8165 | 0.818 | 0.8165 | 0.818 | 0.8175 |
| 25.00 | 0.7875 | 0.787 | 0.787 | 0.787 | 0.787 | 0.787 | 0.818 | 0.8165 | 0.818 | 0.8165 | 0.818 | 0.8175 |
| 30.00 | 0.7875 | 0.7875 | 0.787 | 0.787 | 0.787 | 0.787 | 0.818 | 0.8165 | 0.818 | 0.817 | 0.818 | 0.817 |
| 35.00 | 0.787 | 0.7875 | 0.787 | 0.787 | 0.787 | 0.787 | 0.818 | 0.8165 | 0.818 | 0.8165 | 0.818 | 0.817 |
| 40.00 | 0.787 | 0.788 | 0.787 | 0.787 | 0.787 | 0.787 | 0.818 | 0.816 | 0.818 | 0.816 | 0.818 | 0.817 |
| 45.00 | 0.787 | 0.7875 | 0.787 | 0.787 | 0.787 | 0.7875 | 0.818 | 0.816 | 0.818 | 0.8165 | 0.818 | 0.817 |
| 46.00 | 0.787 | 0.787 | 0.787 | 0.7875 | 0.787 | 0.787 | 0.818 | 0.816 | 0.818 | 0.8165 | 0.818 | 0.817 |
| 47.00 | 0.787 | 0.7875 | 0.787 | 0.787 | 0.787 | 0.787 | 0.818 | 0.816 | 0.818 | 0.8165 | 0.818 | 0.8165 |
| 48.00 | 0.787 | 0.7875 | 0.787 | 0.7875 | 0.787 | 0.787 | 0.818 | 0.8165 | 0.818 | 0.8165 | 0.818 | 0.8175 |
| 49.00 | 0.787 | 0.788 | 0.787 | 0.788 | 0.787 | 0.7875 | 0.818 | 0.8165 | 0.818 | 0.8165 | 0.818 | 0.8175 |
| 50.00 | 0.787 | 0.7875 | 0.787 | 0.7875 | 0.787 | 0.788 | 0.818 | 0.8165 | 0.818 | 0.817 | 0.818 | 0.817 |
| 51.00 | 0.787 | 0.788 | 0.787 | 0.7875 | 0.787 | 0.788 | 0.818 | 0.8165 | 0.818 | 0.8165 | 0.818 | 0.817 |
| 52.00 | 0.787 | 0.789 | 0.787 | 0.788 | 0.787 | 0.789 | 0.818 | 0.8165 | 0.818 | 0.8165 | 0.818 | 0.817 |
| 52.25 | 0.7875 | 0.788 | 0.787 | 0.788 | 0.787 | 0.789 | -- | -- | -- | -- | -- | -- |
| 52.40 | -- | -- | -- | -- | -- | -- | 0.818 | 0.817 | 0.818 | 0.817 | 0.818 | 0.8175 |

TABLE 37 CHAMBER MEASUREMENT DATA

Barrel No. 855119, 20mm Mk 11 Mod 2

| Distance from Breech Surface (ins.) | Chamber Diameter (ins.) | | |
|---|---|---|---|
| | Drawing Dimensions | Prior to Firing | After Firing 492 Rds. |
| .359 | 1.1531+.002 | 1.1542 | 1.1542 |
| 1.209 | 1.1233+.002 | 1.1245 | 1.1245 |
| 1.739 | 1.1048+.002 | 1.1061 | 1.1059 |
| 2.239 | 1.0873+.002 | 1.0891 | 1.0891 |
| 2.739 | 1.0698+.002 | 1.0713 | 1.0713 |
| 3.039 | 1.0593+.002 | 1.0609 | 1.0609 |
| Specs. 3.693±.005 | .942 | .9391 | .9389 |
| 4.100 | .834+.003 | .8348 | .8348 |
| 4.200 | .834+.003 | .8347 | .8340 |
| 4.300 | .834+.003 | .8347 | .8324 |
| Specs. 4.458+.020 | .828 | .8293 | .8303 |
| 4.464 | | .828 | .8298 |
| 4.512 | | .819 | .828 |



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OEVELOPMENT ANO TEST OF NVLON ROTATING BAND FOR 20MM HIGH VELOCITY PROJECTILE, by R. B. Butler. 10 March 1955. 13p. tables. append A-H. NPG Report No. 1342. NAVORO Raport No. 1339. Task assignment NPG-B-3b-225-1-54) CONFIOENTIAL

Previously reported work on the development of a nylon rotating band for the 20mm aircraft gun Mk 12 had shown that the band as developed imparted full spin to the projectile, obturated satisfectorily, and did not fringe noticeably or produca unacceptable yaw, in slow fire at muzzle velocities up to 3500 ft/sec and et temparatures from -65° to 160°F. On the basis of a relatively small amount of firing, the band appeered to be completely retainad in flight even at the tempereture extremes. This report continues the account of the development work on this band, including additional extreme temperature firing, firing for ballistic accuracy, and rapid-fira tests.

I. Rotating bands - Test results

I. Butler, R. B.

II. NAVORO 1339

NPG 1342

Naval Proving Ground, Oahlgren, Virginia

OEVELOPMENT ANO TEST OF NYLON ROTATING BANO FOR 20MM NIGH VELOCITY PROJECTILE, by R. B. Butler. 10 March 1955. 13p. tables. append A-H. NPG Report No. 1342. NAVORO Report No. 1339. Task assignment NPG-B-3b-225-1-54) CONFIOENTIAL

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II. NAVORO 1339

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I. Butler, R. B.

II. NAVORD 1339