AD

12 March 1976

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No. 310-5

FAP-310-5(76)

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SUBJECT AND AUTHOR INDEX OF UNCLASSIFIED FRANKFORD ARSENAL TECHNICAL REPORTS, OPEN LITERATURE, AND PATENTS ISSUED DURING MARCH 1975 THROUGH FEBRUARY 1976.

U.S. ARMY ARMAMENT COMMAND
FRANKFORD ARSENAL
PHILADELPHIA, PENNSYLVANIA 19137

12 March 1976 * FAP 310-5

TABLE OF CONTENTS

* This Pamphlet supersedes FAP 310-5, 21 April 1975.

ABSTRACT

This bibliography is a compilation of 7 technical research articles, 7 technical memorandum reports, 3 technical notes, 26 technical research reports, 9 technical test reports, and 29 patents, which were issued during March 1975 through February 1976. It is the intent of the library to issue this index at least yearly.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER FA-TA-74029	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) PREPARATION AND HOMOPOLYMERIZATION OF METHYL α-n-ALKYLACRYLATES		5. TYPE OF REPORT & PERIOD COVERED Technical Research Article 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) HENRY GISSER and HELEN E. MERTWOY		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS FRANKFORD ARSENAL Attn: SARFA-PDC Philadelphia, PA 19137		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS: 692000.11.H6900 DA Proj: 1T662611AH69
11. CONTROLLING OFFICE NAME AND ADDRESS Fort Belvoir		12. REPORT DATE November 1974 13. NUMBER OF PAGES 11
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Reprinted from MACROMOLECULES, Vol. 7, Page 431, July-August

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Methyl α-n-alkylacrylates
Poly(methyl α-n-alkylacrylates)
α-n-Alkylacrylic esters
Poly(α-n-alkylacrylic esters)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The homopolymerization of methyl α-n-alkylacrylates with long alkyl groups was studied. Methyl α-n-dodecyl-, methyl α-n-hexadecyl-, and methyl α-n-octadecylacrylate were prepared from the appropriate alkylmalonic monomethyl esters via a Mannich-type reaction which yielded a product free from isomeric impurities. Anionic homopolymerizations were carried out using sodium naphthalene (at -75°) and sodium metal (at 0° and room temperature) as initiators. The highest molecular weights and yields of polymer have thus far been obtained using

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20. sodium metal; e.g., after 14 days at 0° a $\overline{M}_n$ of 15,000 (80% yield) was obtained for poly(methyl α-n-dodecylacrylate), and after 8 days at room temperature a M_n of 7083 (70% yield) was obtained for poly(methyl α-n-hexadecylacrylate). Emulsion polymerizations of the methyl α-n-dodecylacrylate and methyl α-n-octadecylacrylate with ammonium persulfate and sodium bisulfite yielded traces of oligomers. Poly(methyl α-n-dodecylacrylate) is a clear, colorless, sticky, rubbery polymer. Its X-ray diffraction pattern shows it to be amorphous at room temperature. The poly(methyl α-n-hexadecylacrylate) and poly(methyl α-n-octadecylacrylate) are white waxes which, when heated, resemble the poly(methyl α-n-dodecylacrylate). X-Ray diffraction studies at room temperature on a thin film of the polymers show crystallinity. All of the polymers are readily soluble in aromatic and aliphatic hydrocarbons and ethers and slightly soluble in alcohols and ketones.

This research has produced the first poly(methyl α-n-alkylacrylates) with alkyl $\geq C_{12}H_{25}$. Such polymers, because of their friction and wear reducing characteristics, are potentially useful as additives for Army fluids and lubricants.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER FA-TA-75047	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) HYDROGEN BONDING IN NITROCELLULOSE AND ITS IMPLICATIONS ON DETERRING OF SMALL ARMS PROPELLANT		5. TYPE OF REPORT & PERIOD COVERED Technical Engineering Abstract 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) B.W. Brodman M.P. Devine M.T. Gurbarg		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS FRANKFORD ARSENAL Attn: SARFA-MDP-R Philadelphia, PA 19137		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS: 611102.11.857 DA: 1T161102A32C03
11. CONTROLLING OFFICE NAME AND ADDRESS Picatinny Arsenal		12. REPORT DATE July 1975 13. NUMBER OF PAGES 9
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Propellant Manufacture
Small Arms Propellant
Propellant Combustion
Small Arms Deterrents
Hydrogen Bonding

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The hydrogen bonding characteristics of well-characterized nitrocellulose samples were studied by means of IR spectroscopy. Results obtained for nitrocellulose samples of varying nitrogen content showed that the strength of the hydrogen bond increases with decreasing nitrogen content. In addition, atmospheric moisture was found to hydrogen bond with nitrocellulose hydroxyl groups. The implications of these findings on the deterring phase of the small arms propellant manufacturing process are discussed.

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TA-75048
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): AUTORADIOGRAPHIC DETERMINATION OF THE Di-n-butyl PHTHALATE CONCENTRATION PROFILE IN A NICROCELLULOSE MATRIX

5. TYPE OF REPORT & PERIOD COVERED: Technical Engineering Abstract

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s): B.W. Brodman, M.P. Devine, R.W. Finch, M.S. MacClaren) Olin Corporation, Chemicals Group, New Haven, CT 06504

8. CONTRACT OR GRANT NUMBER(s):

9. PERFORMING ORGANIZATION NAME AND ADDRESS: FRANKFORD ARSENAL, Attn: SARFA-MDP-R, Philadelphia, PA 19137

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11. CONTROLLING OFFICE NAME AND ADDRESS: Picatinny Arsenal

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Propellant Manufacture
Small Arms Propellant
Propellant Combustion
Small Arms Deterrents
Hydrogen Bonding

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The concentration profile of a deterrent (di-n-butyl phthalate) which had been diffused into a nitrocellulose sphere (ball propellant) containing nitroglycerin was studied by means of autoradiography. Results indicate a level concentration part way into the sphere with an abrupt dropoff in concentration. An explanation for this type of concentration profile is offered based on hydrogen bonding of the deterrent carbonyl group with unesterified hydroxyl groups in nitrocellulose.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TA-75051
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): THE EFFECT OF INGOT PROCESSING TREATMENTS ON THE GRAIN SIZE AND PROPERTIES OF AL ALLOY 7075

5. TYPE OF REPORT & PERIOD COVERED: Technical research article

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s):
J. WALDMAN
H. SULINSKI
H. MARKUS

8. CONTRACT OR GRANT NUMBER(s):

9. PERFORMING ORGANIZATION NAME AND ADDRESS:
Frankford Arsenal
ATTN: SARFA-PDM
Philadelphia, PA 19137

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AMCMS: 612105.11.H8400
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11. CONTROLLING OFFICE NAME AND ADDRESS:
US Army Materials & Mechanics Research Center
Watertown, MA 02172

12. REPORT DATE: August 1975

13. NUMBER OF PAGES: 17

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office):

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Aluminum Alloys
Thermal Mechanical Treatments
Recrystallization
Microstructure
Grain Size
Mechanical Properties

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An investigation was carried out to determine the effect of various ingot thermal mechanical processing treatments on the grain size and mechanical properties of high purity homogeneous 7075 aluminum alloy sheet and plate. The results indicate that the recrystallization of 7075 alloy into a fine grained structure can be controlled by the distribution of the Cr in the microstructure, as well as by the distribution of the major alloying elements, Zn, Mg and Cu. A new ingot processing technique, FA-ITMT, was

20. ABSTRACT (Cont'd)

developed for producing fine grained 7075 sheet and plate. Data are presented which show that fine grained 7075 sheet and plate have equivalent strength and significantly better ductility than conventionally processed material.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER FA-TA-75052	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) THERMOMECHANICAL PROCESSING OF ALUMINUM ALLOY INGOTS		5. TYPE OF REPORT & PERIOD COVERED Technical research article 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) J. WALDMAN H. SULINSKI H. MARKUS		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Frankford Arsenal ATTN: SARFA-PDM Philadelphia, PA 19137		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS: 612105.11.H8400 DA PROJ.: 1T162105AH84
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Materials & Mechanics Research Center Watertown, MA 02172		12. REPORT DATE August 1975 13. NUMBER OF PAGES 32
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

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18. SUPPLEMENTARY NOTES

Presented at Twenty-First Sagamore Army Materials Research Conference, Sagamore, NY, 13-16 August 1974.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Aluminum Alloys	Mechanical Properties
Thermal Mechanical Treatments	Fracture Toughness
Recrystallization	Stress Corrosion
Microstructure	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The Materials Engineering Division at Frankford Arsenal is involved in an extensive research effort aimed at upgrading the engineering properties of wrought high strength 7000 series aluminum alloys through thermomechanical processing of the ingot material. The development of two new ingot thermomechanical processing techniques, ISML-ITMT and FA-ITMT, is presented. The effects of these techniques on the recrystallization behavior, grain morphology, tensile properties, fracture toughness and stress corrosion resistance of high purity 7075 alloy sheet and plate is presented. The recrystallization of

20. ABSTRACT (Cont'd)

7075 alloy into a fine grained material was found to be controlled by the distribution of the major alloying elements, Zn, Mg and Cu, as well as by that of the ancillary element, Cr. The results showed that for a given standard temper, i.e., T6, T76 and T73, high purity ITMT processed 7075 alloy has finer grain size, equivalent strength and better ductility, fracture toughness and stress corrosion characteristics than commerical 7075 alloy. The work also showed that high purity ITMT processed 7075 alloy in the FTMT temper (a temper involving a deformation stage between an initial and a final artificial aging stage) has higher strength, ductility and fracture toughness than commercial 7075-T6 alloy.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TA-75062
2. GOVT ACCESSION NO:
3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): DIFFUSION OF DETERRENTS INTO A NITROCELLULOSE MATRIX. AN EXAMPLE OF DIFFUSION WITH INTERACTION

5. TYPE OF REPORT & PERIOD COVERED: Technical research article

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s):
B. W. Brodman
J. A. Sipia, Jr.
S. Schwartz

8. CONTRACT OR GRANT NUMBER(s):

9. PERFORMING ORGANIZATION NAME AND ADDRESS:
Frankford Arsenal
ATTN: SARFA-MDP-R
Philadelphia, PA 19137

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11. CONTROLLING OFFICE NAME AND ADDRESS:
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12. REPORT DATE: August 1975

13. NUMBER OF PAGES: 9

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Small Arms Propellant	Di-n-Butyl Phthalate
Deterrents	Diffusion
Deterring	Interaction Mechanism
Nitrocellulose	Hydrogen Bonding

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
The diffusion of various concentrations of a deterrent (di-n-butyl phthalate) into a spherical, nitroglycerin-containing nitrocellulose matrix was studied. It was concluded that the final concentration profile could best be explained by a diffusion with interaction mechanism. Based on this mechanism, a method for calculating the depth of deterrent penetration is presented.

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1. REPORT NUMBER: FA-TA-75063	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): THE DETERMINATION OF NORMAL ANISOTROPY FROM POLE FIGURES	5. TYPE OF REPORT & PERIOD COVERED: Technical research article
6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s): Fred Witt A. Lawley - Drexel University	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Frankford Arsenal Attn: SARFA-PDM Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS: 675709.12.03900 DA Proj: 1Y765709D650
11. CONTROLLING OFFICE NAME AND ADDRESS: ARMCOM	12. REPORT DATE: August 1975 13. NUMBER OF PAGES: 10
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Automated x-ray analysis
Preferred orientation
Drawability index
Formability index
Pole figures
Texture

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The in situ determination of normal anisotropy from quantitative {220} pole figures of α-brass has been accomplished using an approach patterned after the analysis of Elias et al. Brasses examined were prepared specifically so that the only material parameter varied was normal anisotropy, and hence crystallographic texture. It is shown that for average normal plastic anisotropy $\bar{R}$ over the range of 0.84 to 1.12, which is a significant range for cubic materials, values derived from pole figures and those obtained from the tensile test are in good agreement. The method is attractive in light

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20. ABSTRACT (Cont'd)

of the conservation of time and material compared with tensile testing for the determination of r of $\bar{R}$.

REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: FA-TM-74035	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): "FUSED ON" ROTATING BANDS FOR PROJECTILES	5. TYPE OF REPORT & PERIOD COVERED: TECHNICAL RESEARCH MEMORANDUM
6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s): David E. Schillinger	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Frankford Arsenal, Attn: SARFA-PDM/P, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS: 611101.11.84400, DA Proj: 1T161101A91A
11. CONTROLLING OFFICE NAME AND ADDRESS: AMMRC	12. REPORT DATE: December 1974
	13. NUMBER OF PAGES: 33
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Rotating Bands
Projectiles
Small Arms

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The purpose of this work was to determine the feasibility of a new idea for applying rotating bands to projectiles. The idea is the in-situ fusion of the rotating band material in a graphite crucible fitted around the projectile. Various heating and shielding methods were explored. It was found that several materials could be successfully deposited using induction or furnace heating in an Argon atmosphere. Metallographic studies (cont.)

20. Abstract (cont.)

and post-application, heat treating studies were carried out. Several bands "fused on" 30 mm projectiles were successfully fired through a 30 mm cannon.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER FA-TM-75010	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) FINITE ELEMENT ANALYSIS OF A MULTI-COMPONENT KINETIC ENERGY PROJECTILE		5. TYPE OF REPORT & PERIOD COVERED Technical research report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) LEONARD M. GOLD NANCY A. STOWELL		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS FRANKFORD ARSENAL Attn: SARFA-PDM-E Philadelphia, PA 19137		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS:664604.12.288.02.02 DA: 1X564604E340
11. CONTROLLING OFFICE NAME AND ADDRESS ARMCOM		12. REPORT DATE February 1975 13. NUMBER OF PAGES 23
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Stress Analysis
Finite Element
Multi-component
KE Projectile

20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Finite element techniques are used to perform a launch stress analysis on a multi-component 27.5mm kinetic energy projectile. The five parts of the projectile are each analyzed separately utilizing a layer of false boundary elements to determine the interaction between each component and those in contact with it. The stress history in the boundary elements is utilized as boundary conditions for the adjacent components. The analysis proceeds from the forward components

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20. ABSTRACT (Cont'd)

toward the rear, providing the additive inertia load to each. The resulting launch stress fields are shown for each component and the advantages and disadvantages of this approach are discussed. The analysis of this round generally indicated no serious problems and will act as an aid in the verification of actual projectile performance.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TM-75011	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): THE DESIGN, MANUFACTURE, AND BALLISTIC ASSESSMENT OF SPECIAL 5.56MM BULLETS	5. TYPE OF REPORT & PERIOD COVERED: Technical Research Memorandum
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Robert McHugh, Richard Kwatnoski	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Frankford Arsenal, Attn: SARFA-MDS-B, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS Code:662603.11.H7800, DA Proj:1W662603AH78
11. CONTROLLING OFFICE NAME AND ADDRESS: ARMCOM	12. REPORT DATE: March 1975
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

The contributors to this report include numerous personnel from the Applied Technology, Manufacturing Technology, Technical Services and Munitions Development and Engineering Directorates and Pitman-Dunn Laboratory of Frankford Arsenal.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Small Arms Ammunition
Penetration
M16 Rifle
M193 Ball Ammunition

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The object of this report is to present and compare the penetration performance of two special small arms penetrating projectiles with the M193 and WAMBEE bullets. The special penetrating projectiles (designated AP-1 and AP-2) were designed, manufactured and ballistically evaluated. Data from comprehensive helmet and plate penetration tests were obtained and analyzed. Limited accuracy, drag and lethality data were also obtained.
(cont'd)

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20. Abstract (cont'd)

Based on the penetration test results, it was concluded that both the AP-1 and AP-2 bullets offer a significant improvement over the M193. The AP-1 and AP-2 penetration performances were comparable. The two projectiles were also comparable to the WAMBEE.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TM-75017	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): COEFFICIENT OF FRICTION OF BRASS OR GILDING METAL ON NYLON	5. TYPE OF REPORT & PERIOD COVERED: Technical Engineering Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): FRED PEARLSTEIN S. SADJIAN	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: FRANKFORD ARSENAL Attn: SARFA-PDC Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS Code: 663607.12.8100 DA Proj: 1W663607D627
11. CONTROLLING OFFICE NAME AND ADDRESS: ARMCOM	12. REPORT DATE: April 1975 13. NUMBER OF PAGES: 11
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Friction
Brass
Gilding Metal
Nylon
Chromate Coatings

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The effect of etching and/or chromating brass and gilding metal on the coefficient of friction in contact with glass-filled nylon was determined. The effect of chemically etching the nylon substrate was also ascertained. It was found that the high frictional forces believed required for successful firing of gilding metal jacketed 17 caliber bullets and glass-filled nylon sabots could be attained by surface modifications.

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1. REPORT NUMBER: FA-TM-75019	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): PGAUSS-LT: A PROGRAM FOR COMPUTING OPTICAL PROPERTIES OF SINGLE SCATTERING AEROSOL CLOUDS OF HOMOGENEOUS PARTICLES	5. TYPE OF REPORT & PERIOD COVERED: Technical Engineering Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): EDWARD W. STUEBING JAMES J. PINTO RICHARD B. GOMEZ*	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Frankford Arsenal, SARFA-PDSA, Phila., PA 19137 USAECOM, Attn: AMSEL-BL-MS	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS: 673726.12.12200 DA Proj: 1G763726.D471
11. CONTROLLING OFFICE NAME AND ADDRESS: HQ, Mobility, Equipment, Research and Development Center Fort Belvoir, VA 22060	12. REPORT DATE: April 1975 13. NUMBER OF PAGES: 32
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: N/A

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

*Richard B. Gomez, Meteorological Satellite Technical Area, Atmospheric Sciences Laboratory, White Sands Missile Range, NM 88002

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Mie Calculation
Aerosol Scattering
Aerosol Light Absorption

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes a modified version of the code PGAUSS and will be referred to as PGAUSS-LT. The documentation for the PGAUSS code has been published as a separate report. The main purpose of PGAUSS-LT is to enable the user to compute luminous transmittance over nonhomogeneous atmospheric paths containing an arbitrary size and number density of liquid and solid particles. The absorbing and scattering particles are assumed to be homogeneous, isotropic spherical particles made up of (cont'd)

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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. ABSTRACT - Cont'd

a material whose complex refractive index is known along with the real index of the surrounding medium. The modifications made to program PGAUSS are discussed, the input specifications to program PGAUSS-LT are given, and an example set of input-output is provided. The modifications made to PGAUSS provide for (1) suppressing much of the detailed PGAUSS output and a slight change in the definition of the phase function, (2) calculating optical density per meter within the system of particles at specified wavelengths as a function of number density, (3) calculating luminous transmittance over various path lengths as a function of number density, (4) providing interpolation of the phase function over angular regions specified in the input, and (5) providing integration under the phase function over the angular regions. A source listing of the FORTRAN program is available upon request from the Atmospheric Sciences Laboratory, White Sands Missile Range, New Mexico, 88002.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TM-75033	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): FABRICATION AND MATERIAL EVALUATION OF ALUMINUM COMPONENTS OF A WARHEAD INNER BODY SHELL AND MOUNTING SUPPORT ASSEMBLY	5. TYPE OF REPORT & PERIOD COVERED: Technical engineering report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): ANTHONY SAIA, RALPH E. EDELMAN	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: FRANKFORD ARSENAL, Attn: SARFA-PDM-P, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS Code: 634307.12.17100, DA Project: 1X364307D212
11. CONTROLLING OFFICE NAME AND ADDRESS: Picatinny Arsenal, ATTN: SARPA-TS-S, Dover, NJ 07801	12. REPORT DATE: April 1975
	13. NUMBER OF PAGES: 29
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
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16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Casting	Fabrication	Metal forming
Aluminum	Metallurgy	Missile components
Welding	Foundry techniques	
Machining	Sand casting	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Practical and economical procedures and techniques for fabrication a Warhead Inner Body Shell and Mounting Support Assembly (Picatinny Arsenal, Drawing No. T-9272838) are described. The aluminum assembly consisted of base and nose castings welded to a spin formed sphere and a cover plate bolted to the nose casting.

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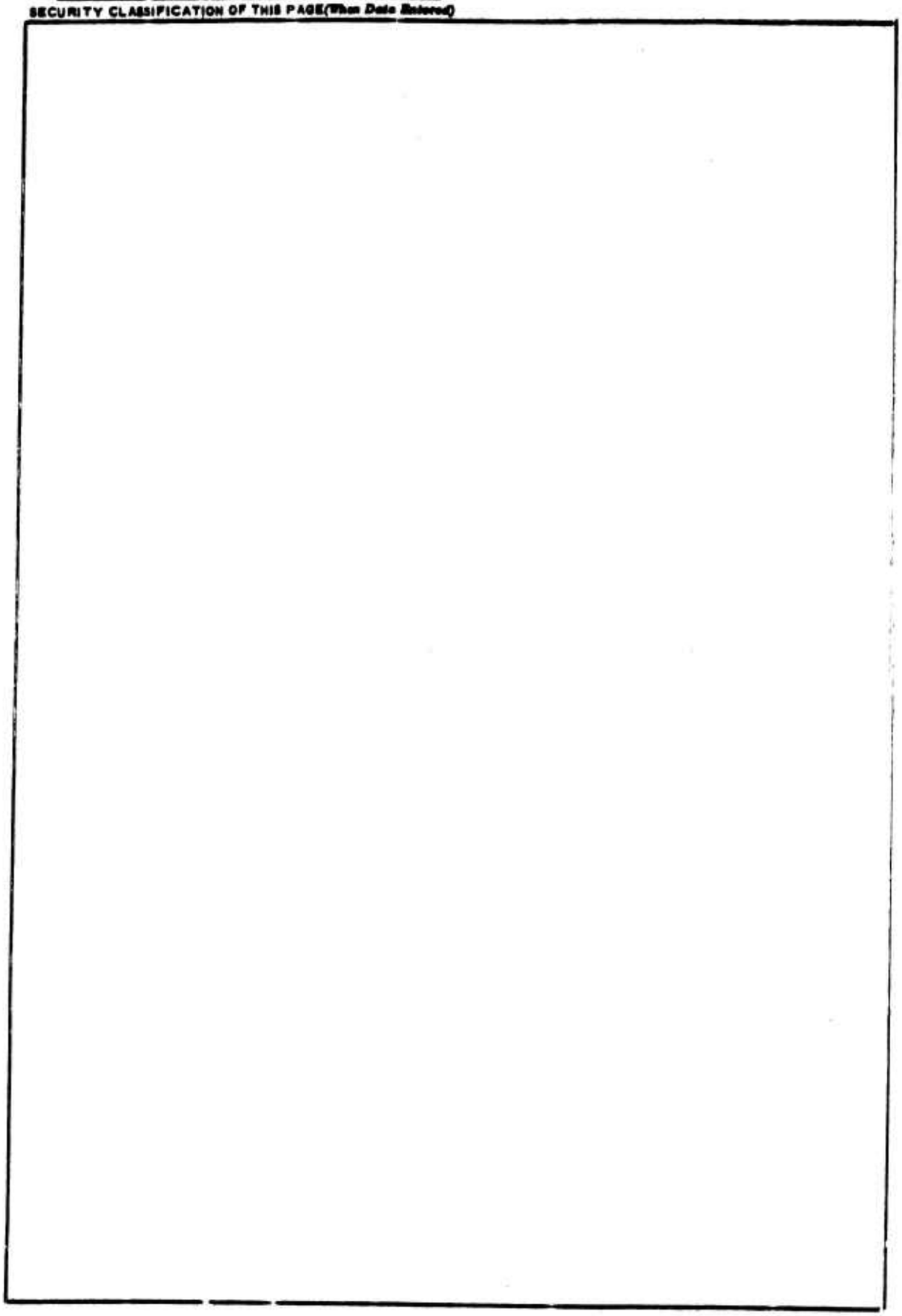

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TM-75054
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): NORMAL FUZE IMPACT AND PENETRATION

5. TYPE OF REPORT & PERIOD COVERED: Technical Research Report

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s):
P. GORDON
F. LEE
M. SCHWARTZ

8. CONTRACT OR GRANT NUMBER(s):

9. PERFORMING ORGANIZATION NAME AND ADDRESS
FRANKFORD ARSENAL
Attn: SARFA-PDM-E
Philadelphia, PA 19137

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
AMCMS CODE: 3653.5000.204
DA PROJ: 1W662616AH77

11. CONTROLLING OFFICE NAME AND ADDRESS
FRANKFORD ARSENAL

12. REPORT DATE: August 1975

13. NUMBER OF PAGES:

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16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Impact
Perforation
Stress distribution
Plugging
Petalling
Stress wave
Projectile

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A model for the penetration through a thin target by a fuzed projectile at normal incidence was developed. It was assumed that the penetration mechanisms were plugging followed by petalling. From this model the force and stress distributions acting on the fuze were plotted. It was found that the major stress on the fuze was the longitudinal component due to plugging. The effects of petalling were negligible. The forces and stresses were found to be proportional to the square of the impact velocity.

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: TECHNICAL NOTE TN-1181	2. GOVT ACCESSION NO. / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): GRAPHICAL TRAJECTORY COMPENDIUM OF CALIBER .50 AND 20MM PROJECTILES IN AN AIR TO GROUND AND GROUND TO GROUND ROLE	5. TYPE OF REPORT & PERIOD COVERED / 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): DIANA L. FREDERICK	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: FRANKFORD ARSENAL, Attn: MDC-A, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS: 5910.22.20430, DA#: MIPR FB 2823-9-13 U
11. CONTROLLING OFFICE NAME AND ADDRESS: ARMCOM	12. REPORT DATE: October 1973 / 13. NUMBER OF PAGES: 164
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED / 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: N/A

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Air to Ground	Time of Flight	M2
Caliber 50	Trajectories	M8
Cannon Caliber Ammunition	PRU-31B	M55
Ground to Ground	20MM	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report is a compendium of trajectories in air to ground and ground to ground role of projectiles shapes of possible interest in cannon caliber ammunition applications. The 20MM projectiles shapes are M53, M56 and SAPI. The caliber 50 drag curves are the M2 and M8.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER TECHNICAL NOTE TN-1185	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) AIR DEFENSE MISS DISTANCE ANALYSIS		5. TYPE OF REPORT & PERIOD COVERED Technical research note 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) ANTHONY Mc GOLDRICK THOMAS SLOOK		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS FRANKFORD ARSENAL Attn: SARFA-FCW-D Philadelphia, PA 19137		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS: 662603.12.22500.03 DA Proj: 1W62603A005
11. CONTROLLING OFFICE NAME AND ADDRESS ARMCOM		12. REPORT DATE April 1974 13. NUMBER OF PAGES 35
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Air Defense Gun Systems
Antiaircraft Gun (Oerlikon)
Autocorrelation Comparison
Azimuth Angle
Correcting Technique
Elevation Angle
Periodicity

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A partial analysis was made of the miss distance of projectiles fired by a modern antiaircraft gun at a moving aircraft. Three sets of data were available for this study. Each set represented an almost linear path flown by an aircraft-type target at approximately constant altitude. The study included an investigation of periodicity, an autocorrelation comparison, and the application of a correcting technique. The following results apply to the data studied. Miss distance is not periodic with

20. ABSTRACT - Cont'd

the period being equal to the time of flight of the projectiles. No correlation exists between the autocorrelation function and "almost autocorrelation" function, as defined in this report. The correcting technique indicates that while bias is reduced, dispersion becomes larger. However, the data on which this report is based is subject to many interpretations.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TN-74020	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): COMPUTER PROGRAM FOR GENERATING GYROSCOPIC AND DYNAMIC STABILITY FACTORS AS A FUNCTION OF RANGE	5. TYPE OF REPORT & PERIOD COVERED: Technical Research Note
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): DIANA L. FREDERICK	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Frankford Arsenal, ATTN: SARFA-MDC-A, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS: 662603.11.H7800.07, DA PROJECT: 1W662603AH78
11. CONTROLLING OFFICE NAME AND ADDRESS: ARMCOM	12. REPORT DATE: August 1974
	13. NUMBER OF PAGES: 47
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16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Stability	Computer Program
Gyroscopic	Exterior Ballistic
Dynamic	Trajectory

20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report describes a computer program which gives gyroscopic and dynamic stability factors as a function of range by combining two existing programs, Spinner and TRAJE. The program generates air-to-air, air-to-ground, and ground-to-ground trajectories. Inputs to the program are the aerodynamic coefficients obtained from Spinner computer program, projectile weight and cross sectional area, projectile muzzle velocity, vehicle velocity, and initial angle of fire.

20. ABSTRACT (Cont'd)

Specific information provided includes time, velocity, spin, gyroscopic and dynamic stability factors, and altitude versus range for air-to-ground, air-to-air, and ground-to-ground trajectories. The air-to-ground and air-to-air trajectories include fixed wing and helicopter launchings.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: R-3006	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): STUDIES IN FLECHETTE/SABOT TECHNOLOGY - Part I: Slip Model for Single Flechette/Sabot Assemblies	5. TYPE OF REPORT & PERIOD COVERED: Technical research report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): John M. Zavada Andrew J. Semeister	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: FRANKFORD ARSENAL Attn: SARFA-PDR-M Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS: 553F.12.23400 DA: 1J563607D013
11. CONTROLLING OFFICE NAME AND ADDRESS: ARMCOM	12. REPORT DATE: April 1974
	13. NUMBER OF PAGES: 32
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES: The authors would like to express their gratitude to Mr. Souren Sadjian in the Chemistry Research Division of Pitman-Dunn Laboratory of Frankford Arsenal for providing the friction measurements on the materials listed in this report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Friction
Le Duc
Sabot
Flechette
Interior ballistics

20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A mathematical model was formulated for interfacial frictional force type flechette/sabot assemblies. Conditions leading to flechette/sabot slipping were examined. A Newtonian force balance analysis was preformed utilizing a previously reported expression predicting the interfacial frictional force produced from inbore pressures. Closed form solutions to the differential equations resulting from the above analysis were obtained by assuming the Le Duc interior

Cont'd - ABSTRACT

ballistic expression for the acceleration. Results indicate the sensitive nature of the critical frictional force. Consideration of serial flechette rifle assemblies show that frictional forces one percent below the critical value are enough to produce muzzle velocity variations of 90 ft/sec. A two percent variation precipitates a complete loss of contact between the flechette and sabot at approximately 13 inches of travel in the bore.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER REPORT R-3007	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) STUDIES IN FLECHETTE/SABOT TECHNOLOGY Part II. Axial Stress Model for Single Flechette/Sabot Assemblies		5. TYPE OF REPORT & PERIOD COVERED Technical research report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Andrew J. Semeister John M. Zavada		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS FRANKFORD ARSENAL Attn: SARFA-PDR-M Philadelphia, PA 19137		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS Code: 553F.12.23400 DA Project: 1J563607D013
11. CONTROLLING OFFICE NAME AND ADDRESS ARMCOM		12. REPORT DATE April 1974 13. NUMBER OF PAGES 37
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES The authors are grateful to Mr. W. Quittman of the Materials Laboratory in Pitman-Dunn for providing the mechanical test properties of various filled and unfilled plastic materials. Also, they wish to thank Mr. S. Sadjian of the Chemistry Research Division of

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Sabot
Flechette
Stress
Interior Ballistics

20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A theoretical model for predicting the axial stress variation throughout the portion of a sabot subjected to inbore pressure in a smooth bore gun was developed. In the model this portion of the sabot is a frustrum of a cone and includes the cylinder as a limiting case. This model assumes that the sabot can be approximated by segmented rigid bodies positioned symmetrically and individually spaced about the projectile.

18. (Cont'd)

Pitman-Dunn who performed the measurements of static and kinetic coefficients of friction on these same materials.

20. (Cont'd)

A Newtonian force balance analysis was performed utilizing a previously derived analytical expression for the normal force containing the relevant sabot parameters. Predicted results of the model with respect to axial yield stress and frictional coefficient were obtained for various geometric variations. Further results determining the effects of variations in peak pressure, bore friction, intersegment spacing, material density, decreased flechette weight and increased sabot head weight on these two design parameters are also included.

Utilizing these results a prototype sabot design was selected whereby the axial stress distribution throughout the sabot would be compressive. This design was successfully fabricated using injection molding techniques and tested. Therefore, a significant breakthrough in current sabot technology was achieved. Finally, laboratory test results of the physical and mechanical properties of various plastic materials, reinforced and unreinforced, are provided for informative and comparative purposes.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER REPORT R-3008	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) SMALL ARMS CARTRIDGE CASE EXTRACTION STUDY		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Sidney Goldstein Paul Gordon Martin Horchler		8. CONTRACT OR GRANT NUMBER(s) AMCMS: 4410.16.0217 DA Proj: F628090
9. PERFORMING ORGANIZATION NAME AND ADDRESS Frankford Arsenal Attn: SARFA-MDS-B Philadelphia, PA 19137		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS: 4410.16.0217 DA Proj: F628090
11. CONTROLLING OFFICE NAME AND ADDRESS ARMCOM		12. REPORT DATE May 1974 13. NUMBER OF PAGES 136
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

The author acknowledges and appreciates the assistance of Mr. Richard Zeitz, Ammunition Branch, Aircraft Munitions Division, Frankford Arsenal, in writing and conducting the computer program which simulates the dynamic

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Aluminum	Brass	Chamber Modulers	Friction
Blowback Force	Cartridge Case	Chamber Pressure	Hammer
Bolt	Case Clearance	Cycling Dynamics	Membrane
Bolt Carrier	Case Plastic Modulers	Extraction	Obturation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Experimental and theoretical studies were initiated to determine the basic factors involved in extracting a cartridge case from the chamber of a small arms weapon. Some of the forces acting on the cartridge which were studied included: (1) the blowback force caused by the internal pressure in the cartridge case at the time of extraction, (2) the frictional force resulting from the interference fit between the cartridge case and chamber,

18. SUPPLEMENTARY NOTES - Cont'd

extraction force for the M16 rifle. The help of Mr. John Duffy of the Special Projects Branch, Small Caliber Ammunition Division, is also acknowledged.

19. KEY WORDS - Cont'd

Pressure Gradient	Rifles	Strain Hardening
Propellant	Shell	Thermal Strains
Residual Pressure	Small Arms	Yield Strength

20. ABSTRACT - Cont'd

(3) the cartridge case inertial force, and (4) the force caused by the impact of the bolt carrier group with the bolt and cartridge case. A cartridge case extraction model based on thin shell theory, has been developed which describes the effects of several mechanical and material parameters on the extraction force of the M16 weapon. Another model describes the cartridge case-chamber interaction with cycling mechanism and weapon dynamics.

A parametric study involving six geometric and materials parameters for both conventional brass and 7475 (TMT) aluminum 5.56 mm cases in the M16 weapon is presented. Results defining the lowering of extraction force in terms of six materials and design factors are stated. It is found, based on these results, that the aluminum case is superior to brass in case of extraction.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: Report R-3009	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): MODEL FOR THE GAS TRANSMISSION SYSTEM OF THE M16A1 RIFLE	5. TYPE OF REPORT & PERIOD COVERED: Technical research report
6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s): SIDNEY GOLDSTEIN	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Frankford Arsenal, Attn: SARFA-MDS-B, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS: 4410.16.0217.8.04.02, DA Proj: F628090
11. CONTROLLING OFFICE NAME AND ADDRESS: ARMCOM	12. REPORT DATE: May 1974
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES
The technical assistance of Mrs. Joanne Brophy and Mr. John Duffy of the Special Projects Branch, Small Caliber Ammunition Division, in writing and conducting the computer portion for Part I of this report and obtaining experimental test data is gratefully acknowledged. Also

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

M16A1 Rifle	Contact Surface	Automatic Weapons
Gas Transmission	Method of Characteristics	Non-Steady Flow
Modeling	Interior Ballistics	Starting Processes
Shock Waves	Cycling Dynamics	Hypersonic Nozzles

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
In Part I a simplified quasi-steady model is presented to describe the flow of the propellant gas and solid particles through the pressure port in the M16A1 rifle barrel, and to establish the initial and boundary conditions for the flow in the gas tube. The behavior of the gas after the projectile leaves the barrel is predicted by Hugoniot's equations for describing the emptying of a reservoir containing a perfect gas

Cont'd

18. SUPPLEMENTARY NOTES - Cont'd

the work performed by Dr. James E. Miller, Consultant, in making operational the complete computer program including the initial and boundary conditions and the characteristic mesh resulting from the use of the method of characteristics is also gratefully acknowledged.

19. KEY WORDS - Cont'd

Fouling
Two-Phase Flow
Boundaries and Discontinuities

20. ABSTRACT - Cont'd

undergoing expansion through a sonic nozzle. Through the use of the "Lagrange approximation," these equations are coupled to describe the flow through the barrel and gas port.

In Part II an analysis is made of the experimental data obtained in the gas tube and bolt cavity of the M16A1 rifle. Numerical techniques are developed for using the method of characteristics to simulate the gas flow. A computer program to accomplish this is described in detail. A good comparison between the experimental data and the computer results is indicated.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER REPORT R-3020	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) LONG WAVELENGTH OPTICS FABRICATION		5. TYPE OF REPORT & PERIOD COVERED Technical research report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) J. R. Goldgraben, Ph.D. (Decilog, Inc.) Joseph P. Jacobson		8. CONTRACT OR GRANT NUMBER(s) DAAA-25-73-A0120
9. PERFORMING ORGANIZATION NAME AND ADDRESS Frankford Arsenal Attn: SARFA-FCD-P Philadelphia, PA 19137		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS: 4097.06.7191 DA Proj: 6727191
11. CONTROLLING OFFICE NAME AND ADDRESS ARMCOM		12. REPORT DATE May 1974 13. NUMBER OF PAGES 98
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

This project has been accomplished as part of the USA MM&T program which has as its objective the timely establishment of manufacturing process techniques or equipment to insure the efficient production of current or future defense materials.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Long Wavelength Optics
Far Infrared
Germanium
Optics Fabrication
Material Evaluation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An investigation was undertaken of the problems associated with fabrication of far infrared optical elements. The objective was to develop and document procedures for the cost-effective fabrication and testing of far infrared lenses for imaging and non-imaging fire control systems. Germanium was chosen as the key material for the project effort. Project personnel documented procedures employed in the Frankford Arsenal optical shop for the fabrication of germanium lenses. The physical

Cont'd

20. ABSTRACT - Cont'd

properties of optical grade germanium were examined. An effort was made to correlate information acquired in these activities, in order to examine critical aspects of each step in the lens-making process in light of the material profile of germanium. The early stages of the lens-making process are covered in this report. Shop procedures were developed and are included in an Appendix. The procurement and testing of optical grade germanium are examined and discussed. It was concluded that the techniques used in the fabrication of optical glass lenses can be used, with minor modifications, for the manufacture of germanium lenses.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TR-74004	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): THE EFFECT OF TALC ON THE BARREL LIFE OF A 20 MM AUTOMATIC GUN SYSTEM	5. TYPE OF REPORT & PERIOD COVERED: Technical research report
6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s): A. Victor Nardi	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Frankford Arsenal, Attn: SARFA-MDP-R, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS Code:5011.11.85700, DA Project:1C014501A32C
11. CONTROLLING OFFICE NAME AND ADDRESS: Propellant Laboratory, SARPA-FR-G, Picatinny Arsenal, Dover, NJ 07801	12. REPORT DATE: July 1974
	13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Barrel life
Talc
Erosion
Propellants
Automatic Cannon
Small Caliber Ammunition

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Barrel life tests were fired with the 20 mm, M39 Automatic Gun using a test schedule of a 200 round burst followed by complete cooling, the results indicate that the incorporation of small amounts of talc in the base grain of an extruded single base propellant increases barrel life. The largest increase in barrel life was obtained with the propellants containing ½ % incorporated talc.

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20. Abstract (cont'd)

The incorporation of the talc in the extruded propellant also changed the reason for disqualification in the barrel life test from excessive velocity drop to excessive yaw with generally very little velocity drop. This may have been caused in part by barrel fouling.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TR-74010	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): STRAIN GAGE INSTRUMENTATION FOR AMMUNITION TESTING	5. TYPE OF REPORT & PERIOD COVERED: Technical research report
6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s): PAUL D. FLYNN	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Frankford Arsenal, Attn: SARFA-PDR-B, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS: 4932.05.6494.0, DA Proj: N/A
11. CONTROLLING OFFICE NAME AND ADDRESS: ARMCOM	12. REPORT DATE: August 1974
	13. NUMBER OF PAGES: 50
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: N/A

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

This study was undertaken in support of a program on ballistic pressure measurements for the Small Caliber Ammunition Modernization Program (SCAMP). The helpful discussions and assistance received from W. A. Dittrich, J. D. Nicolo, and F. W. Stowell are deeply appreciated.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Strain Gages
Stress Gages
Ballistic Pressure Measurements
Ammunition Testing
Experimental Mechanics

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report deals with a feasibility study on the use of electrical-resistance strain gages for quality assurance testing of ammunition. A special combination of strain gages was selected to measure the quantity $(\epsilon_\theta + \nu\epsilon_z)$ on the outer surface of a test barrel. This combination of strain gages was essentially a stress gage which has several advantages over commercially available types. The combined strain

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18. SUPPLEMENTARY NOTES - Cont'd

It is a pleasure to acknowledge the technical assistance and cooperation of J. T. Gilbert in all phases of this work. Thanks are expressed to J. C. Hee for operating the AMINCO pressure balance and making the Kistler measurements, and to H. Wilde for machining the test barrels and the end caps for the hydraulic tests.

20. ABSTRACT - Cont'd

signal was proportional to the circumferential stress which was related to the internal ballistic pressure. The results of ballistic firings and hydraulic tests are reported which demonstrate the feasibility of this method for acceptance testing of ammunition.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TR-74014	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): PRODUCTION PROCEDURES FOR PLASTIC PERISCOPES	5. TYPE OF REPORT & PERIOD COVERED: Technical research report
6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s): JACK SAUNDERS) SACRAMENTO ARMY DEPOT ROBERT STEEL) PHILIP GALLAGHER, COORDINATOR	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Frankford Arsenal Attn: SARFA-MTT-O Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS: 3297.06.7281 DA PROJ.: 6737281
11. CONTROLLING OFFICE NAME AND ADDRESS: U.S. Army Armaments Command	12. REPORT DATE: August 1974
	13. NUMBER OF PAGES: 25
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: N/A

16. DISTRIBUTION STATEMENT (of this Report) Distribution limited to U.S. Government agencies only; Test and Evaluation; August 1974. Other requests for this document must be referred to Commander, Frankford Arsenal, Attn: SARFA-MTT-O, Philadelphia, PA 19137.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES This project has been accomplished as part of the USA MM&T program which has as its objective the timely establishment of manufacturing process techniques or equipment to insure the efficient production of current or future defense materials.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Fire Control Instrument
Plastic Periscope
Optical Instrument
Adhesive Bonding

20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report describes an engineering evaluation of various adhesives for their suitability as laminating materials to bond glass to acrylic in the manufacture of plastic periscopes to the requirements of MIL-P-46329. None of the adhesives evaluated proved totally acceptable. One material, a silicone adhesive-primer system, showed promise as a glass-to plastic laminate; however, improved heat resistance and wetability characteristics of the primer are required.

18. SUPPLEMENTARY NOTES (Cont'd)

This final report is on work conducted by Sacramento Army Depot for Frankford Arsenal. The principle investigators were Mr. Jack Saunders and Mr. Robert Steele. Work was performed from February 1973 to February 1974.

The authors wish to recognize the significant contributions of Mr. John Casper, Mr. Lewis Holley and Mr. William Condron of Frankford Arsenal for the technical assistance and guidance they provided throughout the course of this project.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) 12 March 1976 FAT 310-5

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER FA-TR-74034	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) FOREIGN MATERIAL EXPLOITATION REPORT - Laser Rangefinder PM81-B		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) David J. Lund Stephen Kozul Howard C. Guertler Joseph A. Costantino		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Frankford Arsenal Attn: SARFA-PDS-C Philadelphia, PA 19137		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Proj No: 1Y665702D650 Task No: FSTC Proj:3-220127
11. CONTROLLING OFFICE NAME AND ADDRESS Foreign Intelligence Office Frankford Arsenal Philadelphia, PA 19137		12. REPORT DATE November 1974 13. NUMBER OF PAGES 58
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Laser Rangefinder
Neodymium
Evaluation
Exploitation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes the electrical, optical, mechanical and system evaluation of a laser rangefinder capable of operating as part of the equipment used by artillery forward observers. The object of the evaluation, chosen because it is representative of foreign state-of-the-art technology, was the Simrad PM81-B Laser Rangefinder, manufactured by Simonsen Radio, Oslo, Norway. All experiments and tests conducted in this study were designed to maintain the physical and operational integrity of the device.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER FA-TR-74041	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) EVALUATION TEST OF RADAR CHRONOGRAPH SET, NM87		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Filmore Richter		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Frankford Arsenal Attn: SARFA-FCF-E Philadelphia, PA 19137		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS Code: 5210.17/80H DA Proj:67502.12.03900.01
11. CONTROLLING OFFICE NAME AND ADDRESS USA ARMCOM Rock Island, IL 61201		12. REPORT DATE December 1974 13. NUMBER OF PAGES 95
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Radar Chronograph
Muzzle Velocity
Measurements
Velocimeter

20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The Norwegian Radar Chronograph Set, NM87 was evaluated by Frankford Arsenal from November 1972 through March 1974 to determine the capability of the NM87 to chronograph standard cannon artillery.

The NM87 was subjected to laboratory, environmental, and firing tests. From the results obtained to date, it is concluded that this chronograph is simple to operate, reliable, requires little maintenance,

20. Abstract (cont.)

and is capable of the same order of precision as is possible with the M36 Radar Chronograph Set which is the item currently used for muzzle velocity measurements.

Report indicates some limitations and recommends improvements for utilization of the equipment.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TR-74043	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): STUDY OF TRACER MUNITIONS USING INTERMETALLIC REACTIONS	5. TYPE OF REPORT & PERIOD COVERED: Technical Research Report
6. PERFORMING ORG. REPORT NUMBER: LMSC-D356264	
7. AUTHOR(s): ALEXANDER P. HARDT - Lockheed Missiles & Space Co., Inc.	8. CONTRACT OR GRANT NUMBER(s): DAAA25-72-C-0319
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Lockheed Palo Alto Research Laboratory, Lockheed Missiles & Space Co., Palo Alto, CA 94304	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS:662604.11AH97.6203, DA Proj: 1J662604AH97
11. CONTROLLING OFFICE NAME AND ADDRESS: Small Arms Systems Agency, Aberdeen, MD	12. REPORT DATE: December 1974 13. NUMBER OF PAGES: 36
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): Frankford Arsenal, Attn: SARFA-MDP-Y, Philadelphia, PA 19137	15. SECURITY CLASS. (of this report): UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: N/A

16. DISTRIBUTION STATEMENT (of this Report): Distribution limited to U.S. Government agencies only - Test and Evaluation - 1974. Other requests for this document must be referred to the Commander, Frankford Arsenal, Attn: SARFA-MDP-Y, Philadelphia, PA 19137.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES: Mr. Dennis J. Mancinelli, Pyrotechnic Development Branch, MDP-Y, Frankford Arsenal, Philadelphia, PA was Project Officer and served as Technical Contract Monitor for this effort. Inquiries pertaining to this (Cont'd)

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Pyrotechnics	Titanium
Tracers	Covert Action
Intermetallic Reactions	Small Arms Ammunition
Boron	7.62 NATO Tracer
Carbon	Zirconium

20. ABSTRACT (Continue on reverse side if necessary and identify by block number): This is a feasibility study on the application of intermetallic reactions to tracer munitions. Several types of mixtures, principally those containing powdered titanium or zirconium in carbon or boron were tested at night in 7.62mm tracer bullets. A theoretical analyses of the performance of tracers using gasless reactions was made as well. Experimentally, it was found that a mixture of coarse titanium in amorphous boron produces the brightest trace for the longest duration. The performance of the tracers was improved

#18. (Cont'd)

task should be addressed to his attention.

This study was performed by the Lockheed Palo Alto Research Laboratory, Lockheed Missiles and Space Company, Inc. (LMSC), 3251 Hanover Street, Palo Alto, CA 94304 under contract DAAA25-72-C-0319 for the U.S. Army, Frankford Arsenal, Philadelphia, PA. The Program Manager was Mr. Dennis J. Mancinelli (MDP-Y). The study was conducted between 1 January 1972 and 1 December 1973.

The study was performed under the direction of Dr. Alexander P. Hardt, LMSC Principal Investigator. The test firings of the tracers were directed by Mr. Wilson M. Quick, LMSC Santa Cruz Facility Program Engineer. The laboratory studies were conducted by Mr. R.W. Holsinger, LMSC Program Engineer. Demonstration tests were conducted at Fort Ord, California, under the supervision of Major Clifford McDuffy. The theoretical analysis of the necessary light intensities was performed by Dr. Michel Hone on behalf of Frankford Arsenal.

#20. (Cont'd)

significantly by the admixture of a nitrate. It was concluded that tracer munitions containing intermetallic reaction mixtures may improve the ballistic match of the tracers as well as afford a new approach to providing covert activity capability and improved storageability. Future studies in intermetallic reaction tracers might be extended to various calibers and to study the heat transfer process within the bullet by means of instrumented laboratory and wind tunnel tests. Furthermore, incendiary or spotting characteristics of intermetallic tracer munitions could be further investigated.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER FA-TR-74045	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) RUNAWAY ESCAPEMENT REDESIGN M125A1 MODULAR BOOSTER		5. TYPE OF REPORT & PERIOD COVERED Technical research report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) LOUIS P. FARACE		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Frankford Arsenal Attn: SARFA-MDA-E Philadelphia, PA 19137		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS: 4110.16.4737.6
11. CONTROLLING OFFICE NAME AND ADDRESS ARMCOM		12. REPORT DATE December 1974 13. NUMBER OF PAGES 58
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

M125A1 Booster
Delay Arming Mechanism
Runaway Escapement
Math Model
Gear Mesh
Pivot Friction
Journal Bearing Losses

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An analytical investigation was conducted to determine the effect of friction on the modular version of the M125A1 Booster mechanism, a Safe and Arming Device which operates in a centrifugal force field created by a spinning projectile. The investigation uncovered two points of contact which were extremely sensitive to friction.

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20. ABSTRACT - Cont'd

Subsequent redesign utilizing a simple friction loss math model and a computer program to analyze the escapement mesh resulted in a design which operated significantly smoother and started more readily. Both laboratory and ballistic tests verified that this new version met all timing and functioning requirements with a high degree of accuracy and reliability. It is anticipated that production of the new design in mass quantities will result in increased production yield and improved performance with no increase in cost.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TR-74046	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): X-RAY STUDIES ON THE FLARED CONE COMPONENT FOR METAL PARTS ASSEMBLY M456A1E1	5. TYPE OF REPORT & PERIOD COVERED: Technical research report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Fred Witt	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: FRANKFORD ARSENAL, Attn: SARFA-PDM-E, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS Code: 4810.16.2153.8, DA Proj: N/A
11. CONTROLLING OFFICE NAME AND ADDRESS: Picatinny Arsenal	12. REPORT DATE: December 1974
	13. NUMBER OF PAGES: 34
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Heat Ammunition
Shaped Charge Liners
Automated X-ray Analysis
Preferred Orientation
Metal Drawability Index
Pole Figures
Texture

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The armor penetrating ability of shaped charge liners is considered to be critically dependent upon the annular symmetry of the metallurgical properties of the cone from which the jet is formed. A critical review is given of the current x-ray inspection method for monitoring production and predicting ballistic quality of the liner. Recently developed computer aided equipment and associated mathematics is described for determining the R-value index of metal drawability as determined (cont.)

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20. ABSTRACT (cont'd)

from automated pole figure analysis of coupons cut from the flared liner. A description is given of the shear spin process, the constraints imposed by the sine law, and the complications introduced by deviating from it.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TR-74047	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): STUDY OF REACTION MECHANISM IN TRACER MUNITIONS	5. TYPE OF REPORT & PERIOD COVERED: Technical Research Report
6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s): Alexander P. Hardt and Peter V. Phung (Lockheed Missiles & Space Company, Inc.) Thomas Doris - Coordinator	8. CONTRACT OR GRANT NUMBER(s): DAAA25-73-C-0675
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Lockheed Missiles & Space Company, Inc. Lockheed Palo Alto Research Laboratory 3251 Hanover Street, Palo Alto, CA 94304	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: Frankford Arsenal Attn: SARFA-MDP-Y Philadelphia, PA 19137	12. REPORT DATE: December 1974
	13. NUMBER OF PAGES: 56
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Tracer Munitions
Tracer Reactions
Thermal Analysis
Thermal Conductivities
Nitrate Kinetics
Equilibrium Calculations
Burning Rates

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A study of reaction mechanisms in tracer munitions was performed in which the attempt was made to assess the parametric importance of the mixture characteristics in determining the burning rate and, to the extent possible, on trace duration and visibility. Kinetic data on the decomposition of strontium nitrate and of polyvinyl chloride were measured, as were the thermal conductivities of several tracer mixtures of varying fuel-to-oxidizer ratios. Heat transfer into the solid tracer mixture was

20. ABSTRACT - (cont'd)

analyzed numerically, and the heat flux was obtained from experimentally determined burning rates of stationary and spinning tracer bullets. The presence of the binder was neglected in the analytical study.

By assuming that the metal oxide was generated in the gas phase, the thickness of the reaction zone was obtained as a function of the particle size. Burning rates were computed as a function of heat flux for various fuel-to-oxidizer ratios. The application of these findings to tracer munitions still requires experimentally determined burning rates that define the partition between the heat flux into the solid and the total heat generated by the tracer reaction.

The understanding of tracer reactions which was achieved in this study will be valuable in other applications of metal-oxidant systems such as flares and fumer bullets.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TR-75001	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): X-RAY STUDIES OF BELGIAN PRODUCED 105MM HEAT-T-M456 SPIN COMPENSATED SHAPED CHARGE LINERS	5. TYPE OF REPORT & PERIOD COVERED: Technical research report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Fred Witt	8. CONTRACT OR GRANT NUMBER(s): AMCMS Code: 675709.12.03900 DA Proj: 1Y765709D650
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Frankford Arsenal, Attn: SARFA-PDM-E, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: ARMCOM	12. REPORT DATE: January 1975
	13. NUMBER OF PAGES: 43
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: N/A

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Heat Ammunition
Shaped Charge Liners
Automated X-ray Analysis
Preferred Orientation
Metal Drawability Index
Pole Figures
Texture

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Recently developed computer aided equipment and associated mathematics is described for determining the R- value index of metal drawability as determined from automated pole figure analysis of coupons cut from Belgian produced shaped charge liners.

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TR-75006	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): TMDE TASK 05, INFORMATION DYNAMICS, MAIDS STUDY MICROPROGRAMMING TECHNOLOGY AND APPLICATIONS.	5. TYPE OF REPORT & PERIOD COVERED: Final Engineering Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): ROBERT E. DOLCEAMORE	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Frankford Arsenal, ATTN: SARFA-FCF-C, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS: 662610, DA PROJ: 1G662610-AJ29
11. CONTROLLING OFFICE NAME AND ADDRESS: U.S. Army Armament Command, Rock Island, IL 61201	12. REPORT DATE: JUNE 1975
	13. NUMBER OF PAGES: 93
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
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16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

This effort is part of a coordinated program of applied research and exploratory development in the application of microprogramming toward meeting the hardware and software requirements of the Multipurpose Automatic Inspection and Diagnostic System (MAIDS).

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

MAIDS
MICROPROGRAMMING
EMULATION

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report represents an initial study of the technology of microprogramming and its potential in solving the many technical problems associated with developing the MAIDS. Identified are the character and status of microprogramming and the potential arena in which microprogramming will play an important role in the future. Applications of this technology are discussed and research areas identified which are most appropriate to the technology requirements of MAIDS.

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18. SUPPLEMENTARY NOTES (Cont'd)

This effort was conducted under Common Test, Measurement and Diagnostic Equipment and Techniques - Information Dynamics, TMDE Task 05, Project Number 1G662610AJ2905.

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1. REPORT NUMBER: FA-TR-75024	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): LASER RANGEFINDING TECHNIQUES FOR HELICOPTER FIRE CONTROL APPLICATIONS Phase I - Hardmounted Laser Concept	5. TYPE OF REPORT & PERIOD COVERED: Final Test Report Oct. 1973 - Oct. 1974
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Albert C. Cappiella	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Fire Control Development & Engineering Dir. Frankford Arsenal, ATTN FCW-W Philadelphia, Penna., 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: Prog. Ele. 63206A Proj. No. 1F263206D043 Task Area 03, Work Unit #001 F6
11. CONTROLLING OFFICE NAME AND ADDRESS: U. S. Army Armament Command Rock Island, IL 61201	12. REPORT DATE: January 1975 13. NUMBER OF PAGES: 33
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Lasers
Rangefinders
Fire Control for Helicopters
Hardmounted Configuration

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The concept of hardmounting a laser rangefinder to a helicopter airframe and having the pilot obtain the range to target by pointing the aircraft, was evaluated. The overall results indicate that this technique produced range errors of approximately 10% over all altitudes (300 ft. to 2500 ft.). The evaluation showed the range error to increase significantly as operational altitude decreased.

Continued on next page. . . .

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This was due to small angular pointing errors translating into large horizontal miss distances when small grazing angles are incurred. Range errors of 20-25% were projected at 50-100 ft. altitudes. It was also determined that last pulse return logic produced smaller range errors than first pulse return logic.

In summary, utilization of a laser rangefinder in a hardmounted configuration was found to be severely limited by the pilot's ability to point the aircraft. This indicates the need for independent pointing of the laser for effective rangefinder application to helicopter fire control systems, particularly under nap-of-the-earth (NOE) conditions.

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER FA-TR-75025	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) BINARY PROJECTILE CORROSION PROBLEM - CORROSION & CORROSION INHIBITION OF METALS IN HYDROFLUORIC ACID SOLUTION.		5. TYPE OF REPORT & PERIOD COVERED Technical Research Report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Fred Pearlstein Robert F. Weightman		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Frankford Arsenal ATTN: SARFA-PDC Philadelphia, PA 19137		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS CODE: 611101.11.84400 DA PROJECT: 1T1611101A9A
11. CONTROLLING OFFICE NAME AND ADDRESS Frankford Arsenal		12. REPORT DATE April 1975 13. NUMBER OF PAGES 23
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Binary projectiles	Steel membrane
Corrosion	Hydrofluoric acid
Corrosion inhibition	Electrode potentials
Protective coatings	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Corrosion inhibition studies were conducted in relation to a problem encountered with a binary projectile system. It was found that corrosion of steel in dilute (0.59 N) hydrofluoric acid solution was greatly retarded by the addition of small amounts of As_2O_3, o-tolylthiourea (OTTU), benzotriazole (BT), gelatine (GEL), quinoline ethiodide (QEI), or n-laurylpyridinium chloride (NLPC). The combination of OTTU-BT provided quite effective inhibition with little tendency

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20. ABSTRACT (Cont'd)

for pitting corrosion. The addition of inhibitor to hydrofluoric acid solution resulted in an increase in the corrosion potential of steel indicative of predominant inhibition of the anodic reaction; the highest potential was obtained with OTTU addition. The corrosion potential of steel in acid containing organic inhibitors was unrelated to degree of inhibitor effectiveness but with metal salt addition, the log corrosion weight loss was linearly related to the potential.

The ability for various metals to resist hydrofluoric acid attack was determined in order to arrive at potential coating systems for steel or alternate membrane materials. Steel was rapidly attacked in uninhibited 0.59 N hydrofluoric acid. The metals: steel, antimony, 321 stainless steel, tin, lead, nickel, and magnesium are in the order of increasing resistance to acid dissolution.

Corrosion inhibitors in the actual corrosive agent of the binary projectile were relatively ineffective for reducing corrosion rates of steel.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TR-75026	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): CORRELATION DETERMINATIONS BETWEEN STRESS CORROSION CHARACTERISTICS OF WROUGHT 7039 ALUMINUM ARMOR AND OTHER ALLOY CHARACTERISTICS - BALLISTIC PERFORMANCE, YIELD STRENGTH, AND ELECTRICAL CONDUCTIVITY.	5. TYPE OF REPORT & PERIOD COVERED: Technical research report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): JAMES V. RINNOVATORE, DONALD T. RORABAUGH, ALBERT ZALCMANN	8. CONTRACT OR GRANT NUMBER(s): AMCMS CODE: 662601.11.H9100 DA PROJECT: 1G662601AH91
9. PERFORMING ORGANIZATION NAME AND ADDRESS: FRANKFORD ARSENAL, Attn: SARFA-PDM, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: TACOM	12. REPORT DATE: April 1975
	13. NUMBER OF PAGES: 30
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

The authors wish to thank Messrs. F. Ripkin and J. Gordon for their assistance with the Phase I Statistical Analysis and the Phase II Stress Corrosion Evaluation, respectively.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

7039 Armor
Stress Corrosion
Ballistic Performance
Aluminum Armor

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This study was performed to determine whether a correlation could be established between the stress corrosion resistance of wrought 7039-T6 aluminum armor plates and other alloy characteristics such as ballistic performance, yield strength, and electrical conductivity. A survey and statistical analysis were conducted on acceptance test data available for about 500 preproduction lots of 7039-T6 plates.

(cont'd)

20 Abstract (cont'd)

In addition, 7039 aluminum plates were heat treated to provide several selected strength levels outside the MIL-A-46063 specification range to determine whether a correlation could be found over a wider range of properties than that covered by the specification.

The results of the work indicate that:

1. No linear correlation could be found between the SCC resistance of 7039-T6 alloy plates and other characteristics i.e. yield strength, ballistic performance, and electrical conductivity.

2. No significant distinction could be made between the yield strength or ballistic performance of 7039-T6 material that passed the standard SCC test and the corresponding property of material that failed the test.

Recommendations are given for future work on other weldable aluminum alloys in which correlations might possibly exist.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TR-75029	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): LASER RANGEFINDING TECHNIQUES FOR HELICOPTER FIRE CONTROL APPLICATIONS Phase II - Nonstabilized Gimballed Laser Concept	5. TYPE OF REPORT & PERIOD COVERED: Final Test Report June 1974 - October 1974
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Albert C. Cappiella	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Fire Control Development & Engineering Dir. Frankford Arsenal, ATTN: FCW-W Philadelphia, Pa., 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: Prog. Ele. 63206D Proj. No. 1F263206DK62 Task Area 14, Work Unit #004
11. CONTROLLING OFFICE NAME AND ADDRESS: U.S. Army Missile Command Redstone Arsenal, ATTN: AMSMI-RFW Huntsville, Ala., 35809	12. REPORT DATE: March 1975
	13. NUMBER OF PAGES: 30
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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Lasers
Rangefinders
Helicopter Fire Control Applications
Unstabilized Gimballed Configuration

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The concept of employing a non-stabilized gimbal for mounting a laser rangefinder on an AH-1G helicopter was evaluated using existing hardware. The overall results indicate that this technique produced slant range errors of approximately 7% over the altitudes tested (300, 500, 1000, and 1500 feet). The evaluation showed the range error to increase significantly as operational altitude decreased. This is due

(continued on next page)

to angular pointing errors translating into large slant range errors when small grazing angles are incurred. Range errors approaching 15% were projected with this system at 50-100 foot altitudes. It was also determined that the use of first pulse return logic generally produced smaller range errors than last pulse logic. In addition, a reduction in operational airspeed resulted in a slight decline in the range error.

In summary, utilization of a non-stabilized gimballed laser rangefinder configuration by the copilot/gunner for helicopter fire control systems was only marginally effective at lower altitudes. The need for stabilization of the pointing system is indicated particularly under nap-of-the-earth (NOE) conditions. The addition of a stabilization capability will aid laser pointing while simultaneously allowing use of magnification to improve target detection, recognition and identification ranges.

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TR-75031	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): PROJECTILE SPIN RATE MEASUREMENT USING INDUCED ELECTROMOTIVE FORCE TECHNIQUES	5. TYPE OF REPORT & PERIOD COVERED: Engineering Project Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): M. E. Goldser	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: FRANKFORD ARSENAL, Attn: SARFA-TSE-B, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS: 611101.11.84400 DA PROJ: 1T1611.01A91A/ILIR
11. CONTROLLING OFFICE NAME AND ADDRESS: FRANKFORD ARSENAL, Attn: SARFA-TSE-B, Philadelphia, PA 19137	12. REPORT DATE: May 1975
	13. NUMBER OF PAGES: 12
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18. SUPPLEMENTARY NOTES

Prepared in cooperation with Mr. N. Schweizer, Mr. G. Weiss, & Mr. S. Sneade.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Spin Rate
Magnetized Projectiles
Induced Electromotive Force

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report deals with the problem of measuring the rotation of a projectile (spin) without altering the center of gravity, exterior surface and true weight of the projectile.

Twenty millimeter projectiles were magnetized and fired parallel to a 12 foot long coil. The induced electromotive force (e.m.f.) was amplified and recorded on magnetic tape for playback through an oscillograph recorder. The period of the generated sine wave was then measured to determine (cont'd)

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20. ABSTRACT (cont'd)

the spin (f=1/T). Different barrels were used to obtain data over a wide range of twists. It was found that this system provided a reliable and "production line" method for the measurement of spin rate.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER FA-TR-75037	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) THE EFFECT OF STATISTICAL VELOCITY VARIATION ON THE GAUSSIAN BIVARIATE PROBABILITY OF HIT FOR SMALL CALIBER SYSTEMS		5. TYPE OF REPORT & PERIOD COVERED Technical Research Report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Frederick A. Malinoski Jerzy Niemirow		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS FRANKFORD ARSENAL ATTN: SARFA-MDS-B Philadelphia, PA 19137		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS: 4110.16.0042.6.01 DA Project: F646003
11. CONTROLLING OFFICE NAME AND ADDRESS USA ARMCOM Rock Island, IL 61201		12. REPORT DATE May 1975 13. NUMBER OF PAGES 26
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Normal Probability Distribution	Statistical Analysis
Ballistic Error	Propellant Airspace
Aiming Error	Small Caliber Ammunition
Bias and Linear Standard Deviation	M14 and M16 Rifles

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The statistical variations in both the average velocity and the linear standard deviation of velocity, due to the location of propellant airspace, are investigated by trajectory conversions to errors on a vertical target and by calculations of rectangular hit probabilities with the Gaussian bivariate distribution. The two cartridges examined are the 7.62mm, Ball, M80 and the 5.56mm, Ball, M193. Sources of errors and their magnitudes are discussed. Two diverse levels of aiming error are

20. ABSTRACT (continued)

assumed, corresponding to present requirements for the Future Rifle System. The range-dependent errors due to velocity variations are treated as perturbations of the ballistic error. The nose-tap (NT) procedure of chambering cartridges is compared to the standard base-tap (BT) procedure by assuming that zero bias is applicable to the BT procedure and that the NT procedure introduces a finite bias. Calculations are conducted with assumptions which tend to maximize the influence of the velocity variation, and the limiting case of zero aiming error is also treated. The changes in hit probability due to the statistical velocity variations corresponding to the BT and NT air space positions are shown to be insignificant for these two standard cartridges.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TR-75046	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): DEVELOPMENT OF THE CARTRIDGE, CALIBER .38 SPECIAL, BALL PGU-12/B	5. TYPE OF REPORT & PERIOD COVERED: Technical research report
6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s): VERNON E. SHISLER	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Frankford Arsenal, Attn: SARFA-MDS-E, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS: 4110.16.0132.7
11. CONTROLLING OFFICE NAME AND ADDRESS: Hill Air Force Base, Ogden Air Materiel Area, Attn: MMECB, Ogden, Utah	12. REPORT DATE: July 1975
	13. NUMBER OF PAGES: 68
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Small arms ammunition
Hand gun
Caliber .38
Special
High velocity

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report documents engineering activities associated with the design, development and evaluation of a high velocity Caliber .38 Special Military Cartridge. The object was to develop a cartridge with the highest velocity possible with a 130 grain fully-jacketed bullet while not exceeding a maximum average pressure of 20,000 psi. The cartridge was developed specifically for the Air Force who has subsequently designated it the

20. ABSTRACT - Continued

PGU-12/B. The cartridge utilizes the Standard Caliber .38, M41 case. The bullet, however, is seated deeper into the case. The body of the case is rolled into the cannelure of the bullet, and a slower burning propellant is used. The PGU-12/B cartridge is loaded to a velocity of 1125 ft/sec measured 15 feet from a test barrel.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TR-75050
2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle): ANALYSIS AND DESIGN OPTIMIZATION OF A PERMANENT MAGNET SECOND ENVIRONMENT SENSOR FOR THE SAFING AND ARMING MECHANISM OF THE XM-712 CANNON LAUNCHED GUIDED PROJECTILE (CLGP)

5. TYPE OF REPORT & PERIOD COVERED: Technical engineering report

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s): Alan D. Aronoff
Philip E. Bloomfield

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS: FRANKFORD ARSENAL
Attn: SARFA-PDR-P
Philadelphia, PA 19137

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS Code:633309.12.20100
DA Proj:1X363309D073

11. CONTROLLING OFFICE NAME AND ADDRESS: AMCPM-CAWS/Picatinny Arsenal

12. REPORT DATE: July 1975

13. NUMBER OF PAGES: 77

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18. SUPPLEMENTARY NOTES

The major portion of the work described in this report was funded by DA Project 1X363309D073, AMCMS Code 633309.12.20100, for the Cannon Launched Guided Projectile Program and was performed between 1972 and 1974. The

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Safing and Arming Mechanism (S&A)
Cannon Launched Guided Projectile (CLGP)
XM-712
Second Environment Sensor
Magnetic Induction Sensor
Muzzle Exit Sensor
Dual Safe
Velocity Discrimination

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report investigates the use of a permanent magnet sensor mounted flush with the maximum outer diameter of a 155mm non-spin projectile, and its ability to produce intelligent signals and generate sufficient usable energy during projectile muzzle exit, so that this device may be employed with the second environment locking system of the safing and arming mechanism for the XM-712 Cannon Launched Guided Projectile. The magnetic device involves the interaction of a permanent magnet fitted with a

18. SUPPLEMENTARY NOTES - Cont'd

computer simulation studies were funded in part by AMCMS Code 672721.11.24923, DA Project 1E76271A090 entitled Computer Aided Design and Engineering (CAD-E).

The authors wish to acknowledge the valuable contributions made by the following personnel: John P. Hunt for engineering consulting services, fabrication and assembly of nearly all models and for the high velocity air gun muzzle exit simulation tests, Robert Shaffer for engineering consulting services, Warren Fogg and Donald Ford for their technical assistance in developing the muzzle exit simulator, and technical comments by William Boghosian, Howard Jenkinson and Robert Esposito.

20. ABSTRACT - Cont'd

suitable pick-up coil and embedded in the projectile surface with induced magnetic poles occurring in the barrel wall. The flux change produced on barrel exit yields electrical energy which is stored on a capacitor. Optimization techniques are applied to magnetic materials choice, the magnetic circuit configuration, and methods for storing energy. Such techniques are particularly important in satisfying the constraints of small size and large air gaps where proportional scaling of previously developed, relatively inefficient devices is inadequate to satisfy energy requirements. An analysis has been made, based on the theory of magnetic images, to obtain the flux change produced on barrel exit. This analysis has led to a basis for the selection of device configurations and materials which maximizes the output energy as a fraction of the total energy stored in the magnetic field. Dynamic tests simulating barrel exit have confirmed for the optimum designs a reasonable device efficiency; that is, acceptable output energy per unit volume of the magnetic structure. Design considerations involved in further improvement are discussed, particularly the advantage of rare earth magnets in reducing size and increasing performance. To illustrate the principles involved in magnetic circuit optimization, permeance flux calculations are given for several magnet configurations; and computer circuit programs are used to determine optimum component values for energy storage capacitors as a function of muzzle velocity.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TR-75056	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): A BULLET-IN-BORE STUDY IN CALIBER .38 SPECIAL REVOLVERS	5. TYPE OF REPORT & PERIOD COVERED: Technical research report
6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s): VERNON E. SHISLER	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Frankford Arsenal, Attn: SARFA-MDS-E, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS: 4110.16.0132.7
11. CONTROLLING OFFICE NAME AND ADDRESS: US Army Armament Command, Rock Island, IL 61201	12. REPORT DATE: August 1975
	13. NUMBER OF PAGES: 64
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Caliber .38 Special
Bullet-in-Bore
Revolver
Hand Gun

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A considerable number of malfunctions occur in the Military Caliber .38 Special Revolver-Ammunition System that are characterized by the lodging of a bullet in the barrel of the revolver from which it is being fired. These are called bullet-in-bore (BIB) malfunctions. This report discusses an attempt that was made to determine those factors in the weapon and ammunition that contribute to such a malfunction. (cont'd)

20. ABSTRACT - (cont'd)

The large number of variables and the complexity of modeling interior-ballistic performance as a function of propellant position make theoretical interior-ballistic analysis exceedingly difficult. Therefore, the investigative method was more experimental. The various factors that could contribute to such a malfunction were predicted on the basis of field malfunctions, related practical experience in ammunition design and performance, and established principles of interior ballistics. These predictions were verified experimentally.

From this study it was concluded that of all the possible factors that could contribute to a bullet-in-bore, the large amount of air space is the most significant. Large variations in cartridge performance are possible with different positions of propellant within this air space. It was shown that a low bullet extraction force could also significantly contribute to such a malfunction.

Based on these findings, it was recommended that the cartridge be made less susceptible to these malfunctions by reducing the amount of air space and increasing the controlling the bullet extraction force. Possible design changes for accomplishing this are discussed in the CONCLUSIONS at the end of this report.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER FA-TR-75076	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) EXPERIMENTAL STUDIES AIMED AT PRODUCING EXTRUDED PROPELLANTS HAVING A BULK DENSITY OF 0.93 GRAMS PER C.C. OR BETTER FOR 5.56MM AND 7.62MM U.S. AMMUNITION		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) W. L. Phené		8. CONTRACT OR GRANT NUMBER(s) DAAA25-75-C0193
9. PERFORMING ORGANIZATION NAME AND ADDRESS Canadian Industries Ltd. Explosives Division Valleyfield, P. Q.		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS PEMA F617014 PROJECTS F617004
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Armament Command Rock Island Arsenal Rock Island, IL 61202		12. REPORT DATE June 1975 13. NUMBER OF PAGES 87
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) FRANKFORD ARSENAL PHILA., PA 19137		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Technical superviser of contract DAAA25-75-C0193 was Mr. Ludwig Stiefel, MDP-R, Bldg. 64-3, Frankford Arsenal, Philadelphia, Pennsylvania 19137

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Small Arms Ammunition
Ammunition
Rifle Ammunition
Machine Gun Ammunition
Propellants
Extruded Propellants

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Modified double base granular propellants containing low level percentages of nitroglycerine have been manufactured and ballistically tested in 7.62mm and 5.56mm ball ammunition. Both powders were completely in conformance with specification requirements at all temperature levels. The propellants were easily loadable in their respective cartridges. The 7.62mm propellant met the 0.93 gms/cu. cm. minimum bulk density requirements of the Development

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Contract (CONTRACT NO. DAAA25-75-C0193). The 5.56mm propellant was however a little low in bulk density at 0.915 gms./cc.

With regards the 7.62mm propellants, 0.5% calcium carbonate has been added in an effort to improve barrel erosion properties. With the 5.56mm propellant the potassium sulphate content has been maintained at a relatively high level with the objective of improving flash characteristics.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: T73-5-1	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): AN INVESTIGATION OF A SCRATCH METHOD FOR TESTING THE HARDNESS OF ANODIC COATINGS ON ALUMINUM ALLOYS	5. TYPE OF REPORT & PERIOD COVERED: Technical Test Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): WALTER A. SHEBEST WILLIAM L. BOYER, JR.	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Commander FRANKFORD ARSENAL, ATTN: SARFA-TSE-M-64-1 Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMS Code: 53970M6350 PRON: A1-5-KA005-F6-NH
11. CONTROLLING OFFICE NAME AND ADDRESS: Commander Army Materials and Mechanics Research Center ATTN: AMXMR-MO, Watertown, MA 02172	12. REPORT DATE: April 1973 13. NUMBER OF PAGES: 25
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: N/A

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

The authors are indebted to Mr. Fred Pearlstein for his technical advice and for supplying the anodized panels.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Anodic Coating	3-gm, 5-gm, and 9-gm weights
Bierbaum Tester	Bierbaum, Vickers, and Knoop diamonds
Tukon Tester	Scratch Width
Taber Abraser	Weight Loss after 10,000 cycles

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A preliminary study has been made of the relationship between weight losses in a standard abraser test and scratch-hardness tests made on a series of anodic coatings produced on aluminum alloy panels.

Tests show that for certain conditions of scratch stylus and test load, a general relationship exists wherein coatings that result in higher

(continued)

20. ABSTRACT: (continued)

weight losses in the abraser tests also yield scratches of greater width in the scratch-hardness test.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER TEST REPORT T74-5-1	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) BALLISTIC STUDIES OF IMPROVED 30mm AMMUNITION FOR AIRCRAFT GUN TYPE WEAPONS		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) JOSEPH BORGER BENJAMIN PODOLSKY JOHN SLIVOVSKY		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS FRANKFORD ARSENAL Attn: SARFA-MDC-A Philadelphia, PA 19137		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS: 514B.12.11223.03 DA Proj: 1F164202D133.23.03
11. CONTROLLING OFFICE NAME AND ADDRESS USAWECOM		12. REPORT DATE April 1974 13. NUMBER OF PAGES 685
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Improved 30mm Ammunition Program	Interior Ballistics
Reduced Time-of-Flight	Exterior Ballistics
Extended Range	Muzzle Velocity
Ballistic Testing	Chamber Pressure cont'd

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report documents the data generated in one hundred and twenty-eight test firing programs during the conduct of the Reduced Time-of-Flight sub-task for the Improved 30 mm Ammunition Program from 3 November 1971 to 29 January 1973.

The data represent the firings of approximately four thousand (4000) rounds of ammunition. Categories of study included propellant, primer, cartridge case and cartridge investigations.

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19. KEY WORDS (Cont'd)

Test Categories

Propellant
Primer
Case
Cartridge
Acceptance

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TT-74058	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): THERMAL AND STABILITY STUDY OF TETRACENE USING DIFFERENTIAL SCANNING CALORIMETRY (DSC)	5. TYPE OF REPORT & PERIOD COVERED: Technical Test Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): GEORGE NORWITZ MARTIN E. EVERETT MICHAEL T. GURBARG	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Commander FRANKFORD ARSENAL, ATTN: SARFA-TSE-M-64-1 Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMS Code: 53970M6350 PRON: A1-5-KA005-F6-NH
11. CONTROLLING OFFICE NAME AND ADDRESS: Commander Army Materials and Mechanics Research Center ATTN: AMXMR-MQ, Watertown, MA 02172	12. REPORT DATE: December 1974 13. NUMBER OF PAGES: 21
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: N/A

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Tetracene
1-(5^1-tetrazolyl)-4-guanyltetrazene hydrate
1-guanyl-4-nitrosoaminoguanyl tetrazene
Differential scanning calorimetry
DSC

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A thermal analysis study was made of tetracene using differential scanning calorimetry (DSC). The effect of different scan speeds was investigated. At scan speeds of 0.625°to 10°C per minute two large rounded exothermic peaks were produced. The peaks occurred at an increasingly high temperature as the scan speed increased (for example, the peaks occurred at 128° and 130°C at a scan speed of 0.625°C per
(continued)

20. ABSTRACT: (continued)

minute and at 148° and 150°C at a scan speed of 10°C per minute). When tetracene was heated at a scan speed of 80°C per minute only one large sharp exothermic peak was produced. It is believed the two peaks obtained at scan speeds of 0.625° to 10°C per minute represent decomposition of the tetracene in two successive stages, the first of which is probably decomposition into a liquid product (and nitrogen). The deduction that a liquid product is produced follows from the fact that a distinct apparent melting point occurs about 0.5°C before the explosion point when tetracene is tested in the Vanderkamp melting point apparatus as described in the Government specification for tetracene (MIL-T-46938A). A stability test for tetracene is proposed that involves heating of the tetracene in aluminum pans from the DSC apparatus in ovens at 100°, 75°, and 60°C, removing the pans and samples at intervals of 30 minutes, 24 hours, and 7 days (respectively), subjecting the samples to DSC at 1.25°C per minute, and noting the time interval in the oven that produces a DSC curve that shows obliteration of the second peak. Two lots of tetracene made by different processes showed marked differences in stability characteristics.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TT-74039	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): ULTRAVIOLET AND VISIBLE SPECTRA OF TACOT (TETRANITRODIBENZO-1,3a,4,6a-TETRAAZAPENTALENE) IN VARIOUS SOLVENTS	5. TYPE OF REPORT & PERIOD COVERED: Technical Test Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): GEORGE NORWITZ, HERMAN GORDON	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Commander, FRANKFORD ARSENAL, ATTN: SARFA-TSE-M-64-1, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMS Code: 53970M6350, PRON: A1-5-KA005-F6-NE
11. CONTROLLING OFFICE NAME AND ADDRESS: Commander, Army Materials and Mechanics Research Center, ATTN: AMXMR-MO, Watertown, MA 02172	12. REPORT DATE: December 1974
	13. NUMBER OF PAGES: 33
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Tacot
Tetranitrodibenzo-1,3a,4,6a-tetraazapentalene
Dibenzo-1,3a,4,6a-tetraazapentalene

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The ultraviolet and visible spectra of Tacot (tetranitrodibenzo-1,3a,4,6a-tetraazapentalene) were determined in nine solvents in which the material was significantly soluble. These solvents were sulfuric acid, perchloric acid, nitric acid, glycerin, dimethylsulfoxide, ammonium hydroxide, morpholine, piperidine, triethanolamine, and N,N-dimethylformamide. The first five of these solvents gave orange solutions while the last four gave amber
(continued)

20. ABSTRACT: (continued)

or other dark-colored solutions; however, the colors of all the solutions after aliquoting and diluting prior to the spectral measurements were yellowish. The study in the ultraviolet region was limited by the relatively high cut-off points of some of the solvents. The molar absorptivities of the peaks were calculated. A somewhat arbitrary grouping of the peaks according to location showed that peaks occurred for Tacot in all solvents at 450 to 506 nm except for piperidine which showed a rising slope and significant absorption in this region. Sulfuric acid showed a strong peak at 416 nm. Sulfuric acid, morpholine, and piperidine showed peaks in the area of 395 to 403 nm (peaks did not occur in this region in the other solvents). A peak occurred at 318 to 350 nm for all the solvents except nitric acid and piperidine (which were not useable in this range). A peak occurred at 248 to 281 nm in sulfuric acid, perchloric acid, and ammonium hydroxide (the only solvents useable in this range). The solvents that originally gave orange solutions were inclined to give sharper peaks, while the solutions that originally gave amber and other dark-colored solutions were frequently inclined to give shoulders and plateaus. The colors obtained from the orange solutions tended to be more stable. The extraordinary effect of the solvent on the spectrum of Tacot is probably related to the tendency of Tacot to form complexes with the solvent. Experiments indicated that Tacot could be determined quantitatively by measurement of the color in sulfuric acid, perchloric acid, nitric acid, and dimethylsulfoxide at 416, 486, 487, and 506 nm, respectively. The method could not be applied to the determination of Tacot in primers because of the difficulty of completely extracting the Tacot from the primers and also because the other ingredients of primers interfered with the color.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TT-75004	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): TEST SUMMARY OF THE XM712 CANNON LAUNCHED GUIDED PROJECTILE SAFING AND ARMING MECHANISM (FY73-74 Advanced Development Program)	5. TYPE OF REPORT & PERIOD COVERED: Technical test report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): John P. Hunt, Robert A. Shaffer	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: FRANKFORD ARSENAL, Attn: SARFA-MDA-D, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS Code:633309.12.20100, DA Proj:1X363309D073
11. CONTROLLING OFFICE NAME AND ADDRESS: AMCPM-CAWS/Picatinny Arsenal	12. REPORT DATE: January 1975
	13. NUMBER OF PAGES: 28
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Safing and Arming Mechanism (S&A)
Cannon Launched Guided Projectile (CLGP)
XM712
Second Environment Sensor
Magnetic Induction Sensor
Muzzle Exit Sensor
Dual Safe
Velocity Discrimination

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report discusses the tests conducted during the FY73 and FY74 Advanced Development Program of the Safing and Arming (S&A) Mechanism for the XM712 Cannon Launched Guided Projectile (CLGP). Specifically, the details and results of the bench, laboratory, environmental and ballistic testing phases of the major S&A mechanism components and the complete S&A mechanism are disclosed. Also discussed are the test results of the auxiliary components and sub-systems including a specially designed 155mm test projectile

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20. ABSTRACT (cont'd)

required to conduct the fire-on-arming (FOA) ballistic tests of the complete S&A mechanism.

Results from all phases of the component testing indicated the necessity of only minor design revisions to satisfy operability, reliability, and structural design goals and requirements. While the FOA ballistic tests were not as successful as the laboratory and environmental tests (4 out of 14 armed), causes of all duds were accounted for and the failure modes can be eliminated by better assembly and inspection techniques and different material choices both of which are being implemented in the FY75 program.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TT-75005	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): ON THE ACCURACY OF FLECHETTES BY DYNAMIC WIND TUNNEL TESTS, BY THEORY AND ANALYSIS, AND BY ACTUAL FIRINGS	5. TYPE OF REPORT & PERIOD COVERED: Technical Engineering Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): J.D. Nicolaides, L.E. Lijewski, C.W. Ingram, M.J. Garsik (University of Notre Dame)	8. CONTRACT OR GRANT NUMBER(s): DAAA25-71-C0447, Mod.P00002
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Frankford Arsenal, Attn: SARFA-MDS-D, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMCMS: 662603.11.H7800, DA: 1W662603AH78
11. CONTROLLING OFFICE NAME AND ADDRESS: ARMCOM	12. REPORT DATE: January 1975
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Coordinator - Walter J. Schupp, SARFA-MDS-D.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Flechette	Flash x-ray
Dispersion	Transitional ballistics
Trajectory	Supersonic wind tunnel
Jump angle	Flechette dispersion theory

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The accuracy and dispersion of flechettes are investigated 1) by an exploratory firing program, 2) by a supersonic dynamic testing wind tunnel program, 3) by development of a theory for jump and dispersion for computer computation and analysis and 4) by precision range firings at Frankford Arsenal.

The exploratory firing program reveals the importance of fin and body damage, the blast region, and saboting. The dynamic wind tunnel program

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20. ABSTRACT (Cont'd)

yields the static and dynamic aeroballistic stability coefficients on various flechette designs. The theory and analysis program has presented the effects of the initial launching conditions, the various stability coefficients and asymmetries and has provided accuracy criteria. Lastly, the flechette firing range program provided a correlation between theory and experiment which clearly suggests that high accuracy and low dispersion in flechettes is possible when optimum aerodynamic design is coupled with good saboting and minimization of blast.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TT-75038	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): GAS CHROMATOGRAPHIC DETERMINATION OF METHYLENE CHLORIDE IN EXTRACTED PROPELLANTS	5. TYPE OF REPORT & PERIOD COVERED: Technical Test Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): GEORGE NORWITZ, HERMAN GORDON, JOEL M. GOLDMAN, JOSEPH A. SIPIA, JR.	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Commander, FRANKFORD ARSENAL, ATTN: SARFA-TSE-M-64-1, Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMS Code: 53970M6350, PRON: A1-5-KA005-F6-NH
11. CONTROLLING OFFICE NAME AND ADDRESS: Commander, Army Materials and Mechanics Research Center, ATTN: AMXMR-MO, Watertown, MA 02172	12. REPORT DATE: May 1975
	13. NUMBER OF PAGES: 17
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Propellants
Nitrocellulose-Base Propellants
Nitrocellulose
Methylene Chloride
Gas Chromatography

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

In connection with a nitrocellulose recovery process that involves extraction of the "solvent-extractable" materials from scrap nitrocellulose-base propellant, it was necessary to develop a method for determining residual methylene chloride in the extracted propellant. A method is proposed for this determination whereby the methylene chloride is extracted with benzene and is determined by gas chromatography using a Silicone Rubber UC W98 column at 50°C and toluene as an internal standard. About

(continued)

20. ABSTRACT: (continued)

15% of the methylene chloride is lost in the Soxhlet extraction due to volatilization, so it is necessary to divide by the empirical factor 0.85 in calculating the result. The method was checked with actual and synthetic samples.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TT-75043	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): SPECTROPHOTOMETRIC DETERMINATION OF BISMUTH IN COPPER AND CARTRIDGE BRASS BY THE IODIDE METHOD	5. TYPE OF REPORT & PERIOD COVERED: Technical Test Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): GEORGE NORWITZ MICHAEL GALAN	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Commander FRANKFORD ARSENAL, ATTN: SARFA-TSE-M-64-1 Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMS Code: 53970M6350 PRON: A1-5-K005-F6-NH
11. CONTROLLING OFFICE NAME AND ADDRESS: Commander Army Materials and Mechanics Research Center ATTN: AMXMR-MO, Watertown, MA 02172	12. REPORT DATE: June 1975
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Bismuth
Copper
Cartridge Brass
Brass
Iodide

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An improved spectrophotometric method using iodide was developed for the determination of trace amounts of bismuth in copper and cartridge brass. In the method, the sample (25 g for copper and 10 g for cartridge brass) is dissolved in nitric acid and the bismuth is separated from the copper by an ammoniacal precipitation in the presence of ferric hydroxide as a gathering agent. The hydroxide precipitate is dissolved in hydro-

(continued)

20. ABSTRACT: (continued)

chloric acid, 2 ml of sulfuric acid is added, the solution is evaporated to few ml, hydrobromic acid is added to volatilize the antimony and tin, and the solution is evaporated to fumes of sulfuric acid. The bismuth is then determined by the iodide color after adding a composite potassium iodide-sodium hypophosphite reagent.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FA-TT-75059	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): DETERMINATION OF BARIUM AND STRONTIUM PEROXIDES (ACTIVE OXYGEN) IN IGNITERS IN SMALL ARMS TRACER AMMUNITION	5. TYPE OF REPORT & PERIOD COVERED: Technical Test Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): GEORGE NORWITZ MICHAEL GALAN	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Commander FRANKFORD ARSENAL, ATTN: SARFA-TSE-M-64-1 Philadelphia, PA 19137	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AMS Code: 53970M6350 PRON: A1-5-K005-F6-NH
11. CONTROLLING OFFICE NAME AND ADDRESS: Commander Army Materials and Mechanics Research Center ATTN: AMXMR-MO, Watertown, MA 02172	12. REPORT DATE: August 1975 13. NUMBER OF PAGES: 20
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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Barium peroxide	Igniters
Strontium peroxide	Small Arms
Oxygen	Tracers
Active oxygen	Ammunition

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A method is proposed for the determination of barium and strontium peroxides (active oxygen) in igniters in small arms ammunition. The sample is treated with dilute hydrochloric acid (1 to 9) which dissolves the magnesium powder almost instantaneously and then dissolves the barium or strontium peroxides within 10 to 30 minutes. The solution is then filtered to remove the organic substances (calcium resinate, Parlon, toluidine red toner, and zinc stearate) and the peroxide is determined by the
(continued)

20. ABSTRACT: (continued)

titanium peroxide color. It appears that igniter mixes and igniters used in small arms tracer ammunition deteriorate with storage.

Department of the Army
FRANKFORD ARSENAL
Philadelphia, Pennsylvania 19137
PATENTS ISSUED 1975

Patent No.	Issued	Title	Inventor(s)	FA Case #
3861307	1/21/75	Flare Arrangement	Litz, Charles J., Jr.	2396
3861308	1/21/75	Ammunition and Weapon Systems	Grandy, Andrew J.	2431
3868854	3/4/75	Sampling Mechanism	Travor, Bruce W. Pitney, Lennord	2225
3870526	3/11/75	Electroless Deposition of Copper and Copper-tin Alloys	Pearlstein, Fred Weightman, Robert F.	2343
3872615	3/25/75	Ammunition and Weapon Systems	Grandy, Andrew J.	2400
3880044	4/29/75	Muzzle Attachment For Accelerating A Projectile	Korr, Abraham L. Walker, Evan Harris	2072
3885452	5/27/75	Rocket Catapult Aircraft Escape Arrangement	Weinstock, Manuel Pisano, Frank T.	2394
3886009	5/27/75	Projectile Containing Pyrotechnic Composition For Reducing Base Drag Thereof	Puchalski, Walter J.	2388
3888295	6/10/75	Method of Bonding An Annular Band of Material To An Object	Schillinger, David E.	2385

Patent No.	Issued	Title	Inventor(s)	FA Case #
3888636	6/10/75	High Density, High Ductility, High Strength Tungsten-Nicket-Iron Alloy and Process of Making Therefor	Sczerzenie, Francis E. Zaleski, Frank I.	2366
3890902	6/24/75	Projectile	Travor, Bruce W. Brown, Samuel L.	2355
3890730	6/24/75	Ammunition and Weapon Systems	Grandy, Andrew J.	2427
3890880	6/24/75	Ammunition and Weapon Systems	Grandy, Andrew J.	2428
3890732	6/24/75	Ammunition and Weapon Systems	Grandy, Andrew J.	2429
3890878	6/24/75	Ammunition and Weapon Systems	Grandy, Andrew J.	2430
3897733	8/5/75	High Bulk Density Extruded Propellants for Small Arms Cartridges	Stiefel, Ludwig Levy, Marvin E. Silverstein, Martin	2247
3902424	9/2/75	Projectile	Dietsch, Francis W. DiGirolamo, Ronald D.	2380
3904732	9/9/75	Method For Improving Transparency Of Thermally Damaged Acrylic Glazing	Wick, Reyburn Green, Kenneth A.	2436
3912203	10/14/75	Rocket Catapult Aircraft Escape Arrangement	DeStefano, Leonard Nimylowycz, Osyp	2409

Patent No.	Issued	Title	Inventor(s)	FA Case #
3913445	10/21/75	Ammunition and Weapon Systems	Grandy, Andrew J.	2406
3913446	10/21/75	Ammunition and Weapon Systems	Grandy, Andrew J.	2414
3913489	10/21/75	Projectile	Travor, Bruce W. Brown, Samuel L. Wenocur, Brian D.	2378
3913873	10/21/75	Mechanical Spreader For a Parachute	Nimylowycz, Odyp	2411
3915547	10/28/75	Objective Lens System	Scidmore, Wright H. O'Shaughnessy, Robert P.	2424
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