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SECURITY INFORMATION

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TWENTY-SIXTH

PROGRESS REPORT

OF

THE FIRESTONE TIRE & RUBBER COMPANY

ON

105 MM. BATTALION ANTI-TANK PROJECT

UNDER

Contract No. DA-33-019-ORD-33

ORDNANCE DEPARTMENT PROJECTS

TS4-4020—WEAPONS AND ACCESSORIES

TM1-1540—AMMUNITION

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THE FIRESTONE TIRE & RUBBER COMPANY

Defense Research Division

Akron, Ohio

SEPTEMBER 1952

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PROGRESS REPORT

OF

THE FIRESTONE TIRE & RUBBER CO.

ON

105 MM BATTALION ANTI-TANK PROJECT

Contract No.

DA-33-019-ORD-33 (Negotiated)

RAD ORDTS 1-12383

THE FIRESTONE TIRE & RUBBER CO.

Defense Research Division

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ABSTRACT

The location of and the component parts for each BAT weapon system manufactured by Firestone are presented. Illustrations of the T137E3 rifle, the T152E5 mount and the new fire control mechanism are shown. A charge development program was conducted to establish the pressure which would be developed in the T137E3 rifle with the regular M323 type charge. The test data are given and discussed. Data comparing piezo and copper pressure measurements are presented. The use of M32 cartridge cases in the T137E3 rifle is described. A future program is given.

Two accuracy tests of the T138E57 projectile at 2000-yard range are described and the firing data are presented. All firings with this projectile at this longer range are summarized. A future program is given.

Accuracy tests of the T119 projectile, at ranges of 1000 and 2000 yards are described. One of these programs was fired from a smooth bore tube and the other from a rifled tube. The results of charge development tests are discussed. An advance program is presented.

Penetration tests were conducted to investigate further the effect of internal tee configuration upon penetration. The test data are given. A future program for penetration studies is outlined.

Several aspects of projectile fuzing were investigated. These involved the superquick-delay mechanical fuze, the nose element crystal assemblies and the DRD328 base element. The tests are discussed. A future program is presented.

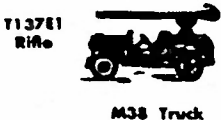
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THE WEAPON SYSTEM

A distribution report is given in Table I showing the locations and the component

parts of the BAT weapon systems manufactured by Firestone.

Table I
Weapon System Distribution
BAT Weapon Systems Manufactured by Firestone
Locations and Component Parts

Fort Benning, Georgia	Aberdeen Proving Ground	Erie Ordnance Depot
 T137E1 Rifle T152E2 Mount M38 Truck One Unit Rifle - T137E1 Mount - T152E2 Spotting Rifle - Returned to Springfield Armory Direct Sight - Returned to Frankford Arsenal Direct Sight Mount - T183 Truck - M38	 T137E2 Rifle M38 Truck T137E3 Rifle T152E2 Mount T152E4 Mount One Unit Rifle - T137E1 Mount - T152E2 Spotting Rifle - Returned to Springfield Armory Direct Sight - Returned to Frankford Arsenal Direct Sight Mount - T183 Truck - Taken for use with other unit One Unit Rifle - T137E2 Mount - T152E4 Spotting Rifle - Returned to Springfield Armory Direct Sight - Returned to Frankford Arsenal Direct Sight Mount - T183 Indirect Sight - M3A1E1 Two Units Rifles T137E3; replace T137E2 rifles Mounts - One T152E4; One T152E5 Spotting Rifles - 146 Direct Sights - M62E4 Direct Sight Mounts - T183 Indirect Sights - M3A1E1 Trucks - M38 Miscellaneous Components 1 Rifle - T137E2	 T137E1 Rifle T152E2 Mount M38 Truck T137E2 Rifle T152E4 Mount One Unit Rifle - T137E1 Mount - T152E2 Spotting Rifle - Returned to Springfield Armory Direct Sight - Returned to Frankford Arsenal Direct Sight Mount - T183 Truck - M38 One Unit Rifle - T137E2 Mount - T152E4
T137E1 - 85 in. tube, Firestone breech mechanism T137E2 - 95 in. tube, modified M27 breech mechanism T137E3 - 105 in. tube, M27 breech mechanism; modified to fire T170 ammunition & T119 and T138 T152E2 - Elevating mechanism forward of trunnions, taper leg locks, center fire control buttons T152E3 - Similar to E2 except for use of roller bearings and guide rails on elevating system T152E4 - Ratchet-type leg locks, safety lock on firing mech.; squeeze type triggers, free traverse lever T152E5 - Identical to E4 except new tripod designed to attach to body flange M38 or M38A1		

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The T137E3 rifle, shown in Fig. 1, was designed to chamber M323 and M325 ammunition as well as T119 and T138 ammunition. Table I shows that a T137E3 rifle is a component of two systems now at Aberdeen Proving Ground, one with a T152E4 mount and one with a T152E5 mount.

The T152E5 mount, shown in Fig. 2, includes all of the revisions of the T152E4 mount plus a new tripod designed to attach to the top body flange of either the M38 or M38A1 truck. The salient features of the T152E5 mount are shown

in Fig. 2. The T152E4 mount at Aberdeen Proving Ground will be made into a T152E5 assembly by replacing the legs and lower housing with corresponding T152E5 parts.

A special feature of the T152E4 and T152E5 mounts is the squeeze type trigger located on the handwheel knobs. Fig. 3 shows this trigger and also the safety lock on the firing mechanism.

Fig. 4 is an assembly of the T137E3 rifle and T152E5 mount.

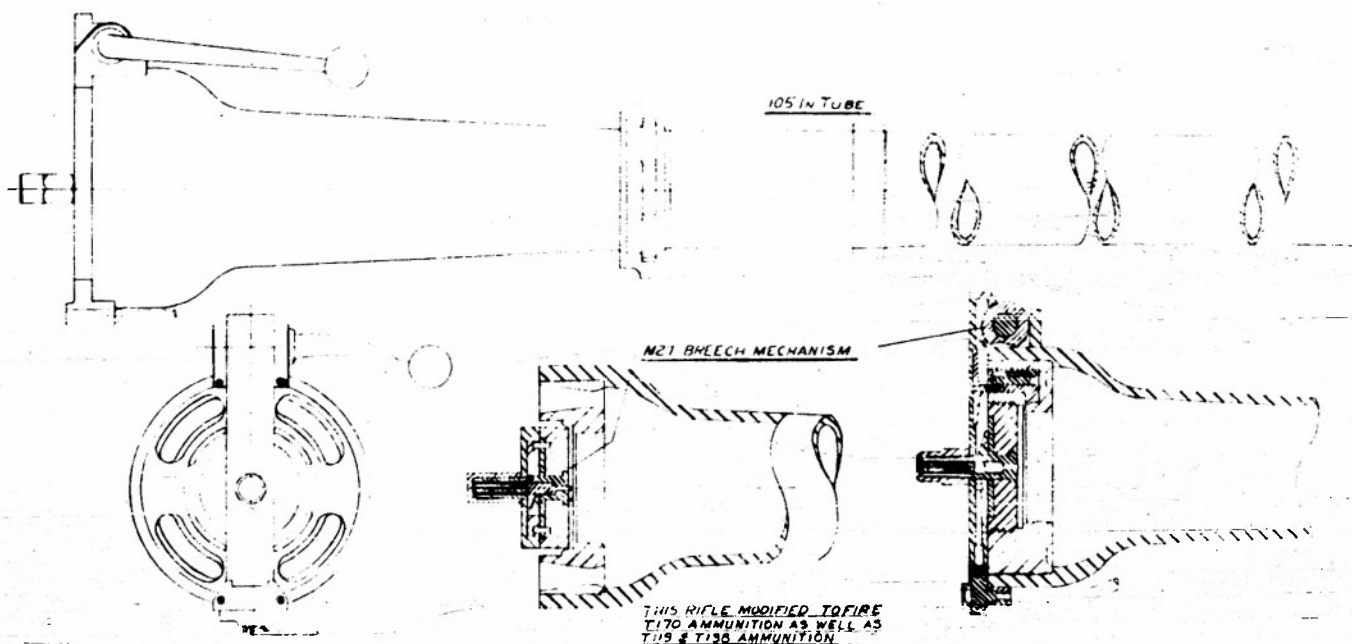


Fig. 1. T137E3 Recoilless Rifle.

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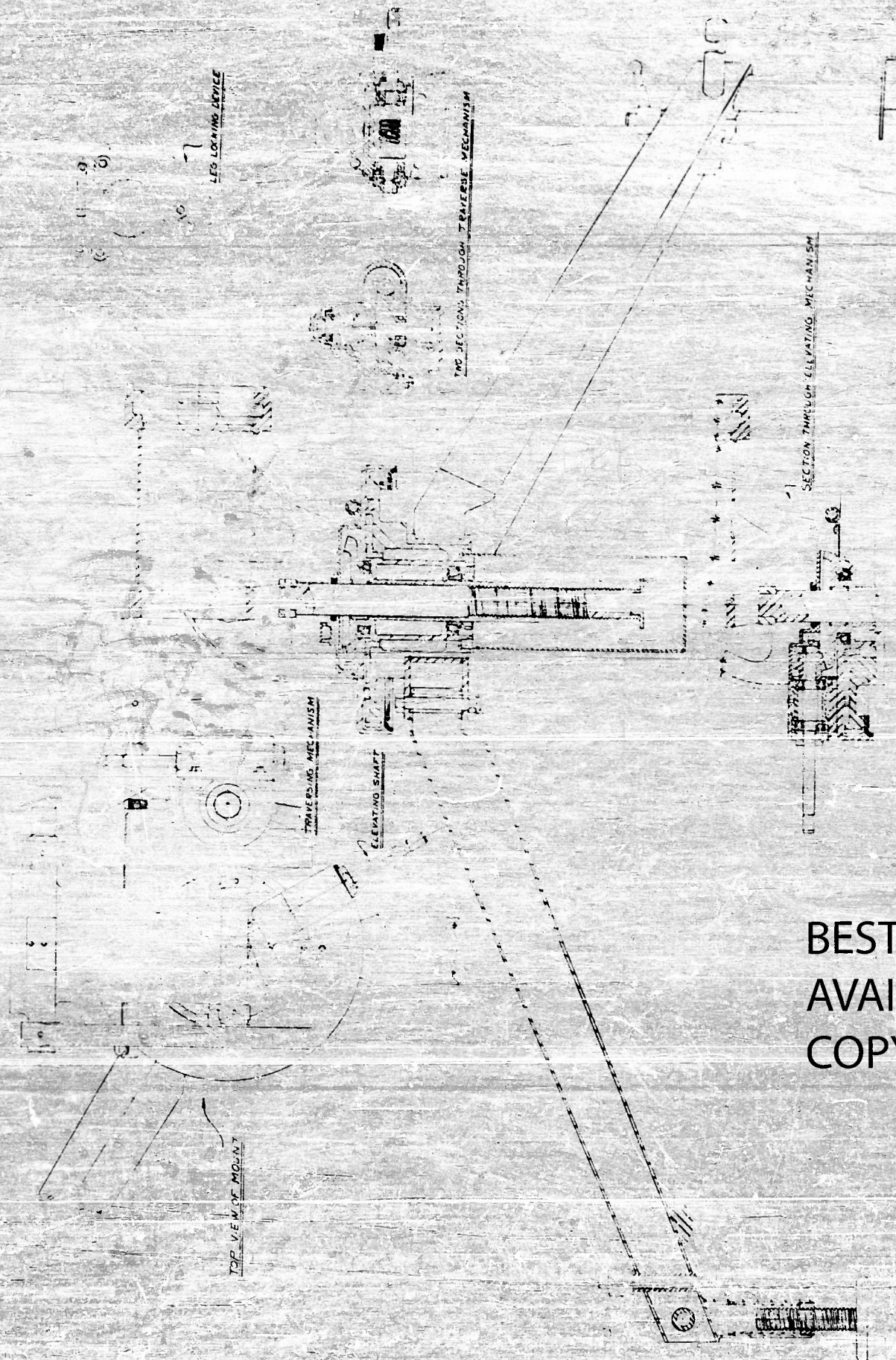


Fig. 2. T152E5 Rifle Mount.

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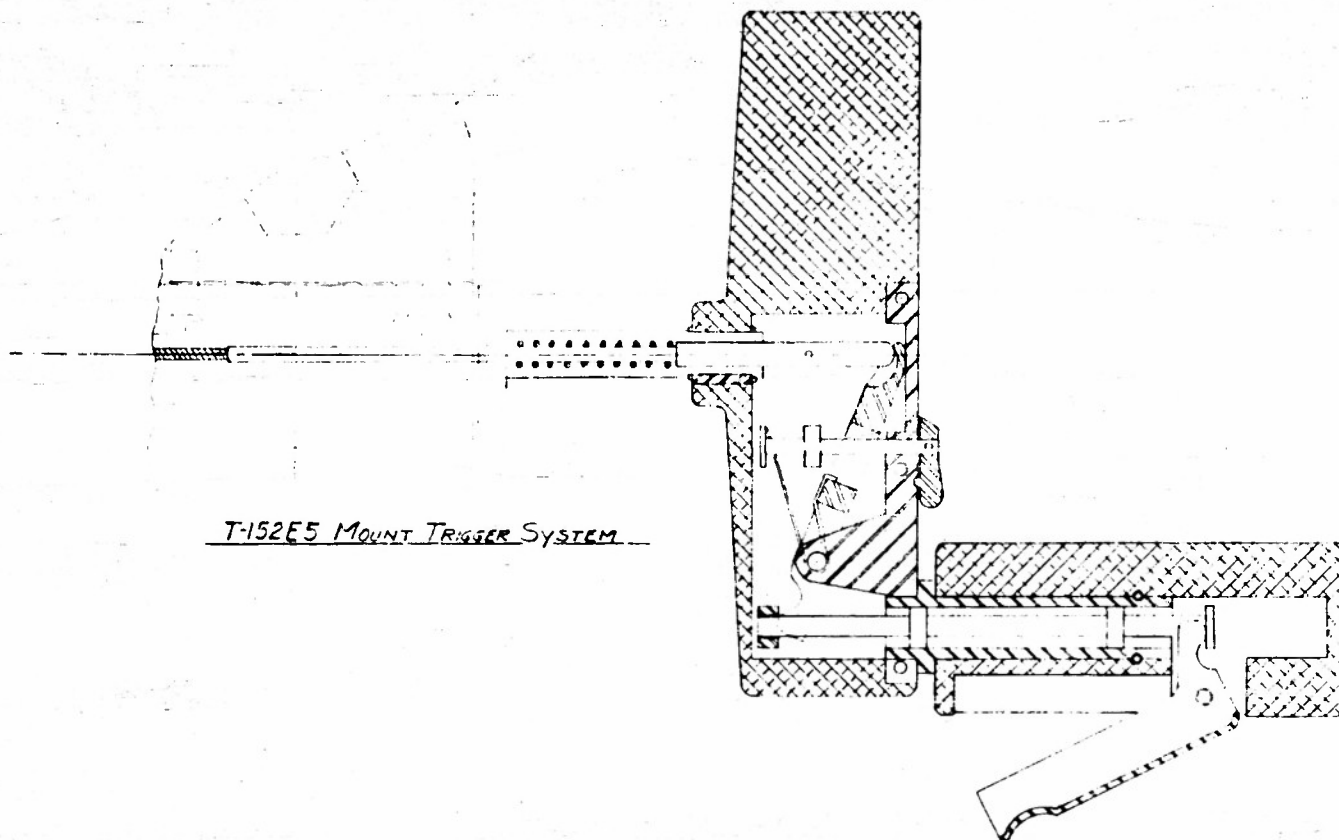


Fig. 3. Squeeze Type Trigger and Safety Lock.

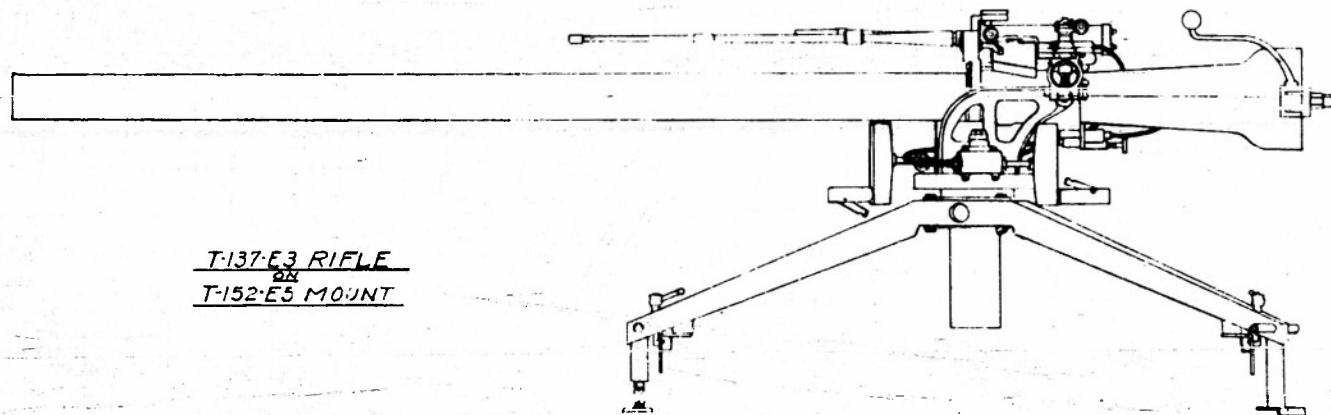


Fig. 4. Assembly of T137E3 Rifle and T152E5 Mount.

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Charge Development for 34-pound Projectile

Since the T137E3 rifle was designed to chamber M323 and M325 ammunition as well as T138 and T119 ammunition it would be convenient if rounds loaded for the M27 rifle could be safely fired from the T137E3 rifle. A charge development program was conducted at Erie Ordnance Depot to see if this is possible. PA-30240 propellant and 34-pound M2A1 howitzer slugs were used to establish the pressure which would be developed in the T137E3 rifle with the regular M323 type charge. The data for this charge development are given in Table II and Fig. 5.

The pressure required for a muzzle velocity of 1120 ft/sec is 12,300 lb/sq in (cu). This exceeds the maximum rated pressure of the rifle (11,000 lb/sq in). The M323 round for the M27 rifle contains approximately 8 lb of M10, .035-in web powder. An extrapolation of the data in Fig. 5 shows that a pressure of 13,700 lb/sq in would result for an 8-lb charge of PA-30240 propellant. Although the web of PA-30240 propellant is smaller (.033 in) than that used with the M323 round (for the M27 rifle) it appears clear that it would not be safe to fire a regular M27 round in the T137E3 rifle. It is proposed to load the M323 and M325 rounds for the T137E3 rifle with PA-E-6119 (.038-in web) or with the duplex loading being developed by Frankford Arsenal.

Table II
Charge Development Data
34-pound Slug

Round No.	Charge (lb-oz)	Velocity (ft/sec)	Pressure (lb / sq in Cu)
1	7-2	1040	10,250
2	7-4	1067	10,650
3	7-6	1089	11,450
4	7-8	1108	12,400
5	7-6	1080	11,400
6	7-8	1096	11,700
7	7-10	1108	12,000
8	7-12	1137	12,800
9	7-11	1136	12,550
Notes: Rifle, T137E2, 105" tube. Powder: PA-30240, M10, MP. Rotating Band: DRB360-3.			

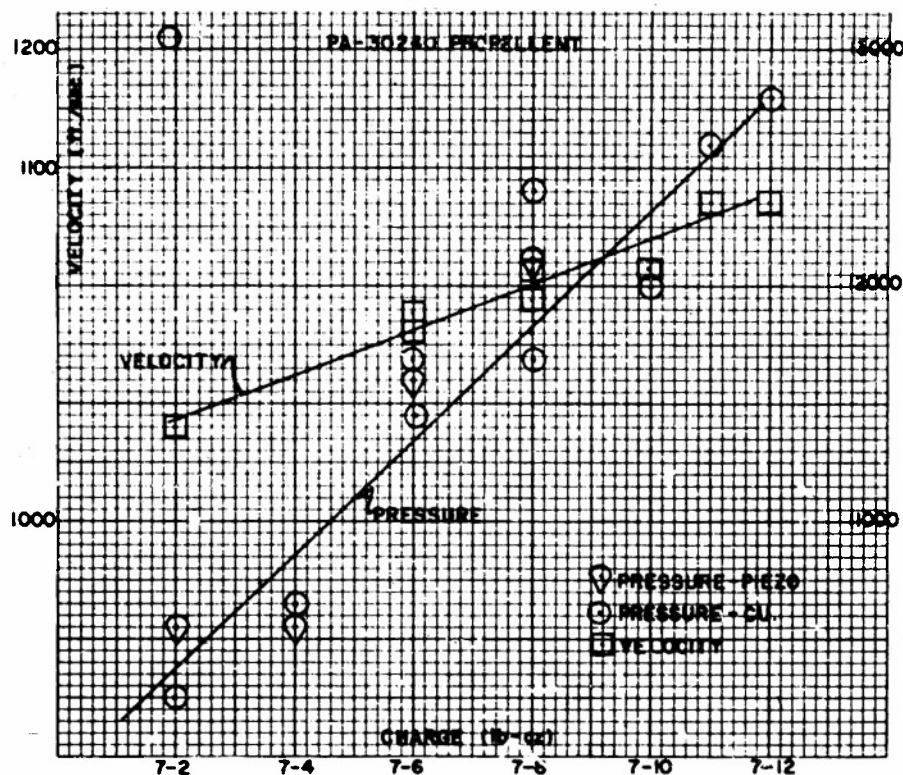


Fig. 5. Charge Development Data.
34-pound Projectile.

Piezo-Copper Pressure Measurement

It is well known that the relation between copper pressure and piezo pressure depends on the particular rifle and propellant used. Table III and Fig. 6 show data obtained with the T137E2 rifle using PA-30240 propellant. Over the range

10,000 lb/sq in to 13,000 lb/sq in, it is seen that the comparison between M3 copper gauges and external piezo gauges is essentially one to one. Since both 17.5-lb slugs and 34-lb slugs were used it appears that over this range the projectile weight does not affect the copper-piezo relationship.

Table III
Copper-Piezo Pressure Relations

Projectile Weight (lb)	Piezo Pressure (lb/sq in)	Copper Pressure (lb/sq in)
17.5	7,382	7,350
17.5	10,810	10,400
17.5	11,601	12,250
17.5	12,128	13,350
17.5	12,919	12,850
17.5	12,655	13,100
34	10,550	10,250
34	10,550	10,650
34	11,600	11,450
34	12,133	12,400
34	10,734	11,150

Note: Copper pressures are averages of two M-3 gages.

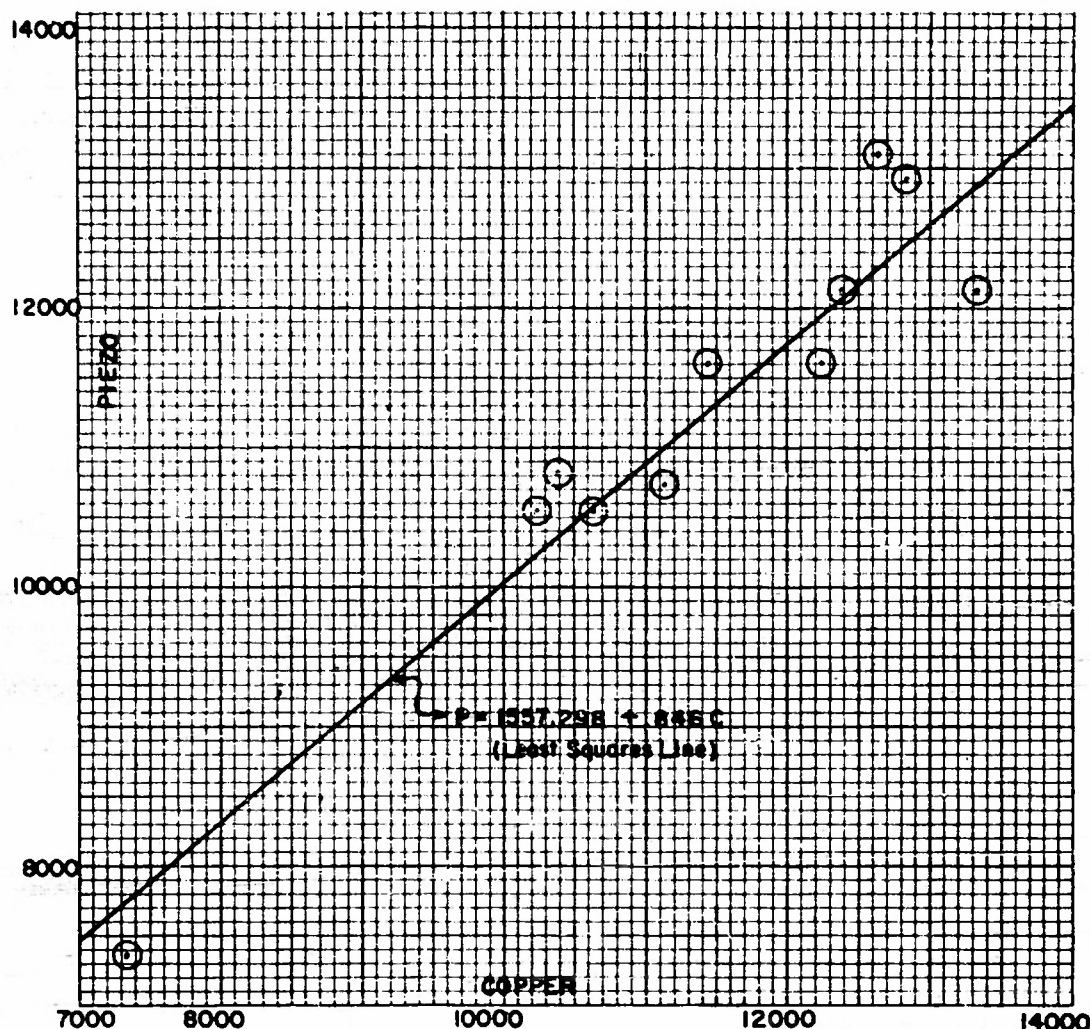


Fig. 6. Copper-Piezo Relationship.

Cartridge Case

It was stated in the Twenty-fifth Progress Report that the M32 cartridge case, with minor modifications, was used in the T137E3 rifle. It was found necessary to heat treat the M32 case to prevent bulging. Several tests were performed with the objective of making the heat treatment unnecessary. The data for these tests are given in Table IV. Modifications A, B, C, D were attempts to obtain more rapid ignition at the base of the shell case. Modification B gives a slight improvement in case bulging but does not

permit a 115% pressure round to be fired without bulging the case. Other modifications did not give significant improvement. Therefore the heat treatment of the M32 shell case is still necessary.

Although the use of the T-88 primer, which has only 300 grains of A-1 black powder, does not reduce case bulging, ignition at 70°F seems as satisfactory as with the 1000 grain M57 primer. Low temperature tests will be conducted with this primer to see whether it is satisfactory at -40°F.

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Table IV
M32 Cartridge Case Tests
Bulging Tests

Case Type	Charge (lb oz)	Pressure (lb/sqin)	Ignition	Remarks
Not heat treated	7-5	8,300	M57 Primer	no bulge
" " "	7-10	10,450	" "	" "
" " "	7-13	10,550	" "	" "
" " "	7-11 1/2	10,150	" "	slight bulge
" " "	7-11 1/2	10,650	" "	" "
" " "	7-11 1/2	9,950	" "	" "
" " "	7-11 1/2	10,450	" "	bad bulge
" " "	8-8*	10,750	" "	" "
" " "	8-6*	9,850	" "	no bulge
Heat treated	8-4	12,700	" "	" "
" "	8-4	12,500	" "	" "
" "	8-6	13,500	" "	" "
" "	8-6	13,500	" "	" "
Not heat treated	7-11 1/2	10,300	M57 Mod. A	slight bulge
" " "	7-11 1/2	10,400	M57 Mod. A	" "
" " "	7-11 1/2	--	M57 Mod. B	no bulge
Not heat treated	8-6	--	M57 Mod. B	bad bulge
" " "	7-13 1/2	11,400	M57 Mod. C	slight bulge
" " "	7-13 1/2	11,700	M57 Mod. D	" "
" " "	7-13 1/2	10,900	T88	no bulge
" " "	8-9	13,800	T88	slight bulge

Modifications:

- A. 3 1/2" sleeve on tip of primer.
- B. Twelve holes at tip of primer covered, no pressure gages, base of polyethylene liner removed.
- C. Twelve additional holes at base of primer.
- D. Doughnut of 100 grains A-1 black powder 3" from base of primer.

* PA-E-6084 propellant. All other rounds used PA-30239.

Future Program

1. Two rifle systems will be shipped to Fort Benning, Georgia for Field Forces evaluation. A third weapon system will be shipped to Aberdeen Proving Ground for engineering tests.

2. Continue design study of a light weight, wheeled mount.

3. Establish an experimental pressure-travel curve.

4. Evaluate four lots of special double base propellents for temperature coefficient.

5. Evaluate the T-88 primer for low temperature ignition.

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T138 PROJECTILE

Performance of T138E57 Projectiles at 2000 Yards

Two programs in which T138E57 projectiles were fired at a 2000-yard range at Erie Ordnance Depot were reported in the Twenty-Third Progress Report.

A third program to test the accuracy of the T138E57 projectile at a 2000-yard range was fired at Aberdeen Proving

Ground. Twenty rounds were fired at a 20 ft by 20 ft target. Four rounds were spent in getting on the target and ten of the next sixteen rounds hit the target. The probable errors for the hits were V. P. E. = .74 mil and H. P. E. = .65 mil. Observers reported good flight for four rounds that missed the target and slight precession in four other rounds. The firing record for this test is found in Table V and Fig. 7 is a plot of the target.

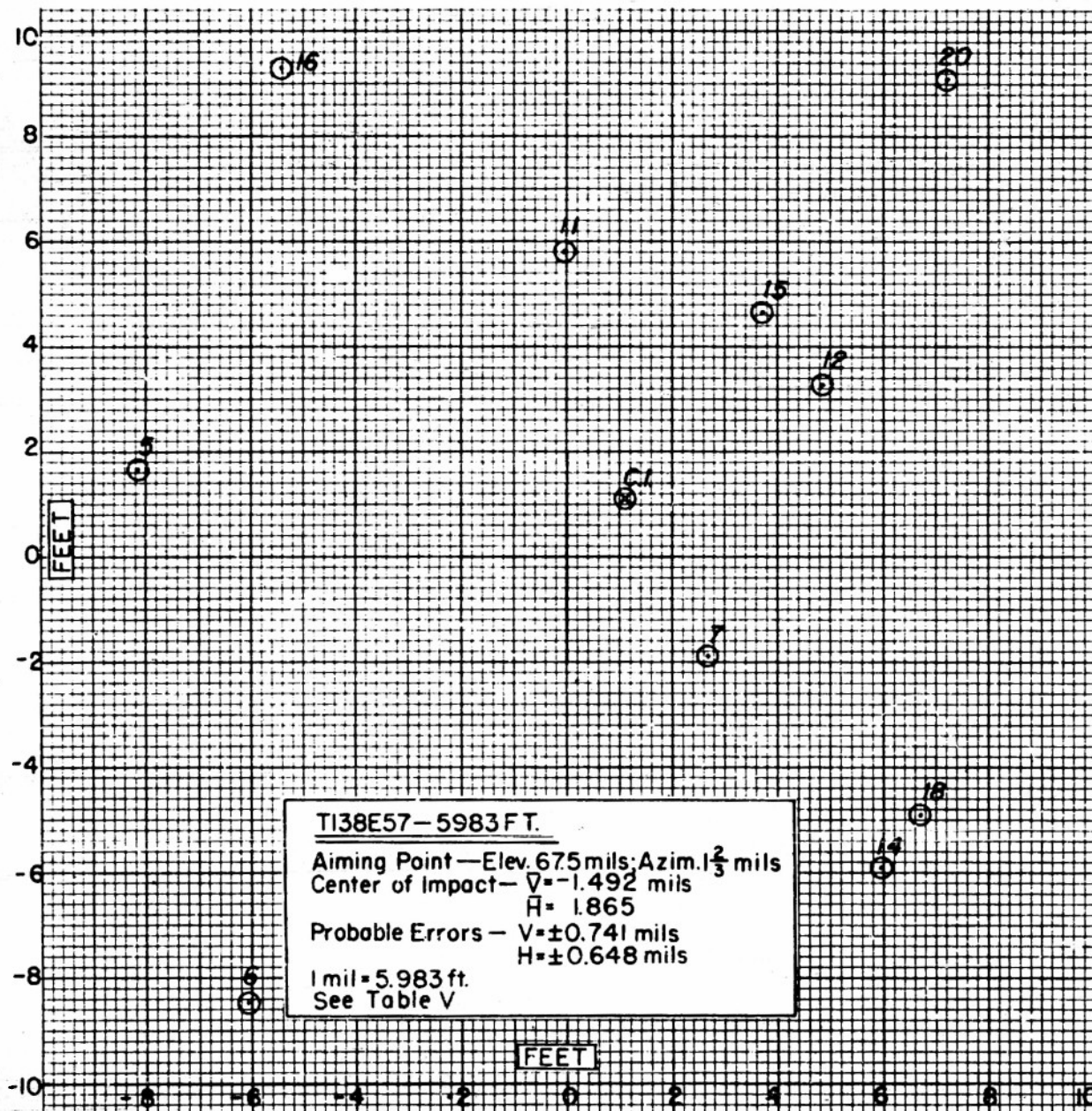


Fig. 7. Dispersion Chart.
 T138E57 Projectile, 2000 Yards, 1-200 Tube.

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Because of the good performance of the T138E57 at ranges of less than 2000 yards it was thought desirable to determine whether the accuracy of the T138E57 at longer ranges (above 1500 yards) could be improved by launching at a higher spin rate. Therefore, a fourth accuracy program at 2000 yards was undertaken.

Nineteen rounds of T138E57 projectiles were fired at Erie Ordnance Depot from a modified T19 rifle with a 1-120 tube. One round hit a velocity coil and fourteen of the remaining eighteen rounds hit the target. The probable errors for the hits are V.P.E. = .54 mil and H.P.E. = .46 mil.

The target size was 20 ft by 20 ft. None of the misses were observed to have poor flight characteristics. Table VI is a copy of the firing record and Fig. 8 is a plot of the hits on the target.

When fired at 45 rev/sec (1-120 tube) twelve of the fourteen hits had no measurable yaw; at 25 rev/sec (1-200 tube) only two of ten had angles of yaw of less than 8 degrees and two had yaw angles of 25 degrees.

Table VII summarizes the data for the performance of the T138E57 projectiles at 2000 yard range.

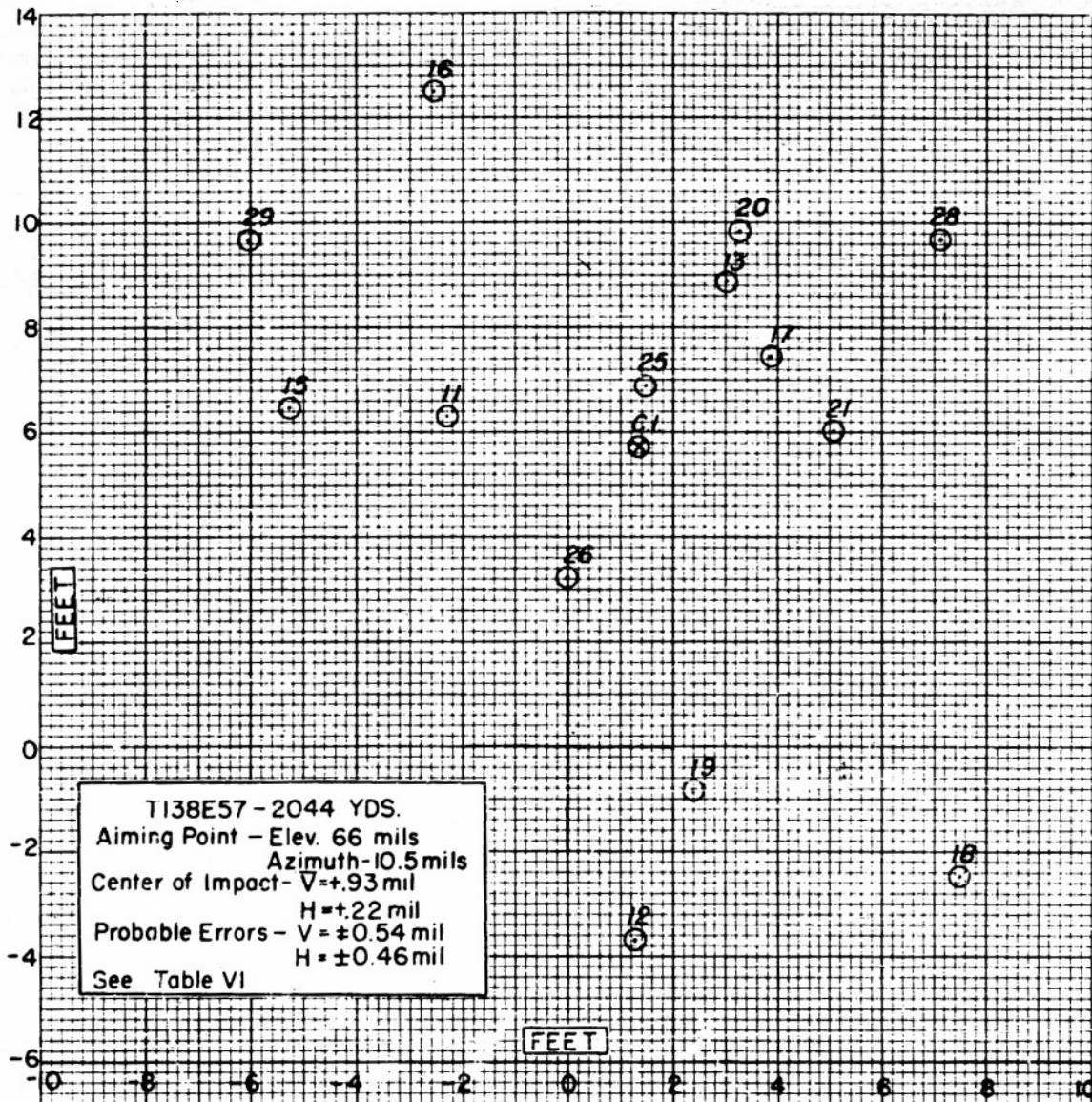


Fig. 8. Dispersion Chart
 T138E57 Projectile, 2000 Yards, 1-120 Tube.

Table V

MISCELLANEOUS DATA

Observations

M. F. Toohey.

Table VI Firing Data 2000-yard Range, T138E57 Projectile, 1-120 Tube Erie Ordnance Depot

Date Sept 25, 1952 Program T138E57
 2000 YARD
 MISCELLANEOUS DATA
 Range 2044 yds
 Propellant
 Type MG22 web 333 1/2 Charge Wt. 816 lbs
 Proof Director ED HUEMAN
 Observers LUCAS, CLARK, L. E. BEER

TEST GUN
 Model I19 No. 6
 Type 105 mm Recoilless Rifle, 30° Vent
 Length of Tube 85.12
 Twist of Rifling 1-120
 Sighting Equipment M1 Mod Elbow Telescope
 Bore Dia. (Lands) 4.134 +.001
 SCREEN DISTANCES
 69' 6" 34'

PROJECTILE
 Model I138
 Type E57
 Weight (Nominal) 17.50 lb
 C.G. Location 5.95 in from base
 Bourrelet Dia (Nom) 4.132 -.002
 Special Features Rotating Band
 DE9 36.7-5

TEMPERATURES
 MAGAZINE
 Max. - 70°
 Min. - 70°
 Ambient - 70°
 Loading Room - 70°
 COMPONENTS
 Polyethylene Liner
 3 Black Universal Rods
 2 6 Small Hole Shell Case
 M57 Primer

Round No.	Proj. No.	Proj. Weight (lb)	Powder Charge (lb - oz)	Wind Vel & Dir (mph - deg)	Corrected to Line of Fire	Zero	Muzzle Velocity (ft/sec)	Elev (mils)	Azimuth (mils)	Position of Hit (in)		Corrected Position of Hit - mils	Yaw (degrees)	Clearance		Observations
										Vert	Horiz			Front	Rear	
3044-11	3056	17.39	8-8	10-95	3.5	1733	1756	66.0	-10.5	+75.5	-27.5	+1.03	-3			
3045-12	3037	17.38	8-8	7-150	"	1725	1748	66.0	-10.5	-44	+14.5	-2.0	0			
3046-13	3045	17.34	8-8	7-135	3.6	1733	1756	66.0	-10.5	+106	+56	+1.44	0			
3047-14	3029	17.34	8-8	13-165	"	1747	1770	66.0	-10.5	M13350						
3048-15	3040	17.31	8-8	15-150	"	1748	1771	66.0	-10.5	+4	-62.5	+1.06	5			
3049-16	3039	17.42	8-8	10-105	"	1744	1767	65.0	-10.5	+76	-81	+2.04	0			
3050-17	3041	17.38	8-8	12-135	4.0	1725	1748	65.0	-10.5	+155	+46	+1.21	0			
3051-18	3054	17.38	8-8	15-120	"	1739	1762	65.0	-10.5	-104	+89	-.41	0			
3052-19	3054	17.35	8-8	11-130	"	1733	1756	65.0	-10.5	-88.5	+28.5	-.14	10			
3053-20	3043	17.29	8-8	12-125	"	1735	1760	65.0	-10.5	+44	+38.5	+1.60	8 1/2			
3054-21	3041	17.35	8-8	14-100	"	1736	1769	65.0	-10.5	-.5	+54.5	+1.99	0			
3055-22	3021	17.33	8-8	20-120	"	1735	1748	65.0	-10.5	M13350						
3056-23	3025	17.31	8-8	18-110	"	1725	1748	65.0	-10.5	M13350						
3057-24	3102	17.29	8-8	15-135	4.2	1760	1773	65.0	-10.5	M17 COIL						
3058-25	3101	17.38	8-8		"	SCREENS	66.0	66.0	-10.5	+81.5	+16.5	+1.12	0			
3059-26	3086	17.40	8-8		"	SHOT OUT	66.0	66.0	-10.5	+39.0	0	+1.53	0			
3060-27	3084	17.38	8-8		"	NP	66.0	66.0	-10.5	M13350						
3061-28	3091	17.34	8-8		"	VELOCITIES	66.0	66.0	-10.5	+85.5	+115	+1.57	5°			
3062-29	3092	17.36	8-8		"		66.0	66.0	-10.5	-71.5	+115	+1.57	0			
Electric Firing System Used																

Retardation Factor 1.245
 Corrected to 68 mil

Corrected to 68 mil
 For 14 HITS

Center of Impact H - 1.22 mil; V - 1.98 mil
 Probable Error - Vertical 1.54 mil
 Probable Error - Horizontal 1.56 mil

Signed - L. Swasey

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Table VII
Summary of 2000-yard Firings
T138E57 Projectile

Date Fired	No. Rds. Fired	No. Hits	Size of Target (ft.)	Twist of Tube	Length of Tube (in.)	P.E. of Hits (mils)		Weight of Proj. (lb)	Rifle	Where Fired
						V.P.E.	H.P.E.			
6-5-52	22	13	18 x 18	1-200	95	.69	.63	17.5	T137E1	E.O.D.
6-20-52	22	17	24 x 24	1-200	95	.76	.83	17.5	T137E1	E.O.D.
9-12-52	16	10	20 x 20	1-200	95	.74	.65	17.5	T137E2	A.P.G.
9-25-52	18	14	20 x 20	1-120	85	.54	.46	17.5	T19#6	E.O.D.

Future Program

1. A group of inert rounds are being prepared for a comparison accuracy firing program to be fired at Aberdeen Proving Ground. Projectiles will be fired for accuracy at ranges of 1500 and 2000 yards using tubes having 1-200 and 1-120 twists under as nearly identical conditions as

possible.

2. A group of HEAT rounds using special liners will be fired for penetration at Aberdeen Proving Ground from a tube having a 1-120 twist.

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T119 PROJECTILE

Accuracy Programs - T119 Projectile

During the past month, T119E8 projectiles were fired for accuracy at ranges of 1000 and 2000 yards.

Accuracy at 2000 Yards

The 2000-yard program, fired at Aberdeen Proving Ground, was intended to provide a check on accuracy data previously obtained at Erie Ordnance Depot. A total of 25 rounds of T119E8 projectiles, including 6 rounds for gun conditioning and "laying on" the target, were fired. Nineteen hits were obtained on the 20 ft. by 20 ft. target. The probable errors of dispersion were V.P.E. = .50 mil and H.P.E. = .34 mil. A T137E2 gun with a 105-in., smooth bore tube was used for this program. Table VIII is a chart showing the details of the T119E8 projectile and Table IX is a copy of the range data.

The results of this test are in agreement with earlier tests at 2000 yards and confirm that the T119 projectile has good accuracy for at least 2000 yards.

Accuracy From a Rifled Tube

To determine the accuracy of the T119E8 projectile when launched without obturation from a tube rifled 1-20, twenty T119E8 projectiles were fired at Erie Ordnance Depot at a range of 1000 yards. A modified T19 rifle was used because an appropriately rifled tube was not immediately available for the T137 rifle.

The rounds were fired in two groups. One group of twelve T119E8 rounds was fired in the morning. Eleven rounds hit the target; the twelfth struck a velocity screen and missed the target. An additional group of eight T119E8 rounds was fired in the afternoon. The second

round fired went over the target, and the aiming point for the remaining rounds was changed. Separate centers of impact were calculated for each group of hits, and the two centers of impact were superimposed for the calculation of the dispersion. The probable errors of the dispersion for the eighteen hits were V.P.E. = .44 mil and H.P.E. = .47 mil. The firing data are contained in Table X.

The shift in the center of impact is attributed to a tightening of the gun tube in the chamber when the gun conditioning slugs were fired. It was noted that the torque from rotation of the banded slugs caused the tube to turn approximately one inch on its circumference relative to the chamber. Total gun elevations were established with a gunner's quadrant positioned on a flat on the chamber. In a later program with another projectile, it was established that the T19 rifle had a large forward recoil and it is felt that this may have contributed to the dispersion.

These results demonstrate that the T119 projectile can be fired, without obturation, from a tube rifled 1-20. The accuracy is within the .5 mil requirement for the BAT weapon.

Charge Development

A charge development program was fired at Aberdeen Proving Ground. A charge of 8 lb. 4 oz. of M10MP propellant, .038-in. web, lot number PA-E-6119, was found to produce a velocity of 1700 ft/sec when the T119E8 projectile, assembled with the T53E1 shell case and M57 primer, was fired from the T137E3 rifle. On the basis of this charge development, Picatinny Arsenal has been instructed to load T119E8 rounds with 8 lb. 4 oz. of PA-E-6119 propellant.

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**T119E8 Projectile for Engineering and
Service Board Tests**

<u>Type</u>	<u>Date Shipped To Picatinny</u>	<u>Quantity</u>
Inert	9-13-52	100
Inert	9-19-52	50
Inert	9-21-52	65
HEAT	8-6-52	35
HEAT	8-13-52	50
HEAT	8-19-52	35
HEAT	9-13-52	35
HEAT	9-19-52	50

An additional 15 each of inert and HEAT T119E8 projectiles are being assembled and will be shipped to Picatinny Arsenal for loading during October. This ship-

ment will complete the entire quantity of T119E8 projectiles which were manufactured.

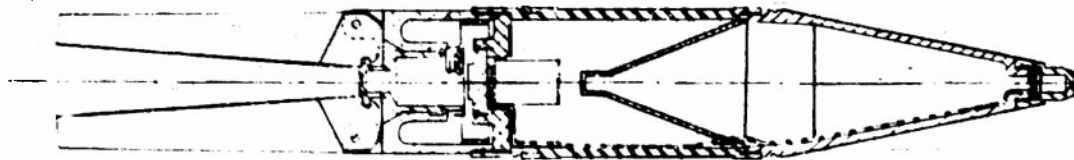
Future Program

A lot of 2500 T119E11 projectiles is being made. A chart showing details of the T119E11 projectile modification is given in Table XI. It is believed that

shipments of these projectiles will start in October, 1952 and that a rate of at least 100 per week can be reached shortly thereafter.

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Table VIII
T119E8 Modification



Part	Dwg. No.	Material	Weight (lb.)
NOSE	DRC-342	MALLEABLE IRON	3.49
BODY	DRC-341	SAE1045	5.58
HOUSING	DRC-412	24ST4	1.76
PISTON	DRB-198	SAE4140	.52
STOP	DRA-173	SAE4140	.09
FINS	DRD-334	24ST4 FORGING	1.01
PINS	DRA-730	SAE1020	.06
NOSE CAP	DRA-699	SAE1020	.21
PLUG	DRA-288	24ST4	.11
PLUG	DRB-419	24ST4	.58
OBTURATING BAND	DRB-420	COPPER	.20
CONE	DRB-398	COPPER	.90
O-RING	Ckcx3-1/8" x 3 7/8"	RUBBER	.01
GAS SEAL	PICATINNY ARSENAL DWG. 75-14-38		
	PcMKE	COPPER & LEAD	.03
BASE ELEMENT	DRA-579	-----	.33
WIRE & TAPE	DRA-628	NYLON & COPPER	--
NOSE ELEMENT	DRA-496	BARIUM TITANATE	.02
PIN STRIP	DRA-454	BAKELITE	--
GROMMET	DRA-492	NYLON	--
SHOCK PAD	DRA-493	FELT	--
SHOCK PAD	DRA-491	FELT	--
SLEEVE	DRA-498	TURBOSIL SILICONE GLASS	--
WASHER			
R. C. ASSY.	DRA-598	-----	--
INSULATOR	DRA-460	FELT	--
ASSEMBLY	DRD-262		
COMPOSITION B			2.79
PROJECTILE WEIGHT (CALCULATED) 17.82 LBS.			
C. P. .68 CAL. FROM HINGE PIN CENTER LINE, FINS OPEN			
C. G. 1.73 " " " " " " "			
TOTAL LENGTH- FINS CLOSED 28.21 IN.			

Table IX
Rang Data, T119E8 Projectile
To Determine Accuracy at 2000 Yards

PROJECTILE
Model T119
Type EB
Weight (Nominal) 17.60 lb.
C.G. Location 10.1 in. from hinge pin & -0.02
Bore Diameter (Nom) 4.130 in.
Special Features 4.14 in. Obstructing Band

ABERDEEN PROVING GROUND, MD
Date 4-12-52
TEST GUN
Model T127
Type E2 Chamber 14699, Tube 228855X
Length of Tube 10.5 in.
Twist of Rifling Smooth Bore
Sighting Equipment T123 Sight Mount, M62E4 Elbow Telescope, Gunner's Quadrant
Bore Dia. (Lands) 4.134 in.
Case T53
Primer T81
Polyethylene-Rayon Liner

MISCELLANEOUS DATA
Range 2383 ft. Target 20 ft Square
Propellant PA-E-6084
Type M100P Pub. Q381a Charge Wt. 9.14 lb.
Observer C. M. Cox, Lucas Tamm
Proof Director M. Conner
APG - Arms & Ammunition
PATON.

Program To determine Accuracy at 2000 yds

Round No	Proj. No	Proj. Weight (lb)	Powder Charge	Wind Vel & Dir.	Chamber Pressure	Muzzle Velocity ^a Instr. Actual	Elev ^c (mils)	Azimuth ^d (mils)	Position of Hit ^e (in.)		Corrected Position ^d of Hit - mils		Observations ^a	
									Vert.	Horiz.	Vert.	Horiz.		
1.	116	17.66		4 - 0		1665	67	+ 1 1/2	M1320				SHORT - APPEARED TO HIT RIGHT OF TARGET	
2.	110	17.65		7 - 0		1674	68	0	M1320				SHORT - RECOGNIZED THROUGH TARGET	
3.	109	17.65		6 - 5		1683	67	0	M1320				SHORT - RECOGNIZED THROUGH TARGET	
4.	126	17.61		6 - 10		1686	67	0	M1320				SHORT - RECOGNIZED THROUGH TARGET	
5.	128	17.63		8 - 10		1675	69	0	M1320				SHORT - RECOGNIZED THROUGH TARGET	
6.	115	17.62		8 - 0		1681	69	1 1/2	-18.65	+11.60	-3.11	1.99	STUCK PLATE PROTECTING TARGET FOOTING - LEFT SIDE	
FIRING INTERRUPTED FOR APPARENTLY 2 HOURS														
7.	123	17.66		4 - 30		1675	69	1 1/2	CONDITIONING ROUND				AMBIENT TEMP. 82°F	
8.	103	17.70		4 - 30			60	1 1/2	-4.60	+7.06	-1.74	1.17		
9.	118	17.67		2 - 25		1671	69	1 1/2	-3.17	+10.90	-1.50	1.82		
10.	107	17.65		2 - 30		1682	69	1 1/2	-1.05	+12.66	-1.17	2.14		
11.	130	17.63		2 - 30		1689	69	1 1/2	-6.80	+6.62	-1.17	1.10		
12.	117	17.61		3 - 40		1675	69	1 1/2	-11.85	+11.96	-1.98	1.97		
13.	120	17.61		2 - 35		1682	69	1 1/2	-15.70	+10.40	-2.62	1.73		
14.	121	17.59		1 - 40		1685	69	1 1/2	-7.20	+8.46	-1.20	1.42		
15.	124	17.57		1 - 45		1677	69	1 1/2	-16.27	+13.46	-2.74	2.48		
16.	106	17.57		1 - 50		1681	69	1 1/2	-8.10	+15.07	-1.54	2.51		
17.	111	17.53		1 - 50		1684	69	1 1/2	-6.15	+12.97	-1.02	2.16		
18.	119	17.58		0 - 50		1676	69	1 1/2	-7.00	+8.82	-1.17	1.47		
19.	129	17.55		0 - 60		1673	69	1 1/2	-12.60	+13.49	-2.10	2.24		
20.	113	17.57		0 - 55		1679	69	1 1/2	-7.50	+9.31	-1.25	1.56		

CONTINUED ON NEXT PAGE

Table X
Range Data, T119E8 and T119E4
To Determine Accuracy from Rifled Tube

PROJECTILE
 Model T119
 Type EB 4
 Weight (Nominal) 17.60 lb.
 C.G. Location 1.1 in. from hinge pin
 Bourrelet Die (Nom.) 4.180 in.
 Special Features Lead turned to 4.180 in.

TEST GUN
 Model 105 mm. Recoilless
 Type Mod. I 19,500 cu. in. chamber liner; 20" breech
 Length of Tube 106 in.
 Twist of Rifling 1:20
 Sighting Equipment Mod. M1ZF how telescope, Gunner's Quadrant
 Bore Dia. (Lands) 5.165 in.
 Case - Reinforced T6 with rear loading plug
 Primer - M57
 Liner - T6, polyethylene cut off at base

MISCELLANEOUS DATA
 Range 1229 yds. Target 12 ft x 18 ft wide
 Propellant PA 30240
 Type M108 Pub. 03312 Change W. B. 1.03
 Proof Director E. HUFFMAN
 Observer LUCAS WENTER, CLARK

Program T119C2: To determine accuracy of T119E8 from rifled tube.

Round No. No. Type Slug	Proj. No. Zero	Proj. Weight	Powder Charge	Wind Vel. & Dir. Inch. sec.	Chamber Pressure (psi. Sa)	Muzzle Velocity Actual	Elev. (mils)	Azimuth (mils)	Position of Hit (in.)			Corrected Position of Hit - mils		Observations
									Vert.	Horiz.	Rotating Band	Vert.	Horiz.	
1	E4	60	17.54											
2	E8	305	17.65		9000	1662	22	0	-18.5	-51.5	-499	-1.498	-1.498	a. The target from the relation of the last two slugs caused a turning and tightening of the tube in the chamber of about one inch on the circumference. Target zero elevation was changed (3.5 mils after last round).
3	E8	262	17.61	195	9500	1696	22	0	-22.5	-1.5	-242	-0.040	-0.040	b. The breech used was later shown to be so badly eroded that the recoil was forward
4	E8	266	17.62	195	9200	1678	22	0	-4.5	+6.5	-121	+1.75	+1.75	c. Elevations and azimuths are with reference to target center.
5	E8	328	17.60	195	9200	1678	22	0	-1.0	-9.5	-243	-2.576	-2.576	d. Corrected to 22 mils elevation and 20.0 azimuth
6	E8	320	17.62	200	9400	1682	22	0	-15.5	-46.5	-418	+1.255	+1.255	e. There was a delay for additional leading after round No. 2 and a delay for lunch after round No. 13.
7	E8	271	17.62	205	9400	1681	22	0	-31.5	-36.0	-850	+3.91	+3.91	f. Used retardation factor 194 ft/sec/ft
8	E8	277	17.65	200	9500	1683	22	0	+13.5	-36.0	-364	-1.972	-1.972	
9	E8	324	17.61	195	9300	1682	22	0	-14.0	+10.0	-378	+2.270	+2.270	
10	E8	307	17.63	200	9400	1681	22	0	+28.0	-28.0	+756	-621	-621	
11	E8	294	17.60	200	9400	1690	22	0	-7.5	0.0	-202	-0.000	-0.000	
12	E8	267	17.62	205	9500	1691	22	0	+10.0	-14.0	+270	-378	-378	
13	E8	323	17.65	205	9400	1646	1682	22	0	Struck 2nd velocity screen. Delay for lunch prior to this slug				
14	E8	274	17.64											
15	E8	258	17.67	10 - 165	8900	1652	1692	231	0	+67.5	-50.5	+452	-1.363	
16	E8	272	17.64	10 - 170	9500	1675	1711	281	0	Just over target				
17	E8	278	17.61	10 - 170	9300	1676	1712	221	0	+61.0	-42.0	+1547	-1.134	Screen distances: Muzzle to 1st screen 111 ft; 1st to 2nd 72.5 ft.
18	E8	293	17.62	10 - 165	9100	1676	1712	211	0	-34.0	+4.5	-018	+2.696	
19	E8	321	17.61	8 - 170	9200	1676	1712	211	0	-13.5	-40.5	+636	-1.093	
20	E8	256	17.61	14 - 175	9300	1675	1711	211	0	-45.5	-65.0	-328	-1.489	
21	E8	325	17.66	11 - 175	9100	1677	1713	211	0	-28.0	-16.0	+144	-492	
				12 - 185	8900	1650	1686	211	0	-61.5	+28.5	-747	+769	

Speed - 1.25 m/s

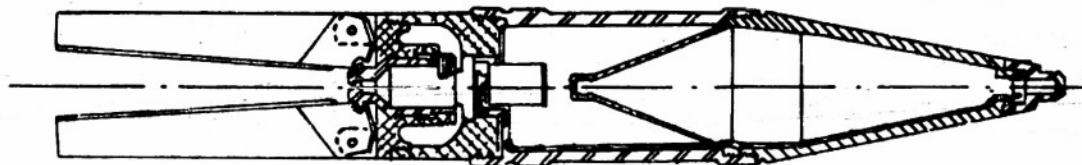
Center of Impact Rounds 2-13 C.I. = -2.8, C.I.N. = -0.6 mils; Rounds 14-21 C.I. = 2.0, C.I.N. = -6.9 mils.

Probable Error - Vertical ± 4.4 mil } For all hits except B1 which was an E4 type projectile.

Probable Error - Horizontal ± 4.7 mil } Centers of impact for morning & afternoon groups were superimposed.

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Table XI
T119E11 Modification



Part	Dwg. No.	Material	Weight (lb.)
NOSE	DRC342	MALLEABLE IRON	3.49
BODY	DRC497	SAE1045	5.64
HOUSING	DRB573	24ST4	.95
CHAMBER	DRC442	24ST4	1.82
PISTON	DRB198	SAE1137	.54
STOP	DRA173	SAE1137	.09
FINS-CANTED	DRD334	14ST6 FORGING	1.02
PINS	.875X.2500	SAE1020	.07
NOSE CAP	DRA699	SAE1112	.21
PLUG	DRA670	24ST4	.11
CONE	DRB398	COPPER	.86
O-RING	DRA459	RUBBER	--
GAS SEAL	PICATINNY ARSENAL DWG. NO. 75-14-38		
	PcMKE	COPPER & LEAD	.02
BASE ELEMENT	DRA579	-----	.33
WIRE & TAPE	DRA628	NYLON & COPPER	--
NOSE ELEMENT	DRA496	BARIUM TITANATE	.03
PIN STRIP	DRA454	BAKELITE	--
GROMMET	DRA492	NYLON	--
SHOCK PAD	DRA493	FELT	--
SHOCK PAD	DRA491	FELT	--
SLEEVE	DRA498	TURBOSIL SILICONE GLASS	--
WASHER			
R.C. ASSY	DRA598	-----	--
INSULATOR	DRA460	FELT	--
ASSEMBLY	DRD391	-----	--
COMPOSITION B			2.79
PROJECTILE WEIGHT (CALCULATED)			17.97
C.G. 1.68 CAL. FROM HINGE PIN CENTER LINE, FINS OPEN			
C.P. .68 CAL. FROM HINGE PIN CENTER LINE, FINS OPEN			
TOTAL LENGTH - FINS CLOSED 28.08 IN.			

NOTE: All components of T119E11 are identical with those of T119E10 with the exception of the body. The obturating band groove has been eliminated from the new body to permit firing of the T119E11 projectile from rifled tubes.

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PENETRATION STUDIES

Effect of Internal Tee Configuration

The reduction in penetration resulting from the use of a DRC314 tee with a non-rotated DRB398 cone was described in the Twenty-Fourth Progress Report. Tests reported in the Twenty-Fifth Progress Report showed that the major portion of the interference is in the boom and/or boom entry hole. These tests have been continued.

Four series of rounds with various tees, totaling twelve rounds, have been tested. Figure 9 shows the various tee modifications. Cone inspection data are shown in Table XII and penetration data are given in Table XIII.

The average penetration for the three

rounds with unmodified tees is 16.83 inches, 4.0 inches less than the penetration of the controls without tees. The average penetration for the rounds having modifications C and D are 17.75 and 17.89 inches, respectively, indicating that about one inch of penetration may be gained by enlarging the boom entry hole slightly. Modification E, complete removal of the boom, permitted an average penetration of 19.00 inches, 2.2 inches better than the unmodified tee but 1.8 inches poorer than a standard nose ring. Thus, of the four inch reduction in penetration arising as a result of jet interference in the DRC 314 tee, approximately 50% (2 inches) is lost in the boom, and 50% (2 inches) is lost in the entry hole to the boom. About 25% (1 inch) may be recovered by enlarging the boom entry hole slightly.

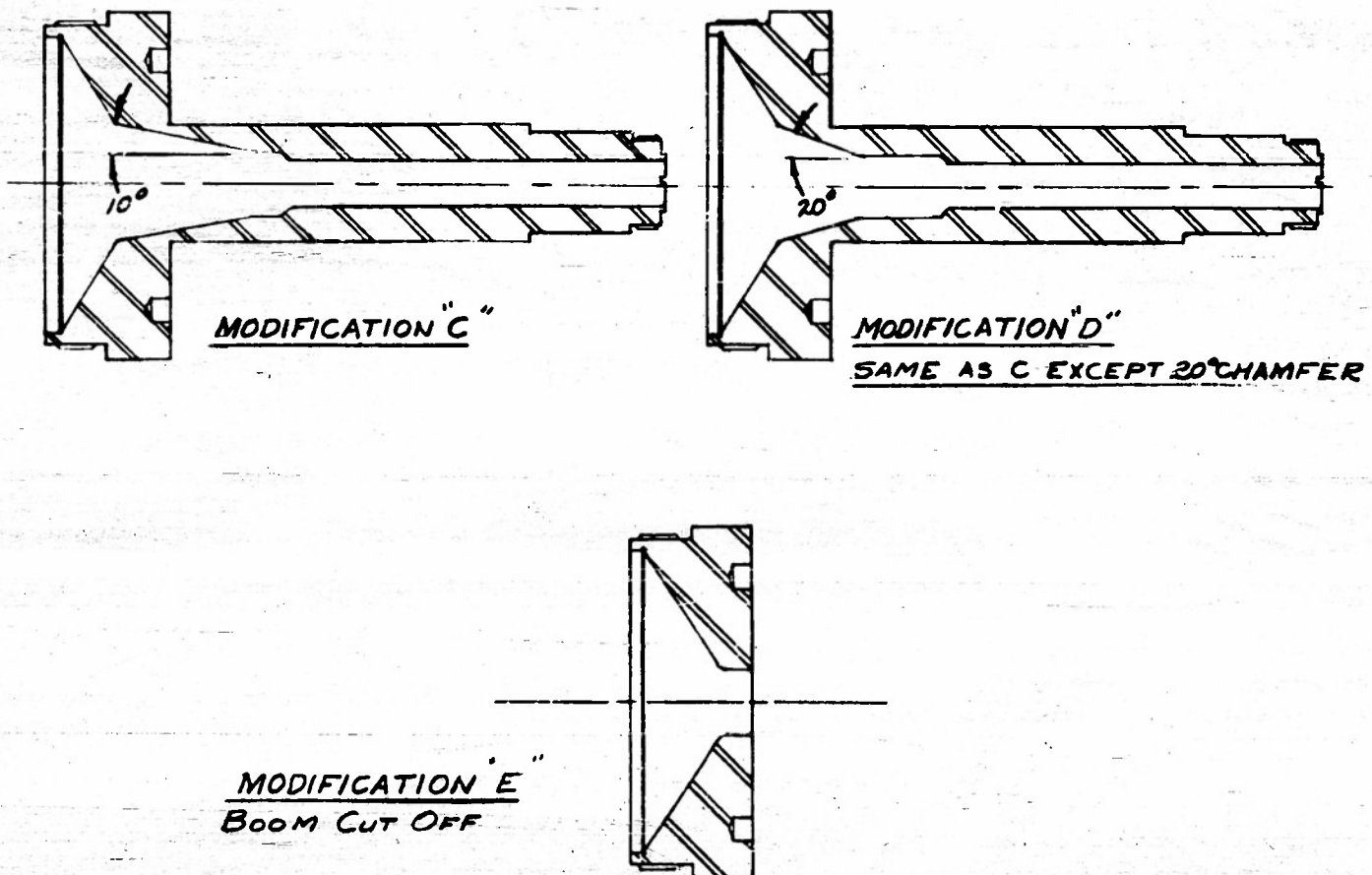


Fig. 9. Various Tee Modifications.

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Table XII
Inspection Data

Cane No.	Maximum Variation		Wall Thickness		Concentricity T.I.R.	
	Transverse	Longitudinal	Maximum	Minimum	Charge to Bourrelet	Cone to Bourrelet
Q373	.006	.005	.104	.098	.003	.007
Q374	.005	.005	.103	.097	.002	.008
Q442	.003	.005	.103	.098	.001	.011
Q443	.002	.005	.103	.099	.001	.011
Q635	.002	.003	.101	.098	.002	.008
Q639	.001	.002	.106	.104	.001	.004
Q645	.002	.001	.105	.103	.001	.003
Q649	.004	.002	.105	.101	.002	.003
Q650	.003	.003	.103	.100	.002	.008
Q655	.006	.005	.105	.099	.002	.007
Q660	.003	.003	.103	.100	.002	.006
Q665	.003	.003	.101	.098	.001	.003

Notes:

1. All measurements are in inches.
2. All cones are drawn DRB398 cones.

Table XIII
Penetration Data
For Modified DRC 314 Tees

Round No.	Tee	Lbs. Comp B	Penetration (inches M.S.)	Max. Spread (in.)	Std. Dev. (in.)
Q443	DRC314	2.58	16.25		
Q660	"	2.58	16.50		
Q665	"	2.58	17.75		
			Avg. <u>16.83</u>	1.50	±.81
Q373	Mod. C.	2.58	19.38		
Q635	"	2.60	16.18		
Q639	"	2.60	17.69		
			Avg. <u>17.75</u>	3.20	±1.57
Q442	Mod. D	2.60	19.31		
Q650	"	2.60	17.75		
Q655	"	2.60	16.62		
			Avg. <u>17.89</u>	2.69	±1.35
Q374	Mod. E	2.60	19.69		
Q645	"	2.62	18.88		
Q649	"	2.60	18.44		
			Avg. <u>19.00</u>	1.25	±.63
Controls (DRC376 Assemblies)			Avg. 20.80	1.00	±.48
See page 26 of Twenty-Fifth Progress Report.					
Notes: 1. DRC376 bodies and base plugs, tees as indicated. 2. Loaded at Ravenna Arsenal, BAT Lot #17, Comp B from Holston Lot 3-126. 3. All rounds fired at 0 rev/sec and 7.5 inches standoff.					

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Future Program

1. Conduct penetration versus standoff tests for 45° and 20° copper cones (100-inch wall) with head of H.E. held constant at 3.63 in.

2. Evaluate the influence of DRC 314 tees made of (a) mild steel (b) high ductility malleable iron, and (c) low ductility malleable iron.

3. Continue tests to determine the effect of interior tee configuration upon

penetration.

4. Continue scaling studies with smaller liners.

5. Composite cones. The penetration behavior of steel and of aluminum cones each with thin copper inserts, and of copper cones with thin aluminum inserts, is being compared with homogeneous copper cones. Initial tests will be at 0 and 25 rev/sec.

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FUZES

T223E2 Superquick-Delay Mechanical Fuze

Nine rounds containing T223E2 fuzes (Fig. 11, Twenty-Fifth Report) were fired at Erie Ordnance Depot. Six, loaded with spotting charges, were fired against a 3 1/2-in. wooden bursting screen. Three, set for superquick functioning, were observed to function on the screen. Two of three others, set for delay functioning, were observed to function after passing through the 3 1/2-in. wooden bursting screen.

The three remaining rounds were fired into the recovery box to study the functioning of the delay element. All three were recovered and inspection showed that the delay elements in each had functioned properly.

T222E3 (DRA 496-2) Nose Element Crystal Assemblies

Test slugs weighing fifteen pounds have been fired from a 75mm gun at T138 E57 tee assemblies containing T223E3 crystal assemblies. In each case a BS28 indicator and an oscilloscope were connected in parallel across the crystal.

Attempts to photograph the voltage-time trace were continued but in these tests the film was presensitized according to the directions in the Dumont 297 Camera Manual. A one megohm potentiometer was placed across the vertical plates of the oscilloscope to obtain a greater attenuation than is available using the internal control.

Four projectiles were fired in this test but only two hit the tees squarely enough to close the foil switch (of the two rounds that failed to close the switch,

one hit the rim of the tee cap and the other hit the shoulder of the tee). The BS28 indicator functioned on all four rounds. The voltage-time trace for round four was successfully photographed and showed that a peak of 800 volts was produced.

A subsequent firing of seven projectiles produced two additional hits. Readable pictures were obtained for both of these rounds. The maximum voltage for one round was 900 volts. This voltage fell to 100 volts in .56 microseconds.

The maximum voltage for the second round was 650 volts, which fell to 150 volts in 1.5 microseconds. The voltage rise time was too short for accurate determination. Additional tests are planned.

Base Elements (DRD328) for T222E5 Fuze

Six T138E57 projectiles containing DRD328 base elements (Fig. 10 of Twenty-Fifth Progress Report) and T222E3 nose elements (DRA496-2) were fired. Each round contained a tetryl pellet and sufficient spotting charge to make possible an observation of functioning. Five rounds were fired at 4-in. wooden bursting screens; two at 75 ft (the maximum arming distance permissible under contract DA-33-019-ORD33); two at 100 ft and one at 200 ft. None of the fuzes functioned. Therefore, the remaining round was fired for recovery. Subsequent examination of the recovered round disclosed that it was unarmed. The setback pins had failed to release the rotor. The inner surface of the holes for the setback pins was quite rough. Furthermore, the number two pin was found to have a too small bearing surface at one end, permitting the pin to tilt and bind. Further tests are planned.

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Future Program

1. Fire a confirmatory test group of 10 T223E2 fuzes, set for delay, before incorporating such fuzes in live loaded HE rounds.

2. Continue the experiments to determine the power generated by the "lucky"

elements.

3. Repeat the arming distance experiments on T222E5 base elements using longer arming pins and with an improved finish on the holes.

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