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TRUNNION REACTION, DISPLACEMENT VS TIME TEST OF THE 20MM H.S. GUN, TYPE 404, EQUIPPED WITH THE T6E1 (EDGEWATER STEEL COMPANY) ADAPTER AND THE CHATELLERAULT FEED, BRITISH, M1

by

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TRUNNION REACTION, DISPLACEMENT VS TIME TEST OF THE 20MM H.S. GUN, TYPE 404, EQUIPPED WITH THE T6E1 (EDGEWATER STEEL COMPANY) ADAPTER AND THE CHATELLERAULT FEED, BRITISH, M1

Summary

The trunnion reactions of the 20mm H. S. gun, type 404, equipped with the T6E1 (Edgewater Steel Company) Adapter and Chatellerault feed, were determined at normal temperature (75°F) by means of piezo-electric gages and the cathode ray oscillograph.

Two tests were made. The greatest observed forces were:

	Force-lbs. In Direction of Recoil	Force-lbs. In Direction of Counter-recoil
Initial test without magazine	2810	3410
Initial test with magazine	2140	3730
Retest without magazine	3010	2000
Retest with magazine	2520	1970

The force required to hold (wind) the magazine and slide was not well determined but probably is between 1000 and 1500 lbs.

The following observations were made on the functioning of the gun equipped as above:

a. The operation of the gun was consistently regular with a reasonably high rate of fire.

b. The trunnion reactions were relatively low and approximately equal both in recoil and counter-recoil.

c. The maximum recoil distances were sufficiently long to operate the Chatellerault feed under most conditions.

d. The return of the gun "in battery" after each cycle was positive and the oscillations caused by this

event were soon damped out so that the gun was at rest before the next round was fired.

The reactions at the trunnions and the movements of the gun and bolt were determined with the gun mounted as rigidly as practicable. In other mountings, where the degree of rigidity is different, the reactions and movements will be, in general, different.

Introduction

1. The Chief of Ordnance directed in OO 472.91/1272; APG 472.5/317-134A that trunnion reactions be measured and displacement-time curves of bolt and gun be taken for the 20mm H.S. gun, Type 404, equipped with the T6E1 adapter (Edgewater Steel Company) when fired from a rigid mount.

2. The first firings to obtain the above records were made on December 18, 1941, witnessed by representatives from Washington, Wright Field and the Edgewater Steel Company. This first test was not satisfactory in that the arm holding the magazine slide and magazine stationary failed during firing. The test was discontinued in order to construct suitable apparatus both to hold the magazine stationary and to measure the forces to hold the magazine stationary.

3. Firings were resumed on December 30, 1941 at which time the forces to hold the magazine stationary were measured. On January 8, 1942, a retest to determine trunnion reactions and to obtain displacement-time records was made. Immediately after this latter test, the forces required to hold the magazine stationary were again determined.

4. So great was the disparity in the results of these forces that a third determination was made on January 10, 1942 in which the degree of magazine winding was varied.

Materiel and Apparatus

5. The following materiel and apparatus were used in this test

<u>a</u>. 20mm H.S. gun, Type 404, No. 10854

<u>b</u>. Adapter, T6E1, (Edgewater Steel Company) (Appendix II).

<u>c</u>. Magazine, Chatellerault, British, M1, (Appendix III)

<u>d</u>. Ammunition, British, Lot 89, Remmington.

<u>e</u>. A specially constructed mount for trunnion reaction determinations (Appendix I, paragraph 1; Photo. BP-9)

f. Apparatus to measure the force needed to hold the Chatellerault feed stationary (Appendix I, paragraph 1; Photo. BP-9).

g. Piezo-electric gages and cathode ray oscillograph to record trunnion reactions as a function of time. (Appendix I, paragraphs 2 and 3; Figure 2.)

h. A revolving drum and pencils to record the movement of gun and bolt slides. (Appendix I, paragraph 4).

i. A muzzle contact to correlate the curves of trunnion reaction vs time with those of displacement vs time.

Procedure and Results

6. The entire test was carried out in the following order:

a. Initial firings to determine trunnion reactions and to obtain displacement vs time records.

b. Initial determination of the force to hold the Chatellerault feed magazine stationary.

c. Retest to determine trunnion reactions, to obtain displacement vs time records and to check the force to hold the magazine stationary.

d. Third determination of the force to hold the magazine stationary, in which the degree of winding was varied.

7. In determining reactions at the trunnions and displacement vs time of the gun and bolt, single shots (with and without the magazine) and bursts of three rounds each were fired. Tracings of a typical trunnion reaction vs time record and its corresponding displacement vs time record for a burst of three rounds is shown in Figure 1. The various intervals or events with the maximum force of each are given in Table I. (Appendix I, paragraphs 5 and 6.)

8. The greatest observed forces at the trunnions during this test were:

	Force-lbs. In Direction of Recoil	Force-lbs. In Direction of Counter-recoil
Initial test without magazine	2810	3410
Initial test with magazine	2140	3730
Retest without magazine	3010	2000
Retest with magazine	2520	1970

9. The force to hold the Chatellerault feed was measured when single shots and when bursts of three (3) to six (6) rounds were fired. Displacement vs time records were taken on all rounds except those fired December 30, 1941. The observed force for all tests on the magazine are given in Table II.

10. Maximum recoil and counter-recoil distances, instrumental velocities (at 75 ft) and rates of fire are given in Table III.

11. A sketch of the adapter and its static diagram are shown in Figures 3 and 4, Appendix II.

12. A short description of the Chatellerault feed mechanism is given in Appendix III.

Accuracy

13. The deflections as recorded on the cathode ray oscillograph can be read within ±0.02 cms. The accuracy of the forces, with respect to reading are: Trunnion reactions, ±30 lbs; force to hold Chatellerault magazine, ±20 lbs.

Discussion

14. The initial test of the gun and adapter (December 15th) was not at all satisfactory in that the force to hold the magazine was not given proper importance. In assembling the gun, it was thought that the arm holding the magazine slide when using the drum type of magazine would be sufficiently strong to hold the Chatellerault feed during a short test of this nature. However, the arm did fail and the test was discontinued until a better method of holding the magazine was constructed.

15. In failing, the keyway in the rear support holding the lower end of the magazine slide arm was enlarged causing some binding between the receiver and the support. Friction may also have been increased between the magazine slide and the receiver due to the twisting effect produced by the lever action of the arm turning about the keyway.

16. Before continuing the test the following changes in gun and mount were made:

a. A new method of holding the magazine slide was devised such that the force was transmitted to a side plate, fixed with respect to the mount, through an arm whose center line was on the same level and parallel to the center line of the slide. This side plate (similar to a trunnion reaction side plate. Appendix I, paragraph 1) was so constructed that the force parallel to axis of the bore holding the slide and magazine stationary could be measured. (Photo. No. BP-9?)

b. The top of the rear support was covered with a bronze plate to improve the bearing surface over which the gun slid. The plate containing the slide arm slot was removed.

c. The original driving spring, which had been broken in a previous test, was replaced by a new spring.

d. The buffer spring, considered no longer typical, (k, 470 lbs/in; initial compression, 230 lbs), was replaced by another spring (k, 460 lbs/in; initial compression, 390 lbs).

17. These changes produced the following differences in the retest:

a. Slightly higher maximum forces in recoil (interval b_1-c, Table I).

b. Much lower maximum forces in counter-recoil (interval c-d, Table I).

c. Generally shorter maximum counter-recoil distances.

18. That portion of the friction eliminated at the rear support did increase the recoil forces but not as much as was expected.

19. The greatest change occurred in the interval c-d (gun returns "in battery"). With a partial elimination of friction at the rear support one would expect these forces to increase. However, due to a change in driving springs (old spring, k = 8.2 lbs/in; new spring, k = 7.4 lbs/in) and in buffer springs (paragraph 15 d) the forces in this interval were lowered by an appreciable amount. In these later test firings the weaker driving spring allowed the bolt to travel rearward with slightly increased speed and, hitting the stronger buffer spring as the gun was moving forward (counter-recoiling), reduced the forward velocity of the gun to such an extent that it returned "in battery" (hit counter-recoil spring) with a reduced velocity. The above events, generally, should increase the cyclic rate noticeably but, due to the slightly higher rearward speed of the bolt, the impact between buffer and bolt occurred slightly nearer the maximum recoil distance where the speed of the counter-recoiling gun is slightly slower. The forward speed of the bolt is influenced also by the weaker driving spring, such that the energy transmitted to the bolt for return into battery is slightly lower.

20. The determination of the force to hold the Chatellerault magazine stationary was inconclusive. Although the magazine was in questionable condition (some 40,000 rounds had been fired from this magazine) the following observations may be made:

a. In automatic fire, the force to hold the magazine stationary is generally higher on the first round. This may be due to the setting in motion of the magazine parts and the rounds in and hanging from the magazine. (Appendix III, paragraph 6.)

b. The winding force (forces to hold the magazine stationary) is proportional to the degree of winding of the spring and to some extent to the number of rounds in the belt hanging from the magazine. (Appendix III, paragraph 7.)

21. While the magnitude of the force was not well established, it is believed that, in automatic fire, the force to hold the magazine stationary is from 1000 to 1500 lbs. This is based on Table III and on the trunnion reactions obtained when firing single shots with and without the magazine (Table I, interval b_1-c.) With the only available magazine in such questionable condition, a retest should be conducted to determine this force when new feeds are available.

22. From the above discussion, Tables I, III and from Figure 1, the following observations are made on the functioning of the 20mm H.S. gun equipped with the T6E1 (Edgewater Steel Company) adapter and the Chatellerault feed:

a. The operation of the gun was consistently regular with a reasonably high rate of fire.

b. The trunnion reactions were relatively low and approximately equal in both recoil and counter-recoil (intervals b_1-c and c-d, Retest, Table I.)

c. The maximum recoil distances were sufficiently long to operate the Chatellerault feed under most all conditions.

d. The return of the gun "in battery" after each cycle was positive and the oscillations caused by this event were soon damped such that the gun was at rest before the next round was fired.

23. The force to hold (wind) the magazine was not well determined and should be redetermined when a new feed is available.

24. The reactions at the trunnions and the movements of gun and bolt were determined with the gun mounted as rigidly as practicable. In other mountings where the degree of rigidity is different the reactions and movements will be, in general, different.

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TABLE I

Trunnion Reaction Maxima of the 20mm H.S. Gun, Type 404, No. 10854
Equipped with the T6E1 (Edgewater Steel Company) Adapter
Mounted on a Rigid Mount. Air Temperature 75°F
Ammunition, British, lot 89, Remington

Dec. 18, 1941 Original driving and buffer springs

Interval	Rd. No.	a-b	$b-b_1$	b_1-c	c-d	d-e	e-f	f-g	g-h
Single shots	1	-1620	+1250	2090	-3160	+830	-1640	+780	-1290
	2*	-1920	+1260	2110	-3620	+720	-1730	+290	-510
	3	-2080	+1090	xxx	-3290	+820	-1780	+690	-1080
Single shots	10***	-1920	+1150	2810	-3410	+880	-2220	+610	-650
	11***	-2100	+1120	2770	-3260	+510	-2220	+530	-1620
Burst of 3 rounds	4	-1990	+1150	2110	-2730	+780	-	-	-
	5	-2830	+880	xxx	-3730	+1150	-	-	-
	6	-2480	+850	1850	-3430	+1060	-3020*	-	-
Burst of 3 rounds	7	-2000	+1140	2080	-2750	+670	-	-	-
	8	-2140	+850	2130	-2990	+850	-	-	-
	9	-1890	+740	2140	-2780	+800	-1940	+740	-970

Jan. 8, 1942 (Retest) New driving and buffer springs.

Interval	Rd. No.	a-b	$b-b_1$	b_1-c	c-d	d-e	e-f	f-g	g-h
Single shots	2***	-1670	+1390	+2860	-1910	+660	-1880	+670	-1220
	3***	-1880	+1410	+3010	-2000	+570	-1970	+520	-1340
Single shots	4	-1860	+1440	+1740	-2160	+550	-1970	+570	-1090
	5	-1790	+1300	+1930	-2100	+510	-1970	+450	-1400
Burst of 3 rounds	6	-1850	+1350	+2520	-1920	+580	-	-	-
	7	-1940	+930	+2050	-1910	+550	-	-	-
	8	-1710	+910	+2290	-1770	+600	-1770	+600	-610
Burst of 3 rounds	9	-1590	+1390	+2170	-1860	+630	-	-	-
	10	-1460	+990	+2280	-1920	+630	-	-	-
	11	-1650	+940	+2250	-1790	+600	-1770	+580	-850
Burst of 3 rounds	12**	-1680	+1050	+2110	-1910	+490	-	-	-
	13	-1640	+900	+2250	-1920	+580	-	-	-
	14	-1670	+910	+2110	-1910	+600	-1970	+580	-970

* Dummy round jammed.
** Bolt of 20mm gun, M1, (Bendix) used in this burst.
*** Without Chatellerault feed.
xxx Interval not distinguishable.
Forces in recoil listed as positive.

Forces in counter-recoil listed as negative
In automatic fire, interval e-f becomes a-b of the next round.

TABLE 11

Force to Hold Chatellerault Feed Stationary

Dec. 30, 1941 — 20 m/m Gun, M 1, No. 1 (Bendix) Adapter T 6 E 1

	Rd.	Force lbs.	
Single Shots	1	2340	Feed wound tightly 7 rds. in magazine
	2	1510	Feed wound tightly 5 rds. in magazine
Burst of 2 rounds	3	1800	Feed wound tightly 3 rds. in magazine
	4	xxx	Feed unwound on second rd.
Burst of 3 rounds	5	2530	Feed wound tightly 11 rds. in magazine
	6	1480	
	7	1580	
Burst of 3 rounds	8	1490	Feed wound tightly 7 rds. in magazine
	9	1490	
	10	1650	
Single	11	1730	Feed wound tightly 3 rds. in magazine
Burst of 3 rounds	12	2060	Feed wound tightly 7 rds. in magazine
	13	1793	
	14	1708	
Single	15	2160	Feed wound tightly 3 rds. in magazine

Jan. 8, 1942 — 20 m/m H. S. Gun, Type 404, Adapter T 6 E 1

	Rd.	Force lbs.	
Burst of 6 rounds	15	563	Winding unknown, 8 rds. in magazine
	16	596	
	17	608	
	18	495	Probable failure to wind
	19	450	
	20	495	

Jan. 10, 1942 — 20 m/m H. S. Gun, Type 404, Adapter T 6 E 1

	Rd.	Force lbs.	
Single shot	1	1420	Feed wound tightly then one round stripped from magazine, 9 rds. in magazine
Burst of 5 rounds	2	1520	Feed wound tightly then one round stripped from magazine, 7 rds. in magazine
	3	700	Probable failure to wind
	4	770	
	5	720	
	6	xxx	Feed unwound on this wound
Burst of 3 rounds	7	890	Feed wound approximately 3 notches from tight 6 rds in magazine
	8	480	Probable failure to wind
	9	480	

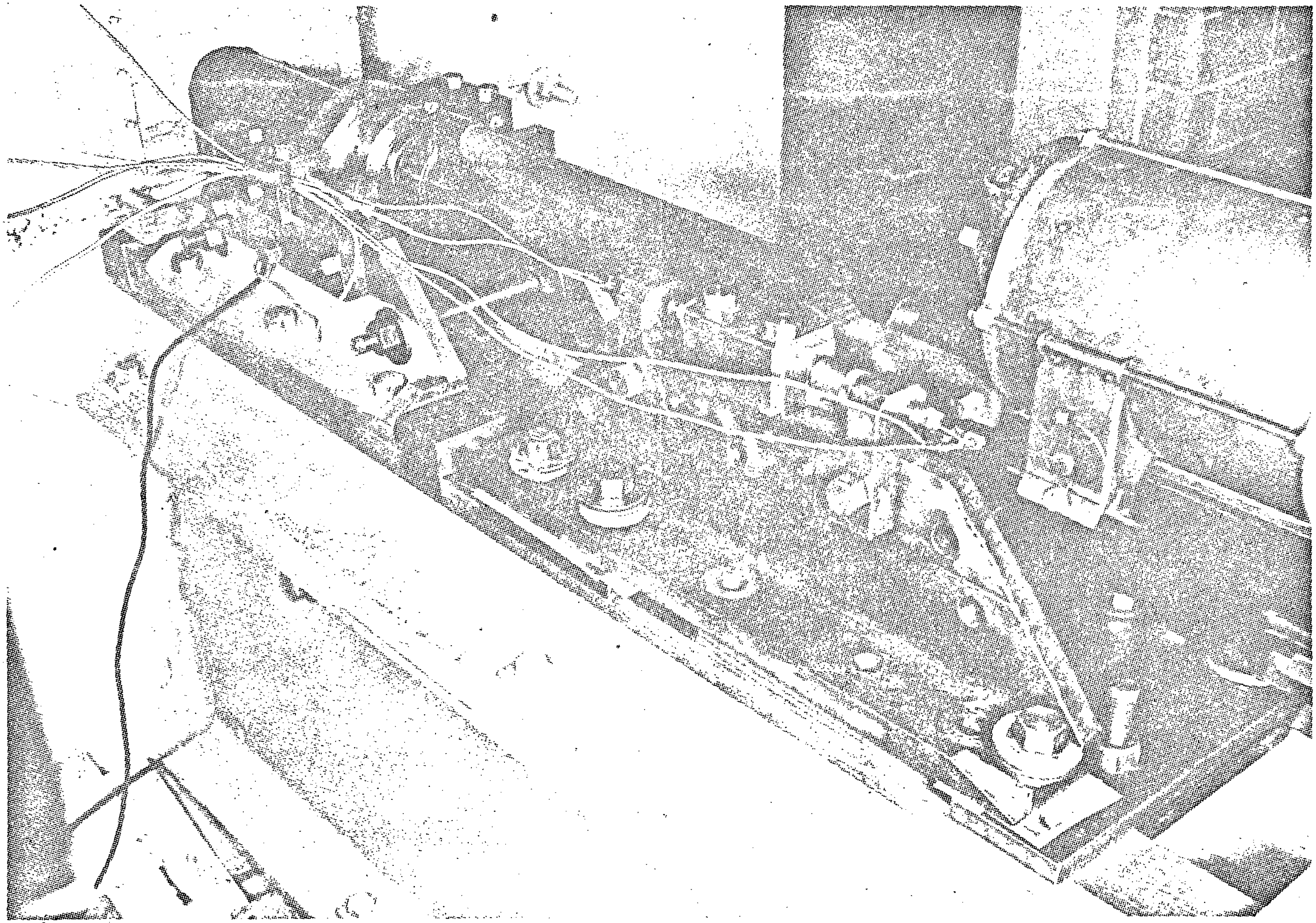
TABLE III

Maximum Displacements; Instrumental Velocities; Rates of Fire

20mm H.S. Gun, Type 404, No.10854 Equipped with the T6E1 (Edgewater Steel Co.)Adapter
Ammunition, British, Lot 89, Remington

	Rd. No.	Max. Displacement Recoil in.	Max. Displacement Ctr.-recoil in.	Instrumental Velocity f/s	Rate of Fire** shots/min.
Dec. 18, 1941	Original driving and buffer springs				
Single	1	.95	.03	2667	
	2*	1.03	.14	2675	
shots	3	.83	.02	2711	
Single	10***	1.18	.07	xxx	
shots	11***	1.17	.05	xxx	
Burst	4	.97	.03	2667	
of 3	5	.84	.12	2694	670
rounds	6*	.92	.06	xxx	
Burst	7	1.00	.03	xxx	
of 3	8	.99	.03	xxx	695
rounds	9	1.02	.04	xxx	
Jan. 8, 1942	New driving and buffer springs				
Single	2***	1.14	.02	xxx	
shots	3***	1.14	.03	xxx	
Single	4	.90	.02	xxx	
shots	5	.93	.03	xxx	
Burst	6	1.01	.03	2680	
of 3	7	.93	.03	2662	680
rounds	8	1.04	.03	2692	
Burst	9	1.00	.03	2681	
of 3	10	1.01	.03	2695	675
rounds	11	1.02	.03	2693	
Burst	12	1.01	.02	2688	
of 3	13	1.01	.02	2665	680
rounds	14	1.01	.02	2672	
	15	1.02	.02		
Burst	16	1.01	.02		
of 6	17	1.03	.02		670
rounds	18	1.10	.02		
	19	1.10	.02		
	20	1.10	.02		

* Dummy round jammed
** To nearest 5 shots per min.
*** Without Chatellerault feed
xxx Record lost



BAL. RES. LAB. APG MD. A 7457 Fig. 9. 20 M/M H. S. Gun Mounted to determine Trunnion Reactions and force to hold the Feed Mechanism stationary.

TABLE III (CONT'D)

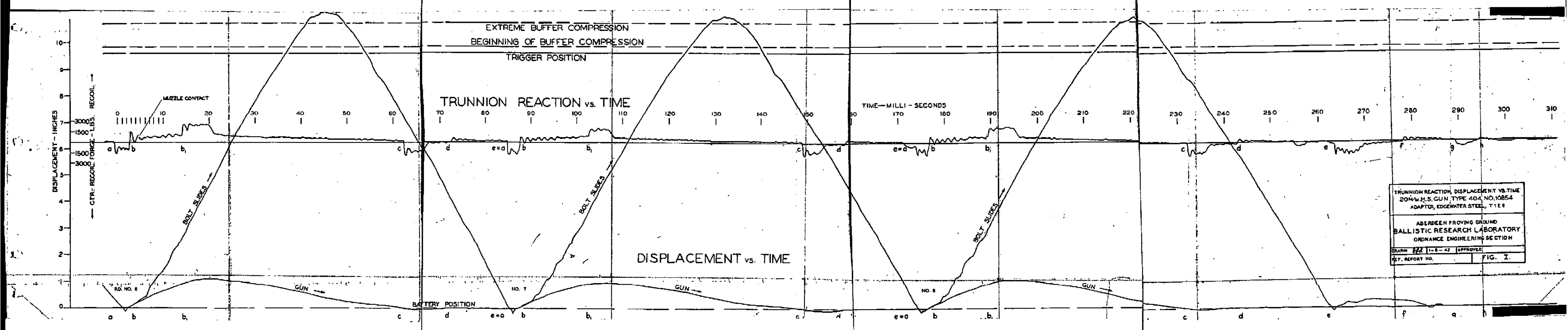
Maximum Displacements; Instrumental Velocities; Rates of Fire

20mm H.S. Gun, Type 404, No.10854 Equipped with the T6E1 (Edgewater Steel Co.)Adapter
Ammunition, British, Lot 89, Remington

Jan. 10, 1942 New driving and buffer springs

	Rd. No.	Max. Displacement Recoil in.	Max. Displacement Ctr.-recoil in.	Instrumental Velocity f/s	Rate of Fire** shots/min.
Single shot	1	1.00	.03		
	2	1.00	.04		
Burst	3	1.01	.03		
of 5	4	1.00	.04		690
rounds	5	1.01	.05		
	6	1.08	.04		
Burst	7	1.14	.05		
of 3	8	1.10	.02		680
rounds	9	1.12	.02		

** To nearest 5 shots per min.



TRUNNION REACTION, DISPLACEMENT VS. TIME
20 M/M H.S. GUN, TYPE 404, NO. 10854
ADAPTER, EDGEWATER STEEL, T1E6

ABERDEEN PROVING GROUND
BALLISTIC RESEARCH LABORATORY
ORDNANCE ENGINEERING SECTION

DRAWN 1-8-42 APPROVED
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FIG. I.

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Appendix I

1. The 20mm H.S. Gun, Type 404, No. 10854 with attached T6E1 (Edgewater Steel Company) adapter was mounted rigidly and level in a mounting constructed specially for obtaining trunnion reactions. The gun was 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 of 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 blocks 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 support 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 volute 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--April, 1939, p.281.

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

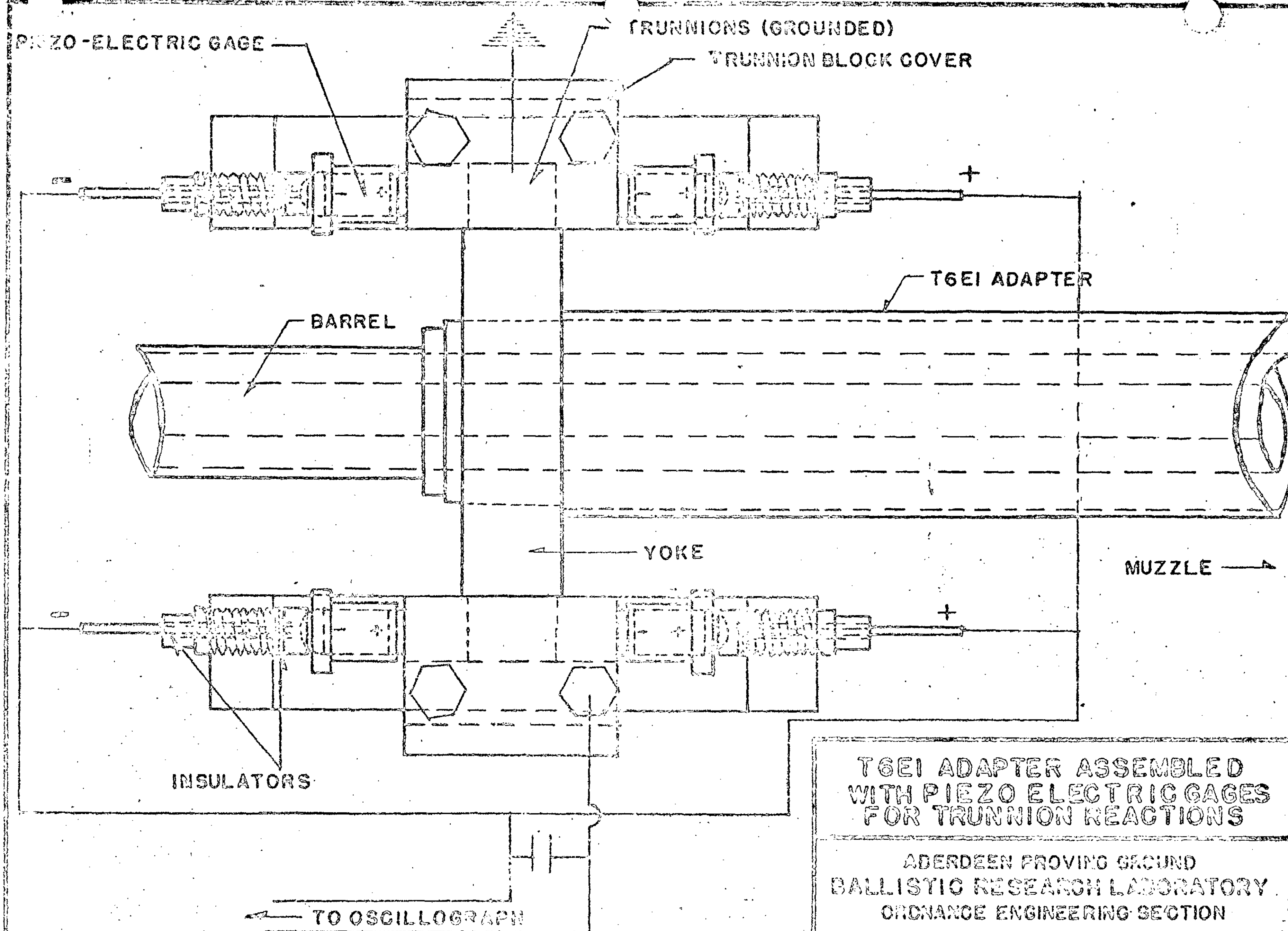
5. Trunnion reaction and displacement vs time records were obtained when single rounds and when bursts of three rounds each were fired. A copy of the records obtained from a burst is shown in Figure 1. Recoil forces and displacements as shown are positive upwards and negative downwards.

6. The records were divided into the intervals a-b, b-c, etc. as shown in Figure 1. A description of these intervals is:

Interval	Description
a - b	Bolt strikes breech.
b - b_1	Gun fires and begins recoil compressing the coil spring.
b_1 - c	Ring spring recoil unit operates in series with coil spring.
c - d	Gun hits counter-recoil ring spring and travels beyond "in battery" position
d - e	Gun returns "in battery".
e - f*	Bolt returns "in battery".
f - g	Gun and /or bolt and bolt slides rebound in direction of recoil.
g - h	Gun and/or bolt and bolt slides return "in battery".

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

* In automatic fire interval e - f becomes a - b of the next round.



T6E1 ADAPTER ASSEMBLED WITH PIEZO ELECTRIC GAGES FOR TRUNNION REACTIONS

ABERDEEN PROVING GROUND
BALLISTIC RESEARCH LABORATORY
ORDNANCE ENGINEERING SECTION

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Appendix II

1. The T6E1 adapter, built by the Edgewater Steel Company of Pittsburgh, Pa., is a unique shock absorber. It is a single method of using two distinct types of springs to absorb the forces in recoil and counter-recoil and at the same time to act as a damping agent on the oscillations of the gun after returning into battery.

2. The adapter was disassembled and measured. A sketch, which is shown in Figure 3, should not be scaled as the measurements are only approximate. The static diagram, taken of the adapter both in recoil and counter-recoil, is shown in Figure 4.

3. A description of the adapter and the manner in which it operates is as follows:

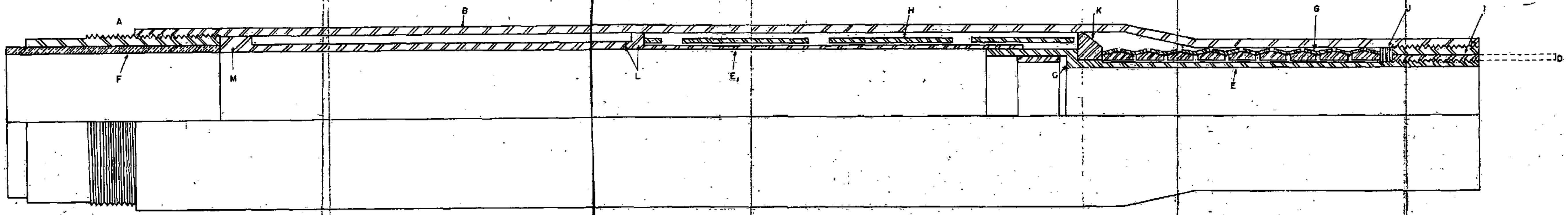
a. At A the adapter is threaded into a trunnion yoke, which fixes the outer shell, B, stationary with respect to the mount. The gun tube is then slid into the adapter until it shoulders at C. By means of a sleeve butting the adapter at D and secured by a nut at the muzzle, the inner case is fixed with respect to the tube. The brass bushing at F is slid further to the rear of the tube until it fits snugly and, after securing by Allen set screws, acts as a bearing between the rear of the adapter and the tube.

b. The essential parts within the adapter are the ring spring assembly, G, and the coil spring, H. The ring spring, G, is composed of nine (9) units. Each unit is composed of an inner and outer ring whose outer and inner surfaces, respectively, are beveled on an angle of approximately 20°. Under compression the movement of the rings are in opposition one to the other and the spring effect is produced by the tension of the outer ring and compression of the inner ring. Assembled at a length of approximately 4-1/2 inches, the ring spring has an initial compression of approximately 1000 lbs. and a spring coefficient in compression of approximately 10,000 lbs. per inch. In release, however, due to the large frictional force opposing motion, the hysterisis loss is approximately 60%. The assembled coil spring (rectangular stock, 2 inches x .1 inch, approximately) has an initial compression of approximately 200 lbs. and a spring coefficient of approximately 490 lbs. per inch.

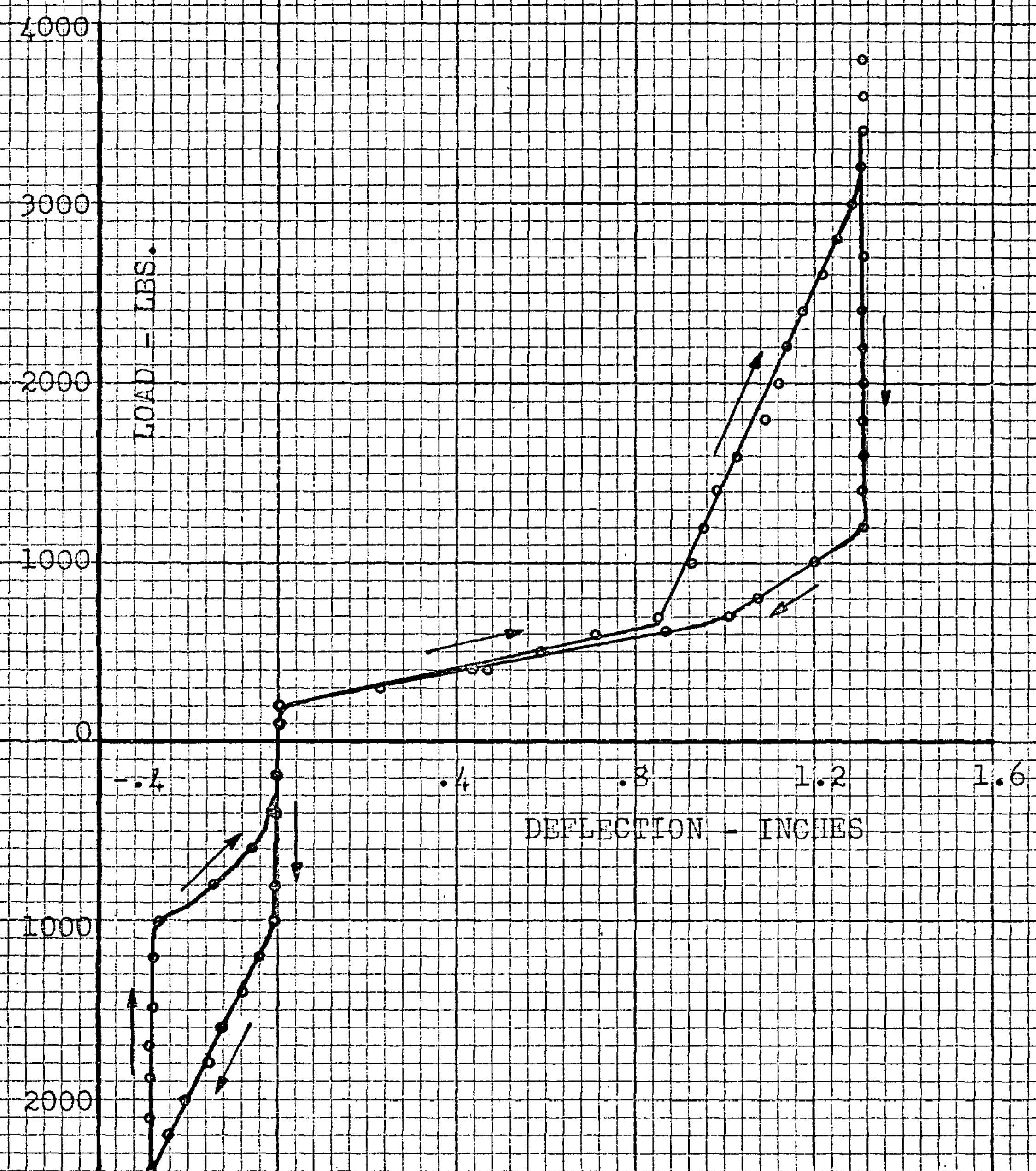
c. When firing, the gun recoils carrying the inner case, E, rearward, bearing at I and at F. The coil spring, H, is compressed (the spring coefficient is very small in relation to that of the ring spring) by the ring spring assembly and the stop at K. When the coil spring has compressed approximately .9 inch the inner case, E, hits against the stop, K, compressing the ring spring. Thus the two springs act in series during recoil. In counter-recoil, however, the gun is returned into battery by the action of both springs and moves beyond the "in battery" position, compressing the ring spring, G, between the stops, K and J. The gun reaches maximum counter-recoil (approximately .03 inch) and due to the larger hysterisis loss of the ring spring is returned slowly into battery. Any subsequent bounces in the direction of either recoil or counter-recoil are soon damped out by the action of the ring spring before the bolt returns "in battery" firing the next round.

4. Section L M could easily be eliminated saving material and weight. This change would place the trunnions nearer the muzzle and eliminate whip of the tube.

5. In assembling, the ring spring section is packed with a graphite grease. In automatic firing the adapter becomes quite hot causing some of the grease to be lost through the bearing, I, and drying out the balance so that its lubricating value is reduced. It seems quite possible that an alemite grease cup could easily be installed thereby eliminating chances of galling the ring spring units.



ADAPTER T6E1 (EDGEWATER STEEL CO.) FOR 20 MM AUTOMATIC GUN	
ABERDEEN PROVING GROUND BALLISTIC RESEARCH LABORATORY ORDNANCE ENGINEERING SECTION	
DRAWN E.J. 2-5-42	APPROVED
REF. REPORT NO. 270	FIG. NO. 3



ABERDEEN PROVING GROUND BALLISTIC RESEARCH LABORATORY Ordnance Engineering Section	STATIC DIAGRAM ADAPTER T6E1 (EDGEWATER STEEL) 20mm Gun
DRN. [illegible] FEB. 1942 APPROVED	REF. FIG. NO. 4

Appendix III

1. The Chatellerault feed mechanism is a belt fed, continuously operating magazine that draws in the belt, extracts the rounds and feeds them to the gun, receiving its power from the gun during recoil. It is cylindrical in shape and is mounted on the magazine slide such that the center line of the feed is in a vertical plane parallel to the center line of the bore. (Photo. BP-9)

2. The belts may contain several hundred rounds each folded layer upon layer in an ammunition box so that the feed mechanism will not lift more than a few rounds at any one time. The rounds are held together by metal links which have semi-circular prongs, one at the rear and two at the front (front being the direction the belt moves), which grip the rounds immediately behind the drawn section of the case. When assembled, each case is gripped by three prongs such that a force of 15 to 20 lbs. is required to remove the round from the links.

3. Most of the important parts, designated by capital letters, are shown in Figures 5 and 6. These drawings were made from Ordnance Office drawings D 36370 and C 70625. The assemblies to which these parts belong are:

a. The sprocket assembly consisting of the three sprockets, B, C, and K, keyed to the solid shaft, J, and attached to the spiral spring, H, at the front sprocket.

b. The ejector assembly consisting of the ejector sprocket, L, and the stop, N.

c. The winding assembly consisting of the cam, S, the follower, R, the segment, P, the coil spring, O, the ratchet, Q, and the spiral spring, H.

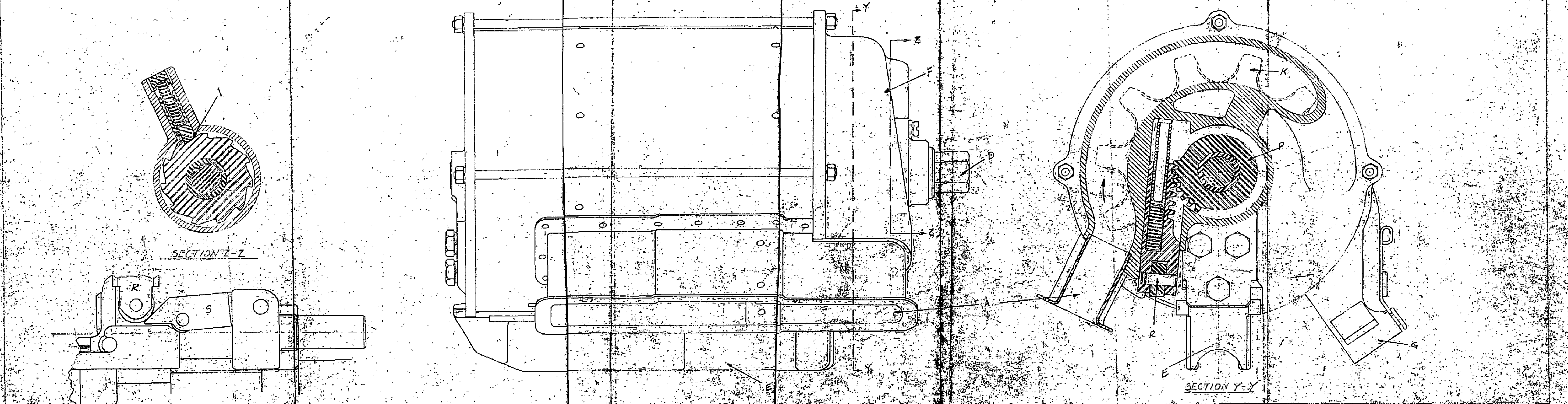
4. When loading the magazine, the belt is introduced into the guideway, A, where by turning the nut, D, the rounds are engaged by the three sprockets, B, C and K and are drawn into the feed. As the rounds are carried around by the sprockets, the nose of the projectiles bear on the cam surface, F, which pushes the rounds rearward out of the links which are held between the sprockets, C and K. The rounds continue around until the first round reaches the ejector, L. Here it is forced out of the sprocket compartment clear of the clip into the feed guideway, E. The link thus disengaged is shoved out into the chute, G, by the ejector also. The magazine is thus filled, two rounds in the feed guideway and nine in the sprocket compartments.

5. The inner end of the spiral spring, H, is connected to the hollow shaft, M, of which the nut, D, is an integral part. The outer end is connected to the front sprocket, K. By turning the nut, D, manually, the spring, H, is wound tightly being held from turning forward by the third round acting as a stop between the sprockets and the second round and from turning backward by the dog, I, acting against the ratchet, Q. The magazine is now ready for automatic fire.

6. When the bolt strips the first round from the magazine, the sprockets are moved forward one-eleventh turn by the spring, moving each round forward into the place of the one immediately ahead. In doing this the spring unwinds one-eleventh turn. After the gun is fired and the gun recoils the spring is automatically rewound to its original winding by means by the cam, S, moving with the gun, and acting on the follower, R. During automatic fire it is believed that the movement of the rounds through the feed is continuous although jerky. This is perhaps substantuated by the fact that the force to hold the feed stationary (practically equivalent to the winding force) is higher for the first round than for any succeeding round. In the initial movement, after the first round has been stripped from the magazine, the spring must set in motion the sprockets, the stripping of the rounds from the belt and the rounds in and hanging from the feed. Thus the initial speed with which the sprockets turned could have been slow enough that rewinding occurred before unwinding had been completed. However, once the movement started, it seems to have been continuous as the forces required to hold the feed stationary for the succeeding rounds are quite consistant.

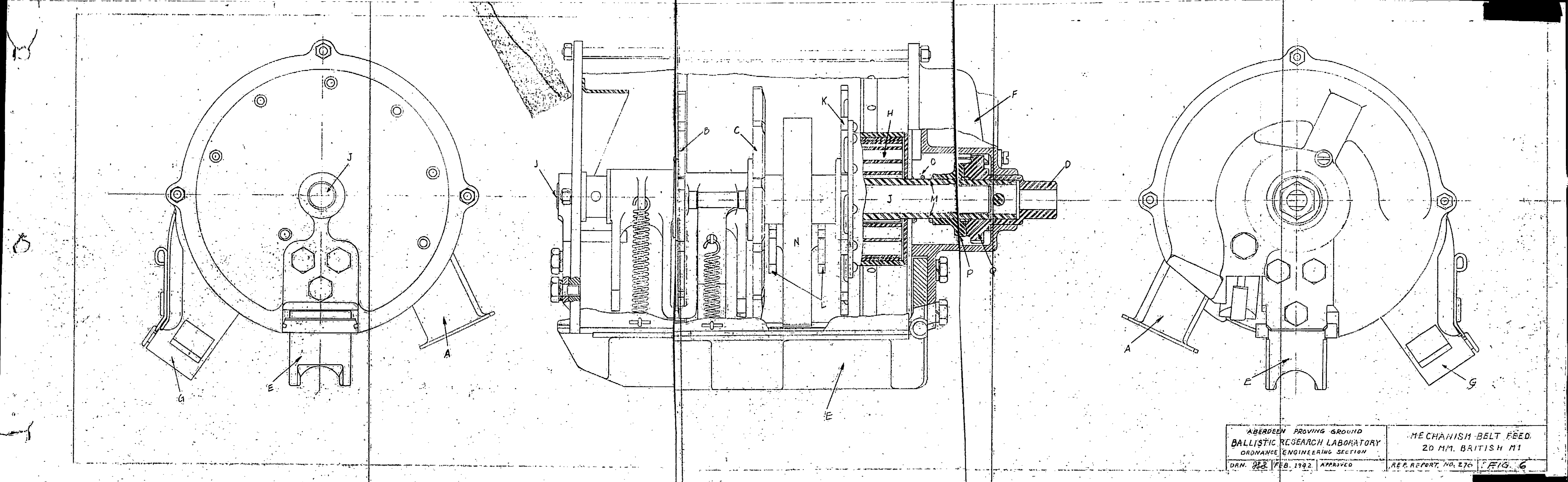
7. As the number of rounds hanging from the magazine (weight) is increased the speed with which the sprockets move will be decreased until a point may be reached where the spring can no longer exert enough pressure to turn the sprockets. In this case the force to hold the magazine will be extremely high.

8. In order to operate the winding assembly properly a recoil distance of not less than .75 inch is required. This recoil distance, however, should be slightly over an inch to provide a margin of safety to operate in extremely low temperature conditions or in any other condition which will increase the friction opposing the recoil of the gun or operation of the feed mechanism.



ABERDEEN PROVING GROUND BALLISTIC RESEARCH LABORATORY ORDNANCE ENGINEERING SECTION	MECHANISM BELT FEED 20 MM BRITISH M1
DRN. 9-28 FEB. 1942 APPROVED	REF. REPORT NO. 270 FIG. 5

[redacted]



ABERDEEN PROVING GROUND
BALLISTIC RESEARCH LABORATORY
ORDNANCE ENGINEERING SECTION

MECHANISM BELT FEED
20 MM. BRITISH M1

DRN. JJ.S.	FEB. 1942	APPROVED	REF. REPORT NO. 270	FIG. 6