

AD A075 364

TECHNICAL LIBRARY

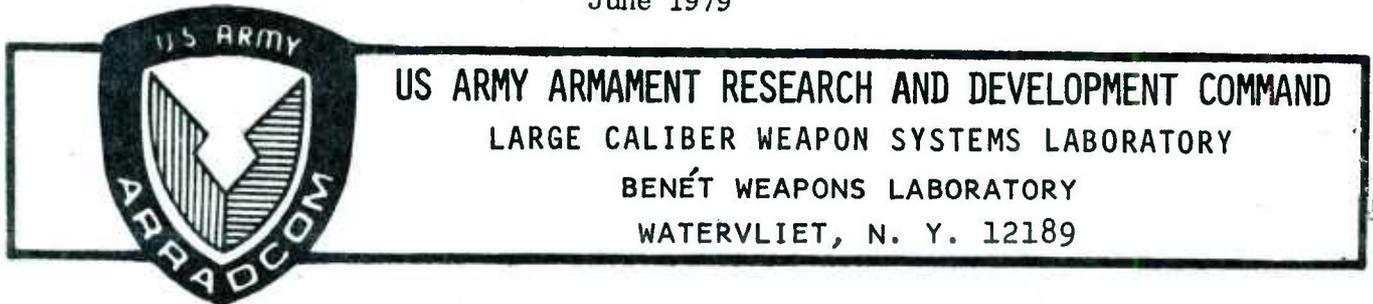
AD A075364

SPECIAL REPORT ARLCB-SP-79012

INDEX TO BENET WEAPONS LABORATORY (LCWSL) TECHNICAL REPORTS - 1978

B. Rahrer
Technical Publications and Editing Unit

June 1979



APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

DISCLAIMER

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

The use of trade name(s) and/or manufacturer(s) does not constitute an official indorsement or approval.

DISPOSITION

Destroy this report when it is no longer needed. Do not return it to the originator.

-- 1 OF 1
-- 1 - AD NUMBER: A075364
--48 - SBI SITE HOLDING SYMBOL: RSIH
-- TTR
-- 2 - FIELDS AND GROUPS: 11/6, 11/6.2, 19/1, 19/6
-- 3 - ENTRY CLASSIFICATION: UNCLASSIFIED
-- 5 - CORPORATE AUTHOR: ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND
-- WATERVLIET NY LARGE CALIBER WEAPON SYSTEMS LAB
-- 6 - UNCLASSIFIED TITLE: INDEX TO BENET WEAPONS LABORATORY (LCWSL)
-- TECHNICAL REPORTS - 1978.
-- 8 - TITLE CLASSIFICATION: UNCLASSIFIED
-- 9 - DESCRIPTIVE NOTE: SPECIAL REPT.,
--10 - PERSONAL AUTHORS: RAHRER,B. ;
--11 - REPORT DATE: JUN , 1979
--12 - PAGINATION: 53P MEDIA COST: \$ 6.00 PRICE CODE: AA
--14 - REPORT NUMBER: ARLCB-SP-79012
--18 - MONITOR ACRONYM: SBI
--19 - MONITOR SERIES: AD-E440 037
--20 - REPORT CLASSIFICATION: UNCLASSIFIED
--21 - SUPPLEMENTARY NOTE: SEE ALSO AD-A056 107.
--23 - DESCRIPTORS: *GUNS, *METALLURGY, *REPORTS, ABSTRACTS, INDEXES,
-- ARMY RESEARCH, GUN COMPONENTS, ORDNANCE STEEL, GUN BARRELS, METAL
-- <<P FOR NEXT PAGE>> OR <<ENTER NEXT COMMAND>>

MSG RECEIVED

1a ROW=24 COL= 01

<Ctrl>H For Help

N Poll

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-SP-79012	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) INDEX TO BENET WEAPONS LABORATORY (LCWSL) TECHNICAL REPORTS - 1978		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) B. Rahrer		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE June 1979
		13. NUMBER OF PAGES 60
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)		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This is a compilation of technical reports published during 1978.		

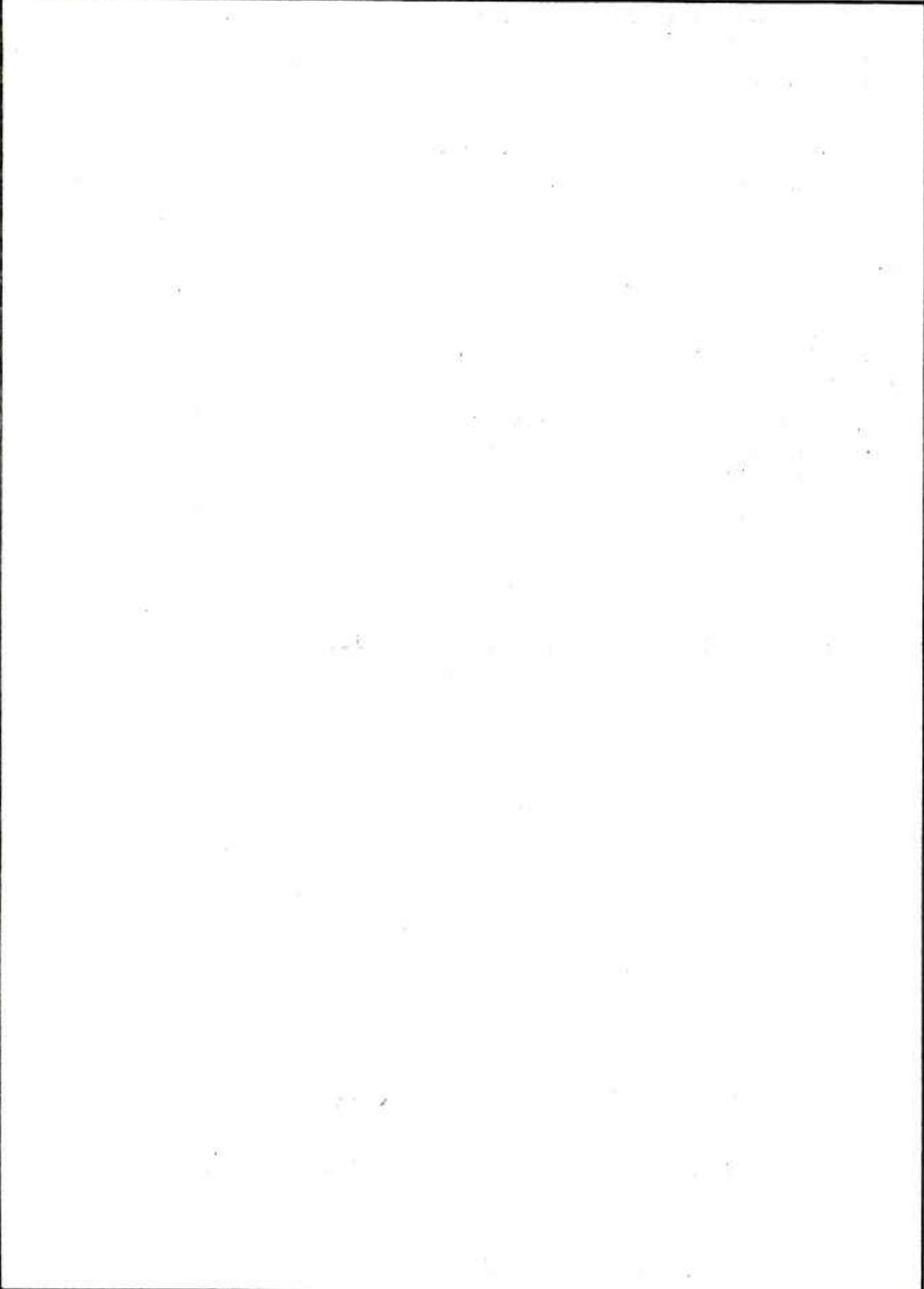


TABLE OF CONTENTS

	<u>Page</u>
List of Reports	1-2
Author Index	3-4
Subject Index	5-8
Abstracts-Report Documentation Page (DD Form 1473)	9-56

TECHNICAL REPORTS 1978

<u>REPORT NUMBER</u>	<u>TITLE</u>	<u>AUTHOR</u>	<u>DATE</u>
ARLCB-TR-78002	Friction of Rotating Band Material During Engraving and Initial Projectile Travel	R.S. Montgomery	Feb 78
ARLCB-SP-78003	Index to Benet Weapons Laboratory (LCWSL) Technical Reports-1977	R.F. Tario	Feb 78
ARLCB-TR-78004	Fatigue-Crack Propagation Through a Measured Residual Stress Field in Alloy Steel	J.H. Underwood L.P. Pook J.K. Sharples	Feb 78
ARLCB-TR-78005	Fourth Order Elastic Constants for Sodium Chloride to 270 Kbar by Wave Dynamics	M.A. Hussain J. Frankel R.D. Scanlon	Mar 78
ARLCB-TR-78006	Heat Treating Gun Steel	F. Heiser	Mar 78
ARLCB-MR-78007	Feasibility Study of Filament Wound Cartridge Cases	G. D'Andrea R. Cullinan P. Croteau	Mar 78
ARLCB-TR-78008	Reversible Effects of Temperature on the Structure of Amorphous NiP	P.J. Cote G.P. Capsimalis L.V. Meisel	Mar 78
ARLCB-TR-78009	175MM/8 Inch Howitzer Spindle Problem-Final Report	R.L. Rosenblum B.J. Rowekamp J.E. Brower V.J. Colangelo	Apr 78
ARLCB-TR-78010	The Influence of Tip Mass Offset on the Stability of Beck's Column	G.L. Anderson J.D. Vasilakis J.J. Wu	May 78
ARLCB-MR-78011	8 Inch M201 Muzzle Inclusion Fatigue Study	B. Brown	Apr 78
ARLCB-TR-78012	A Metallographic Study of White Layers in Gun Steel	M.H. Kamdar A. Campbell T. Brassard	Aug 78
ARLCB-SP-78013	Proceedings, Second U.S. Army Symposium on Gun Dynamics	T.E. Simkins J.J. Wu	Sep 78
ARLCB-TR-78014	Temperatures and Stresses Due To Quenching of Hollow Cylinders	J.D. Vasilakis	Aug 78

TECHNICAL REPORTS 1978 (CONTINUED)

<u>REPORT NUMBER</u>	<u>TITLE</u>	<u>AUTHOR</u>	<u>DATE</u>
ARLCB-MR-78015	Failure Analysis of 81MM Mortar Tube, SN 13299	P. Thornton	Sep 78
ARLCB-TR-78016	Comparison of Properties of Several Heats of ESR Melted 4335 + V Steel	V.J. Colangelo G.P. Lessen	Sep 78
ARLCB-TR-78017	Preliminary Study of the Effect of a Recoil Keyway on the Fatigue Life of M185 Cannon Tubes	M.A. Hussain S.L. Pu	Nov 78
ARLCB-TR-78018	A Photoplastic Study of Residual Stress in an Overloaded Breech Ring	Y.F. Cheng	Nov 78
ARLCB-TR-78019	Stress Concentration Around Inclined Holes in Pressurized Thick-Walled Cylinders	Y.F. Cheng	Nov 78
ARLCB-TR-78020	A Comparison of Blast Data from a 105MM Recoilless Rifle and a Laboratory Simulator	G.C. Carofano	Nov 78
ARLCB-TR-78021	Friction of Gilding Metal Sliding on Chromium-Plated Steel	R.S. Montgomery	Nov 78
ARLCB-TR-78022	Bi Phase Transitions Below 80° to 150 Kbars in an Ar Pressure Medium	C.G. Homan J. Frankel D.P. Kendall	Dec 78
ARLCB-TR-78023	Refractory-Lined Composite Pressure Vessels	G. D'Andrea R.L. Cullinan P.J. Croteau	Dec 78
ARLCB-TR-78025	Asymptotic Solutions to a Stability Problem	D.A. Peters J.J. Wu	Dec 78
ARLCB-TR-78026	Singular Plastic Element: Nastran Implementation and Application	M.A. Hussain S.L. Pu W.E. Lorensen	Dec 78

AUTHOR INDEX--1978

<u>AUTHOR</u>	<u>REPORT NUMBER</u>
Anderson, G.L.	ARLCB-TR-78010
Brassard, T.	ARLCB-TR-78012
Brower, J.E.	ARLCB-TR-78009
Brown, B.	ARLCB-MR-78011
Campbell, A.	ARLCB-TR-78012
Capsimalis, G.P.	ARLCB-TR-78008
Carofano, G.C.	ARLCB-TR-78020
Cheng, Y.F.	ARLCB-TR-78018 ARLCB-TR-78019
Colangelo, V.J.	ARLCB-TR-78009 ARLCB-TR-78016
Cote, P.J.	ARLCB-TR-78008
Croteau, P.J.	ARLCB-MR-78007 ARLCB-TR-78023
Cullinan, R.L.	ARLCB-MR-78007 ARLCB-TR-78023
D'Andrea, G.	ARLCB-MR-78007 ARLCB-TR-78023
Frankel, J.	ARLCB-TR-78005 ARLCB-TR-78022
Heiser, F.	ARLCB-TR-78006
Homan, C.G.	ARLCB-TR-78022
Hussain, M.A.	ARLCB-TR-78005 ARLCB-TR-78017 ARLCB-TR-78026
Kamdar, M.H.	ARLCB-TR-78012
Kendall, D.P.	ARLCB-TR-78022
Lessen, G.P.	ARLCB-TR-78016

AUTHOR INDEX--1978 (CONT.)

<u>AUTHOR</u>	<u>REPORT NUMBER</u>
Lorensen, W.E.	ARLCB-TR-78026
Meisel, L.V.	ARLCB-TR-78008
Montgomery, R.S.	ARLCB-TR-78002 ARLCB-TR-78021
Peters, D.A.	ARLCB-TR-78025
Pook, L.P.	ARLCB-TR-78004
Pu, S.L.	ARLCB-TR-78017 ARLCB-TR-78026
Rosenblum, R.L.	ARLCB-TR-78009
Rowekamp, B.J.	ARLCB-TR-78009
Scanlon, R.D.	ARLCB-TR-78005
Sharples, J.K.	ARLCB-TR-78004
Simkins, T.E.	ARLCB-SP-78013
Tario, R.F.	ARLCB-SP-78003
Thornton, P.	ARLCB-MR-78015
Underwood, J.H.	ARLCB-TR-78004
Vasilakis, J.D.	ARLCB-TR-78010 ARLCB-TR-78014
Wu, J.J.	ARLCB-TR-78010 ARLCB-SP-78013 ARLCB-TR-78025

SUBJECT INDEX--1978

<u>SUBJECT</u>	<u>REPORT NUMBER</u>
Alloy Steel	ARLCB-TR-78006
Alloys	ARLCB-TR-78004
Aluminum, Friction on Gun Steel	ARLCB-TR-78002
Amorphous	ARLCB-TR-78008
Approximate Solutions	ARLCB-TR-78025
Asymptotic Method	ARLCB-TR-78025
Autofrettage	ARLCB-TR-78017
Ballistics	ARLCB-SP-78013
Barrel Vibration	ARLCB-SP-78013
Beam Vibration	ARLCB-TR-78010
Bismuth Phase Transitions	ARLCB-TR-78022
Blast Simulator	ARLCB-TR-78020
Breech Ring	ARLCB-TR-78018
Cannon	ARLCB-TR-78009
Cartridge Cases	ARLCB-MR-78007
Ceramic Materials	ARLCB-TR-78023
Composite Materials	ARLCB-TR-78023
Composites	ARLCB-MR-78007
Continuum Mechanics	ARLCB-TR-78005
Crack Propagation	ARLCB-TR-78004 ARLCB-TR-78017
Cryogenics	ARLCB-TR-78022
Dynamics	ARLCB-SP-78013 ARLCB-TR-78025
Eigenvalues	ARLCB-TR-78025
Elastic Stability	ARLCB-TR-78025

SUBJECT INDEX--1978 (CONT)

<u>SUBJECT</u>	<u>REPORT NUMBER</u>
Engraving, Rotating Band	ARLCB-TR-78002
Equation of State	ARLCB-TR-78005
Erosion	ARLCB-TR-78009 ARLCB-TR-78012
ESR	ARLCB-TR-78016
Failure	ARLCB-MR-78015
Fatigue	ARLCB-MR-78011
Filaments	ARLCB-TR-78023
Filament Winding	ARLCB-MR-78007
Finite Differences	ARLCB-TR-78014
Finite Elements	ARLCB-TR-78025 ARLCB-TR-78026
Fracture (Materials)	ARLCB-TR-78004
Fracture Mechanics	ARLCB-MR-78011
Friction	ARLCB-TR-78021
Friction, Projectile	ARLCB-TR-78002
Friction, Rotating Band	ARLCB-TR-78002
Gilding Metal, Friction on Gun Steel	ARLCB-TR-78002
Gun Barrel	ARLCB-MR-78011
Guns	ARLCB-TR-78012
Guns, 8" Howitzer, M110	ARLCB-TR-78009
Guns, 175mm M107	ARLCB-TR-78009
Gun Steel	ARLCB-TR-78006
Heat Treating	ARLCB-TR-78006
High Pressure	ARLCB-TR-78022
Hole	ARLCB-TR-78019

SUBJECT INDEX--1978 (CONT)

<u>SUBJECT</u>	<u>REPORT NUMBER</u>
Inclusions	ARLCB-MR-78011
Magnesium, Friction on Gun Steel	ARLCB-TR-78002
Mechanical Properties	ARLCB-TR-78016
Missiles	ARLCB-TR-78025
Mortar, 81mm	ARLCB-MR-78015
NASTRAN	ARLCB-TR-78026
Nonconservative Forces	ARLCB-TR-78025
Nonconservative Stability	ARLCB-TR-78010
Non-Self-Adjoint Problems	ARLCB-TR-78025
Nylon, Friction on Gun Steel	ARLCB-TR-78002
Obturator Spindle	ARLCB-TR-78009
Photoplasticity	ARLCB-TR-78018
Precision	ARLCB-SP-78013
Pressure	ARLCB-TR-78005
Pressure Calibration	ARLCB-TR-78022
Pressurized Cylinders	ARLCB-TR-78019
Primer	ARLCB-TR-78009
Recoilless Guns	ARLCB-TR-78020
Residual Stress	ARLCB-TR-78018 ARLCB-TR-78023
Reversible Effects	ARLCB-TR-78008
Rifles	ARLCB-TR-78020
Rotating Band Materials	ARLCB-TR-78002
Rotating Bands	ARLCB-TR-78021
Segregation	ARLCB-TR-78016

SUBJECT INDEX--1978 (CONT)

<u>SUBJECT</u>	<u>REPORT NUMBER</u>
Shrink Fitting	ARLCB-TR-78023
Singular Elements	ARLCB-TR-78026
Sintered Iron, Friction on Gun Steel	ARLCB-TR-78002
Soft Iron, Friction on Gun Steel	ARLCB-TR-78002
Stabilization	ARLCB-SP-78013
Steel	ARLCB-TR-78012 ARLCB-TR-78016
Steel Wire	ARLCB-TR-78023
Stress Concentration	ARLCB-TR-78019
Stresses	ARLCB-TR-78017
Structure	ARLCB-TR-78008
Target Acquisition	ARLCB-SP-78013
Tempering	ARLCB-TR-78006
Thermal Expansion	ARLCB-TR-78008
Thick-Walled Cylinders	ARLCB-TR-78019
Tip Mass	ARLCB-TR-78010
Transformation Stresses	ARLCB-TR-78014
Transient Heat Conduction	ARLCB-TR-78014
Ultrasonics	ARLCB-MR-78011
Ultrasonic Velocities	ARLCB-TR-78005
Wear	ARLCB-TR-78012
Winding	ARLCB-TR-78023
Vibration	ARLCB-TR-78025

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-78002	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) FRICTION OF ROTATING BAND MATERIAL DURING ENGRAVING AND INITIAL PROJECTILE TRAVEL		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) R. S. Montgomery		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 612603.H180011 DA Proj. No. 554104900 (GE6) PRON No. GG-8-25541-GG
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE February 1978
		13. NUMBER OF PAGES 48
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) Aluminum, Friction on Gun Steel Magnesium, Friction on Gun Steel Engraving, Rotating Band Nylon, Friction on Gun Steel Friction, Projectile Rotating Band Materials Friction, Rotating Band Sintered Iron, Friction on Gun Steel Gilding Metal, Friction on Gun Steel Soft Iron, Friction on Gun Steel		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The sliding characteristics and coefficients of friction of rotating band and potential rotating band material on steel were studied in the laboratory at velocities corresponding with projectile velocities near the origin-of-rifling. The band materials investigated were gilding metal, 7075 aluminum alloy, AZ61A magnesium alloy, sintered iron, soft iron, nylon 6-6, and vulcanized fiber. It is possible to draw a number of conclusions and make a number (continued on reverse side)		

Continued from Block 19.

Vulcanized Fiber, Friction on Gun Steel

Continued from Block 20.

of conjectures about the engraving and initial travel of cannon projectiles from the results of this study. A comparison of the different sliding characteristics and laboratory friction coefficients provides insight into the behavior of projectiles and will help to allow the design of rotating bands without the expensive extensive firing of an actual cannon.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-SP-78003	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) INDEX TO BENET WEAPONS LABORATORY (LWSL) TECHNICAL REPORTS - 1977		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Roy F. Tario Technical Publications and Editing Unit (BWL)		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE February 1978
		13. NUMBER OF PAGES 94
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)		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This is a compilation of technical reports published during 1977.		

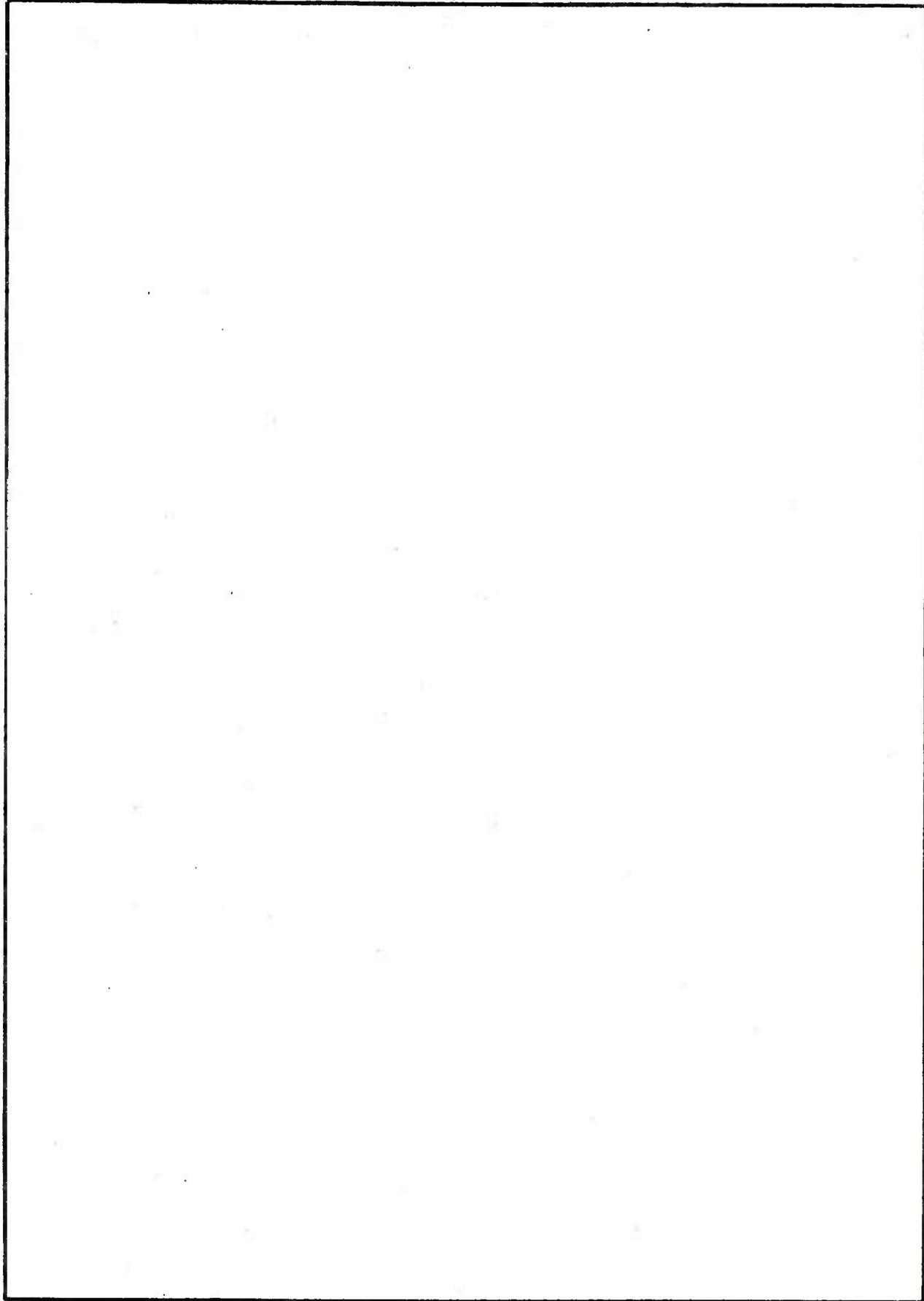
REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-78004	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) FATIGUE-CRACK PROPAGATION THROUGH A MEASURED RESIDUAL STRESS FIELD IN ALLOY STEEL		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) J. H. Underwood L. P. Pook J. K. Sharples		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 36525000204 DA Proj. No. 579101900GR1 PRON No. GG-8-25791-GG-M7
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE February 1978
		13. NUMBER OF PAGES 17
14. MONITORING AGENCY NAME & ADDRESS (If different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
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) Crack Propagation Fracture (materials) Alloys		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Fatigue crack-propagation tests were performed using 5 by 30mm cross-section bend specimens of a nickel-chromium-molybdenum steel. The fatigue crack-propagation rate was determined from a group of stress-free specimens by measuring crack length on the specimen surfaces at intervals during cycling. Residual stress was produced in a second group of specimens by using a localized plastic deformation process. Resistance strain gages were first applied (continued on reverse side)		

Continued from Block 20.

near one edge of each specimen along the line of intended crack growth. A series of 1mm deep plastic indentations was then made along the opposite edge of the specimen using a 25mm diameter pin. The strain gages provided a direct, accurate measure of the elastic, residual stress produced on one side of the specimen due to the local plastic deformation on the opposite side.

Measured crack-propagation rates in the specimens with residual stress are compared with rates in residual stress-free specimens. Crack-propagation rates are lower, as expected, near the edge of the specimen where the initial residual stress is compressive. Propagation rates remain lower even as the crack grows deeper into the specimen where the initial residual stress is tensile, which is not what would be expected from a simple superposition of stresses. However, an analysis involving the combination of the applied stress-intensity factor with that estimated from a redistribution of the residual stress in the specimens can account for the lower crack-propagation rates.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-78005	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) FOURTH ORDER ELASTIC CONSTANTS FOR SODIUM CHLORIDE TO 270 KBAR BY WAVE DYNAMICS		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Moayyed A. Hussain Julius Frankel Raymond D. Scanlon		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 611102.11.AH60 DA Project No. 1L161102AH60 PRON No. GG-8-25496-GG
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE March 1978
		13. NUMBER OF PAGES 30
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15e. 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) Continuum Mechanics Equation of State Pressure Ultrasonic Velocities		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) We derive the dilatational and shear velocities and the equation of state for an isotropic material under high hydrostatic pressures by the methods of continuum mechanics using the theory of small deformation superposed on a finite strain. The strain energy density of the material is taken to fourth order in terms of the strain invariants.		



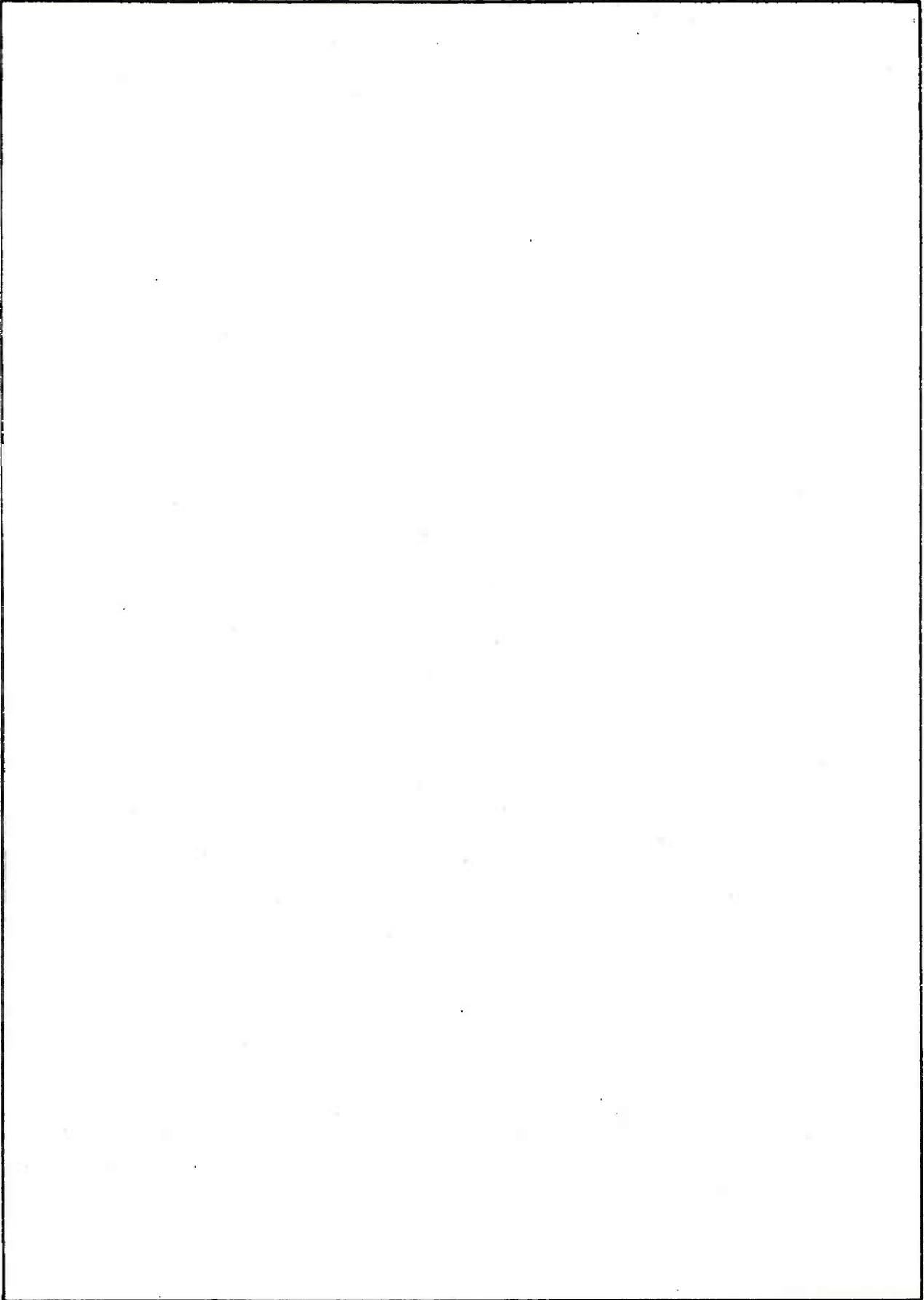
REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-78006	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) HEAT TREATING GUN STEEL		5. TYPE OF REPORT & PERIOD COVERED
7. AUTHOR(s) F. Heiser		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 3297.06.7588 PRON No. M1-6-A1726-01-M7-M7 DA Project No. 6767236
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE March 1978
		13. NUMBER OF PAGES 25
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
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) Tempering Gun Steel Alloy Steel Heat Treating		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A study was conducted to evaluate the effect of tempering time on the mechanical properties of gun steel, a medium C, Ni-Cr-Mo steel used in cannon tube forgings. The results on small specimen tests show that in tempering at temperatures up to 1100°F, time is not important beyond 60 minutes. Above 1100°F, time becomes a more important factor. For the yield strength range of many tubes, 160-180 ksi, tempering at 1000-1100°F is required. Thus, for Continued on reverse.		

Continued from Block 20.

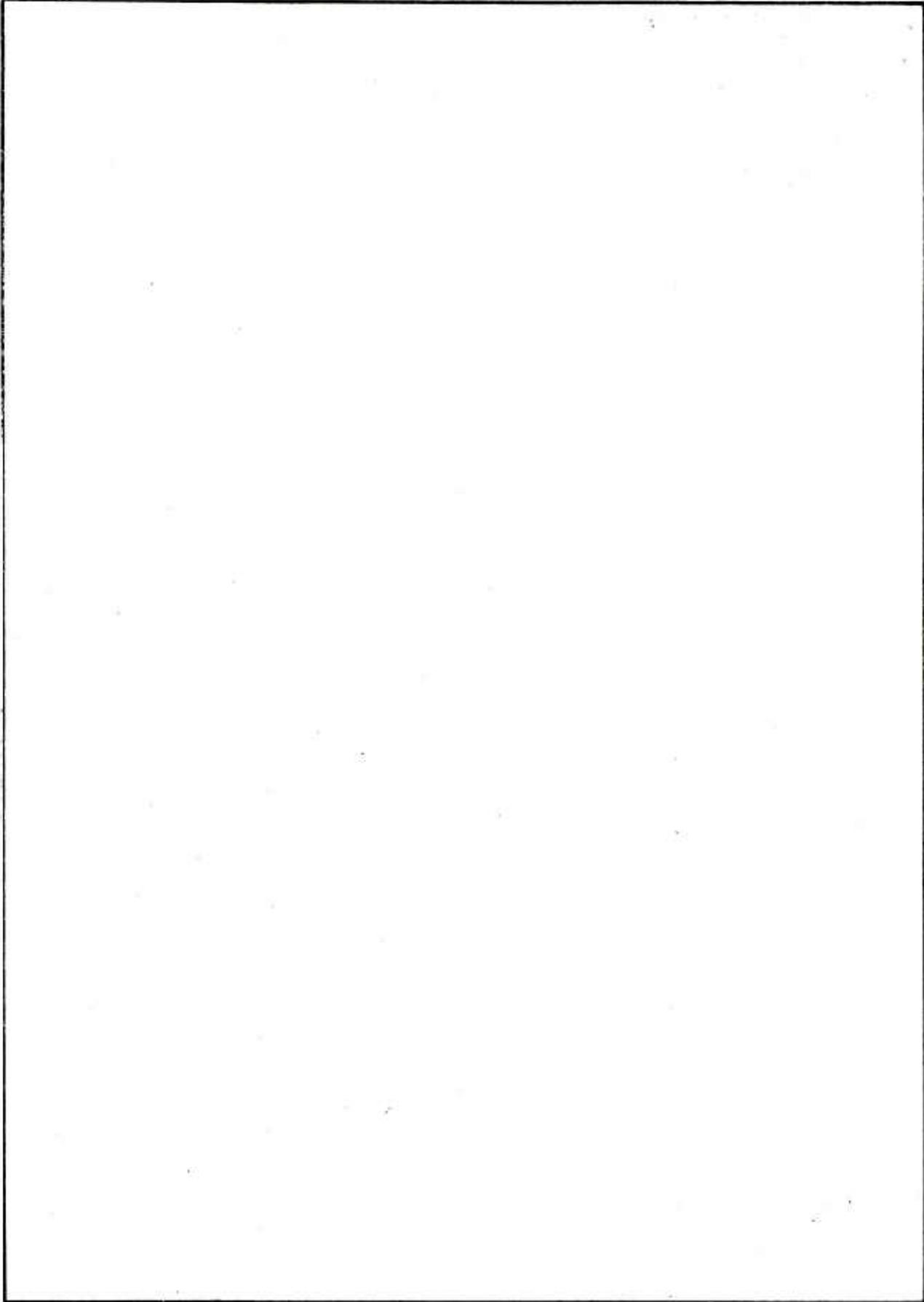
these tubes, the tempering cycle can be drastically shortened.

Data were also developed for two austenitizing temperatures, 1550°F (which is usually used) and 1750°F (which is used in some furnaces which utilize a high thermal head and allow a short austenitizing cycle). It is demonstrated that the latter would not allow the tube forging requirements to be satisfied, and dictate that austenitizing temperatures must be maintained at lower temperature.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARL CB-MR-78007	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) FEASIBILITY STUDY OF FILAMENT WOUND CARTRIDGE CASES		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) G. D'Andrea R. Cullinan P. Croteau		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 611101.91A0011 DA Proj. No. 1T161101A91A PRON No. 1A-7-233A3-GG-M7
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE March 1978
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		13. NUMBER OF PAGES 18
		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) Cartridge Cases Composites Filament Winding		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The feasibility of fabricating a 60mm composite cartridge case by the filament winding process has been demonstrated. Fabrication procedures for the manufacturing of this type of case are presented in this report.		



REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-78008	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) REVERSIBLE EFFECTS OF TEMPERATURE ON THE STRUCTURE OF AMORPHOUS NiP		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) P.J. Cote G.P. Capsimalis L.V. Meisel		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 611101.910011 DA Proj. No. 1L161101A91A PRON No. GG-8-25567-GG
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE March 1978
		13. NUMBER OF PAGES 4
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 Published in Physical Review B, Volume 16, Number 10, 15 November 1977, pp 4651 - 4654.		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Reversible Effects Structure Amorphous Thermal Expansion		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The influence of temperature on the structure of amorphous NiP was determined by means of x-ray and thermal-expansion measurements. The results compare well with the theoretical predictions for the static x-ray structure factor of an amorphous Debye solid. Observed changes in the structure factor with temperature are of the correct magnitude to explain the temperature dependences of the resistivity of amorphous metals in terms of the Ziman liquid-metal theory; this is taken as further experimental confirmation of the validity of liquid-metal theory for electron transport in these systems.		

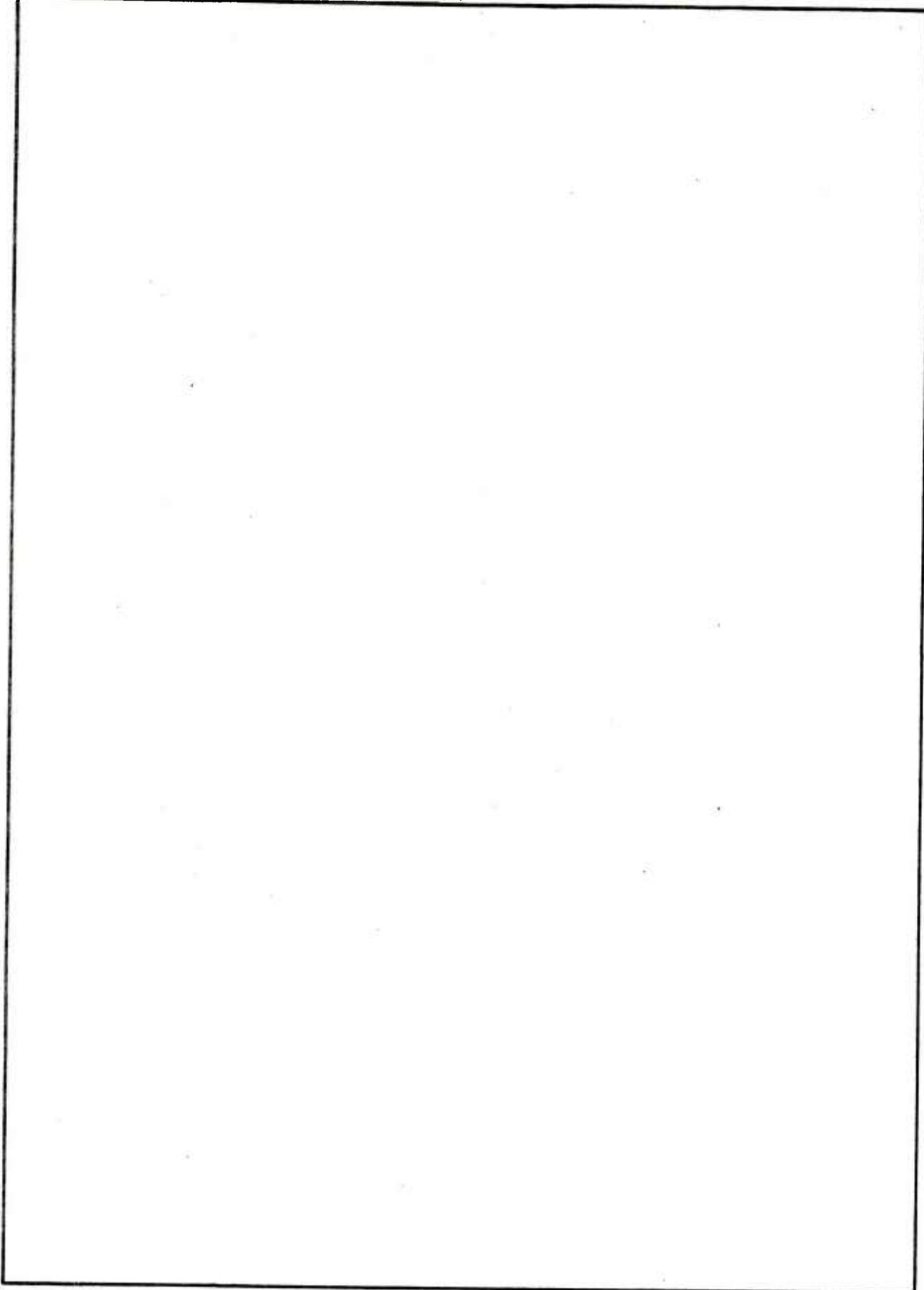


REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-78009	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) 175MM/8 INCH HOWITZER SPINDLE PROBLEM - FINAL REPORT		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Robert L. Rosenblum Bernard J. Rowekamp John E. Brower Vito J. Colangelo	8. CONTRACT OR GRANT NUMBER(s)	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N. Y. 12189 DRDAR-LCB-DP		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 732207.C30J10191CU PRON No. M1-8-9M405-M1-M7
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research & Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE April 1978
		13. NUMBER OF PAGES 24
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) Distribution limited to US Government Agencies only because of test and evaluation; April 1978. Other requests for this document must be referred to Commander, ARRADCOM, ATTN: Benet Weapons Laboratory, DRDAR-LCB-DPD, Watervliet Arsenal, Watervliet, N.Y. 12189.		
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) Obturator Spindle Cannon Primer 175MM Gun, M107 Erosion 8 In. Howitzer, M110		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The failure of an FRG Army M110 SP Howitzer spindle assembly during practice firing initiated an extensive investigation of US spindles in CONUS and Europe and Allied spindles in Europe. The objective was to verify the extent of the problem, find cracked spindles, if any, and develop a spindle condemnation criteria. Of all spindles inspected only one exhibited cracks. Erosion and pitting were found in some of the primer chambers. It was resolved that no hazardous condition of US or Allied spindles had existed (over)		

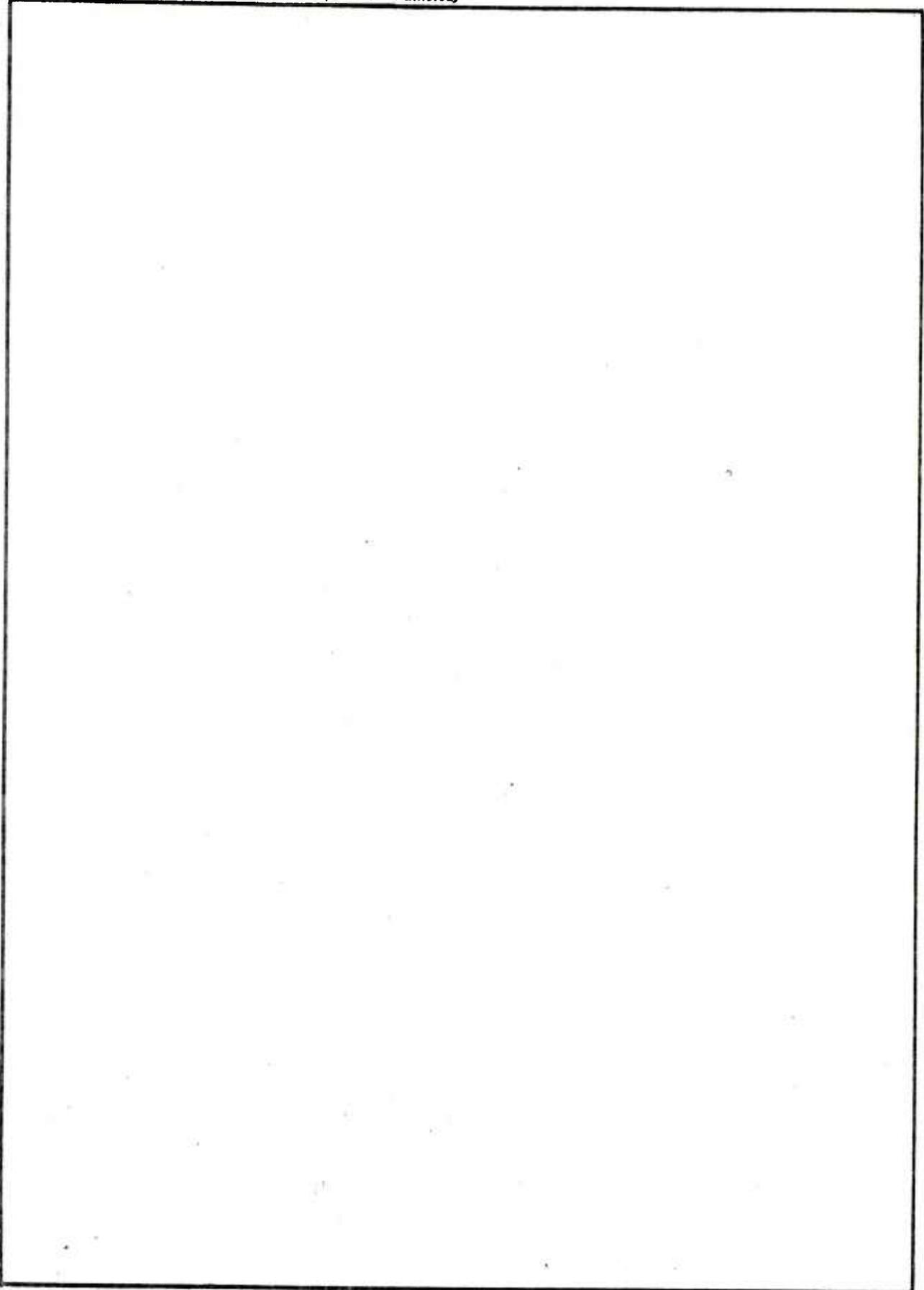
Block 20 (cont)

except for FRG spindle, Identification Number 1, which is considered an isolated instance. A spindle condemnation criteria was, however, issued based on primer extraction difficulty.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-78010	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) THE INFLUENCE OF TIP MASS OFFSET ON THE STABILITY OF BECK'S COLUMN		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) G.L. Anderson J.D. Vasilakis J.J. Wu		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 611102.11.H4500.30 (7PA) DA Project No. 1L161102AH45 PRON No. EJ-7-Y0011-EJ-M7
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE May 1978
		13. NUMBER OF PAGES 13
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) Non-Conservative Stability Beam Vibrations Tip Mass		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) In this report, the stability of a slender cantilever carrying a tip mass at its free end and subjected there to a follower force is investigated.		



REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-MR-78011	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) 8" M201 MUZZLE INCLUSION FATIGUE STUDY		5. TYPE OF REPORT & PERIOD COVERED
7. AUTHOR(s) Bruce Brown		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research & Development Command Large Caliber Weapons Systems Laboratory Dover, New Jersey 07801		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 3110.15.2224 PRON No. M7-5-P4847-M7-M7
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE June 1978
		13. NUMBER OF PAGES 23
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Distribution limited to Watervliet Arsenal and Benet Weapons Laboratory activities only. Other requests for this document must be referred to Commander, ARRADCOM, ATTN: Benet Weapons Laboratory, DRDAR-LCB-D, Watervliet Arsenal, Watervliet, New York 12189.		
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) Fatigue Inclusions Gun Barrel Ultrasonics Fracture Mechanics		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The fatigue performance of production barrel segments containing inclusion clusters was compared to that of normal barrel segments. The inclusion filled specimens gave significantly poorer performance in fatigue life and the stress level causing crack initiation and growth.		



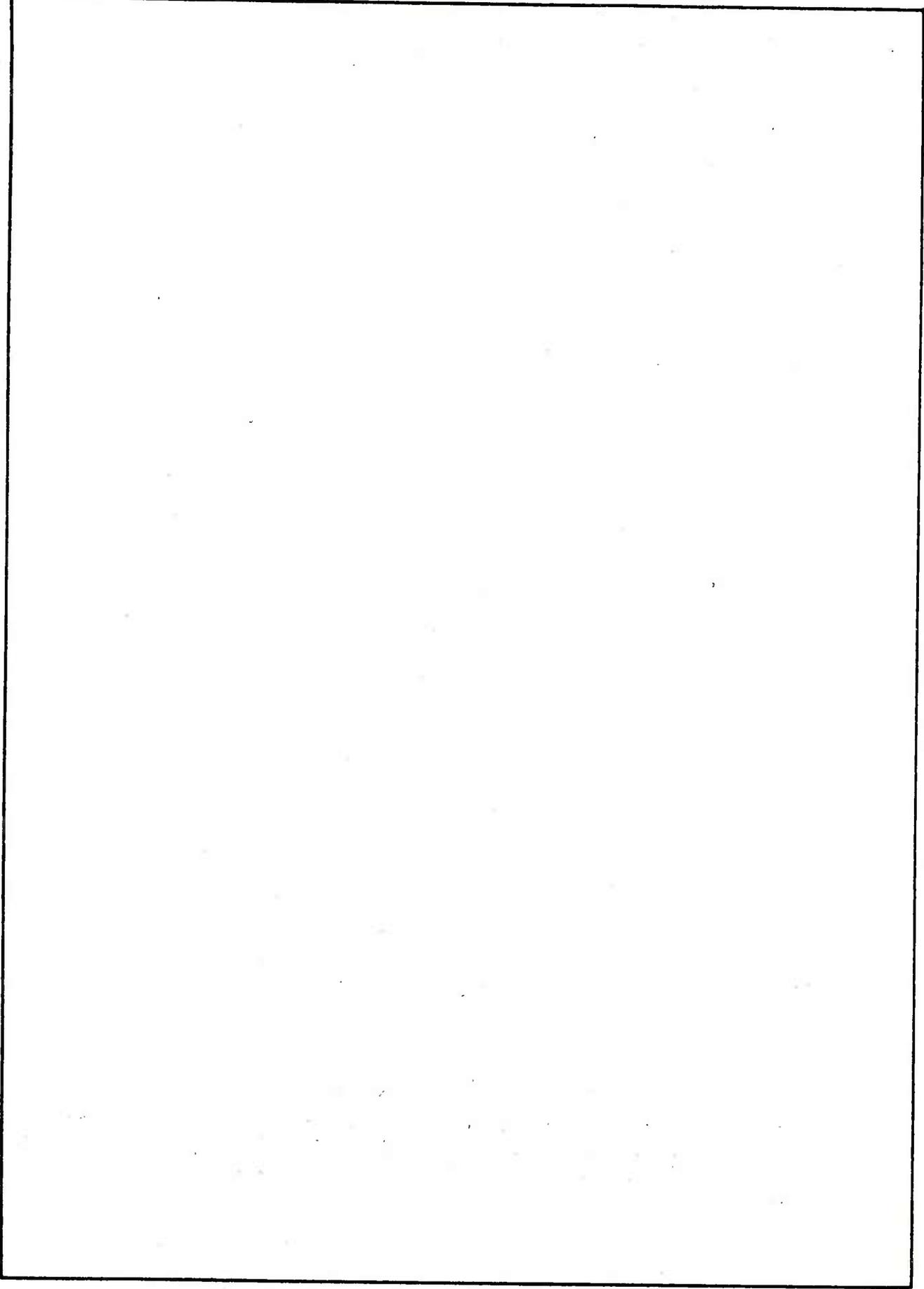
REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-78012	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A METALLOGRAPHIC STUDY OF WHITE LAYERS IN GUN STEEL		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) M. H. Kamdar A. Campbell T. Brassard		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-ICB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 611102.H540011 DA Proj. No. 1L161102AH54 PRON No. 1A7233A5GGM7
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research & Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE August 1978
		13. NUMBER OF PAGES 23
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15e. 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) Erosion Guns Steel Wear		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A metallographic investigation has been made of the white layers formed on the bore surface of a fired Army and Navy cannon and those produced in gun steel specimens in laboratory where firing conditions were simulated. White layers are produced in laboratory specimens in reducing environments (e.g. methane gas) but not in argon or nitrogen and appear similar to those produced in the fired cannons. These are formed at the melting as well as lower temperatures. The Continued on reverse side		

Continued from Block 20.

effects of increase in the pressure of the environment appears first to aid the formation of white layers and furthermore to increase their thickness. These results and the earlier studies of the characterization of white layers from fired cannons suggests that carbon from the gaseous environment of the propellant combustion products and the pressures of gases have significant effects on the formation and growth of white layers.

The white layers produced in the Navy cannon where NACO, low flame temperature propellant was used are compared with those produced in the Army cannons where high flame temperature propellant was used. These observations are also discussed.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-SP-78013	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Proceedings, Second U.S. Army Symposium on Gun Dynamics		5. TYPE OF REPORT & PERIOD COVERED FINAL
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) EDITORS: T. E. Simkins J. J. Wu		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Armament Research & Development Command Watervliet Arsenal, Watervliet, NY		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE September 1978
		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) NO RESTRICTION		
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) Ballistics, Precision, Target Acquisition, Dynamics, Barrel Vibration, Stabilization		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Twenty papers on various aspects of analysis, design and instrumentation of gun dynamics are presented by authors from five universities, five industrial research laboratories and various laboratories of the U.S. Army, Navy, and Air Force.		



REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-78014	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) TEMPERATURES AND STRESSES DUE TO QUENCHING OF HOLLOW CYLINDERS		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) John D. Vasilakis		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-ICB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 6111019A0011 DA Project No. 1L161101A91A Pron No. 1A825567GGM7
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE August 1978
		13. NUMBER OF PAGES 24
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) Finite Differences Transformation Stresses Transient Heat Conduction		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) After forging, gun tube blanks are heated to a high temperature and quenched to near room temperature before tempering to achieve the required material properties. The purpose of the quench is to bypass the knee of the pearlite phase. This program was undertaken to establish cooling curves while the material is being quenched and to compute the thermal and transformation stresses involved.		

Continued on reverse side

Continued from Block 20.

The temperatures are computed using implicit finite difference schemes. The problem treated is a nonlinear one in radial heat flow. The problem with cylindrical geometry is assumed to be axisymmetric and the coefficients in the equation such as thermal conductivity are treated as functions of temperature. The boundary conditions are written in a general form allowing the use of temperature, convection or heat flux boundary conditions. The nonlinear problem is solved by using two finite difference schemes in tandem. The first computes the temperatures at the $n+\frac{1}{2}$ time step assuming constant coefficients computed from a previous temperature distribution. This generates a temperature distribution throughout the thickness which is used to compute new coefficients for the second finite difference scheme which calculates the temperature distribution at the $n+1$ time step. This process is continued until a steady state or some desired level is reached.

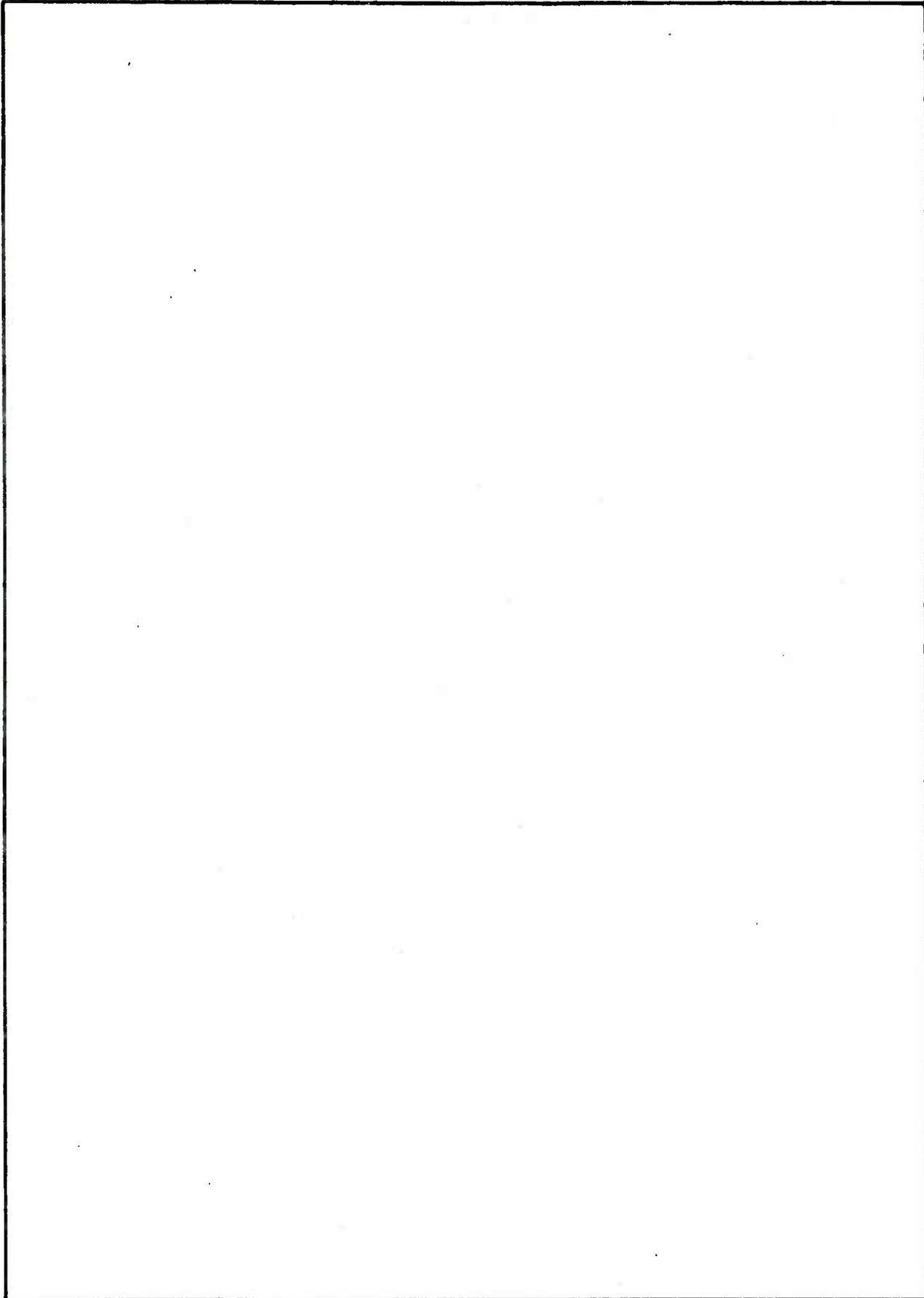
At each time step, the program computes the thermal stresses associated with the temperatures. In addition to this, when the temperature reaches a certain level, called martensite start (M_s), the material begins to undergo the martensite transformation. This transformation involves an increase in material volume of about 3%-4%. A simple view of these transformation stresses is taken and the stresses due to this volume change are computed as the temperature cools to below the martensite start temperature throughout the wall thickness.

Results are presented for various boundary conditions including those expected to exist in the quenching facility.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-MR-78015	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) FAILURE ANALYSIS OF 81MM MORTAR TUBE, SN 13299	5. TYPE OF REPORT & PERIOD COVERED	
	6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s) P. Thornton	8. CONTRACT OR GRANT NUMBER(s)	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 3210.16.0008 PRON No. M1-6-00996-M7-M7	
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801	12. REPORT DATE September 1978	
	13. NUMBER OF PAGES 11	
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) Distribution limited to US Government Agencies only because of test and evaluation; September 1978. Other requests for this document must be referred to Commander, ARRADCOM, ATTN: Benet Weapons Laboratory, DRDAR-LCB-SE, Watervliet Arsenal, Watervliet, N. Y. 12189.		
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) 81mm Mortar Failure		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report summarizes the investigation of a failed 81mm Mortar Tube, SN 13299. This weapon was involved in a malfunction, 14 June 1977, in Germany. The analysis included a metallurgical examination and a limited mechanical property evaluation of the tube material. The conclusion of this investigation is that the malfunction occurred as a result of premature detonation of the projectile. The mortar tube material did not contribute to the failure.		

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-78016	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) COMPARISON OF PROPERTIES OF SEVERAL HEATS OF ESR MELTED 4335 + V STEEL		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Vito J. Colangelo Gary P. Lessen		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR LCB TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 3297.06.7500 PRON No. M1-5A-1731-01-M7-M7
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon System Laboratory Dover, New Jersey 07801		12. REPORT DATE September 1978
		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
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) ESR Steel Mechanical Properties Segregation		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) In order to compare the mechanical properties of ESR material from different manufactures, material was obtained from five producers with all material being of the same nominal composition. In order to compare quality of each, samples from each manufacturer were subjected to a water quench and tempering at a temperature of 975°F. Subsequent to this heat treatment, mechanical testing, consisting of Charpy, tensile, ductility and microhardness tests was done on samples from each producer.		



REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-78017	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) PRELIMINARY STUDY OF THE EFFECT OF A RECOIL KEYWAY ON THE FATIGUE LIFE OF M185 CANNON TUBES		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) M. A. Hussain S. L. Pu		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 643628.0080051 DA Project No. 1X463628D008 PRON No. 64-8-27276-GG-M7
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE November 1978
		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
16. DISTRIBUTION STATEMENT (of this Report) Distribution limited to US Government Agencies only because of test and evaluation; November 1978. Other requests for this document must be referred to Commander, ARRADCOM, ATTN: Benet Weapons Laboratory, DRDAR-LCB-RA, Watervliet Arsenal, Watervliet, N.Y. 12189.		
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) Autofrettage Crack Propagation Stresses		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report contains a preliminary study of the effect of a keyway on the fatigue life of a 155 mm, M185 tube with an assumption that a crack starts from the base of the keyway. This analysis is carried out for guidance in the processes of design and configuration changes within the constraints specified and also for further refined studies. It is indicated that the tube life can be increased by a factor of three with the reduction of autofrettage to 70%.		

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-78018	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A PHOTOPLASTIC STUDY OF RESIDUAL STRESS IN AN OVERLOADED BREECH RING		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(•) Y.F. Cheng		8. CONTRACT OR GRANT NUMBER(•)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-ICB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 61110191A0011 PRON No. 1A-8-25567-GG-M7
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE November 1978
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		13. NUMBER OF PAGES 24
		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) Breech Ring Photoplasticity Residual Stress		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A two-dimensional model of the meridian section of a breech ring was made of a photoplastic material which had been calibrated optically and mechanically. The maximum fillet stress was determined for an elastic load as well as an elastoplastic load. Residual stress resulting from complete unloading was calculated by subtractive superposition of elastic and plastic solutions. An elastic process is assumed during unloading. Transition from model to prototype was discussed.		

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-78019	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) STRESS CONCENTRATION AROUND INCLINED HOLES IN PRESSURIZED THICK-WALLED CYLINDERS		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Y.F. Cheng		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 61110191A0011 PRON No. 1A-8-25567-GG-M7
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE November 1978
		13. NUMBER OF PAGES 24
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) Hole Pressurized Cylinders Stress Concentration Thick-Walled Cylinders		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Photoelastic investigation has been conducted to study stress concentration around inclined holes in pressurized thick-walled cylinders. It has been found that an inclination in the transverse plane reduces the stress concentration and an inclination in the meridional plane increases the stress concentration. Also, the stress concentration depends upon the bore-to-hole diameter ratio among other parameters.		

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-78020	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A COMPARISON OF BLAST DATA FROM A 105MM RECOILLESS RIFLE AND A LABORATORY SIMULATOR		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) G.C. Carofano		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 61110191A0011 PRON No. 1A-8-25567-GG-M7
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE November 1978
		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
16. DISTRIBUTION STATEMENT (of this Report) Distribution limited to US Government Agencies only because of test and evaluation; November 1978. Other requests for this document must be referred to Commander, ARRADCOM, ATTN: Benet Weapons Laboratory, DRDAR-LCB-RA, Watervliet Arsenal, Watervliet, N.Y. 12189.		
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) Blast Simulator Recoilless Guns Rifles		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A comparison was made between the blast data obtained from an experimental 105mm recoilless rifle and that produced by a laboratory blast simulator. The data agree sufficiently well to justify use of the simulator in the comparative type experiments in which it has been used in the past.		

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCE-TR-78021	2. GDOT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) FRICTION OF GILDING METAL SLIDING ON CHROMIUM-PLATED STEEL		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) R.S. Montgomery		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 36525000204 DA Proj. No. 554104900 PRON No. GG825541GGM7
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE November 1978
		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
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) Friction Rotating Bands		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A comparison of friction for gilding metal sliding on chrome plate with that for gilding metal sliding on gun steel is important because a number of cannon tubes are chrome plated and it is important to know how this affects their interior ballistics. The frictional resistance of the projectile is largely that of the rotating bands on the bore of the cannon tube and gilding metal is the most common material of rotating bands. It was found that the Continued on next page.		

Continued from Block 20.

coefficients of friction for gilding metal sliding on chrome plate are identical with those for gilding metal sliding on steel at velocities of 300 fps and higher at least for bearing pressures greater than about 2 ksi. This would be predicted for melt lubricated sliding at high velocities. At lower velocities (somewhere between 150 fps and 300 fps) the coefficients become different with those for gilding metal sliding on chrome plate significantly less than those for gilding metal sliding on gun steel.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-78022	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Bi PHASE TRANSITIONS BELOW 80 ⁰ K TO 150 ⁰ K KBARS IN AN Ar PRESSURE MEDIUM		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) C. G. Homan J. Frankel D. P. Kendall		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-ICB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 611102H600011 DA Proj. No. 1L161102AH60 PRON No. 1A825496GGM7
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE December 1978
		13. NUMBER OF PAGES 13
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) Bismuth Phase Transitions High Pressure Cryogenics Pressure Calibration		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Resistometric measurements on thin film Bi specimens embedded in a solid Ar pressure medium were made to 150 kbars in the temperature range of 40 ⁰ to 80 ⁰ K. The ratio of longitudinal to transverse acoustic velocity was simultaneously measured on the Ar medium and the EOS of Ar deduced. Correlation is made between the changes in the resistance due to polymorphic phase transitions in Bi and the pressure deduced from the Ar EOS. The present data will be com- Continued on next page.		

Continued from Block 20.

pared with earlier results on Bi embedded in a pyrophyllite medium which suggests large non-hydrostatic medium effects in pyrophyllite at low temperatures. Experimental details will be discussed.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-78023	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) REFRACTORY-LINED COMPOSITE PRESSURE VESSELS		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) G. D'Andrea R. L. Cullinan P. J. Croteau		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 611101.11.84400 PRON No. M1-T-51700-M7-M7
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE December 1978
		13. NUMBER OF PAGES 80
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) Ceramic Materials Shrink Fitting Composite Materials Steel Wire Filaments Winding Residual Stress		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Refractory lined pressure vessels, possessing good corrosion and erosion resistance at low and high temperatures, seem to be ideal for extending the wear life of conventional gun tubes Since refractory materials exhibit high compressive and low tensile strength, prescribed residual stresses must be introduced to eliminate the significant Continued on next page.		

Continued from Block 20.

tensile stresses produced during firing.

The prominent problem in fabricating such vessels is to restrict the refractory material from expanding axially during the application of the residual stresses.

This report presents manufacturing procedures to prevent the axial expansion; theoretical and experimental analyses predicting the residual and firing stress state in the vessel; and test results on 12.5 mm and 60 mm ceramic liners.

Preliminary work on 6.4 mm Tungsten-Carbon Alloy is also reported.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM										
1. REPORT NUMBER ARLCB-TR-78025	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER										
4. TITLE (and Subtitle) ASYMPTOTIC SOLUTIONS TO A STABILITY PROBLEM		5. TYPE OF REPORT & PERIOD COVERED										
		6. PERFORMING ORG. REPORT NUMBER										
7. AUTHOR(s) D. A. Peters J. J. Wu		8. CONTRACT OR GRANT NUMBER(s)										
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DRDAR-LCB-TL		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 611102.11.H4500.30 (7 PA) DA Proj. No. 1L161102AH45 PRON No. EJ-7-Y0011-01-EJ										
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801		12. REPORT DATE December 1978										
		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										
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 Reprinted from Journal of Sound and Vibration (1978) Volume 59(4), 591-610.												
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)												
<table border="0"> <tr> <td>Approximate Solutions</td> <td>Finite Element</td> </tr> <tr> <td>Asymptotic Method</td> <td>Missiles</td> </tr> <tr> <td>Dynamics</td> <td>Nonconservative Forces</td> </tr> <tr> <td>Eigenvalues</td> <td>Non-self-adjoint Problems</td> </tr> <tr> <td>Elastic Stability</td> <td>Vibration</td> </tr> </table>			Approximate Solutions	Finite Element	Asymptotic Method	Missiles	Dynamics	Nonconservative Forces	Eigenvalues	Non-self-adjoint Problems	Elastic Stability	Vibration
Approximate Solutions	Finite Element											
Asymptotic Method	Missiles											
Dynamics	Nonconservative Forces											
Eigenvalues	Non-self-adjoint Problems											
Elastic Stability	Vibration											
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)												
<p>This paper is concerned with the lateral stability of a free flying column subjected to an axial thrust with directional control. The stability curve (i. e., eigenvalue vs thrust, in the neighborhood of zero eigenvalues) and the associated eigenfunctions of this problem have not been fully understood. Here, asymptotic expansions are used to examine closely, for all values of the thrust directional control parameter, both the intersection of the eigenvalue curves</p> <p style="text-align: center;">Continued on reverse side</p>												

Continued from Block 20.

with the zero branch and the associated eigenfunctions of zero and nearly zero eigenvalues. Several analytical proofs are provided substantiating previous numerical findings.

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCB-TR-78026	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) SINGULAR PLASTIC ELEMENT: NASTRAN IMPLEMENTATION AND APPLICATION	5. TYPE OF REPORT & PERIOD COVERED	
	5. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s) M. A. Hussain S. L. Pu W. E. Lorensen	8. CONTRACT OR GRANT NUMBER(s)	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Benet Weapons Laboratory Watervliet Arsenal, Watervliet, N.Y. 12189 DEPAR-ICB-TL	10. PROGRAM ELEMENT PROJECT, TASK AREA & WORK UNIT NUMBERS AMCMS No. 611102.11-H4500.50 (7PA) DA Proj No. 1L161102AH45 PRON No. EJ-7-Y0011-EJ	
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Armament Research and Development Command Large Caliber Weapon Systems Laboratory Dover, New Jersey 07801	12. REPORT DATE December 1978	
	13. NUMBER OF PAGES 26	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report)	
	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) Finite Elements NASTRAN Singular Elements		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The elastic and plastic singularities near a crack tip are obtained from higher order isoparametric elements. This is simply accomplished by collapsing the quadrilateral element into a triangular element and by judicious choice of adjacent mid-side nodes. Specifically for the cubic element, the elastic singularity is obtained by Continued on next page.		

Continued from Block 20.

placing the mid-side nodes adjacent to the crack tip at 1/9th and 4/9th locations. The plastic singularity is constructed using the sliding node concept. These elements have been implemented in NASTRAN as user dummy elements.

WATERVLIET ARSENAL INTERNAL DISTRIBUTION LIST

	<u>NO. OF COPIES</u>
COMMANDER	1
DIRECTOR, BENET WEAPONS LABORATORY	1
CHIEF, DEVELOPMENT ENGINEERING BRANCH	1
ATTN: DRDAR-LCB-DA	1
-DM	1
-DP	1
-DR	1
-DS	1
-DC	1
CHIEF, ENGINEERING SUPPORT BRANCH	1
CHIEF, RESEARCH BRANCH	2
ATTN: DRDAR-LCB-RA	1
-RC	1
-RM	1
-RP	1
TECHNICAL LIBRARY	5
TECHNICAL PUBLICATIONS & EDITING UNIT	2
DIRECTOR, OPERATIONS DIRECTORATE	1
DIRECTOR, PROCUREMENT DIRECTORATE	1
DIRECTOR, PRODUCT ASSURANCE DIRECTORATE	1

NOTE: PLEASE NOTIFY DIRECTOR, BENET WEAPONS LABORATORY, ATTN: DRDAR-LCB-TL, OF ANY REQUIRED CHANGES.

EXTERNAL DISTRIBUTION LIST (CONT)

	<u>NO. OF COPIES</u>		<u>NO. OF COPIES</u>
COMMANDER US ARMY RESEARCH OFFICE P.O. BOX 1211 RESEARCH TRIANGLE PARK, NC 27709	1	COMMANDER DEFENSE DOCU CEN ATTN: DDC-TCA CAMERON STATION ALEXANDRIA, VA 22314	12
COMMANDER US ARMY HARRY DIAMOND LAB ATTN: TECH LIB 2800 POWDER MILL ROAD ADELPHIA, MD 20783	1	METALS & CERAMICS INFO CEN BATTELLE COLUMBUS LAB 505 KING AVE COLUMBUS, OHIO 43201	1
DIRECTOR US ARMY INDUSTRIAL BASE ENG ACT ATTN: DRXPE-MT ROCK ISLAND, IL 61201	1	MPDC 13919 W. BAY SHORE DR. TRAVERSE CITY, MI 49684	1
CHIEF, MATERIALS BRANCH US ARMY R&S GROUP, EUR BOX 65, FPO N.Y. 09510	1	MATERIEL SYSTEMS ANALYSIS ACTV ATTN: DRXSY-MP ABERDEEN PROVING GROUND MARYLAND 21005	1
COMMANDER NAVAL SURFACE WEAPONS CEN ATTN: CHIEF, MAT SCIENCE DIV DAHLGREN, VA 22448	1		
DIRECTOR US NAVAL RESEARCH LAB ATTN: DIR, MECH DIV CODE 26-27 (DOC LIB) WASHINGTON, D.C. 20375	1 1		
NASA SCIENTIFIC & TECH INFO FAC P.O. BOX 8757, ATTN: ACQ BR BALTIMORE/WASHINGTON INTL AIRPORT MARYLAND 21240	1		

NOTE: PLEASE NOTIFY COMMANDER, ARRADCOM, ATTN: BENET WEAPONS LABORATORY,
DRDAR-LCB-TL, WATERVLIET ARSENAL, WATERVLIET, N.Y. 12189, OF ANY
REQUIRED CHANGES.

EXTERNAL DISTRIBUTION LIST

	<u>NO. OF COPIES</u>		<u>NO. OF COPIES</u>
ASST SEC OF THE ARMY RESEARCH & DEVELOPMENT ATTN: DEP FOR SCI & TECH THE PENTAGON WASHINGTON, D.C. 20315	1	COMMANDER US ARMY TANK-AUTMV R&D COMD ATTN: TECH LIB -- DRDTA--UL MAT LAB - DRDTA--RK WARREN, MICHIGAN 48090	1 1
COMMANDER US ARMY MAT DEV & READ. COMD ATTN: DRCDE 5001 EISENHOWER AVE ALEXANDRIA, VA 22333	1	COMMANDER US MILITARY ACADEMY ATTN: CHMN, MECH ENGR DEPT WEST POINT, NY 10996	1
COMMANDER US ARMY ARRADCOM ATTN: DRDAR--TSS DRDAR--LCA (PLASTICS TECH EVAL CEN)	2 1	COMMANDER REDSTONE ARSENAL ATTN: DRSMI--RB DRSMI--RRS DRSMI--RSM ALABAMA 35809	2 1 1
DOVER, NJ 07801		COMMANDER ROCK ISLAND ARSENAL ATTN: SARRI--ENM (MAT SCI DIV) ROCK ISLAND, IL 61202	1
COMMANDER US ARMY ARRCOM ATTN: DRSAR--LEP--L ROCK ISLAND ARSENAL ROCK ISLAND, IL 61299	1	COMMANDER HQ, US ARMY AVN SCH ATTN: OFC OF THE LIBRARIAN FT RUCKER, ALABAMA 36362	1
DIRECTOR US ARMY BALLISTIC RESEARCH LABORATORY ATTN: DRDAR--TSB--S (STINFO) ABERDEEN PROVING GROUND, MD 21005	1	COMMANDER US ARMY FGN SCIENCE & TECH CEN ATTN: DRXST--SD 220 7TH STREET, N.E. CHARLOTTESVILLE, VA 22901	1
COMMANDER US ARMY ELECTRONICS COMD ATTN: TECH LIB FT MONMOUTH, NJ 07703	1	COMMANDER US ARMY MATERIALS & MECHANICS RESEARCH CENTER ATTN: TECH LIB --DRXMR--PL WATERTOWN, MASS 02172	2
COMMANDER US ARMY MOBILITY EQUIP R&D COMD ATTN: TECH LIB FT BELVOIR, VA 22060	1		

NOTE: PLEASE NOTIFY COMMANDER, ARRADCOM, ATTN: BENET WEAPONS LABORATORY, DRDAR--LCB--TL, WATERVLIET ARSENAL, WATERVLIET, N.Y. 12189, OF ANY REQUIRED CHANGES.