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THIRTY-FIRST

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

TMI-1540-AMMUNITION

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THE FIRESTONE TIRE & RUBBER COMPANY

Defense Research Division

Akron, Ohio

FEBRUARY 1953

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**THIRTY-FIRST
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
Akron, Ohio**

FEBRUARY, 1953

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ABSTRACT

An inventory is presented of recoilless rifles and mounts manufactured by Firestone for the BAT and ONTOS projects.

Design changes on the T137 rifle and T152 mount, aimed at improved performance and ease of handling, are described.

A mount to hold six T170E1 rifles, and a remote control firing system, are being developed for the ONTOS vehicle. These developments are discussed.

Projectiles of the T138E57 type, for evaluating the effect upon flight behavior of spin rate and center of gravity location, have been manufactured and long range firing tests are being arranged.

Tests with the T119 projectile to investigate long and short ogives and shortened fins are scheduled. Twenty T119E11 projectiles with the new plug-in nose element, DRA726, are to be tested in March. A shipping report is given for T119E11 projectiles.

The penetration studies for this report period were concerned with the effect on penetration of certain loading variables. The test data are presented.

Two fuze tests are described: (1) sensitivity of the DRA726 plug-in nose element using a one-inch thick bursting screen, and (2) function tests of the delay and of the superquick actions of the T267 base element.

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THE WEAPON SYSTEM

An inventory of recoilless rifles and the BAT and ONTOS projects is presented in Table I.
mounts manufactured by Firestone for in Table I.

Table I
Inventory of Recoilless Rifles and Mounts
Manufactured by Firestone for BAT and ONTOS Projects

RIFLES		
Rifle No.	Location	Comments
<u>T137E3 Rifles</u>		
Ser. No. 1	Akron	Returned from Fort Benning
2	Akron	Returned from Fort Benning
3	Allis-Chalmers	T165 Serial No. 5
4	Allis-Chalmers	T165 Serial No. 7
5	Allis-Chalmers	Shipped to Allis-Chalmers 1-17-53
6	Allis-Chalmers	T166 Serial No. 2
7	Allis-Chalmers	T165 Serial No. 6
8	Allis-Chalmers	T165 Serial No. 5
9	Allis-Chalmers	T165 Serial No. 6
10	Allis-Chalmers	T166 Serial No. 3
11	Allis-Chalmers	T165 Serial No. 7
12	Akron	Ready for shipment to Allis-Chalmers
13	Aberdeen Proving Ground	BAT Engineering Test
14	Akron	Ready for shipment to Allis-Chalmers
15	Allis-Chalmers	Shipped to Allis-Chalmers 1-17-53
16	Akron	Ready for shipment to Allis-Chalmers
17	Akron	Ready for shipment to Allis-Chalmers
18	Akron	Ready for shipment to Allis-Chalmers
19	Akron	Ready for proofing
20	Akron	Ready for proofing
21	Not Completed	
22	Not Completed	
23	Akron	Ready for proofing
24	Not Completed	
25	Not Completed	
<u>T137E2 Rifles</u>		
Ser. No. 1	Akron	Used for spare parts
2	Akron	E.O.D. for test facility
<u>T137E1 Rifle</u>		
Ser. No. 1	Akron	Salvaged
2	Akron	Salvaged
3	Akron	Salvaged
4	Watertown Arsenal	To be returned to Firestone on completion of metallurgical study.
5	Akron	Salvaged
6	Akron	Salvaged
7	Akron	Salvaged
8	Akron	To be kept for historical value.
<u>T137 Rifle</u>		
Ser. No. 1	Akron	Destroyed in proofing
Inventory of T152 Mounts on next page.		

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Table I (Cont.)

MOUNTS		
Mount No.	Location	Comments
<u>T152E5 Mount</u> Ser. No. 1 2 3	Akron Akron Aberdeen Proving Ground	Returned from Fort Benning Returned from Aberdeen BAT Engineering Test
<u>T152E4 Mount</u> Ser. No. 1 2 3 4 5 6 7 8 9 10 11 12	Allis-Chalmers Allis-Chalmers Allis-Chalmers Allis-Chalmers Allis-Chalmers Allis-Chalmers Akron Akron Akron Akron Not Completed Not Completed	T165 Serial No. 5 T165 Serial No. 6 T166 Serial No. 2 T166 Serial No. 3 T165 Serial No. 7 Shipped to Allis-Chalmers 1-17-53 Ready for shipment to Allis-Chalmers Ready for shipment to Allis-Chalmers Ready for shipment to Allis-Chalmers Ready for proofing
<u>T152E3 Mount</u> Ser. No. 1 2 3 4	Akron Akron Akron Akron	Salvaged Converted to E4 Converted to E4 Salvaged
<u>T152E2 Mount</u> Ser. No. 1 2	Akron Akron	Salvaged Salvaged
<u>T152E1 Mount</u> Ser. No. 1	Akron	Salvaged
<u>T152 Mount</u> Ser. No. 1	Akron	Salvaged

The T137 Rifle

The T137 rifle is being modified for improved performance and ease of handling. The chamber contour is being redesigned to improve the gas flow conditions in the chamber so that the pressure differential across the cartridge case is reduced. The breakdown feature is being made selective so that the chamber and tube may be disconnected from the mount either separately or as a single unit. Lastly, a gas seal is being provided for the junction of the chamber and barrel.

The T152 Mount

A new mount is being made of aluminum. The carriage has the same basic design as the T152E4 mount, but two tripods are planned. One tripod made entirely of aluminum has two wheels for man-tow on the ground; the second is the standard T152E4 lightweight steel tripod. This mount has a new firing control system which requires much less trigger effort to fire either major or minor caliber rifle.

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The ONTOS Firing System

A mount for six T170E1 rifles and a remote control firing system is being developed for the ONTOS vehicle. Design work on the mount is nearly complete. The quick-disconnect system of these rifles will be used to lock them to the mounting bracket. The remote control firing system permits the gunner to open or close the breech or to fire any rifle he wishes without leaving the firing panel inside the vehicle. Some delay in finding power packages for controlling the breeches and firing the rifles occurred, but Lear Incorporated of Grand Rapids, Michigan has suitable electrically-powered rotary actuators for firing the

rifles and linear actuators for control of the breeches. Slight modifications of these production units are required and Lear is now estimating delivery dates. If these units can be supplied during March it may be possible to complete one vehicle system by April 1, 1953.

A diaphragm-type blast switch has been designed and is being manufactured for test purposes. This switch will be attached to the rear of the chamber and will control the telltale lights which indicate when a round has been fired from a gun. Opening and closing the breech will automatically reset the indicator lights.

Future Program

The design changes described in the preceding paragraphs will be completed and evaluated. To facilitate the chamber redesign, a series of pressure stations will be installed in a T137E3 rifle and

the actual pressure distribution of the present design will be determined. Several types of gas seal for the rifle chamber connection are being manufactured for tests.

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T138 PROJECTILE

Projectiles for determining the effect of center of gravity location and spin rate on the accuracy of the T138 projectile (Twenty-Ninth Progress Report) have been manufactured. The future program is being amplified to include

long range accuracy tests. Adequate range facilities are available at Aberdeen Proving Ground and a request for authorization to carry out these tests at that place is being formulated.

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T119 PROJECTILE

No T119 projectile tests were conducted at Erie Ordnance Depot during the month of February, 1953.

The manufacture of projectiles with long and short ogives is continuing. These projectiles will be used to determine the effect of ogive length on flight characteristics.

A group of fifteen T119 projectiles have been fitted with fins shortened by

two inches. These projectiles will be tested and the performance compared with standard T119E11 projectiles.

Twenty T119E11 projectiles with the new plug-in nose element (DRA726, Thirtieth Progress Report, Figure 8) have been shipped to Picatinny Arsenal for live loading. It is planned to have these projectiles fired at Aberdeen Proving Ground during March, 1953.

Projectile Shipments

<u>Type</u>	<u>Quantity</u>	<u>Shipped To</u>	<u>Date Shipped</u>
T119E11 Live	105	Picatinny Arsenal	2-14-53
T119E11 Inert	165	Picatinny Arsenal	2-14-53
T119E11 Inert	300	Picatinny Arsenal	3-5-53

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PENETRATION STUDIES

Effect of "Holding Time" on Penetration

When a number of charges are cast from a single melt the explosive in the last charge has been held at the pouring temperature considerably longer than the first. The following experiment was undertaken to determine the effect of "holding time" upon the penetration performance. All charges were poured at 85°C into warmed DRC376 test assemblies having DRB398 drawn cones. Two lots of Composition B, Holston 3-126 and Holston 4-131, were used. Charges were

cast with each lot of explosive as soon as the melt reached 85°C and also after having held the melt at the pouring temperature for 1.5 hours. All charges were radiographed and were found satisfactory.

The penetration data are shown in Table II and the analyses of the two lots of Comp B are shown in Table III. With each lot of explosive, the average penetration of the charges, cast as soon as the melt reached the pouring temperature, is slightly higher than after a holding time of 1.5 hours but the difference, about 2%, has no practical importance.

Future Program

1. Composite cones. The penetration behavior of steel and aluminum cones having thin copper inserts, of copper cones with thin aluminum inserts, and of homogeneous copper cones are to be compared. Initial tests will be at 0 and 25 rev/sec.

2. Effect of Standoff. Standoff-penetration curves for drawn, machined and recoined liners are being extended to longer standoffs, 42 inches.

3. Effect of Internal Tee Contour. Three new tee designs are to be evaluated.

4. Scaling studies. Two series of scaling studies are planned. One series with simple apex copper cones is geometrically scaled to 75, 90 and 105 mm. The other uses DRB398 cones (with short spitback of constant size) with height and wall thickness adjusted to 75, 90 and 105mm size.

5. Cones made of zinc and aluminum are to be tested for penetration. Penetrations approaching those of copper cones have been reported for certain aluminum and zinc alloys.

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Table II
Penetration Data
Effect of "Holding Time"

Round No.	Lbs. Comp B	Lot Comp B	Holding Time (hours)	Penetration (inches M.S.)	Max. Spread (in.)	Std. Dev. (Inches M.S.)
FS963	2.60	Holston 3-126	0	19.88		
FS964	2.60	"	"	19.88		
FS965	2.61	"	"	20.00		
FS966	2.61	"	"	21.25		
FS967	2.60	"	"	21.38		
				Avg. 20.48	1.50	±.77
FS968	2.59	Holston 3-126	1.5	18.69		
FS969	2.60	"	"	21.00		
FS970	2.60	"	"	18.94		
FS971	2.61	"	"	19.75		
FS972	2.59	"	"	20.18		
				Avg. 20.11	3.49	±1.47
FS973	2.62	Holston 4-131	0	19.81		
FS974	2.63	"	"	20.25		
FS975	2.62	"	"	21.31		
FS976	2.62	"	"	19.75		
FS977	2.62	"	"	22.00		
				Avg. 20.62	2.25	±.99
FS978	2.62	Holston 4-131	1.5	20.56		
FS979	2.62	"	"	19.56		
FS980	2.62	"	"	19.56		
FS981	2.61	"	"	20.44		
FS982	2.62	"	"	20.75		
				Avg. 20.17	1.19	±.70

Notes:
 1. DRC376 test assemblies with DRB398 copper cones.
 2. Loaded at Ravenna Arsenal, BAT Lot No. 25.
 3. Tested at Erie Ordnance Depot, 0 rev/sec, 7.5 inches standoff.

Table III
High Explosive Analysis
Two Lots of Comp. B

Composition	Lot 3-126	Lot 4-131	Specifications
RDX	59.16%	59.71%	59.5 ± 2.0%
TNT	39.80%	39.42%	39.5 ± 2.0%
Desensitizer	1.04%	0.87%	1.0 ± 0.3%
Moisture	.062%	.055%	.25% Max.
Acidity	.006%	.004%	.01% Max.
Benzene-acetone insoluble	.002%	.02%	0.1% Max.
Inorganic insoluble	none	.02%	.05% Max.
Specific gravity	1.66	1.66	1.64 Min.
Viscosity	*	*	
Grit	Passes Test		Passes Test
Form			

* The Control Laboratory is not equipped to run viscosity and particle size.

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FUZES

Field Tests on DRA726 Nose Elements (PI, Superquick)

The Thirtieth Progress Report described the testing of ten DRA726 nose elements against a 4-inch bursting screen. As a test of sensitivity, additional rounds have been tested against a 1-inch bursting screen. The rounds were inert loaded and were equipped with spotting charges and T208E7 base elements. Table IV is a copy of the firing record. All ten rounds functioned satisfactorily, bringing the total to twenty functionings out of twenty rounds fired. As a result of this test it is evident that the element is quite sensitive and that there is a sufficient reserve of power available.

Plans have been initiated for functioning tests of the DRA726 nose element assembly in live loaded HEAT projectiles. Twenty T119E11 projectiles and fifty T138E57 projectiles have been shipped to Picatinny Arsenal for loading.

Field Tests on T267 Base Elements (Superquick and Delay)

A superquick and delay fuze, designated T267, is under development (page 15, Thirtieth Progress Report). Rounds using this fuze are equipped with M2 delay detonators (inertia operated) which are designed to function an M21 detonator. Nine rounds, equipped with base elements of the T267 fuze, were fired, but only one round was equipped with detonators. Seven of the nine rounds were recovered. Table V is a copy of the firing record. Examination of the recovered projectiles disclosed that six fuzes, set for superquick action, had functioned satisfactorily - the rotors were in the armed position - but that in the one round equipped with the delay explosive train, the M2 delay detonator had functioned but it had failed to actuate the M21 detonator. Certain elements of the delay train are being slightly modified in an effort to improve the ease of initiation of the M21 detonator. After the modifications have been completed, additional tests, with complete explosive trains, are planned.

Future Program

The following fuze tests are scheduled for early completion:

1. T222E5 base elements in live loaded HEAT shell.
2. DRA726 nose elements in live loaded T138E57 and T119E11 projectiles.

3. T267 superquick and delay base elements with live detonators.

4. Evaluation of the "inverted" firing system using 9GA20 No. 1 rectifiers and condensers in projectiles having burster charges.

Table IV
Range Data
Functioning Tests with DRA726 Nose Elements

PROJECTILE FUSE - 7222E6
 Model IL3A
 Type E57A
 Weight (Nominal)
 C.G. Location
 Bourrelet Dia (Nom.) 4.62 in.
 Special Features DRE360-3 Ext Base
 Retardation Factor 2.25 (1.00/ft)
 Pendulum Constant 2.25 (1.00/in)

TEST GUN
 Model IL3
 Type JACMAN Recoilless
 Length of Tube 28 in.
 Twist of Rifling 1:300
 Sighting Equipment ALZ Binocular Telescope
 Bore Dia. (Lands) 3.62 in.

TEMPERATURES
 Max. 70°F
 Min. 70°F
 L. Room 70°F
 Ambient 50°F

MISCELLANEOUS DATA
 Range BAKED Recovery Box
 Propellant PA 202-6
 Type DRE360-3 Change Wt. (L.A. 5.25)
 MGT Primer, T6 (reinforced) case;
 T6 Liners, 1 case per case.
 Proof Director E. M. MURPHY

Observers L. G. STEIN, R. BOGGS
H. YOUNG, O. MILLER

Date 2-10-58 Program SUCR-II
 To Determine Sensitivity Of Fuse Elements
 Tube - 18704
 Chamber - T9 No. 6
 Vent Ring - 7230226
 Recoilless Mount

Standard fired - Mechanical

Round No.	Gage No.	Proj. Weight	Powder Charge	Recoil (in.)	Chamber Pressure	Muzzle Velocity		Elev. (mils)	Azimuth (mils)	Position of Hit		Corrected Position of Hit - mils		Bourrelet Diameter		Clearance		Observations		
						Instr.	Actual			Vert.	Horiz.	Vert.	Horiz.	Front	Rear	Front	Rear			
1	18076	3 F	3 F	12,000																
2	6622	4 1/2 F	4 1/2 F	11,600																
3	10189	5 F	5 F	11,100																
4	961	6 1/2 F	6 1/2 F	11,700																
5	962	8 1/2 F	8 1/2 F	11,100																
6	968	9 1/2 F	9 1/2 F	12,000																
7	966	9 1/2 F	7 F	11,300																
8	965	11 1/2 F	6 1/2 F	12,300																
9	966	8 1/2 F	7 1/2 F																	
10	12678	10 1/2 F	10 1/2 F	11,000																
11	968	16 1/2 F	7 1/2 F	12,300																
12	969	9 1/2 F	10 1/2 F	11,300																
13	970	10 1/2 F	12 F	12,300																
Note: All loadings and rounds were fired as a single unit and no bedding was used.																				

Signed - L. G. Stein

Table V
Test Data
T267 Base Elements (Superquick and Delay)

Date 2-27-53 Program Supp. II
 TEST GUN T267 BASE ELEMENT
 Model IL9 Tube 12009
 Type 105 mm Recoilless Cartridge No. 6
 Length of Tube 108.10 V.C. No. 13826
 Twist of Rifling 1:500 V.C. No. 14886
 Sighting Equipment ILL Ruler and Telescope
 Bore Dia. (Lands) 4.134 ¹⁰⁰¹
 Bore Dia. (Grooves) 4.134 ¹⁰⁰¹
 Special Features With head per 340-3
 Retardation factor 0.85 ft/sec/ft
 Propellant PAE 50240
 Range Excess Bar & 2 in. Sighting Screen
 Proof Director Standard
 Observer M. E. ...

Round No.	Gage No.	Pro. Weight	Powder Charge	Recoil (in)	Chamber Pressure	Screen Thickness (in)	Elev. (mils)	Position of Hit		Corrected Position of Hit - mils		Bourrals' Diameter		Clearance		Observations	
								Vert.	Azimuth (mils)	Vert.	Horiz.	Front	Rear	Front	Rear		
4577	1	17.5	8-4	2.5 E	12,000	2.74 ckes		Armed for superquick									No recovery; went back to base.
4578	2	9.10		7 E	11,700												
4579	3	11.875		5 E	12,800												
4520	4	10.00		4 E	12,100												
4521	5	13.449		4 E	11,900												
4522	6							Armed for superquick									
4523	7	14.930		2.25 E	11,700												NOTE 3 Recovered
4524	8	17.684		9.5 E	13,100												
4525	9	12.953		5 E	11,800												
4526	10	11.762		2.75 E	11,700			Armed and M2 detonator functioned; M2 failed to function									No recovery; went out at base.
Notes: (1) All rounds were loaded and fired as single units. (2) All rounds were fired by means of a lanyard. (3) Round No. 6 could not be chambered because of interference between front boycrochet ring and tube diameter (inside). (4) All recovered rounds were taken to Akron to determine if fuses functioned.																	

Signed - L. Glitch.

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