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# TRUNNION REACTION, DISPLACEMENT VS TIME TEST OF FIVE (5) 20MM GUNS, M2, MOUNTED IN THE FRENCH FRONT SPRING (SQUARE STOCK) RECOIL ADAPTER AND COUNTER-RECOIL AIR PISTON BUFFER

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by

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# TRUNNION REACTION, DISPLACEMENT VS TIME TEST OF FIVE (5) 20MM GUNS, M2, ([redacted]); MOUNTED IN THE FRENCH FRONT SPRING (SQUARE STOCK) RECOIL ADAPTER AND COUNTER-RECOIL AIR PISTON BUFFER.

## Synopsis


The trunnion reactions of five (5) 20mm Guns, M2 (Olds) mounted in the French front spring recoil adapter and counter-recoil air buffer were determined at normal temperature (78°F) by means of piezo-electric gages and the cathode ray oscillograph.

The greatest observed forces were:

| Gun No. | Force-lbs. In Direction Of Recoil | Counter-recoil |
|---|---|---|
| 24495 | 5740 | 10900 |
| 24494 | 5620 | 10750 |
| 24492 | 5870 | 13130 |
| 24491 | 4650 | 9520 |
| 24490 | 3260 | 13370 |

These forces were determined on a (practically) rigid mount. Where the mount is less rigid the forces, in general, will be different.

The movement of the gun ~~xxx kxxx xkxdxx~~ was recorded simultaneously with the determination of the forces at the trunnions. From both records the following may be observed:

a. The trunnion reactions are excessively high.
b. The counter-recoil air buffer is of doubtful value.
c. Maximum recoil, in automatic fire, is erratic and generally short.



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d. The guns will not maintain automatic fire when the Chatellerault feed is used due to short recoil distances.

e. The guns will maintain automatic fire with the drum feed but the cyclic rate will be erratic.

## Authority

1. The Chief of Ordnance in OO 400.3295/44997-Misc., APG 472.5/317-10, 1st Ind., paragraph 4, directed that trunnion reactions be determined for five (5) 20mm Guns, M2 (Olds Motor Works Division).

## Materiel and Apparatus

2. The following materiel and apparatus were used:

a. 20mm Gun, M2, No. 24495 equipped with French Front Spring (square stock) recoil adapter, counter-recoil air buffer and muzzle brake.

b. Gun No. 24494 with air buffer and bolt of No. 24495 assembled as in a above.

c. Gun No. 24492 with air buffer of No. 24495, left side bolt plate and back plate buffer of 24494.

d. Gun No. 24491 with air buffer of No. 24495, otherwise complete.

e. Gun No. 24490 with air buffer of No. 24495, otherwise complete.

f. Ammunition, British Lot 89, Remington.

g. A specially constructed mount for the determination of trunnion reactions. (Ref. Appendix I, paragraph 1, Photo No. BP-10).

h. Piezo-electric gages and cathode ray oscillograph. (Ref. Appendix I, paragraphs 2 and 3, Figure 2, Photo No. BP-11).

i. A revolving drum and pencil to record the movement of the guns. (Ref. Appendix I, paragraph 4, Photo No. BP-10).

j. A muzzle contact to correlate the records of trunnion reaction vs time with those of displacement vs time.

## Procedure and Results

3. The trunnion reactions were determined and time travel curves were taken of the five (5) Guns, M2 (Olds) as given in paragraph 2.

The front recoil springs were all tightened to an approximate assembled length of 11-5/16 inches. The air buffer of Gun No. 24495, used throughout the entire test, was kept well

lubricated. Trunnion reaction vs time and displacement vs time records were obtained for each gun when single shots and bursts of three rounds each were fired. A copy of a typical record of a burst for four of the five guns is shown in Figure I.

4. Various intervals or events with their corresponding maximum forces are given in Table I. (Ref. Appendix I, paragraphs 5 and 6). The greatest observed forces were:

| Gun No. | Force-lbs. In Direction Of Recoil | Force-lbs. In Direction Of Counter-recoil |
|---|---|---|
| 24495 | 5740 | 10900 |
| 24494 | 5620 | 10750 |
| 24492 | 5870 | 13130 |
| 24491 | 4650 | 9520 |
| 24490 | 3260 | 13370 |

5. Maximum recoil distances and instrumental velocities are given in Table II.

6. The recoil, driving and buffer springs were calibrated producing the following coefficients:

| Gun No. | Rds. Fired Previous to Test | Spring Coefficient - lbs/in. Recoil | Driving | Buffer |
|---|---|---|---|---|
| 24495 | 140 | 445 | 8.4 | 490 |
| 24494 | 4145 | 480 | 6.7 | 480 |
| 24492 | 142 | 485 | | 500 |
| 24491 | 4144 | 461 | 6.4 | 480 |
| 24490 | 4139 | 490 | 7.9 | 490 |

## Accuracy

7. The accuracy in reading the deflections as recorded on the cathode ray oscillograms are within ±0.02 cm. and, as the force scale was approximately 3200 lbs/cm., the accuracy as far as the reading should be within ±65 lbs.

## Discussion

8. From the test of these five M2 Guns, the following is observed:

a. The trunnion reactions are excessively high.
b. In general, in automatic fire, the events of one firing cycle are not similarly repeated in the next.
c. Slight difference in functioning between guns.

9. Excessive trunnion reactions for 20mm Guns mounted in this adapter have been observed in other tests (Ref. Ballistic Research Laboratory Report No. 194). Such high forces in rapid changes of direction tend to shorten the life of all moving parts, particularly of the bolt assembly. The counter-recoil air buffer was designed to absorb the shock of the gun returning into battery and to dampen out the oscillations. Since its use is ineffective, it should be replaced with a more positive shock absorber.

10. The irregularity in events from round to round within an individual gun may be caused by one or more of the following:

a. Inability of the counter-recoil air buffer to dampen the oscillations of the gun so that the gun is at rest before the next round is fired.
b. Variations in time of bolt unlocking.
c. The direction and speed with which the gun is moving when the impact between bolt and buffer occurs.

11. As may be seen from Figure I and Tables I and II, the irregular movements of bolt and gun react in several different combinations to produce (a) short recoil distances and relatively low reactions, (b) long recoil distances and high reactions or, at times the reverse of a and b. These combinations of reactions, acting together, cause the guns to fire out of battery frequently.

12. In addition to a, b and c of paragraph 10, what differences in functioning exist between the M2 Guns may be due to the following:

a. A change in gas vent sizes, i.e., burnt out or filled with carbon.
b. Different characteristics of recoil, driving and buffer springs.
c. Number of rounds fired from each gun previous to this test.

13. From the spring calibrations, paragraph 6, it is observed that there is quite some differences in the recoil springs.

While these springs control directly the record distance, they also influence the timing of the bolt during its cycle of operation. Referring to paragraphs 10 and 11, it is evident that each gun will have some slight differences in operation.

14. The number of rounds fired from each gun seems to make slight differences in functioning except for changes in instrumental velocities.

15. It is noticeable throughout this test that the maximum recoil distance is seldom over .75 inch. This is not objectionable when a drum type of feed is used with this front spring adapter, but is of the utmost importance when using the Chatellerault feed. The Chatellerault feed requires a minimum recoil distance of .75 inch in order to wind and operate properly. From Table II it may be noted that in firing a burst of three rounds at least one recoil distance (sometimes two) is far below this distance. From test, this feed will fire eight rounds without winding. Based on the recoil distances of Table II, the maximum number of rounds that could be fired before a stoppage occurs will be from eighteen to twenty-four rounds. This fact is borne out by Small Arms firings with this adapter and the Chatellerault feed in which stoppages occurred after the eighteenth to twenty-first round. This test demonstrates that, in its present form, the French front spring cannot be used satisfactorily with the Chatelleratult feed.

## Conclusion

16. This test has shown the following:

a. Reactions at the trunnions are excessively high.
b. These reactions may be eliminated by replacing the counter-recoil air buffer with a more positive shock absorber that will dampen out the oscillations of the gun before firing the next round.
c. The guns will operate automatically with a drum type of feed but the time between rounds will be irregular.
d. The guns, mounted in this adapter, will not satisfactorily maintain automatic fire with the Chatellerault feed, although this may be possible by reducing either the strength of the recoil spring or the initial compression. However, this change will not reduce the high counter-recoil forces at the trunnions.

17. The trunnion reactions and movements of these guns were determined on a mount built as rigidly as practical. In a less rigid mount the forces and movements may be different.

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## Appendix I

1. The 20mm Hispano Guns, M2 (Olds) with attached French Front spring adapter were mounted rigidly and level in a mounting constructed specially for obtaining trunnion reactions. The guns were supported at the front (trunnions) and at the rear. A brief description of each support follows:

a. The front support consisted of two vertical plates securely bolted and doweled to a pair of railroad rails bolted to large "I" beams. The "I" beams were securely bolted to a heavy iron base sunk into a concrete floor. Horizontal guideways were provided near the top of each plate in which rested a pair rectangular steel blocks neatly fitted to the trunnions of a yoke holding the adapter. Sliding clearance was provided between blocks and guideways. At both ends of the guideways were placed adjusting screws drilled and insulated for electrical contacts. Between these adjusting screws and trunnion block were placed piezo-electric gages, one at the front and another at the rear of each block. Initial pressure was applied to each gage to keep lost motion at a minimum.

b. The rear support consisted of an iron support with a base attached to the aforementioned rails. Bolted to the top of this cylinder was a rectangular plate slotted to receive the slides along the sides of the gun receiver. Mounted in this manner the gun was free to move forward or rearward, restrained by the gages only.

2. Figure 2 shows the piezo-electric gages, used in the determination of trunnion reactions, assembled with the front spring. All four gages are matched, i.e., have the same characteristics. The gages are connected (with reference to polarity) in a manner such that a loading of the rear gages and unloading of the front gages (recoil) produced a deflection of the cathode ray beam in one direction, while a loading of the front gages and unloading of the rear gages (counter-recoil) produced an opposite deflection.

3. The piezo-electric gages had been calibrated prior to this test to determine the relationship between force and the piezo-electric charge. The electrical apparatus was calibrated immediately before the test, and check-calibrated immediately after, to determine the relationship between charge and deflection of the cathode ray beam. From these two calibrations the deflection may be expressed in units of force.*

* Ref. "The Use of the Piezo-electric Gage in the Measurement of Powder Pressures" by R. H. Kent and A. H. Hodge, trans. of the A.S.M.E., Vol. 61, No. 3, April, 1939, P. 197. "The Piezo-electric Gage" by R. H. Kent, Army Ordnance, Vol. 18, March--Arpil, 1939, P. 281.

4. In order to correlate the movement of the gun a pencil was attached to each gun and its motion recorded on cross section paper tacked to a rotating drum.

5. Trunnion reaction and displacement vs time records were obtained when single rounds and when bursts of three rounds each were fired. A copy of the records obtained from a burst is shown in Figure 1. The trunnion reaction vs time curve is shown first with the displacement vs time curve immediately below. Recoil forces and displacements as shown are positive upwards and negative downwards.

6. The records were divided into intervals a - b, b - c, etc. as shown in Figure I. Inasmuch as the guns changed their sequence of events in automatic fire, a description of these intervals for single shots only are given as:

| Interval | Description |
|---|---|
| a - b | Bolt strikes breech |
| b - c | Gun fires and begins recoil |
| c - d | Gun returns " in battery" |
| d - e | Gun rebounds in direction of recoil |
| e - f | Gun returns " in battery" |
| f - g | Same as d - e |
| g - h* | Bolt returns "in battery" |
| h - i | Gun and/or bolt and bolt slides rebound in direction of recoil |
| i - j | Gun and/or bolt and bolt slides return "in battery" |
| j - k | Same as h - i |
| k - l | Same as i - j |

Several more impacts occur after the interval k - l but their reactions are of relatively small magnitude.

* Generally, in automatic fire, the interval g - h becomes the interval a - b of the next round.

TABLE I

A

Trunnion Reaction Maxima* of the 20mm Gun, M2 (Olds)

Ammunition Temperature 78°F (Approx.)

Dec. 2, 1941 Gun No. 24495--Single driving spring--Rounds fired previously, 140

| Interval | Rd. No. | a - b | b - c | c - d | d - e | e - f | f - g | g - h | h - i | i - j | j - k | k - l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Single Shots | 4 | -2070 | +1870 | - 8640 | +1780 | - 6810 | +1240 | -6870 | +1450 | -4260 | +1150 | -2550 |
| | 5 | -2160 | +1870 | - 9000 | +1270 | - 6810 | + 970 | -6630 | +1240 | -4170 | + 880 | -2310 |
| | 7 | -2280 | +1780 | - 7860 | +1360 | - 5611 | +1270 | -7740 | +1330 | -4920 | +1000 | -2220 |
| Burst of 3 Rounds | 8 | -1980 | +1780 | -10230 | +1750 | - 8370 | | | | | | |
| | 9 | *** | +1210 | -10050 | +1720 | - 9450 | +1994 | | | | | |
| | 10 | -9180 | +5740 | - 9480 | +1390 | - xxx | +1870 | -5670 | +1300 | -2760 | | |
| Burst of 3 Rounds | 11 | -2010 | +2050 | - 9330 | +1780 | - 7200 | +1660 | | | | | |
| | 12 | -8790 | +1930 | - 6480 | +1360 | - 3810 | +1240 | | | | | |
| | 13 | -5220 | +5110 | - 7830 | +1720 | - 8642 | +1180 | -2460 | + 880 | -1410 | | |
| Burst of 3 Rounds | 14 | -2130 | +2270 | - 8010 | +1300 | - 5790 | +1390 | | | | | |
| | 15 | -4590 | +4410 | - 8820 | +2050 | - 7320 | +1750 | -5340 | +1390 | | | |
| | 16 | *** | +1330 | - 9990 | +2230 | -10920 | +2210 | -7650 | +1600 | -4650 | +1240 | -3180 |

* With trunnions held rigidly
*** Gun fired out of battery, interval not distinguishable
xxx Maximum force off film
Forces in direction of recoil are listed as positive
Forces in direction of counter-recoil are listed as negative

TABLE I
(cont'd)

Dec. 3, 1941 Gun No. 24494--Three strand driving spring--Counter-recoil buffer and bolt of gun No. 24495--Rounds fired previously, 4145

| Interval | Rd. No. | a - b | b - c | c - d | d - e | e - f | f - g | g - h | h - i | i - j | j - k | k - l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Single Shots | 6 | - 2080 | +1590 | - 9380 | +2400 | - 3800 | + 980 | -3630 | +1170 | -1250 | + 870 | -1220 |
| | 17 | - 2100 | +1700 | - 9780 | +1890 | - 8310 | +1700 | -6900 | +1170 | -4260 | +1100 | -1820 |
| | 18 | - 1880 | +1390 | - 9750 | +1610 | - 3700 | + 850 | -3070 | + 980 | -1380 | + 850 | - 970 |
| Burst of 3 Rounds | 19 | - 2010 | +1580 | - 9180 | +1670 | - 7870 | +1670 | | | | | |
| | 20 | *** | +1360 | - 9370 | +1550 | - 9780 | +1860 | | | | | |
| | 21 | - 8530 | +3880 | - 9780 | +1450 | -10750 | +2050 | -9560 | +1830 | -5920 | +1100 | -3350 |
| Burst of 3 Rounds | 25 | - 1850 | +1260 | - 8840 | +1390 | - 7490 | +1390 | | | | | |
| | 26 | *** | + 726 | - 8970 | +1390 | - 6710 | +1260 | -3540 | + 880 | | | |
| | 27 | - 5740 | +5620 | - 7650 | +1520 | - 5520 | +1010 | -2980 | + 820 | -1470 | | |
| Burst of 3 Rounds | 28 | - 2040 | +1480 | - 5450 | +1670 | - 4140 | + 850 | | | | | |
| | 29 | - 7460 | +4390 | -10250 | +2300 | - 8840 | +1670 | | | | | |
| | 30 | -10560 | +2110 | - 9970 | +1170 | - 9590 | +1990 | -6210 | +1070 | -3570 | +1010 | -1880 |

*** Gun fired out of battery, interval not distinguishable
Forces in direction of recoil are listed as positive
Forces in direction of counter-recoil are listed as negative
Ⓓ Single driving spring used during this burst

TABLE I
(cont'd)

Dec. 4, 1941 Gun No. 24492--Single driving spring--Left side bolt plate and back plate of gun No. 24494--Counter-recoil buffer of Gun NO. 24495--Rounds fired previously, 142

| Interval | Rd. No. | a - b | b - c | c - d | d - e | e - f | f - g | g - h | h - i | i - j | j - k | k - l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Single Shots | 3 | -1780 | +2240 | -11800 | +2570 | -10820 | +2240 | -7980 | +1550 | -4660 | +1060 | -2066 |
| | 6 | -1780 | +2652 | -12890 | +2570 | -11630 | +2240 | -9520 | +1550 | -6040 | xxx | xxx |
| | 7 | -1340 | +2730 | -12400 | +2980 | -11224 | +2530 | -8630 | +2450 | -5920 | +1390 | -3810 |
| Burst of 3 Rounds | 8 | -1580 | +2240 | -12240 | +2570 | -11184 | +2040 | | | | | |
| | 9 | *** | +1140 | - 9360 | +2450 | - 5670 | +1510 | -3400 | +1260 | | | |
| | 10 | -5470 | +2000 | - 7330 | +2040 | - 5020 | +1300 | -7250 | +1710 | -4500 | +1020 | -2510 |
| Burst of 3 Rounds | 11 | -1580 | +2410 | -13130 | +2610 | -11468 | +2040 | | | | | |
| | 12 | *** | +1183 | - 9770 | +2200 | - 5830 | +1100 | -3480 | +1060 | | | |
| | 13 | -5790 | +2490 | - 8100 | +1670 | - 6690 | +1670 | -6560 | +1630 | -4380 | +1020 | -2310 |
| Burst of 3 Rounds | 14 | -1820 | +2450 | -12440 | +2570 | -10980 | +2320 | | | | | |
| | 15 | *** | +1220 | - 9360 | +2320 | - 5710 | +1430 | -3890 | +1430 | | | |
| | 16 | -7050 | +5870 | -10740 | +2320 | -10410 | +2200 | -7330 | +1630 | -4620 | +1220 | -2670 |

*** Gun fired out of battery, interval not distinguishable
xxx Maximum force off film
Forces in direction of recoil are listed as positive
Forces in direction of counter-recoil are listed as negative.

TABLE I
(cont'd)

Dec. 4, 1941 Gun No. 24491--Single driving spring--Counter-recoil buffer of Gun No. 24495--Rounds fired previously, 4144

| Interval | Rd. No. | a - b | b - c | c - d | d - e | e - f | f - g | g - h | h - i | i - j | j - k | k - l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Single Shots | 17 | -1540 | +1220 | -4500 | + 820 | -2840 | + 900 | -6400 | +1300 | -3240 | + 940 | -1620 |
| | 19 | -1700 | +1790 | -5910 | +2120 | -8180 | +1960 | -4620 | +1510 | -2750 | +1300 | -2100 |
| Burst of 3 Rounds | 20 | -1500 | +1220 | -5630 | +1100 | -3160 | + 940 | | | | | |
| | 21 | -5230 | +4280 | -5550 | +1390 | -4740 | +1300 | | | | | |
| | 22 | -6640 | +4200 | -6480 | +1350 | -7980 | +1350 | -4250 | +5020 | -2310 | + 820 | -1210 |
| Burst of 3 Rounds | 23 | -1130 | +1430 | -5310 | +1350 | -3520 | + 900 | | | | | |
| | 24 | -2920 | +3430 | -8550 | +2370 | -9520 | +2080 | | | | | |
| | 25 | -*** | +1350 | -4010 | +1220 | -2390 | +1140 | -6480 | +1180 | -3120 | | |
| Burst of 3 Rounds | 26 | -1620 | +3020 | -5590 | + 900 | -3480 | + 700 | | | | | |
| | 27 | -5630 | +4650 | -5754 | +1060 | -3160 | + 820 | | | | | |
| | 28 | -5230 | +3670 | -4050 | + 980 | -2750 | + 570 | -6360 | + 980 | -3160 | + 650 | -1500 |

*** Gun fired out of battery, interval not distinguishable
Forces in direction of recoil are listed as positive
Forces in direction of counter-recoil are listed as negative

TABLE I
(cont'd)

Dec. 4, 1941 Gun No. 24490--Three strand driving spring--Counter-recoil buffer of gun No. 24495--Rounds fired previously, 4139

| Interval | Rd. No. | a - b | b - c | c - d | d - e | e - f | f - g | g - h | h - i | i - j | j - k | k - l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Single Shots | 29 | -1860 | +1920 | -10860 | +3260 | - 9730 | +2980 | -4820 | +1590 | -2590 | +1220 | -1540 |
| | 30 | -1900 | +1260 | - 5590 | + 900 | -12430 | + 570 | -6850 | +1260 | -3120 | + 900 | -1580 |
| | 31 | -1740 | +1350 | - 5470 | +1470 | - 3000 | +1100 | -6360 | +1430 | -3440 | + 860 | -1340 |
| Burst of 3 Rounds | 32 | -1580 | +1270 | - 6040 | +1630 | - 3730 | + 810 | | | | | |
| | 33 | -6810 | +1800 | - 8350 | +1840 | - 9890 | +4040 | | | | | |
| | 34 | *** | +2690 | -11270 | +1840 | -10010 | +1800 | -6280 | +1060 | -3200 | + 690 | -1500 |
| Burst of 3 Rounds | 35 | -1780 | +1300 | - 5630 | + 980 | - 2880 | + 820 | | | | | |
| | 36 | -6930 | +1430 | - 8060 | +1470 | - 2960 | + 730 | | | | | |
| | 37 | -7050 | +1430 | - 7330 | +1330 | - 6400 | +1060 | -1900 | + 770 | - 970 | | |
| Burst of 3 Rounds | 38 | -1700 | +1220 | -10860 | +2000 | - 8910 | +1550 | | | | | |
| | 39 | *** | +1180 | -13370 | +2320 | -13290 | +2080 | | | | | |
| | 40 | *** | + 940 | - 9320 | +1630 | - 5510 | +1140 | -2920 | + 690 | -5350 | + 730 | -1620 |

*** Gun fired out of battery, interval not distinguishable
Forces in direction of recoil are listed as positive
Forces in direction of counter-recoil are listed as negative

TABLE II

Recoil Distances and Instrumental Velocity

Dec. 2, 1941 Gun No. 24495
Rounds fired previously, 140

| | Rd. No. | Recoil Distance in. | Instr. Velocity f/s |
|---|---|---|---|
| Single Shots | 4 | .75 | 2728 |
| | 5 | .75 | 2793 |
| | 7 | .75 | 2678 |
| Burst of 3 Rounds | 8 | .75 | xxx |
| | 9 | .50* | xxx |
| | 10 | 1.03 | xxx |
| Burst of 3 Rounds | 11 | .78 | xxx |
| | 12 | .37** | xxx |
| | 13 | .90 | xxx |
| Burst of 3 Rounds | 14 | .78 | 2709 |
| | 15 | .37* | 2706 |
| | 16 | .46** | 2728 |

Dec. 3, 1941 Gun No. 24494
Rounds fired previously, 4145

| | Rd. No. | Recoil Distance in. | Instr. Velocity f/s |
|---|---|---|---|
| Single Shots | 6 | .65 | 2670 |
| | 17 | .71 | xxx |
| | 18 | .71 | xxx |
| Burst of 3 Rounds | 19 | .71 | xxx |
| | 20 | .40* | xxx |
| | 21 | .43** | xxx |
| Burst of 3 Rounds | 25 | .71 | 2668 |
| | 26 | .34* | 2695 |
| | 27 | .87 | xxx |
| Burst of 3 Rounds | 28 | .71 | 2675 |
| | 29 | .65 | xxx |
| | 30 | .50 | 2660 |

Dec. 4, 1941 Gun No. 24491
Round fired previously, 4144

| | Rd. No. | Recoil Distance in. | Instr. Velocity f/s |
|---|---|---|---|
| Single Shots | 17 | .71 | 2644 |
| | 18 | .75 | xxx |
| | 19 | .71 | 2661 |
| Burst of 3 Rounds | 20 | .71 | 2653 |
| | 21 | .62 | 2681 |
| | 22 | .75 | 2630 |
| Burst of 3 Rounds | 23 | .75 | 2664 |
| | 24 | .53** | 2639 |
| | 25 | .68* | xxx |
| Burst of 3 Rounds | 26 | .65 | 2647 |
| | 27 | .75 | 2669 |
| | 28 | .68 | 2603 |

Dec. 4, 1941 Gun No. 24490
Rounds fired previously, 4139

| | Rd. No. | Recoil Distance in. | Instr. Velocity f/s |
|---|---|---|---|
| Single Shots | 29 | .78 | xxx |
| | 30 | .68 | xxx |
| | 31 | .68 | 2669 |
| Burst of 3 Rounds | 32 | .71 | 2658 |
| | 33 | .50** | xxx |
| | 34 | .37** | xxx |
| Burst of 3 Rounds | 35 | .72 | 2665 |
| | 36 | .93 | xxx |
| | 37 | 1.06 | 2626 |
| Burst of 3 Rounds | 38 | .75 | 2665 |
| | 39 | .59* | xxx |
| | 40 | .40* | 2660 |

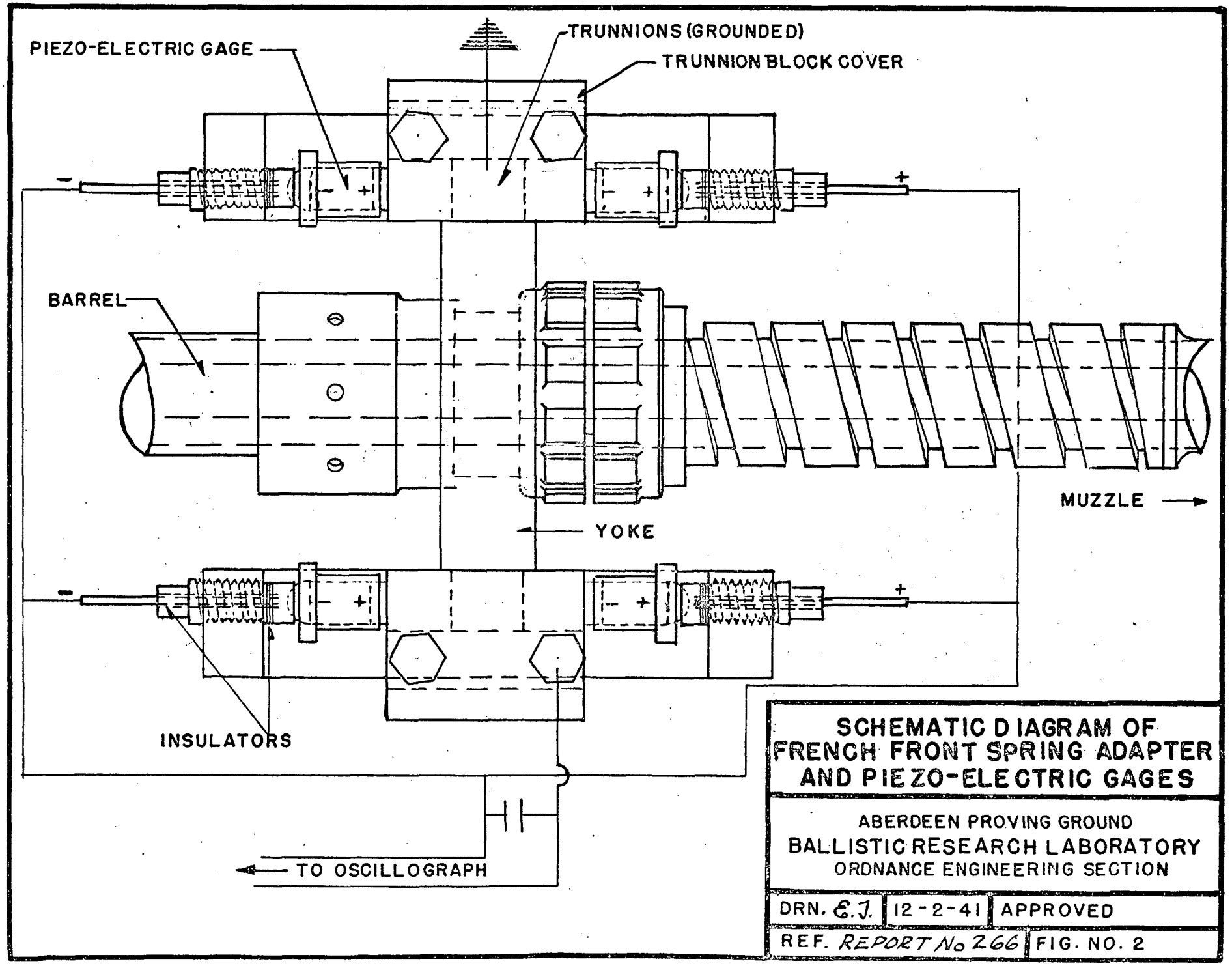
* Gun fired out of battery
** Gun apparently fired slightly out of battery but does not show on records.
xxx Record lost

TABLE II
(cont'd)

Dec. 4, 1941 Gun No 24492
Rounds fired previously, 142

| | Rd. No. | Recoil Distance | Instr. Velocity |
|---|---|---|---|
| | | in. | f/s |
| Single Shots | 3 | .65 | 2709 |
| | 6 | .62 | 2723 |
| | 7 | .62 | 2721 |
| Burst of 3 Rounds | 8 | .62 | 2706 |
| | 9 | .37* | 2706 |
| | 10 | .78 | 2744 |
| Burst of 3 Rounds | 11 | .71 | xxx |
| | 12 | .40* | 2740 |
| | 13 | .80 | 2714 |
| Burst of 3 Rounds | 14 | .62 | 2702 |
| | 15 | .40* | 2717 |
| | 16 | .60 | xxx |

* Gun fired out of battery
xxx Record lost


PIEZO-ELECTRIC GAGE
TRUNNIONS (GROUNDED)
TRUNNION BLOCK COVER
BARREL
YOKE
MUZZLE
INSULATORS
TO OSCILLOGRAPH
SCHEMATIC DIAGRAM OF
FRENCH FRONT SPRING ADAPTER
AND PIEZO-ELECTRIC GAGES
ABERDEEN PROVING GROUND
BALLISTIC RESEARCH LABORATORY
ORDNANCE ENGINEERING SECTION
DRN. E.J.
12-2-41
APPROVED
REF. REPORT No 266
FIG. NO. 2

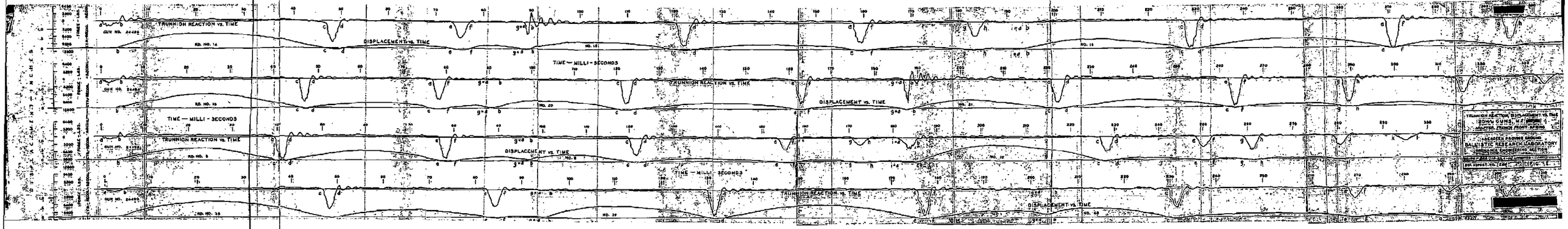

TRUNNION REACTION vs. TIME
DISPLACEMENT vs. TIME
TIME — MILLI - SECONDS
GUN NO. 24485
RD. NO. 14
RD. NO. 16
RD. NO. 5
RD. NO. 38
NO. 18
NO. 20
NO. 8
NO. 39
NO. 15
NO. 21
NO. 10
NO. 40
TRUNNION REACTION, DISPLACEMENT VS. TIME
120MM GUNS, M47
ADAPTED TRUNION FROM SPRING
ABERDEEN PROVING GROUND
BALLISTIC RESEARCH LABORATORY
ENGINEERING DIVISION
REP. REPORT NO. 1236
[redacted]

PHOTO NO. RP-11
BALTIMORE, MD. 21
CLOSE UP SHOWING PHOTOMETRIC GAGES AND PROBE FROM SPRING VALLEY.

SOUTH GUN, NS 2K (01TO) SOUTHWEST PENNSYLVANIA, PA.
PHONO. NO. 8P-10
8/1/78
97748