64-8

TECHNICAL MEMORANDUM 1330

DESCRIPTION OF LAW SYSTEM AND CONTROL OF EROSION IN ROCKET MOTOR

SEYMOUR KAPLOWITZ

COPY 57 OF 58

JANUARY 1964

PICATINNY ARSENAL
DOVER, NEW JERSEY

DISPOSITION

DDC AVAILABILITY NOTICE

TECHNICAL MEMORANDUM 1330

DESCRIPTION OF LAW SYSTEM
AND
CONTROL OF EROSION
IN
ROCKET MOTOR

BY

SEYMOUR KAPLOWITZ

JANUARY 1964

REVIEWED BY: D. Katz
D. KATZ
Chief, Process
Engineering Laboratory

APPROVED BY:
J. [illegible] MATT
Chief, Ammunition
Production and Maintenance
Engineering Division

AMMUNITION ENGINEERING DIRECTORATE
PICATINNY ARSENAL
DOVER, NEW JERSEY

TABLE OF CONTENTS

ACKNOWLEDGMENT

The metallurgical photographs of the sectioned LAW motors (Figure 10, 11) were taken from a report prepared by Mr. D. Molella of the Picatinny Arsenal Technical Services Laboratory.

The work discussed herein represents not only the efforts of Picatinny Arsenal, but of Radford Army Ammunition Plant which did most of the testing; Hesse Eastern Division of Flightex Fabrics who effected many of the metal parts modifications; as well as several other Government agencies and contractors. It was a good demonstration of what a Government-Industry team can accomplish by using the capabilities of both to solve a mutual problem.

INTRODUCTION

The information in this report was presented by the author at the joint meeting of the Propulsion Section and Nonferrous Metallurgy Section, American Ordnance Association (A.O.A.), held at Picatinny Arsenal on 3 December 1963.

DESCRIPTION OF LAW SYSTEM

One of the newest limited war weapons in the Army inventory is the 66mm LAW M72. The LAW (Figure 1) is a lightweight shoulder-fired rocket which provides the individual infantryman with close-in antitank defense and the ability to defeat hard targets. It is a single-shot throw-away weapon. The launcher serves as the protective package for the rocket until the weapon is opened and fired, after which the launcher can be discarded (Figure 2).

Several of the problems connected with the production and development of this weapon have been thought to be of particular interest to this group, and will be discussed in papers to be presented today.

The LAW was developed by the U.S. Army Missile Command with the Hesse Eastern Division of Flightex Fabrics, Incorporated, as prime contractor. With the completion of the Research and Development program, system management was transferred to the U.S. Army Munitions Command. For the industrial phase of the program, which is currently underway, Picatinny Arsenal has systems-engineering responsibility, and the Ammunition Procurement and Supply Agency at Joliet, Illinois, has procurement responsibility. The production is being handled as a joint Government-Industry program, with Industry manufacturing the inert components, and the Army Ammunition Plants (responsible to) and within the Munitions Command complex manufacturing the propellants and explosives and assembling the complete systems.

The LAW is waterproof and will function when exposed to environmental conditioning between the limits of -40°F and 140°F. The maximum range for which the sight is calibrated is 325 meters. The basic components of the weapon are the rocket launcher, rocket motor, warhead and fuze. The total weight of the weapon is approximately 4-3/4 pounds, with the rocket weighing 2-1/2 pounds. This light over-all weight is made possible by the use of aluminum alloys and plastics for the major components, which will be described briefly.

The launcher (Figure 3) consists of three basic components: telescoping front and rear tube assembly, firing mechanism and sighting assembly. The front tube is the outer tube and is made of spirally wrapped, plastic-impregnated glass fiber. The rear tube is the inner tube and is made of aluminum. Both tubes are sealed when the launcher is in the closed position with aluminum cover and gasket assemblies. When the launcher is opened, the rear tube is guided with respect to the front tube by two detent pins that ride in longitudinal grooves in the rear tube. The rear tube is locked automatically in the open or firing position when one of the detent pins drops into an indentation in the rear tube. There is an 0-ring seal between the two tubes for waterproofing and to prevent gas leakage during firing.

The trigger mechanism is located on the top surface of the front tube and is the squeeze lever type. When the trigger is squeezed the tension on the firing pin cable is released, allowing the firing pin to impact the primer.

A cross section view of the rocket is shown in Figure 4. The motor body is a 1-piece impact extrusion manufactured from 7001 aluminum alloy. Six folding-fin attachment lugs are extruded as an integral part of the motor. The fins are made of aluminum and are spring actuated. The rocket is held in position in the launcher until firing by a soft steel round lock which fits over a fin at one end and the launcher at the other end.

The propellant charge consists of 19 sticks of modified M7 Propellant supported in the head end of the motor on a drop-through plate by means of suspension studs bonded to the grain I.D. The stud plate is an aluminum stamping and the stud has an aluminum head and shank with an ethyl cellulose collar which bonds to the propellant. Nominal charge weight of the 19 sticks is 62 grams.

The igniter is of 1-piece construction and serves as the nozzle closure. It is made of molded polyethylene with a brass insert at the primer end. The firing train consists of an M29A1 Percussion Primer, three strands of ITL transmission cord, and the ignition charge of 1.9 grams of Grade A-4 black powder.

The motor closure is also a high-strength-to-weight-ratio aluminum impact extrusion. The closure houses the fuze and provides the high-strength bulkhead between the motor chamber and fuze. The closure is threaded onto the motor at one end and attached to the warhead at the other end with a metal-matic solder joint.

The M412 Fuze is held in the safe position by a locking device which can only be released by the acceleration force provided by the firing of the rocket motor (approximately 1,200g's at -40°F). Initiation on nose impact is caused by crushing of the Lucky element in the nose cap, providing electrical energy to the electric detonator. For graze functioning, there is a spring-loaded firing pin which is released by the decelerating force of impact and strikes the stab primer located adjacent to the electric detonator.

The shaped charge warhead is a lightweight shrink-fit fabrication of thin gage deep-drawn metal parts. The head assembly consists of the following metal parts and explosives: copper conical-shaped liner, thin gage steel head body, thin gage aluminum ogive, conduit and lead wire, nose cap assembly and Octol explosive; 70% HMX and 30% TNT. The total explosive charge weight is 0.67 pound.

The detailed characteristics of the rocket motor, which are of particular interest in connection with several of the papers to be presented today, are shown in Figures 5-7.

CONTROL OF EROSION IN THE LAW ROCKET MOTOR

The problem of minimizing erosion in the convergent section and throat of a rocket motor is usually associated with rockets having long burning times. In the LAW motor, however, where the burning time ranges from 6 to 11 milliseconds across the operating temperature range, it was also found to be a problem which produced some unusual side effects. The cause of this problem, and the corrective actions which were taken, has provided valuable experience in the use of high-strength aluminum alloys in rocket motor applications.

During firing of the initial quantities of LAW systems manufactured under the industrial program, high-speed camera coverage showed flame leakage past the joint of the inner and outer tubes of the launcher. The flame, which contained a heavy concentration of luminescent particles, occurred in a majority of the firings at 140°F. Nothing approaching this condition either in severity or frequency was observed at the lower temperatures. Review of all the film further showed that the interior ballistics of the rocket were disturbed; in some firings the burning distance extended well into the outer tube of the launcher. Under normal operation at 140°F, burnout occurs entirely within the inner tube. At lower temperatures, burnout extends beyond the joint but the propellant mass discharge rate is lower and the flame can be contained almost entirely by the 0-ring seal and overlap.

Examination of the fired motors showed heavy erosion in the convergent section, which appeared in a continuous pattern of jagged streaks 2 to 4 inches long (Figure 8). Normally there is no erosion in this area. Erosion in the throat and exit cone were normal and similar to that obtained with the R&D motors.

A test program was conducted to isolate the cause of the problem and determine the extent to which propellant, igniter and metal parts were contributory factors. The tests involved firings with the following variables:

Igniters - 1. Current production lot.
2. R&D production.
3. Alternate igniter designs including use of a metal-oxidant ignition mixture in place of black powder.

Propellant - 1. Current production lot.
2. R&D production.

Metal Parts - 1. Current production lot.
2. R&D production.

A series of 142 firings was made in production launchers. The results were very clear-cut. Convergent section erosion and flame leakage occurred in 46 out of 81 firings made with the production metal parts, while only 1 out of 41 occurred with the R&D metal parts (Figure 9). It was evident, therefore, that this was not due to any factor in the propellant-ignition system, but that some characteristic of the inner contour and surface condition of the industrial motor bodies was responsibile for the convergent section erosion.

This was confirmed by a metallurgical examination which showed the production motors to be significantly different from the R&D motors in the following ways:

The blending of the nozzle radius was not smooth and a sharp-edged contour was present in many of the motors (Figure 10).

The interior surface adjacent to the convergent section had a roughened appearance and the grain boundaries were exposed (Figure 11).

Several approaches were investigated to determine which was the more serious problem -- nozzle contour or surface finish -- and to come up with a quick fix. One group of production motors was taken to the R&D supplier and the throats retraced with the R&D tooling. Half of these motors were then given a hard-coat protective finish on the interior surface to within 1/8 inch of the throat. Similarly, another group of motors had the throats hand-blended to provide a smooth contour. Half of these were also given the partial hard-coat treatment. Motors reflecting the latest production tooling, as well as R&D motors, were used for a series of firings made with the same lots of propellant and igniters to eliminate any extraneous variables.

As seen from the results listed in Figure 12, a flame leakage incidence of close to 100% was obtained with all the test groups while one motor out of 15 from the R&D group (Group G) showed a slight evidence of leakage. The improved blending of the nozzle contour in the production motors which had been retraced did not reduce erosion. Quantitative data on the erosion and the velocity measurements were, however, quite revealing. It can be seen that for the R&D motors, there was an average weight loss on firing of 1.33 grams, while the production motors averaged a loss of 3.1 to 4.0 grams. Hard-coating had no effect on the weight loss, although examination of the motors showed it eliminated erosion in the area in which it was applied. All the weight loss on these motors occurred in the nozzle throat, producing very severe pitting. In some instances, holes in the wall at the nozzle area were produced. It can be estimated that the weight loss due to nozzle erosion alone is about 1.5 grams, while an additional 2 grams of metal is lost by erosion in the convergent section. In the case of the hard-coated motors, the total of 3.5 grams was lost in the nozzle alone, apparently as a result of some induced surface weakness at the junction of the hard-coated area with the throat.

The velocity results appeared to agree well with the weight loss data, showing a 10 foot/second increase produced by the loss of 2 grams of aluminum. This substantial increase in performance indicated that the aluminum was entering into the combustion reaction at the 8,200 psi operating pressure, and that we had an aluminized propellant providing an increase in specific impulse of approximately 6 seconds.

It was evident that complete surface protection of the motor past the throat was required both to reduce erosion and eliminate the velocity bias. Two basic techniques were evaluated: (1) hard-coating and anodizing the complete motor to provide a resistant surface and (2) use of a chemical surface coating to provide a layer of material to react with the propellant in place of the aluminum. As seen from data on the last three test groups (i.e., H, I and J), both techniques were successful. The anodized and hard-coated motors showed no erosion, not even in the nozzle, and caused no flame leakage. Group J, which was prepared by brushing in a 1-gram coat of a hardware store variety of chemical- and moisture-resisting enamel, also produced satisfactory results; there was no flame leakage in a series of 15 firings at 140°F and the velocity and weight loss values compared very favorably with the R&D motors. As seen in Figure 13, the paint completely prevented erosion in the convergent section and caused no excess erosion in the throat.

To confirm these findings, and to qualify these surface protection methods for production use, two groups of 100 motors each were prepared; one group was painted with enamel and the other group was sulfuric-acid anodized and sealed. The hard-coating approach was dropped since it was more expensive than anodizing.

These motors were fired at 140°F and at intermediate temperatures down to 90°F to encompass the cross-over region; i.e., where the normal burnout point moves from the rear tube to the forward tube. This is a potentially critical point where the joint must withstand a high propellant mass discharge rate without leaking.

As seen from the data summary in Figure 14, the results were completely successful. There was no flame leakage in either group and no instance of excessive weight loss or erosion occurred. As a further confirmation of the surface smoothness effect, a third group of 25 production motors was honed on the interior to provide a mirror finish. These motors fired successfully at 140°F with no flame leakage. The velocities and weight loss values were comparable to the R&D group.

The interacting effects of weight loss, velocity, and flame leakage can be seen graphically in Figure 15. Velocity and weight loss at 140°F appear to correlate very well. It is noted that the honed production motors, the painted motors and the R&D motors are very close together, while the anodized motors, which suffer the least weight loss, also produce a downward velocity bias. The production motors, which had an average weight loss of 3.85 grams, had a velocity approximately 17 fps higher than the anodized motors. Thus, it is concluded that if the motor weight loss is kept below 1.75 grams, flame leakage will be eliminated and no velocity bias will occur.

These changes have been implemented into the LAW motor production. All the motors produced prior to the resolution of the problem will be painted on the interior since anodizing motors already having fins and springs installed, and painted on the exterior, would not be practical. All new motors produced are being anodized.

As regards the velocity bias between the painted and anodized motors, this will be compensated for in the propellant production. All propellant charge lots to be loaded in systems having painted motors, will have the ballistic level adjusted and be accepted with painted motors. When the anodized motors are phased in, they will be used in the propellant ballistic adjustment and acceptance without shifting limits. Thus, it is anticipated there will be no degradation in LAW system accuracy by this change.

In conclusion, it was learned that the degree of erosion in aluminum motors which must operate in a high pressure region is largely dependent on the interior surface finish. If the manufacturing process does not provide a surface of the requisite smoothness, the erosion can be minimized by an anodizing treatment or use of a suitable chemical protective coating.

APPENDIX

APPENDIX A

FIGURES

Figure 1. M72 LAW, 66mm

Kneeling position.

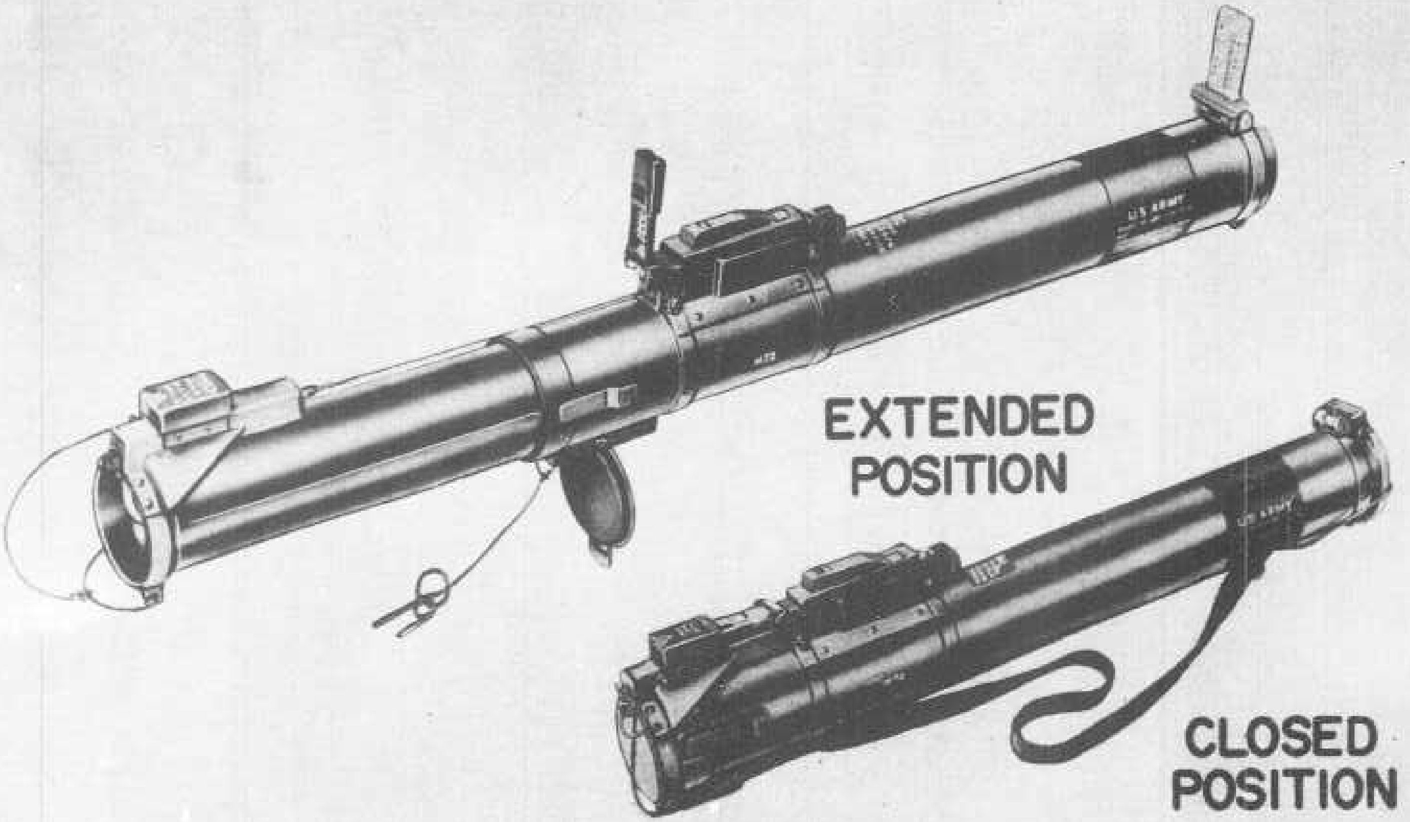


Figure 2. The M72 LAW Launcher

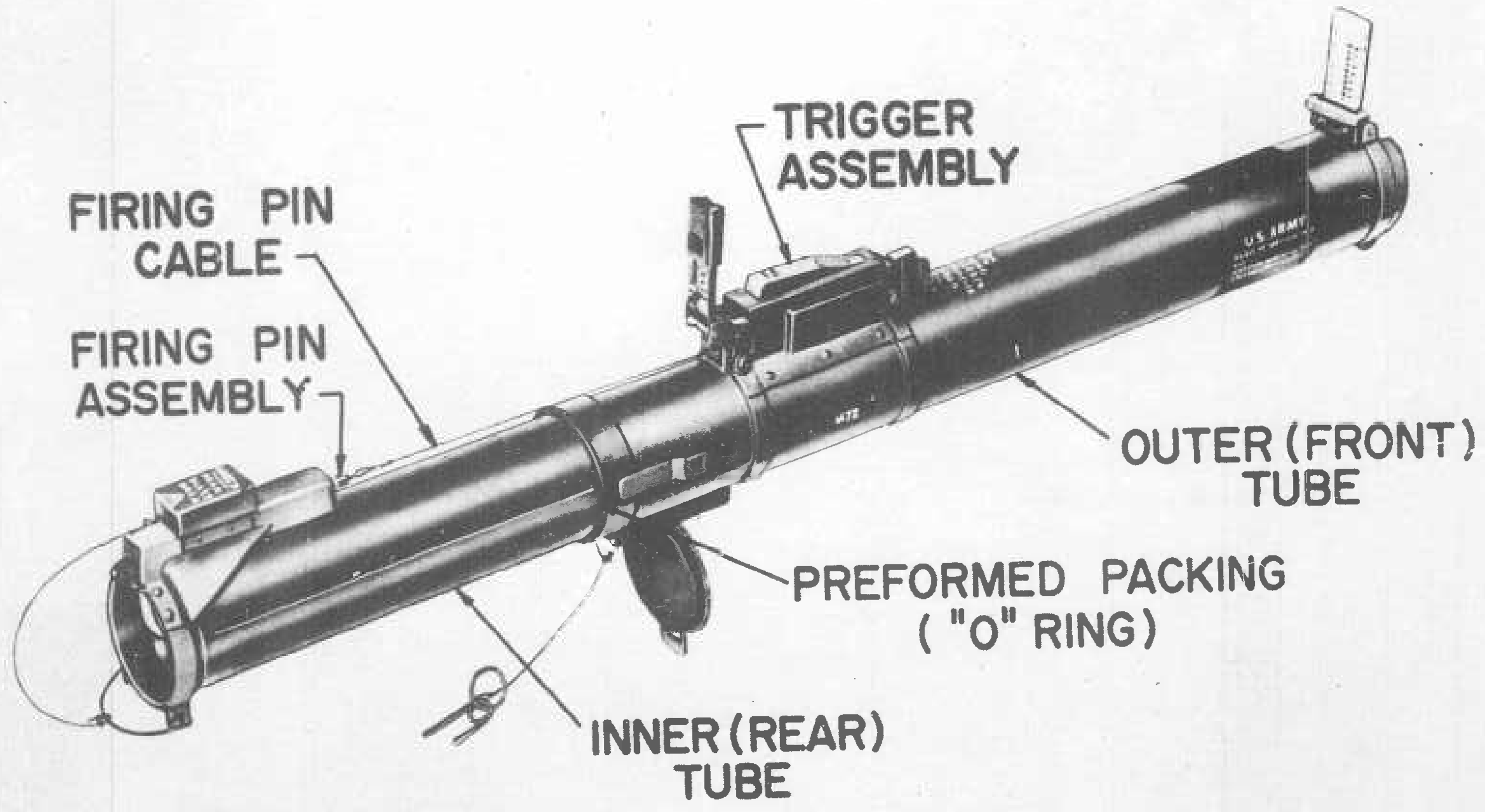


Figure 3. The M72 LAW Launcher

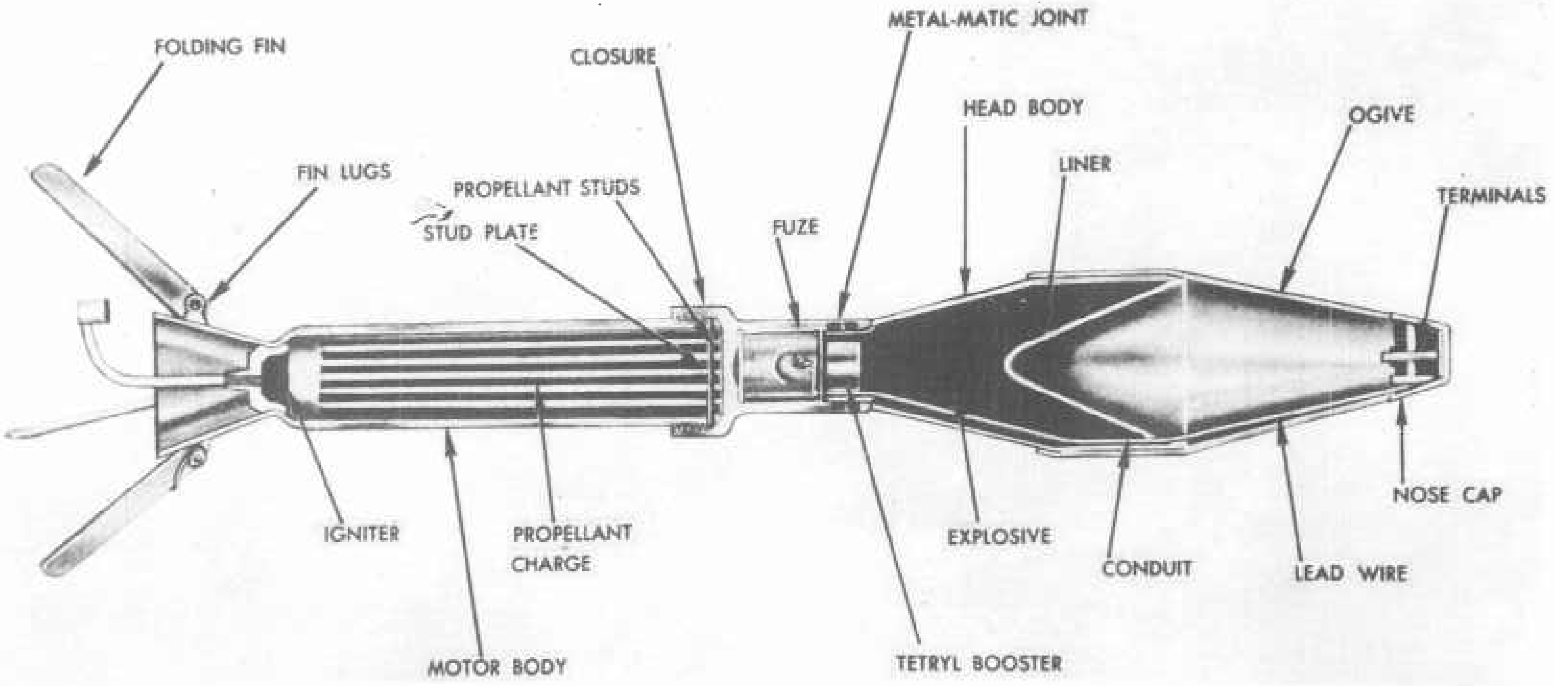


Figure 4. **ROCKET, HE, 66mm, M72**

LAW MOTOR CHARACTERISTICS

PROPELLANT CHARGE

COMPOSITION: MOD M7 DOUBLE BASE

CHARGE DESIGN: HEAD END SUSPENDED; 19 MONO - PERFORATED STICKS

STICK O.D. IN.	0.23
STICK L, IN.	5.7
WEB, IN.	0.035
CHARGE WT., GMS	62.

Figure 5.

LAW MOTOR CHARACTERISTICS

MOTOR BODY

MATERIAL: 7001 AL ALLOY-MFD. BY IMPACT EXTRUSION

I.D., IN.	1.29
LENGTH, IN.	8.45
WALL THICKNESS, IN.	0.132
DIAM. THROAT, IN.	0.870
DIAM. EXIT, IN.	2.156
HYDROSTATIC PROOF, PRESSURE, PSI	14,500
BURST STRENGTH, MIN. PSI	16,500

Figure 6.

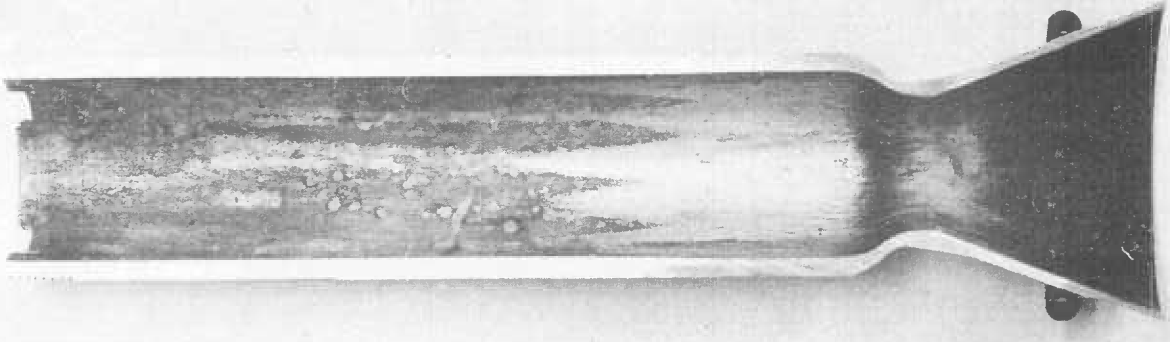
LAW MOTOR CHARACTERISTICS

BALLISTIC PERFORMANCE

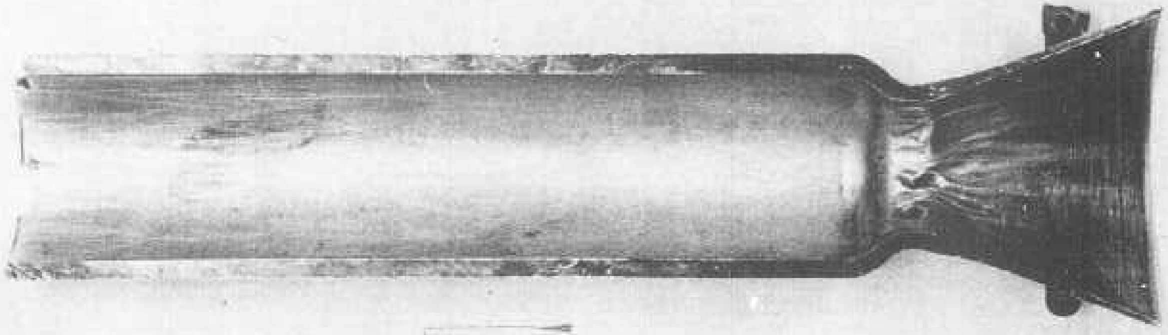
	−40°F	70°F	140°F
Pmax, PSI	4280	5760	8200
ta, M- SEC	116	7.8	6.6
Isp, lb- SEC/ lb	209	229	242
Muzzle Velocity, FPS	444	479	505

Figure 7.

PHOTOGRAPHS OF SECTIONED LAW MOTORS



PRODUCTION MOTOR AFTER FIRING AT 140°F



R & D MOTOR AFTER FIRING AT 140°F

Figure 8.

FLAME LEAKAGE SUMMARY – TEST SERIES I

TEMP. °F	PROD'N MOTORS		R&D MOTORS	
	NO. FIRED	NO. LEAKED	NO. FIRED	NO. LEAKED
140	61	44	26	0
125	–	–	5	0
100	–	–	5	1
85	–	–	5	0
75	20	2	–	–
TOTALS	81	46	41	1

Figure 9.

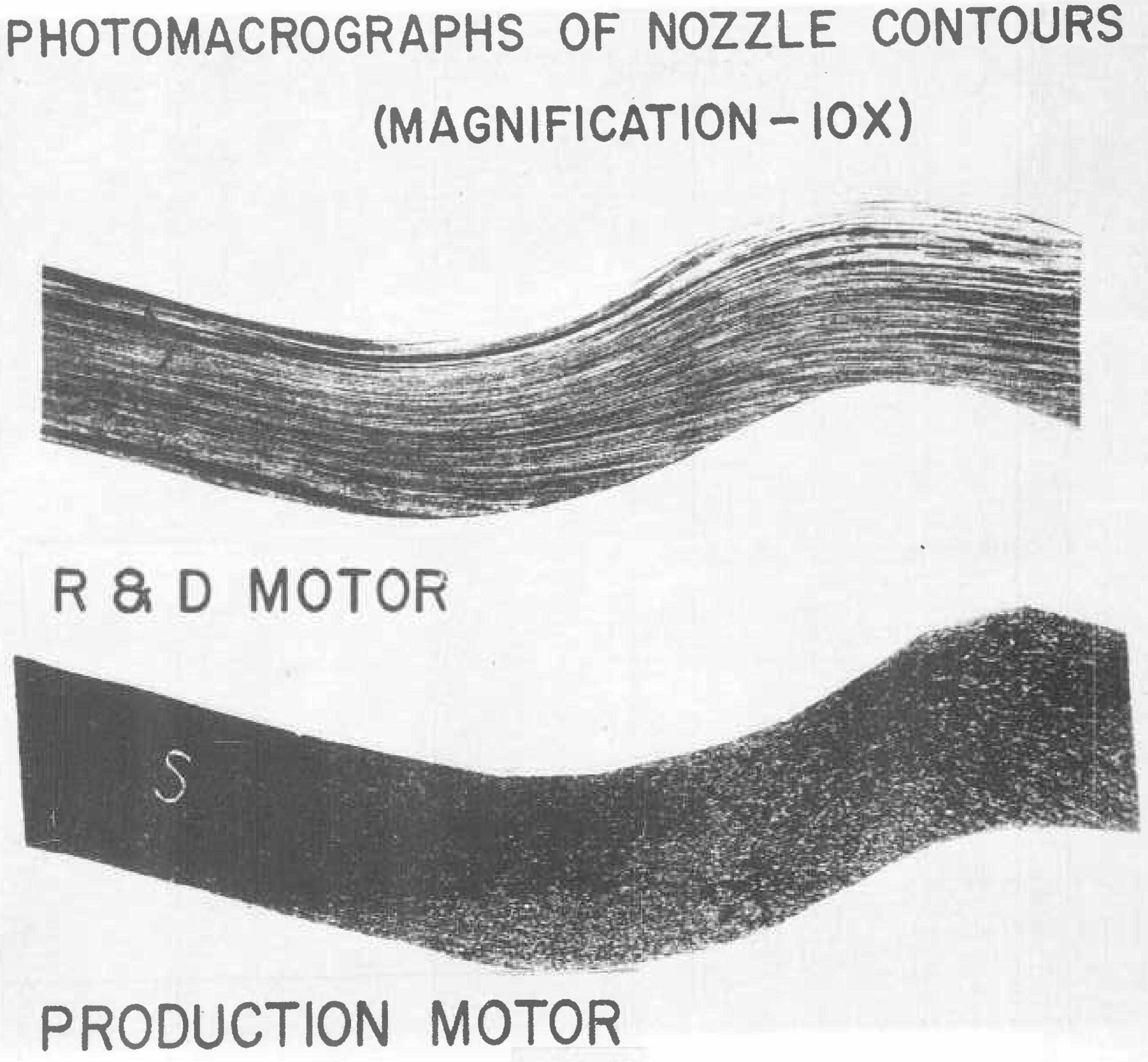
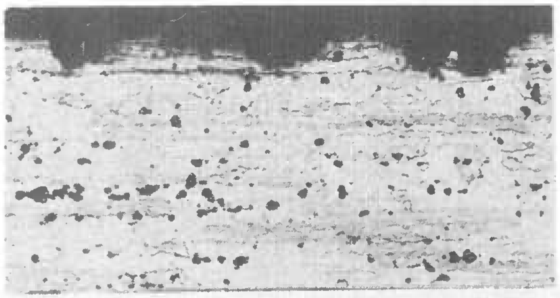
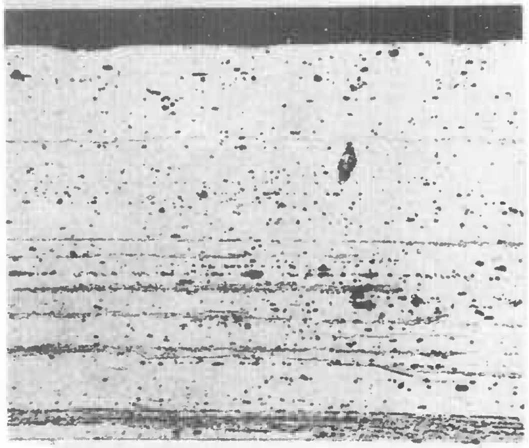

PHOTOMACROGRAPHS OF NOZZLE CONTOURS
(MAGNIFICATION - 10X)
R & D MOTOR
S
PRODUCTION MOTOR

Figure 10.

PHOTOMICROGRAPHS OF MOTOR INTERIOR SURFACE
(MAGNIFICATION - 250X)



PRODUCTION MOTOR



R & D MOTOR

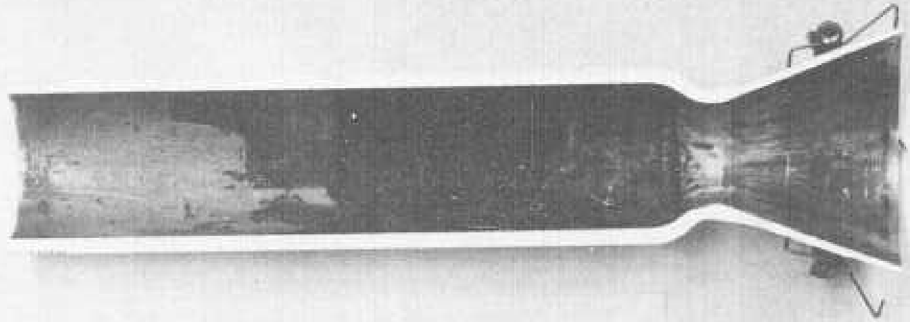
Figure 11.

FLAME LEAKAGE SUMMARY — TEST SERIES II

	MOTOR VARIABLES		RESULTS			
	NOZZLE MACHINING	SURFACE TREATMENT	NO. FIRED (140°F)	NO. LEAKED FLAME	AVG. VEL. FPS	AVG. MOTOR WT. LOSS, GMS
A	THROAT RETRACED BY R & D SUPPLIER	STD. ALODINE	9	9	515.9	3.5
B	THROAT RETRACED BY R & D SUPPLIER	HARDCOAT TO WITHIN 1/8" OF THROAT	9	7	516.4	3.1
C	HAND BLENDED THROAT	STD. ALODINE	8	8	515.6	3.9
D	HAND BLENDED THROAT	HARDCOAT TO WITHIN 1/8" OF THROAT	10	9	515.6	4.0
E	STD. PROD'N. BLEND	STD. ALODINE	10	10	517.2	3.7
F	MODIFIED PROD'N BLEND	STD. ALODINE	10	10	518.7	4.0
G	R & D MOTOR	STD. ALODINE	15	1	505.9	1.33
H	STD. PROD'N BLEND	COMPLETE ANODIZE	5	0	503.0	NONE
I	STD. PROD'N BLEND	COMPLETE HARDCOAT	5	0	505.2	NONE
J	STD. PROD'N BLEND	AFT SECTION OF MOTOR PAINTED WITH ENAMEL TO 1/8" PAST THROAT	15	0	506.6	0.9

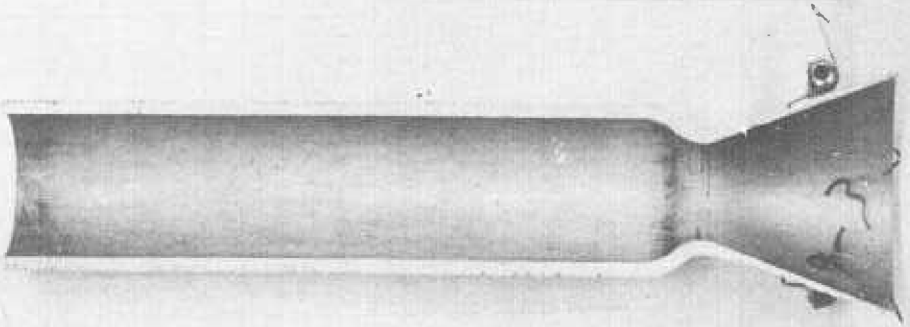
Figure 12.

PHOTOGRAPHS OF SECTIONED LAW MOTORS



PRODUCTION MOTOR

(INTERIOR PAINTED) AFTER FIRING AT 140°F



PRODUCTION MOTOR

(ANODIZED) AFTER FIRING AT 140°F

Figure 13.

FLAME LEAKAGE SUMMARY – TEST SERIES III

IDENTIFICATION	FIRING TEMP. °F	NO. FIRED	NO. LEAKED FLAME	AVG. VEL., FPS	AVG. MOTOR WT. LOSS, GM
INTERIOR PAINTED	140	25	0	507.7	1.65
	110	25	0	501.3	1.19
	100	25	0	500.4	1.11
	90	25	0	499.2	1.06
INTERIOR ANODIZED	140	48	0	500.8	0.37
	100	25	0	494.1	0.21
	90	25	0	488.7	0.29
INTERIOR HONED	140	25	0	505.5	1.25

Figure 14.

VELOCITY vs MOTOR WEIGHT LOSS
LAW MOTOR 140°F FIRING

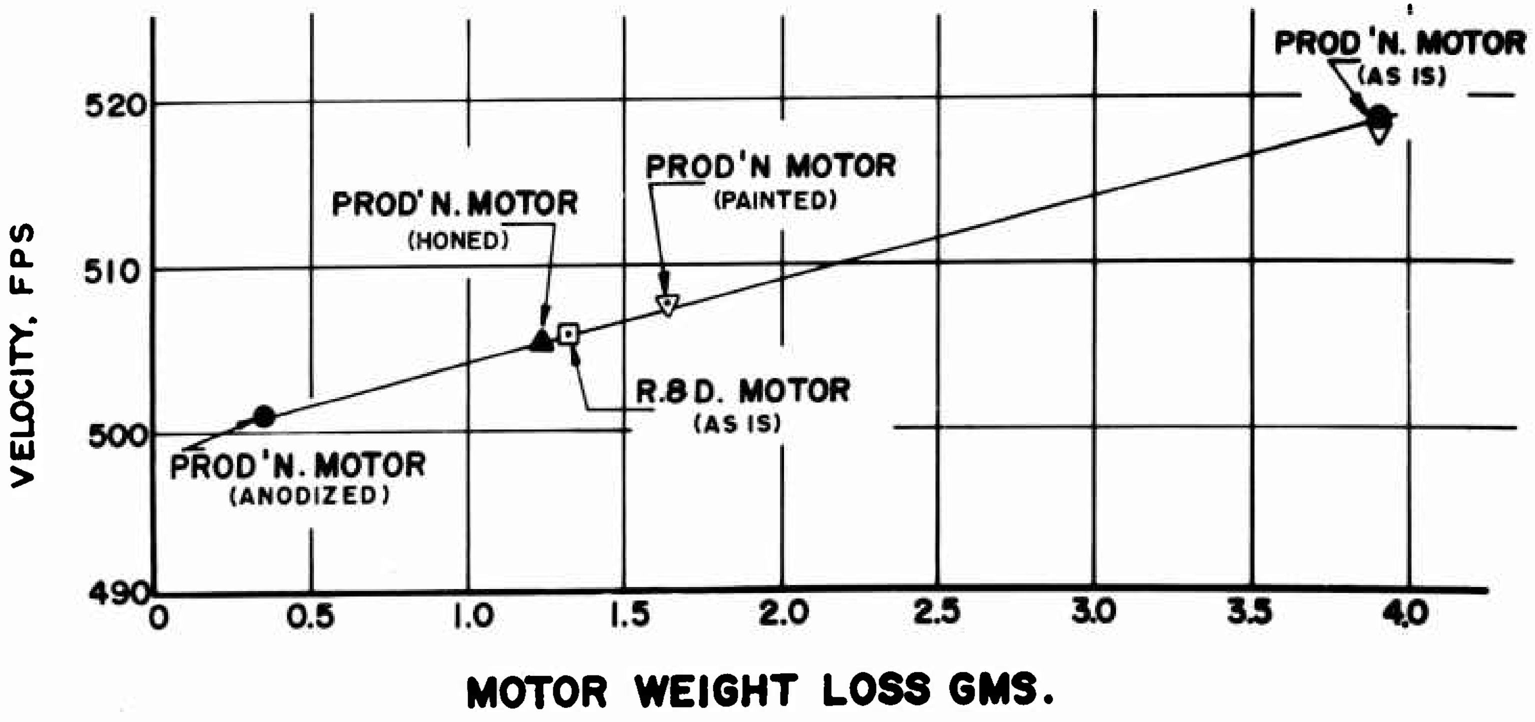


Figure 15.

ABSTRACT DATA

ABSTRACT

Accession No.________________AD________________

Picatinny Arsenal, Dover, New Jersey

DESCRIPTION OF LAW SYSTEM AND CONTROL OF EROSION IN ROCKET MOTOR

Seymour Kaplowitz

Technical Memorandum 1330, January 1964, 27 pp. Unclassified report from the Process Engineering Laboratory, Ammunition Engineering Directorate.

This report records information presented by the author at the joint meeting of the Propulsion Section and Nonferrous Metallurgy Section of the American Ordnance Association, at Picatinny Arsenal on 3 December 1963. The information includes a description of the M72 LAW system and a study of the cause and control of erosion in the LAW Rocket Motor.

UNCLASSIFIED

1. Antitank ammunition
2. Weapons
3. Rocket motors

I. M72-LAW
II. A.O.A. meeting
III. Description of Law System and Control of Erosion in Rocket Motor
IV. Kaplowitz, S.

UNITERMS

Antitank
Ammunition
Weapon
Rocke
Motor
M72
LAW
Description
A.O A.
Meeting
Erosion
Anodizing
Treatment
Coating
Kaplowitz, S.

Accession No. ________ AD ________

Picatinny Arsenal, Dover, New Jersey

DESCRIPTION OF LAW SYSTEM AND CONTROL OF EROSION IN ROCKET MOTOR

Seymour Kaplowitz

Technical Memorandum 1330, January 1964, ____ pp. Unclassified report from the Process Engineering Laboratory, Ammunition Engineering Directorate.

This report records information presented by the author at the joint meeting of the Propulsion Section and Nonferrous Metallurgy Section of the American Ordnance Association, at Picatinny Arsenal on 3 December 1963. The information includes a description of the M72 LAW system and a study of the cause and control of erosion in the LAW Rocket Motor.

(over)

UNCLASSIFIED

1. Antitank ammunition
2. Weapons
3. Rocket motors

I. M72 LAW
II. A. O. A. meeting
III. Title
IV. Kaplowitz, Seymour

UNITERMS

Antitank
Ammunition
Weapon
Rocket
Motor

UNCLASSIFIED

Accession No. ________ AD ________

Picatinny Arsenal, Dover, New Jersey

DESCRIPTION OF LAW SYSTEM AND CONTROL OF EROSION IN ROCKET MOTOR

Seymour Kaplowitz

Technical Memorandum 1330, January 1964, ____ pp. Unclassified report from the Process Engineering Laboratory, Ammunition Engineering Directorate.

This report records information presented by the author at the joint meeting of the Propulsion Section and Nonferrous Metallurgy Section of the American Ordnance Association, at Picatinny Arsenal on 3 December 1963. The information includes a description of the M72 LAW system and a study of the cause and control of erosion in the LAW Rocket Motor.

(over)

UNCLASSIFIED

1. Antitank ammunition
2. Weapons
3. Rocket motors

I. M72 LAW
II. A. O. A. meeting
III. Title
IV. Kaplowitz, Seymour

UNITERMS

Antitank
Ammunition
Weapon
Rocket
Motor

UNCLASSIFIED

Accession No. ________ AD ________

Picatinny Arsenal, Dover, New Jersey

DESCRIPTION OF LAW SYSTEM AND CONTROL OF EROSION IN ROCKET MOTOR

Seymour Kaplowitz

Technical Memorandum 1330, January 1964, ____ pp. Unclassified report from the Process Engineering Laboratory, Ammunition Engineering Directorate.

This report records information presented by the author at the joint meeting of the Propulsion Section and Nonferrous Metallurgy Section of the American Ordnance Association, at Picatinny Arsenal on 3 December 1963. The information includes a description of the M72 LAW system and a study of the cause and control of erosion in the LAW Rocket Motor.

(over)

UNCLASSIFIED

1. Antitank ammunition
2. Weapons
3. Rocket motors

I. M72 LAW
II. A. O. A. meeting
III. Title
IV. Kaplowitz, Seymour

UNITERMS

Antitank
Ammunition
Weapon
Rocket
Motor

UNCLASSIFIED

Accession No. ________ AD ________

Picatinny Arsenal, Dover, New Jersey

DESCRIPTION OF LAW SYSTEM AND CONTROL OF EROSION IN ROCKET MOTOR

Seymour Kaplowitz

Technical Memorandum 1330, January 1964, ____ pp. Unclassified report from the Process Engineering Laboratory, Ammunition Engineering Directorate.

This report records information presented by the author at the joint meeting of the Propulsion Section and Nonferrous Metallurgy Section of the American Ordnance Association, at Picatinny Arsenal on 3 December 1963. The information includes a description of the M72 LAW system and a study of the cause and control of erosion in the LAW Rocket Motor.

(over)

UNCLASSIFIED

1. Antitank ammunition
2. Weapons
3. Rocket motors

I. M72 LAW
II. A. O. A. meeting
III. Title
IV. Kaplowitz, Seymour

UNITERMS

Antitank
Ammunition
Weapon
Rocket
Motor

UNCLASSIFIED

UNCLASSIFIED

UNITERMS

M72
LAW
Description
A. O. A.
Meeting
Erosion
Anodizing
Treatment
Coating
Kaplowitz, S.

UNCLASSIFIED

UNCLASSIFIED

UNITERMS

M72
LAW
Description
A. O. A.
Meeting
Erosion
Anodizing
Treatment
Coating
Kaplowitz, S.

UNCLASSIFIED

UNCLASSIFIED

UNITERMS

M72
LAW
Description
A. O. A.
Meeting
Erosion
Anodizing
Treatment
Coating
Kaplowitz, S.

UNCLASSIFIED

UNCLASSIFIED

UNITERMS

M72
LAW
Description
A. O. A.
Meeting
Erosion
Anodizing
Treatment
Coating
Kaplowitz, S.

UNCLASSIFIED

Accession No. ______________ AD ______________

Picatinny Arsenal, Dover, New Jersey

DESCRIPTION OF LAW SYSTEM AND CONTROL OF EROSION IN ROCKET MOTOR

Seymour Kaplowitz

Technical Memorandum 1330, January 1964, _____ pp. Unclassified report from the Process Engineering Laboratory, Ammunition Engineering Directorate.

This report records information presented by the author at the joint meeting of the Propulsion Section and Nonferrous Metallurgy Section of the American Ordnance Association, at Picatinny Arsenal on 3 December 1963. The information includes a description of the M72 LAW system and a study of the cause and control of erosion in the LAW Rocket Motor.

(over)

UNCLASSIFIED

1. Antitank ammunition
2. Weapons
3. Rocket motors

I. M72 LAW
II. A. O. A. meeting
III. Title
IV. Kaplowitz, Seymour

UNITERMS

Antitank
Ammunition
Weapon
Rocket
Motor

UNCLASSIFIED

Accession No. ______________ AD ______________

Picatinny Arsenal, Dover, New Jersey

DESCRIPTION OF LAW SYSTEM AND CONTROL OF EROSION IN ROCKET MOTOR

Seymour Kaplowitz

Technical Memorandum 1330, January 1964, _____ pp. Unclassified report from the Process Engineering Laboratory, Ammunition Engineering Directorate.

This report records information presented by the author at the joint meeting of the Propulsion Section and Nonferrous Metallurgy Section of the American Ordnance Association, at Picatinny Arsenal on 3 December 1963. The information includes a description of the M72 LAW system and a study of the cause and control of erosion in the LAW Rocket Motor.

(over)

UNCLASSIFIED

1. Antitank ammunition
2. Weapons
3. Rocket motors

I. M72 LAW
II. A. O. A. meeting
III. Title
IV. Kaplowitz, Seymour

UNITERMS

Antitank
Ammunition
Weapon
Rocket
Motor

UNCLASSIFIED

Accession No. ______________ AD ______________

Picatinny Arsenal, Dover, New Jersey

DESCRIPTION OF LAW SYSTEM AND CONTROL OF EROSION IN ROCKET MOTOR

Seymour Kaplowitz

Technical Memorandum 1330, January 1964, _____ pp. Unclassified report from the Process Engineering Laboratory, Ammunition Engineering Directorate.

This report records information presented by the author at the joint meeting of the Propulsion Section and Nonferrous Metallurgy Section of the American Ordnance Association, at Picatinny Arsenal on 3 December 1963. The information includes a description of the M72 LAW system and a study of the cause and control of erosion in the LAW Rocket Motor.

(over)

UNCLASSIFIED

1. Antitank ammunition
2. Weapons
3. Rocket motors

I. M72 LAW
II. A. O. A. meeting
III. Title
IV. Kaplowitz, Seymour

UNITERMS

Antitank
Ammunition
Weapon
Rocket
Motor

UNCLASSIFIED

Accession No. ______________ AD ______________

Picatinny Arsenal, Dover, New Jersey

DESCRIPTION OF LAW SYSTEM AND CONTROL OF EROSION IN ROCKET MOTOR

Seymour Kaplowitz

Technical Memorandum 1330, January 1964, _____ pp. Unclassified report from the Process Engineering Laboratory, Ammunition Engineering Directorate.

This report records information presented by the author at the joint meeting of the Propulsion Section and Nonferrous Metallurgy Section of the American Ordnance Association, at Picatinny Arsenal on 3 December 1963. The information includes a description of the M72 LAW system and a study of the cause and control of erosion in the LAW Rocket Motor.

(over)

UNCLASSIFIED

1. Antitank ammunition
2. Weapons
3. Rocket motors

I. M72 LAW
II. A. O. A. meeting
III. Title
IV. Kaplowitz, Seymour

UNITERMS

Antitank
Ammunition
Weapon
Rocket
Motor

UNCLASSIFIED

UNCLASSIFIED

UNITERMS

M72
LAW
Description
A. O. A.
Meeting
Erosion
Anodizing
Treatment
Coating
Kaplowitz, S.

UNCLASSIFIED

UNCLASSIFIED

UNITERMS

M72
LAW
Description
A. O. A.
Meeting
Erosion
Anodizing
Treatment
Coating
Kaplowitz, S.

UNCLASSIFIED

UNCLASSIFIED

UNITERMS

M72
LAW
Description
A. O. A.
Meeting
Erosion
Anodizing
Treatment
Coating
Kaplowitz, S.

UNCLASSIFIED

UNCLASSIFIED

UNITERMS

M72
LAW
Description
A. O. A.
Meeting
Erosion
Anodizing
Treatment
Coating
Kaplowitz, S.

UNCLASSIFIED

TABLE OF DISTRIBUTION

TABLE OF DISTRIBUTION

		Copy Number
1.	Commanding General U.S. Army Munitions Command Dover, New Jersey ATTN: AMSMU-RE-EE	1
2.	Commanding Officer Picatinny Arsenal Dover, New Jersey ATTN: SMUPA-DE	2-16
	SMUPA-DC	17-18
	SMUPA-DS	19
	SMUPA-DX1	20-21
	SMUPA-VA6	22-26
3.	Commanding Officer Radford Army Ammunition Plant Radford, Virginia ATTN: Mr. J. Horvath	27-28
4.	Hercules Powder Company Wilmington, Delaware ATTN: Mr. F. Hakenjos	29
5.	Hesse Eastern Division Flightex Fabrics, Inc. Everett, Massachusetts ATTN: Mr. C. Weeks	30
6.	Commanding Officer Ammunition Procurement and Supply Agency Joliet, Illinois ATTN: Major W. Wells	31
	SMUAP-AMMP	32
	SMUAP-AE	33
7.	Commanding Officer Lone Star Army Ammunition Plant Texarkana, Texas ATTN: Miss I. English	34-35

TABLE OF DISTRIBUTION (Cont'd)

		Copy Number
8.	Harry Diamond Laboratories Van Ness and Connecticut Avenues Washington 25, D.C. ATTN: Technical Library	36-37
9.	Commandant U.S. Army Ordnance Center and School Aberdeen Proving Ground, Maryland ATTN: AISO-SL	38
10.	Defense Documentation Center Cameron Station Alexandria, Virginia	39-58