Army Research Laboratory

Replacement Packing for 37MM Antitank Gun Recoil

by Donald J. Little

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Weapons and Materials Research Directorate, ARL

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14. ABSTRACT
A method to reproduce the packing in a 1940 era gun recoil was needed to keep it in service. The recoil is used throughout the U.S. Army Research Laboratory (ARL) in numerous test facilities.

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- Mr. Alan Teets
- Mr. Dave Flanagan
- Mr. Paul Touchet
- Mr. Rob Jenson
- Lethal Mechanisms Branch
- Mrs. Eleanor Deal

1. Introduction

The 1940 era M4 gun recoil system is used throughout the U.S. Army Research Laboratory (ARL) with the 1.042 in. smoothbore lab gun used to launch medium caliber test projectiles (figure 1).

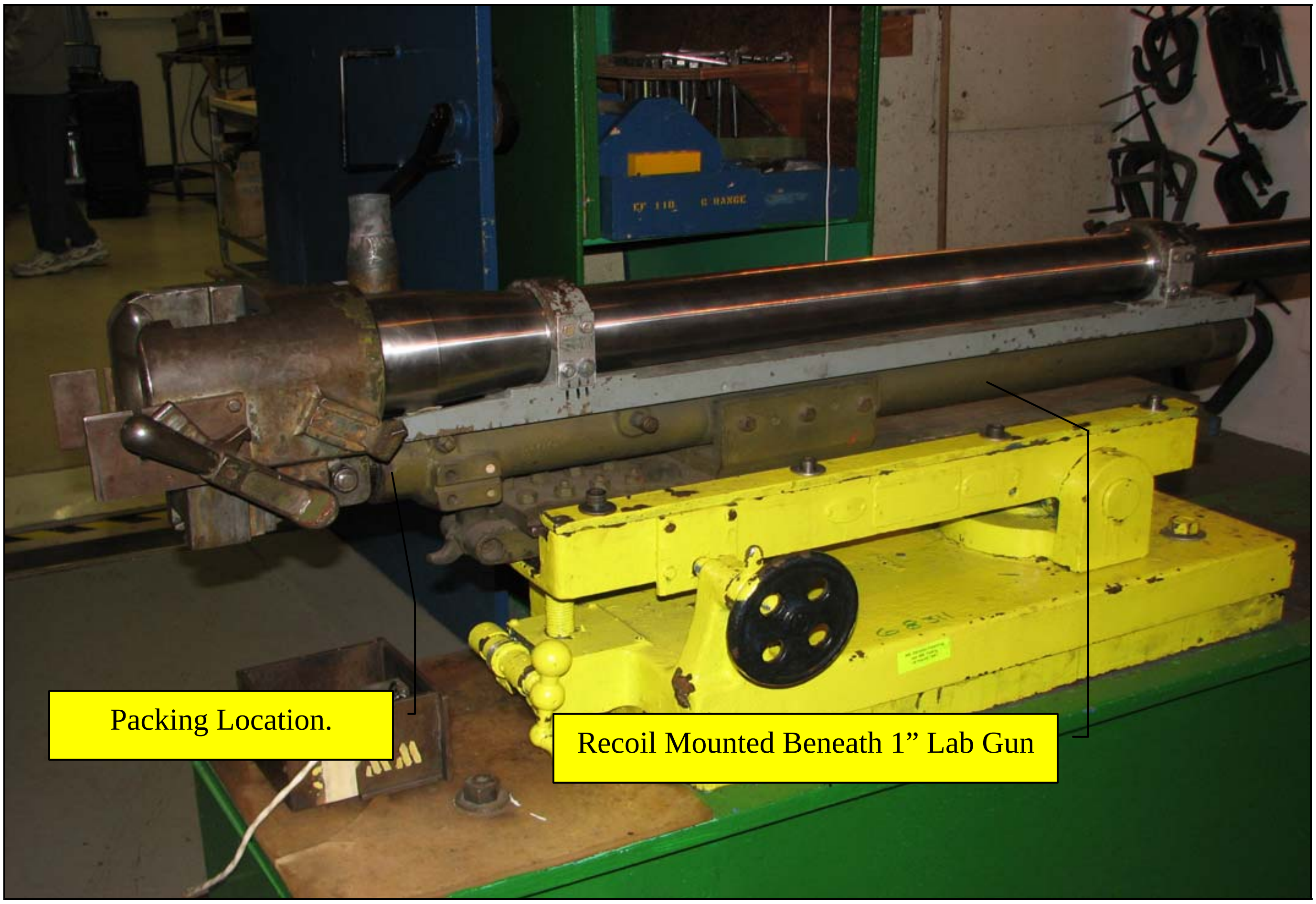

Figure 1. 1.042 in. smoothbore lab gun mounted in M4 recoil system.

The forward packing developed a hydraulic fluid leak, which threatened to take the recoil from service. Figures 2 and 3 show the breakdown of the recoil and the location of the packing that was failing.

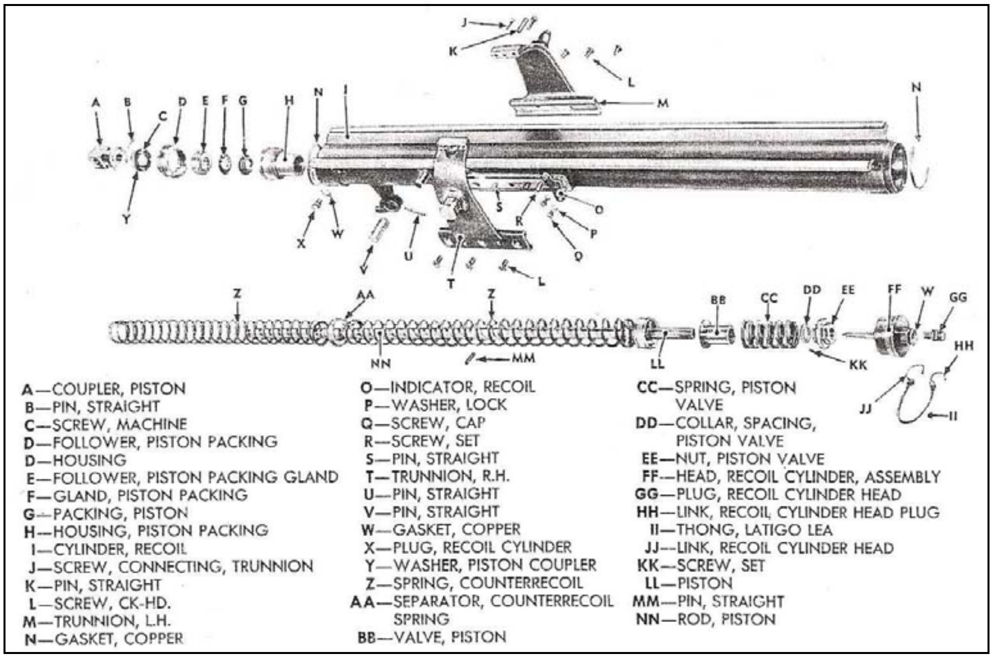

Figure 2. Exploded view of M4 recoil mechanism.[1]

[1] TM-9-1245 37MM Antitank Guns M3 and M3A1, and Carriages M4 and M4A1, 6 February 1943 War Department (figure 44).

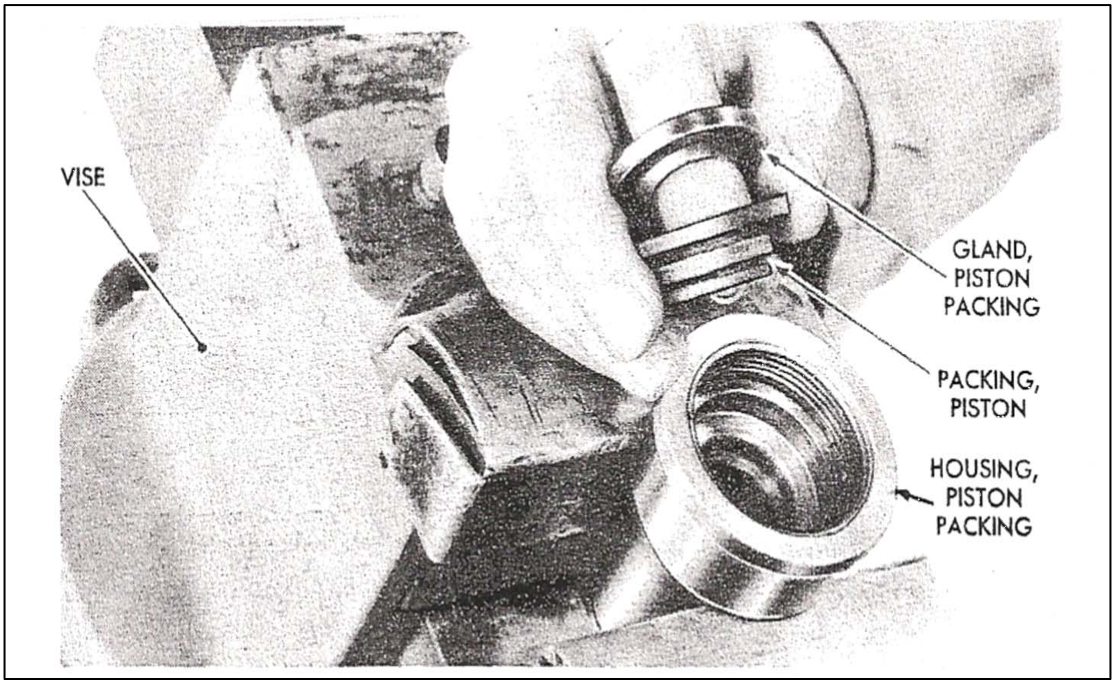

Figure 3. Close-up view of assembly with packing.[1]

The leather packing has been hardened by age and constant exposure to hydraulic fluid and no longer conforms to the piston rod when tightened in the packing housing. This system has been obsolete for many years and replacement parts are no longer available. Efforts to find a custom leather manufacturer to fabricate replacement packing were not successful.

2. Approach

The author consulted with Mr. Alan Teets of the Engineered Materials Team, Multi Functional Materials Branch, ARL, on the problem and the best approach determined was to fabricate a replacement packing from a rubber polymer type material that had the same outside geometry as the original packing. Research was undertaken to find a polymer that would withstand the hydraulic fluid and the internal pressures. Table 1 gives the ingredients and properties of the nitrile rubber compound chosen.

[1] TM-9-1245 37MM Antitank Guns M3 and M3A1, and Carriages M4 and M4A1, 6 February 1943 War Department (figure 57).

Table 1. Composition and properties of Nitrile rubber.

Nitrile Rubber Compound For Gun Recoil System	
Material ID	
Ingredients, Parts Per Hundred Rubber (PPHR)	**NBR-07-GRS-01**
Paracril AJ Nitrile Rubber	100.00
Zinc Oxide	5.00
Stearic Acid	1.00
AC) 617 Polyethylene	2.00
(DQ) Antioxidant,2,2,4-Trimethyl-1,2 Dihydroquinoline	2.00
N-550 Carbon Black	25.00
N-991 Carbon Black	125.00
Dioctyl Phthalate Plasticizer (DOP) Plasticizer	15.00
Fexricin P-4 Plasticizer	10.00
Mercaptobenzothiazole (MBTS)	1.50
Methyl Tuads, Tetramethylthiuram (TMTD)	0.50
Sulfur	1.50
Formula Weight	288.50
Rheometer Properties	
Cure Time, Minutes/° F	15/280
Monsanto Rheom. 2000E, Max Torque, pounds per inch (Lb-Ln)	22.67
Scortch (ts2), Minute	6.02
(Mh)95, Lb-Ln	21.62
(Mh)120, Lb-Ln	22.67
Torque Difference, Mh120-M95, Lb, Ln	0.05
Peak Rate, Lb-Ln/Min	5.5
Physical Properties	
Tensile Strength, Pounds per Square Inch (PSI)	1651
Ultimate Elongation,%	242
100% Modulus, PSI	658
200% Modulus, PSI	1452
Energy at Break, Ln -Lb	100
Hardness, ShoreA, Points	64
Bashore Rebound,%	35
Die C Tear, Lb-Ln	194

The ingredients were mixed on a rolling mill to produce the compound as shown in figure 4.

Figure 4. Nitrile rubber compound being produced on rolling mill.

A two-piece mold was machined from 7075 aluminum to produce the packing to the proper shape (figure 5).

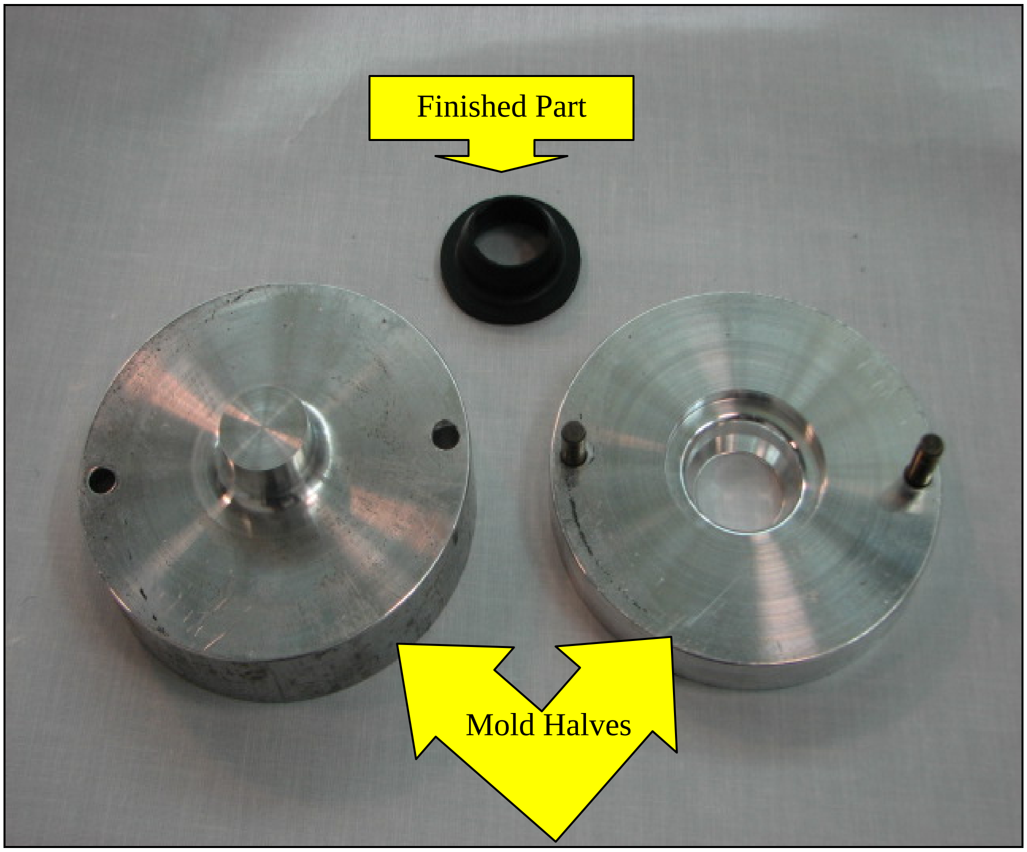

Figure 5. The two aluminum mold halves and the finished part.

The dimensions to machine the cavity area of the mold were acquired by measuring old original packing pieces and the internal area of the recoil that housed the packing. Figure 6 shows the required finished dimensions of the reproduced packing.

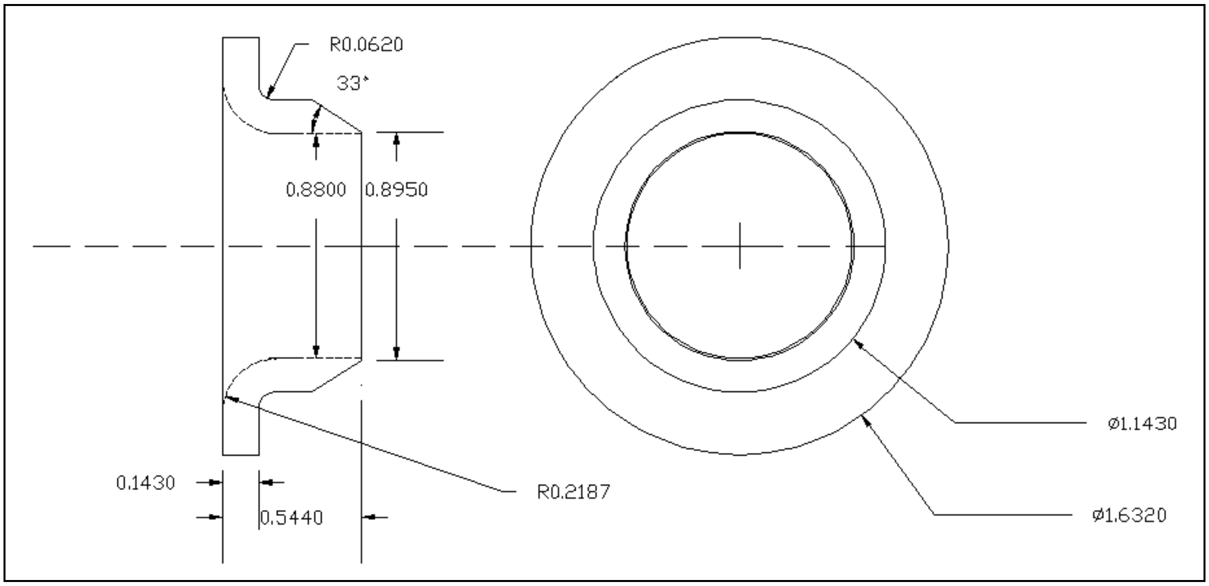

Figure 6. Finished packing dimension specifications.

Due to the shrink factor of the polymer chosen, the internal mold cavity dimensions were made two percent over size of final part dimensions to ensure the finished part was properly sized. The two halves of the mold were then loaded into a hot press with an 8 gram strip of polymer between the mold halves and pressed at 280° F for 15 min to form the packing. Figure 7 shows the mold with the polymer sample loaded.

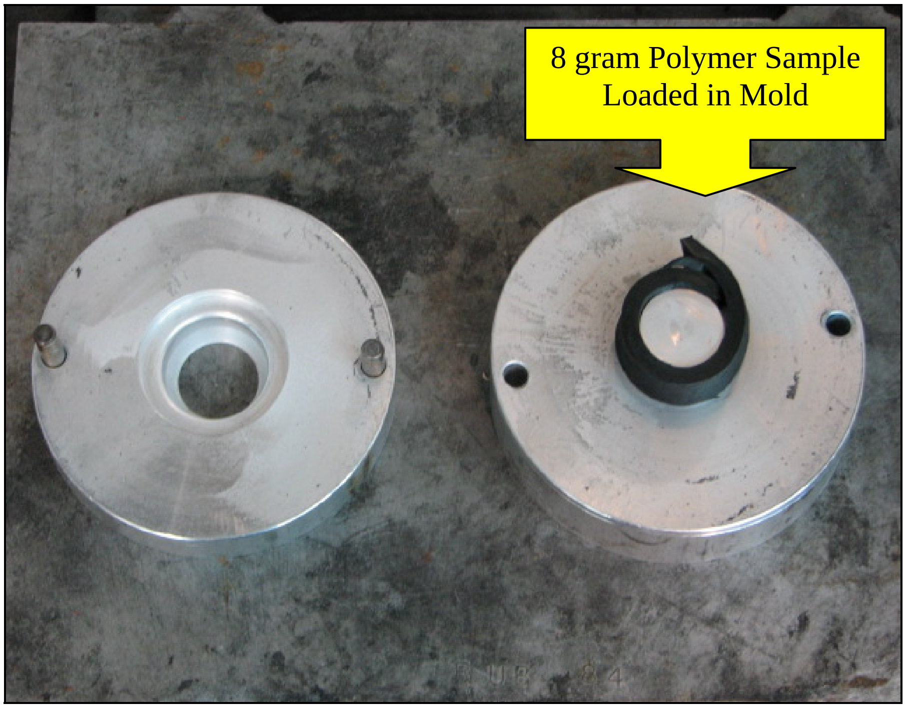

Figure 7. Polymer sample loaded in mold prior to pressing.

The 8 grams of material, 10 to 15 % more by volume then is required to fill the cavity, was used to ensure the part would be completely fill and free of voids. The excess material was squeezed out of the mold at the parting line of the mold halves and trimmed off after the sample cooled (figure 8).

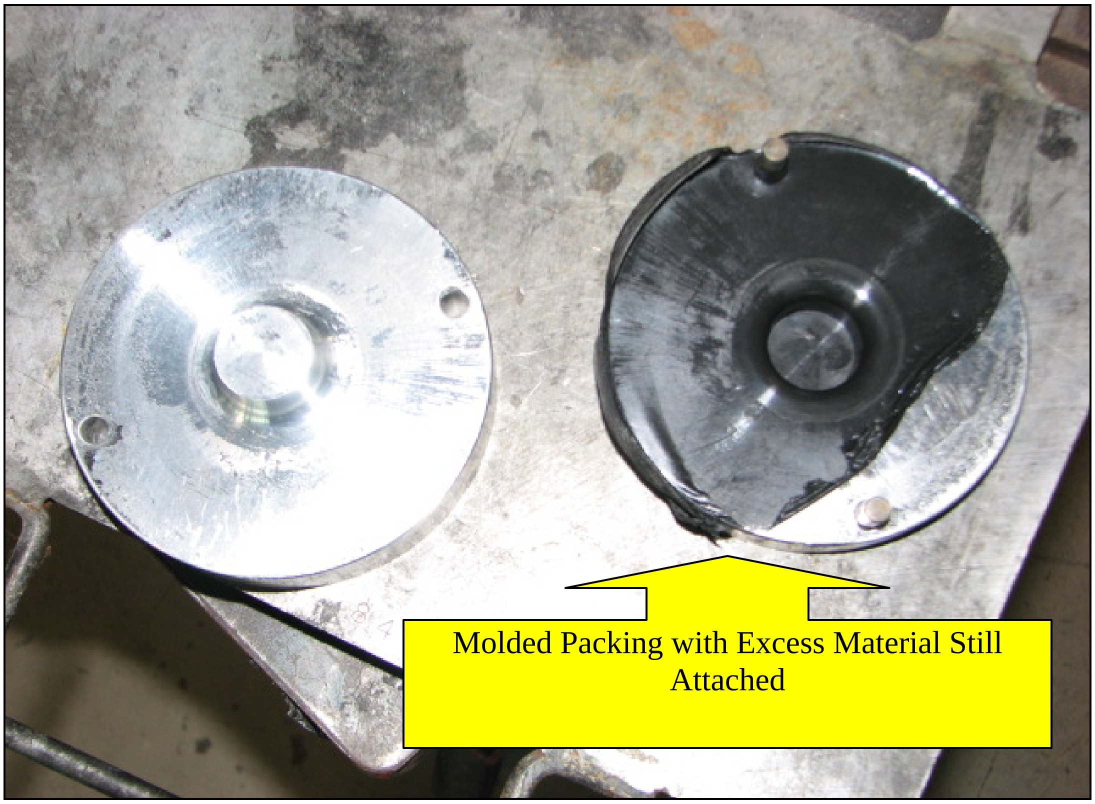

Figure 8. Finished packing after pressing with excess material still attached.

3. Conclusion

The new packing was assembled in the recoil system and tested by firing the weapon with heavy launch package weights and high velocities. After one year of service, there have been no signs of leaking or breaking down of the redeveloped packing.

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