

UNCLASSIFIED

AD NUMBER

AD830290

LIMITATION CHANGES

TO:

Approved for public release; distribution is unlimited. Document partially illegible.

FROM:

Distribution authorized to U.S. Gov't. agencies and their contractors;
Administrative/Operational Use; SEP 1963. Other requests shall be referred to Army Materiel Command, Alexandria, VA. Document partially illegible.

AUTHORITY

USAMC ltr, 2 Jul 1973

THIS PAGE IS UNCLASSIFIED

AMCP-706-244

AMC PAMPHLET

CP 706-244

THIS IS A REPRINT WITHOUT CHANGE OF ORIGIN

Cy 5816

AMCP 706-244

RESEARCH AND DEVELOPMENT OF MATERIEL

ENGINEERING DESIGN HANDBOOK

AMMUNITION SERIES

SECTION 1, ARTILLERY AMMUNITION—GENERAL

WITH TABLE OF CONTENTS, GLOSSARY AND INDEX FOR SERIES

LOAN COPY ONLY - DO NOT DESTROY
PROPERTY OF
REDSTONE SCIENTIFIC INFORMATION CENTER
MAY 16 1969



REDSTONE SCIENTIFIC INFORMATION CENTER



5 0510 01030971 1

FOR REFERENCE ONLY
(AMCP File)

73-16

HEADQUARTERS, U. S. ARMY MATERIEL COMMAND

SEPTEMBER 1963

my Attl Cmd Pam 706-244

HEADQUARTERS
UNITED STATES ARMY MATERIEL COMMAND
WASHINGTON 25, D.C.

30 September 1963

AMCP 706-244, Section 1, Artillery Ammunition--General, forming part of the Ammunition Series of the Army Materiel Command Engineering Design Handbook, is published for the information and guidance of all concerned.

(AMCRD)

FOR THE COMMANDER:

SELWYN D. SMITH, JR.
Major General, USA
Chief of Staff

OFFICIAL:



R. O. DAVIDSON

Colonel, GS
Chief, Administrative Office

DISTRIBUTION: Special

FOREWORD

The ARTILLERY AMMUNITION SERIES is being issued as an interim publication of the Ordnance Engineering Design Handbook, a comprehensive sequence of publications planned to treat the entire field of Ordnance design. When the Handbook was begun it was found to be impractical to integrate into it the series relating to Artillery Ammunition already in preparation under the direction of Picatinny Arsenal. Although they were similar, the objectives of the two projects were not identical. The subject breakdown adopted for the Handbook would have necessitated redistribution of the material of this series throughout several of the planned volumes of the Handbook, with consequent delay in publication of much of the material. It was therefore decided to issue this material intact as an interim publication to make it available as early as possible. The material appearing in this series will be gradually superseded as pertinent volumes of the Ordnance Engineering Design Handbook become available.

Material for this series was prepared by the Technical Writing Service of the McGraw-Hill Book Company, under Contract DAI-28-017-501-ORD-(P)-912. Technical supervision and much of the basic information were furnished by Picatinny Arsenal. Engineers from other Ordnance Design Centers also supplied much information, and aided in the review. In fact, so many persons have given time and energy to this project that it has been difficult to compile a complete list of acknowledgements.

The following were responsible for the conception and direction of the project.

ARTILLERY AMMUNITION SECTION, ARTILLERY AMMUNITION AND PACKING DEVELOPMENT LABORATORY, SAMUEL FELTMAN AMMUNITION LABORATORIES, PICATINNY ARSENAL

Alfred F. Teitscheid	Chief, Artillery Ammunition Branch
Wilder R. Carson	Chief, Artillery Ammunition Branch
Roy H. Wood	Chief, Artillery Ammunition Laboratory A

MAJOR CONTRIBUTORS

George Demitrack	Picatinny Arsenal	Interior Ballistics, Propellants
Lars Enequist	Ballistics Research Laboratory	Lethality Criteria
Henry P. Hitchcock	Ballistics Research Laboratory	Exterior Ballistics
Dr. Robert H. Kent	Ballistics Research Laboratory	Exterior Ballistics
Charles Lenchitz	Picatinny Arsenal	Thermodynamics of Explosive Materials
Prof. Arthur F. MacConochie	Prof. of Mechanical Engineering, Uni- versity of Virginia	Manufacturing Methods
Arnold O. Pallingston	Picatinny Arsenal	Physical Testing of Explosive Materials
Richard E. Todd	Picatinny Arsenal	Quality Control
Col. Herman U. Wagner, USA (Retired)		General Contributor and Consultant
Murray Weinstein	Picatinny Arsenal	Physical Testing of Explosive Materials
Dr. Lewis Zernow	Ballistics Research Laboratory	Shaped Charge Theory, Blast
Col. Herman H. Zornig, USA (Retired)		Ordnance Specialist and Consultant

GENERAL ASSISTANCE

Kenneth H. Abbott	Watertown Arsenal	Kinetic Energy Ammunition
Theodor Advokat	Picatinny Arsenal	Special Purpose Shell
Norman E. Beach	Picatinny Arsenal	Chemical Testing of Explosive Materials
Donald R. Beeman	Picatinny Arsenal	Head Ammunition Design Branch

GENERAL ASSISTANCE (cont)

Willard R. Benson	Picatinny Arsenal	Lethality Theory
Warren Blittersdorf	Frankford Arsenal	Cartridge Case Design, Manufacturing Methods
Joseph I. Bluhm	Watertown Arsenal	Rotating Bands
William Byrne	Frankford Arsenal	Cartridge Case
John E. Capell	Picatinny Arsenal	Ammunition Design Standards
Herbert N. Cohen	Picatinny Arsenal	Pyrotechnics
Corwin S. Davis	Picatinny Arsenal	Chief Propellant Section
Abraham L. Dorfman	Picatinny Arsenal	Pyrotechnics
Cyrus G. Dunkle	Picatinny Arsenal	Shaped Charge Ammunition
Leonard H. Eriksen	Picatinny Arsenal	Explosives Chemistry Laboratory
Harold N. Euker	Frankford Arsenal	AP Shell
Patrick Falivene	Picatinny Arsenal	Propellant Ignition
Arthur P. Field	Picatinny Arsenal	Inspection
Al Fox	Frankford Arsenal	Manufacturing Methods
Leo J. Frey, Jr.	Picatinny Arsenal	Special Purpose Shell
Robert Frye	Picatinny Arsenal	Head Chemical Branch
Andrew J. Galko	Picatinny Arsenal	GB Shell
Thomas Hall	Picatinny Arsenal	HEP Shell
Dr. David Hart	Picatinny Arsenal	Head Pyrotechnics Laboratory
Floyd Hill	Ballistics Research Laboratory	Tank Vulnerability
Sidney Jacobson	Picatinny Arsenal	Kinetic Energy Ammunition

GENERAL ASSISTANCE (cont)

William Josephs	Picatinny Arsenal	Propellants
Kurt Kupferman	Picatinny Arsenal	Shaped Charge Ammunition
Robert G. Leonardi	Picatinny Arsenal	Primer Ignition
William L. Lukens		Formerly in charge of Ammunition De- sign Branch, Picatinny Arsenal
Ulysses S. MacDonald	Picatinny Arsenal	Inspection
James R. McKay	Picatinny Arsenal	Special Purpose Shell
Harold Markus	Frankford Arsenal	AP Shell
Anthony Muzicka	Watervliet Arsenal	Rifling and Gun Chambers
Jacob H. Niper	Picatinny Arsenal	Inspection
Karl G. Ottoson	Picatinny Arsenal	Asst. Chief, Chem- ical Test Section
Lawrence W. Pell	Picatinny Arsenal	High Explosives
Ballard E. Quass	Picatinny Arsenal	Special Purpose Shell
Lt. Richard RhieI	D & P S Aberdeen Proving Grounds	Plate Penetration Monograms
Dr. William H. Rinkenbach		Formerly in charge of Picatinny Arsenal
Gilbert E. Rogers	Picatinny Arsenal	General Artillery Ammunition Design
Max Rosenberg	Picatinny Arsenal	Ammunition Design
William M. Rowe	Picatinny Arsenal	HEP Shell
Samuel Sage	Picatinny Arsenal	Chief, High Ex- plosives Section
Marvin B. Schaffer	Picatinny Arsenal	Canister Shell
Arthur B. Schilling	Picatinny Arsenal	Foreign Ammunition

GENERAL ASSISTANCE (cont)

Robert M. Schwartz	Picatinny Arsenal	General Ammunition Design
William F. Shirk	Picatinny Arsenal	Canister Shell
Morgan Smith	Ballistics Research Laboratory	Aircraft Vulnerability
Joseph V. Sperazza	Ballistics Research Laboratory	Blast Theory
Joseph Sterne	Ballistics Research Laboratory	Lethality, Fragmentation
Theodore W. Stevens	Picatinny Arsenal	High Explosives
Noah A. Tolch	Ballistics Research Laboratory	Lethality, Fragmentation
Paul B. Tweed	Picatinny Arsenal	High Explosives
Robert J. Vogel	Picatinny Arsenal	Assistant, Research and Development Section
Leo Volkheimer	Picatinny Arsenal	WP Shell
Stanley Wachtell		Chief, Physical Test Section
Garry Weingarten	Picatinny Arsenal	Head, Chemical Research Section Pyrotechnics Laboratory
Edward Wurzell	Picatinny Arsenal	Interior Ballistics

PREFACE

This series is a compilation of available data on the design of artillery ammunition. It is intended to introduce the graduate engineer to the art of ammunition design and to serve as a ready reference for the practicing artillery ammunition designer.

Information contained in these publications has been obtained from development reports and drawings of ammunition items, from proof firing records, and from research reports by United States and British government agencies. The information obtained from these sources was corroborated and supplemented by means of direct interviews and correspondence with personnel of U. S. government and private research and design agencies.

This series consists of six sections. Section 1 is an introduction to the general subject of ammunition and its design. It is primarily intended to familiarize newcomers to the field with the nomenclature and classification of ammunition items. For convenience in publication, the features applying to the entire series, such as Table of Contents, Glossary and Index, have been bound with Section 1.

Section 2 is concerned with terminal ballistics, or the production of effect by the various types of ammunition. Section 3 deals with the control of flight, and exterior ballistic design of both fin-stabilized and spin-stabilized rounds.

Section 4, on design for projection of ammunition, includes the design of propellants for desired interior ballistic characteristics, stress analysis, and the design of cartridge case, gun chamber, and rifling and rotating bands.

Section 5 describes the inspection aspects of artillery ammunition design. It is included to acquaint the designer with dimensioning practices and the nature of the limitations placed on design by the requirements of gaging and quality control.

Section 6, on manufacturing methods, has been included to give the neophyte designer some insight into the overall problem of the manu-

facture of metal parts of ammunition items, since methods of manufacture impose limitations upon the design of such items.

Much effort has been spent in locating and verifying this data. However, in spite of this, it is probable that valuable sources have been overlooked and that a certain percentage of the information is already obsolescent because of the rapid advances being made in the field. It is hoped that the users of the Artillery Ammunition Series will inform the Office of Ordnance Research, Box CM, Duke Station, Durham, North Carolina, of any omissions or errors that they may notice.

table of contents

Section	Page	Paragraphs
FOREWORD	iii	
PREFACE	ix	
1 ARTILLERY AMMUNITION — GENERAL	1-1	
Types and Classification of Complete Rounds	1-1	1-1 to 1-12
Types of Projectiles	1-2	1-13 to 1-21
Projectile Components	1-3	1-22 to 1-28
Fuzes, Boosters, and Detonators	1-4	1-29 to 1-37
Explosives for Ammunition	1-6	1-38 to 1-41
Propelling Charges	1-6	1-42 to 1-50
General Design Requirements	1-8	1-51 to 1-54
References and Bibliography	1-8	
2 DESIGN FOR TERMINAL EFFECTS	2-1	
Introduction	2-1	2-1 to 2-16
Blast Effect	2-7	2-17 to 2-49

Section	Page	Paragraphs
2	DESIGN FOR TERMINAL EFFECTS (cont)	
	References and Bibliography	2-20
	Characteristics of High Explosives	2-22 2-50 to 2-70
	Shaped Charge Ammunition	2-30 2-71 to 2-153
	Fragmentation	2-93 2-154 to 2-207
	References and Bibliography	2-113
	Kinetic Energy Ammunition for the Defeat of Armor	2-117 2-208 to 2-265
	References and Bibliography	2-148
	Canister Ammunition	2-150 2-266 to 2-278
	References and Bibliography	2-155
	High-Explosive Plastic (HEP) Shell	2-156 2-279 to 2-291
	References and Bibliography	2-159
	Special Purpose Shell	2-160 2-292 to 2-371
	References and Bibliography	2-199
3	DESIGN FOR CONTROL OF FLIGHT CHARACTERISTICS	3-1
	Design for Precision	3-1 3-1 to 3-22
	References and Bibliography	3-33
	Design for Maximum Range or Minimum Time of Flight	3-38 3-23 to 3-48
	References and Bibliography	3-77
	Projectile Geometry	3-81 3-49 to 3-64
4	DESIGN FOR PROJECTION	4-1
	Propellants and Interior Ballistics	4-1 4-1 to 4-75
	Cartridge Case and Gun Chamber Design	4-117 4-76 to 4-116
	References and Bibliography	4-137

Section		Page	Paragraphs
4	DESIGN FOR PROJECTION (cont)		
	Rotating Band and Rifling Design . . .	4-149	4-117 to 4-154
	References and Bibliography	4-176	
	Stress in Shell	4-177	4-155 to 4-177
	References and Bibliography	4-190	
5	INSPECTION ASPECTS OF ARTIL- LERY AMMUNITION DESIGN	5-1	
	Quality Assurance Aspects of Ammunition Design	5-1	5-1 to 5-21
	References and Bibliography	5-12	
	Effect of Dimensioning and Tol- erancing on Inspection	5-13	5-22 to 5-28
6	MANUFACTURE OF METALLIC COMPONENTS OF ARTILLERY AMMUNITION	6-1	
	Introduction	6-1	6-1 to 6-10
	Forging of HE Shell	6-4	6-11 to 6-33
	Machining of HE Shell	6-14	6-34 to 6-56
	Cold Extrusion of HE Shell	6-21	6-57 to 6-68
	Compromise Method of Shell Forming	6-25	6-69 to 6-70
	Manufacture of High-Explosive Plastic Shell	6-26	6-71 to 6-77
	Manufacture of Armor-Piercing Shot and Caps	6-29	6-78 to 6-86
	The Manufacture of Hypervelocity Armor-Piercing (HVAP) Shot	6-35	6-87 to 6-91
	The Manufacture of Tungsten Carbide Cores	6-36	6-92 to 6-95
	The Manufacture of Brass Cartridge Cases	6-37	6-96 to 6-103
	The Manufacture of Drawn-Steel Cartridge Cases	6-41	6-104 to 6-122

Section	Page	Paragraphs
6	MANUFACTURE OF METALLIC COMPONENTS OF ARTILLERY AMMUNITION (cont)	
	The Manufacture of Trapezoidal- Wrapped Steel Cartridge Cases . . . 6-46	6-123 to 6-131
	The Manufacture of Perforated Cartridge Cases 6-48	6-132 to 6-133
	References and Bibliography 6-49	
	GLOSSARY G-1	
	INDEX I-1	

GLOSSARY

A

ABSOLUTE DEVIATION: The shortest distance between the center of the target and the point where a projectile hits or bursts.

ABSOLUTE ERROR: Shortest distance between the center of impact or the center of burst of a group of shots and the point of impact or burst of a single shot within the group.

ACCURACY LIFE: The estimated average number of rounds that a particular weapon can fire before its tube becomes so worn that its accuracy tolerance is exceeded.

ACCURACY OF FIRE: The measurement of the precision of fire expressed as the distance of the center of impact from the center of the target.

ADIABATIC FLAME TEMPERATURE: The temperature a combustible system would attain if all the energy of combustion went into the formation of gas without energy loss to the surroundings.

AMATOL: High explosive made of a mixture of ammonium nitrate and trinitrotoluene; sometimes used as a bursting charge in high-explosive projectiles.

AMMONAL: High-explosive substance made of a mixture of ammonium nitrate, trinitrotoluene, and flaked or powdered aluminum. Ammonal is sometimes used as a bursting charge in high-explosive projectiles, and produces bright flashes on explosion.

AMMUNITION DATA CARD: Identification card prepared for each individual lot of ammunition manufactured, giving the type and composition of the ammunition, and identifying its components by lot number and manu-

facturer. When necessary, it may also include instructions for handling the ammunition.

AMMUNITION IDENTIFICATION CODE: Code symbol (for example, P5HBA) assigned to each ammunition item for identification and to facilitate the supply of ammunition to the field. The first two characters refer to the pertinent ordnance catalog, and the remaining three characters to the weapon group, type and model, and packaging. In small arms ammunition the grade is indicated.

AMMUNITION LOT NUMBER: Code number that identifies a particular quantity of ammunition from one manufacturer. The number is assigned to each lot of ammunition when it is manufactured.

ANGLE OF DEPARTURE: Angle between the line of sight and the axis of the bore of a gun at the instant the projectile leaves the muzzle. Angle of departure is the sum of the angles of site, elevation, and vertical jump.

ANGLE OF FALL: Angle between the horizontal and the tangent to the trajectory at the point at which a projectile falls.

ANGLE OF IMPACT: Acute angle between the tangent to the trajectory at the point of impact of a projectile and the plane tangent to the surface of the ground at the point of impact; angle at which a projectile strikes the ground or a target.

ANGLE OF INCIDENCE: Angle at which a projectile strikes a surface; acute angle between the tangent to the line of impact of a projectile and the perpendicular to the surface of the ground at the point of impact. It is the complement of the angle of impact.

AREA TARGET: Target for gunfire or bombing covering a considerable space, such as ammunitions factory, airport, or freight yard. An area target differs from a point target, which is a particular object or structure.

ARMING: As applied to fuzes, the changing from a safe condition to a state of readiness for initiation. Generally a fuze is caused to arm by acceleration, rotation, clock mechanism, or air travel, or by combinations of these.

ARMOR: Protective covering, especially metal plates used on ships, tanks, motor vehicles, etc.

ARMOR-PIERCING: A term applied to bullets and projectiles designed to pierce armor plate.

ARMOR-PIERCING CAPPED: Term applied to armor-piercing projectiles which have a steel cap in front of the projectile point, to assist in defeating face-hardened armor plate.

AUTOMATIC (Self-Acting): Moving or acting by itself. After the first round is fired, an automatic weapon fires, extracts, ejects, and reloads without application of power from an outside source, repeating the cycle as long as the firing mechanism is held in the proper position. Automatic action involves repeating the cycle of operation, as distinguished from semi-automatic, which is restricted to one complete cycle at a time.

AUTOMATIC FEED MECHANISM: Mechanism in an automatic gun that puts fresh shells into the chamber in position for firing.

B

BACK-BLAST: Rearward blast of gases from the breech of recoilless weapons and rockets upon the burning of the propellant charge. It is sometimes referred to as breech-blast.

BALLISTIC CAP: Cap for projectile, designed to improve its ballistic efficiency.

BALLISTIC COEFFICIENT: Measure of the ability of a missile to overcome air resistance.

BALLISTIC CONDITIONS: Conditions which affect the motion of a projectile in the bore and through the atmosphere, including muzzle velocity, weight of projectile, size and shape of projectile, rotation of the earth, density of the air, elasticity of the air and the wind.

BALLISTIC CURVE: Actual path or trajectory of a bullet or shell.

BALLISTIC DENSITY: Computed constant air density that would have the same total effect on a projectile during its flight as the varying densities actually encountered.

BALLISTIC EFFICIENCY: Ability of a projectile to overcome the resistance of the air. Ballistic efficiency depends chiefly on the weight, diameter, and shape of the projectile.

BALLISTIC LIMIT: Velocity at which a given type of projectile will perforate a given thickness and type of armor plate at a specified obliquity.

BALLISTIC MORTAR: Instrument used to determine the relative energy obtainable from explosive materials.

BALLISTICS: The science of the motion of projectiles.

BALLISTIC TEMPERATURE: A computed constant temperature that would have the same total effect on a projectile traveling from the gun to the target as the varying temperatures actually encountered.

BALLISTIC WAVE: Audible disturbance or wave caused by the compression of air ahead of a projectile in flight.

BALLISTIC WIND: Assumed constant wind that would have the same total effect on a projectile traveling from the gun to the target as the varying winds actually encountered.

BALLISTITE: Smokeless powder used as a propelling charge in small-arms and mortar ammunition.

BALLOTING: The bounding from side to side of a projectile in the bore of a gun.

BASE EJECTION SHELL: Type of special purpose shell which functions by expelling its filler out of the base of the shell. Expulsion is usually achieved by a small charge of propellant, called an expelling charge.

BASE LINE: Line of known length and direction between two points whose locations are known; used in fire control.

BASE PLUG: Seal in base of projectile.

BASE OF TRAJECTORY: Straight horizontal line from the center of the muzzle of a weapon to the point in the downward curve of the path of a projectile that is level with the muzzle.

BASE SPRAY: (See **SPRAY**.)

BIOLOGICAL AGENT: Viruses, any of certain classifications of micro-organisms and toxic substances, derived from living organisms used to produce death or disease in man, animals, and growing plants.

BIOLOGICAL WARFARE: Tactics and techniques of conducting warfare by use of biological agents.

BLACK POWDER: A sensitive, easily ignitable explosive mixture, which produces dense smoke; few remaining military uses, such as igniters, expelling and blank-fire charges. Black powder was used as a propellant before the advent of so-called smokeless powder.

BLANK AMMUNITION: Ammunition containing power but no projectile. Blank ammunition is used in training, in signaling, and in firing salutes.

BLAST: Sudden air pressure created by the discharge of a gun or the explosion of a charge.

BLASTING CAP: Small cylindrical case with a thin wall in which is enclosed a sensitive explosive, such as mercury fulminate, used as a detonator to set off another explosive charge. The explosive in the blasting cap is fired either by a burning fuse or by electricity. Also called a detonator.

BLAST CUBE: Angle iron frame covered with aluminum sheets; used for testing effectiveness of blast.

BLAST TUBE: Device used for the study of shock waves, and for calibration of air-blast gages.

BLASTING MACHINE: Small hand-powered generator for electrically firing one or more detonators or squibs to explode or ignite munitions or series of munitions.

BLOWBACK: Escape, to the rear and under pressure, of gases formed during the firing of a gun. Blowback may be caused by a defective breech mechanism, a ruptured cartridge, or a faulty primer.

BOAT-TAIL: Rear end of a projectile that is tapered or cone-shaped, and not cylindrical, as in a projectile having a square base.

BOOSTER: High-explosive element, sufficiently sensitive to be actuated by small explosive elements in a fuze, and powerful enough to cause detonation of the main explosive filling.

BORE: The cylindrical, and usually rifled, portion of the gun tube, or barrel interior, extending from the forcing cone to the muzzle. Bore is used both for the inside surface of the barrel or tube of a gun, with its rifling, and for the cylindrical space enclosed by that portion of the tube.

BORE IMPRESSION: Impression of the bore of a gun tube, made with a plastic substance in order to determine the condition of the rifling.

BORESAFE FUZE: Type of fuze having an interruptor in the explosive train that prevents a functioning until after the projectile has cleared the muzzle of a weapon.

BOURRELET: Finely machined band or ring of metal just behind the ogive of a projectile, designed to support the front portion of the projectile by riding the lands as the projectile travels through the bore of a gun.

BOW WAVE: (See **BALLISTIC WAVE**.)

BREECH: The rear part of the bore of a gun, especially the opening that permits the projectile to be inserted at the rear of the bore.

BREECH-BLAST: (See BACK-BLAST.)

BREECHBLOCK: Movable steel block that closes the rear part of the barrel in a firearm.

BRIDGE WAVES: Mach waves caused by the interaction of two shock waves to form a third that bridges the volume between the original two.

BRISANCE: Shattering power of high explosives.

BURNING (of propellant): (See LINEAR BURNING RATE.)

BURST: Explosion of a projectile in the air, or when it strikes the ground or target.

BURSTER: Explosive charge used to break open and spread the contents of chemical projectiles, bombs, or mines.

BURSTER TUBE: Tube that holds the burster in a chemical projectile.

BURSTING CHARGE: Quantity of explosive which breaks the casing of a projectile to produce demolition, fragmentation, or chemical action. (See EXPLOSIVE CHARGE.)

C

CALIBER: (1) Diameter of the bore of a gun. In rifled gun bores the caliber is obtained by measuring between opposite lands. A caliber .45 revolver has a barrel with a land diameter 45/100 of an inch. (2) Diameter of a projectile. (3) Unit of measure used to express the length of the bore of a weapon. The number of calibers is determined by dividing the length of the bore of the weapon, from the breech face of the tube to the muzzle, by the diameter of its bore. A gun tube whose bore is 40 feet (480 inches) long and 12 inches in diameter is said to be 40 calibers long.

CANISTER: (1) Metal cylinder containing metal fragments which are scattered when the cylinder breaks. (2) Cylinder containing materials for special terminal effects, such as smoke, propaganda leaflets, chaff, etc.

CANNISTER AMMUNITION: Shell containing preformed metal fragments which are dispersed by the centrifugal force caused by the shell's rotation.

CANNELURE: (1) A ring-like groove in the jacket of a bullet which provides a means of securely crimping the cartridge case to the bullet; analogous to the crimping groove in artillery ammunition. (2) Ring-like groove for locking the jacket of an armor-piercing bullet to the core. (3) Ring-like groove in the rotating band of a projectile, intended to lessen the resistance offered to the gun riflings. (4) Groove around the base of the cartridge case, where the extractor takes hold.

CANNON: (1) Fixed or mobile weapon, larger than small arms, that ejects its projectile by the action of an explosive. Cannon include guns, howitzers, and breech-loading mortars. (2) That portion of such a weapon required to fire a projectile (that is, tube, breech mechanism, and firing mechanism), as contrasted to that portion which supports the weapon and which is called the carriage or mount.

CANT: A leaning or tilt, to one side, of any object; militarily, the sidewise tilting of a gun.

CAP: (1) Nosepiece on a projectile. (2) (See BLASTING CAP.)

CARTRIDGE: Round of ammunition wherein the propellant and primer are contained in a casing and in which the propellant, primer, and projectile are assembled, stored, shipped, and issued as a complete unit.

CARTRIDGE BAG: Cloth bag holding the propelling charge for some types of cannon.

CARTRIDGE CASE: Container that holds the primer and propellant, and to which the projectile may be affixed.

CAST LOADING: Loading of HE shell by the pouring of molten high-explosive filler into shell body.

CAVITY CHARGE: (See SHAPED CHARGE.)

CENTER OF BURST: Point in the air about which the bursts of several projectiles, from rounds fired under like conditions, are evenly distributed.

CENTER OF BURST ERROR: Distance between the target and center of burst.

CENTER OF DISPERSION: Theoretical center of hits or bursts that would have been made if an unlimited number of shots had been fired with the same data. Actually it has to be considered the center of impact or bursts of all shots already fired.

CHAFF: Electromagnetic-wave reflectors in the form of narrow metallic strips, used for creating echoes with which to confuse the enemy; also called window.

CHAFF SHELL: Hollow projectile containing a filler of chaff. (See CHAFF.)

CHAMBER: Part of a gun in which the charge is placed; in a cannon, that space between the obturator or breechlock and the forcing cone. Nominally it is the space occupied by the cartridge case.

CHAMBER CAPACITY: Space available for gas expansion when the projectile is seated in position; measured from the face of the closed breechblock, around the base of the projectile, to the rear of the rotating band (or obturator). In fixed ammunition, it is the volume of the cartridge case behind the projectile.

CHEMICAL AGENT: Solid, liquid, or gas whose chemical properties produce lethal, injurious, or irritant effects; a screening or colored smoke; or an incendiary agent. (War gases, smokes, and incendiaries are the three main groups.)

CHOKING GAS: Casualty producing gas which causes irritation and inflammation of the bronchial tubes and lungs. Phosgene is an example of this type of gas.

CHORD: Straight line parallel to the centerline of the projectile from the leading edge to the trailing edge of a fin; the length of that line.

CHRONOGRAPH: Instrument for measuring and graphically recording small intervals of time; frequently used for measuring velocity of projectiles.

CLASSIFICATION OF DEFECTS: Enumeration of possible defects of a product classified according to their importance.

CLOSED BOMB: Apparatus used for determining the thermochemical characteristics of combustible materials. Also called closed chamber; bomb calorimeter.

COEFFICIENT OF FORM: Factor introduced into the ballistic coefficient of a projectile, based on its shape.

COLORLED MARKER SHELL: Projectile containing a colored dye which is ejected by a burster charge; used for spotting, marking, and signaling.

COMPLETE PENETRATION: (1) In the Army, penetration obtained when the projectile in the target or light through the target can be seen from the rear of the target. (2) In the Navy, penetration obtained when the projectile passes through the target intact or a major portion of the projectile passes through.

COMPLETE ROUND: (1) A complete round of separate-loading artillery ammunition consists of a primer, propelling charge, and (except for blank ammunition) a projectile. (2) A complete record of fixed or semi-fixed ammunition comprises a primer, propelling charge, cartridge case, and a projectile.

COMPUTED MAXIMUM PRESSURE: For any type of gun, the theoretical value of maximum pressure computed by interior ballistics formulas. When a new gun of the type in question is fired under standard conditions, with a propelling charge that will give a projectile its rated muzzle velocity, this is the pressure which should be developed.

CONFINEMENT: Degree of physical restriction to passage of detonation wave through explosive material.

COOK-OFF: Functioning of a chambered round of ammunition, initiated by the heat of the weapon.

COPPER CRUSHER GAGE: Device used to measure pressure developed in gun chamber by measuring the deformation of a copper cylinder.

COPPERING: Metal fouling left in the bore of a weapon by the rotating band or the jacket of a projectile.

CORDITE: Double-base powder in the form of cords, composed of guncotton, nitroglycerin, and mineral jelly, used by some foreign nations as a propellant in rounds of ammunition.

COUNTERRECOIL: Forward movement of a gun returning to firing position after recoil.

CROSS-WIND FORCE (LIFT): Component of air resistance in a direction perpendicular to the motion of the center of gravity, in the plane of yaw.

CRYSTAL DENSITY: Maximum density attainable for a given substance.

D

DECELERATOR: Device for slowing the rotation of parachute-containing projectile, before ejection of the parachute.

DEFLAGRATION: Rapid reaction (explosion) with evolution of considerable heat, accompanied by some disruptive effect but less violent than a detonation.

DEGRESSIVE GRANULATION: Propellant grain which burns with a continually decreasing surface until the grain is completely consumed.

DELAY FUZE: Fuze that has a delay element incorporated in the fuze train, permitting the missile to penetrate the target a dis-

tance corresponding to the delay. Such fuzes are used to permit penetration of the target before detonation, or for mining effect.

DESIGN PROCEDURE: Outline of steps to follow in designing an item.

DETERRENT: Material diffused into the surface of propellant grains to control burning.

DETONATE: Explode suddenly and violently.

DETONATING AGENT: Explosive used to set off another explosive. Fulminate of mercury and tetryl are used as detonating agents to set off other less sensitive explosives.

DETONATING CHARGE: Charge used to set off a high-explosive charge.

DETONATING CORD: Flexible fabric tube containing a filler of high explosive that is set off by a blasting cap or by an electric detonator. It has an extremely high rate of explosion, and is used to set off other high-explosive charges. The detonating cord currently in use is known commercially as primacord.

DETONATING EXPLOSIVE: (See HIGH EXPLOSIVE.)

DETONATION: Extremely rapid reaction with evolution of considerable heat accompanied by considerable violently disruptive effect and intense shock wave. (See also DEFLAGRATION.)

DETONATION FRONT: (See WAVE FRONT.)

DETONATION RATE: Velocity at which the detonation wave travels through an explosive material.

DETONATION WAVE: (See SHOCK WAVE.)

DETONATOR: Sensitive explosive used to set off an explosive train, as well as the mechanism and container connected therewith.

DEVELOPED MUZZLE VELOCITY: The actual muzzle velocity produced by any gun.

DOUBLE-BASE POWDER: (See DOUBLE-BASE PROPELLANT.)

DOUBLE-BASE PROPELLANT: Propellant whose principle active ingredients are nitrocellulose and nitroglycerin. (See **PROPELLANT**.)

DRAG: Component of air resistance in the direction opposite to that of the motion of the center of gravity of a projectile.

DRILL AMMUNITION: Ammunition without an explosive charge, used in training and practice.

DUMMY PROJECTILE: Shell that has no explosive charge. Dummy projectiles are used for practice and training purposes.

E. C. BLANK FIRE: (See **E. C. SMOKELESS POWDER**.)

E. C. SMOKELESS POWDER: Orange or pink explosive powder, resembling coarse sand. It is used as a charge in small arms, in blank cartridges. Also called blank-fire powder or E. C. blank fire.

ECCENTRICITY: Distance from center line to center of gravity of projectile.

ELASTIC STRENGTH PRESSURE: The computed internal gas pressure in a gun which, at the section under consideration, will stress the metal in some layer of the wall tangentially, up to the minimum elastic limit which is prescribed for the metal from which the member is made.

ELECTRIC PRIMER: Metallic device containing a small amount of a sensitive explosive or charge of black powder which is actuated by energizing an electric circuit. It is used for setting off explosive or propelling charges.

ELECTRIC SQUIB: Commercial flash-fuze device for electrical firing of burning type munitions such as smoke pots. It consists essentially of a small tube sealed with sulfur, containing a small charge of powder compressed around a fine resistance wire. There are three types: open-end, flash-vented, and closed-end.

EQUAL SECTION CHARGE: Propelling charge made up of a number of charges equal in

size. The number of sections used determines the muzzle velocity and range of the projectile.

EQUATION OF STATE: An equation relating the volume, temperature, and pressure of a system.

EROSION: Wearing away of a bore due to combined effect of gas washing, scouring, and mechanical abrasion. Due to the high temperatures and velocities, and chemical action, the bore diameter becomes enlarged.

EXPELLING CHARGE: Quantity of propellant used in special purpose shell to eject the contents of the shell.

EXPLOSIVE: Substance which, when subjected to heat, impact, friction, or other suitable initial impulse, undergoes an explosion that is a very rapid chemical transformation, forming other more stable products entirely or largely gaseous, whose combined volume is much greater than that of the original substance. Explosives are classified as high-explosive or low-explosive, according to the rate of the transformation. (See **HIGH EXPLOSIVE** and **LOW EXPLOSIVE**.)

EXPLOSIVE CHARGE: Predetermined quantity of explosive required to produce a specific effect. (See **BURSTING CHARGE**; **EXPELLING CHARGE**; **PROPELLING CHARGE**.)

EXPLOSIVE D: Ammonium picrate, a high-explosive charge that is not easily set off in transportation, or in handling, etc. Sometimes it is used as a bursting charge in armor-piercing projectiles.

EXPLOSIVE TRAIN: That portion of a fuze or fuze system consisting of explosive components, such as primer, detonator, booster, etc., necessary to cause functioning of a warhead or destructor.

EXTERIOR BALLISTICS: The branch of ballistics which deals with the motion of the projectile after leaving the gun.

F

FIN: Light metal portion of a mortar shell, bomb, and some rockets, designed for stabilizing and controlling them while in flight.

FIN STABILIZATION: Method of stabilizing a projectile, bomb, or missile during flight by the fitting of fins.

FIXED AMMUNITION: Ammunition with primer and propellant powder contained in a cartridge case permanently crimped or attached to a projectile, that is loaded into a weapon as a unit.

FIXED ROUND: Round of fixed ammunition.

FLAME TEMPERATURE. (See **ADIABATIC FLAME TEMPERATURE.**)

FLASH REDUCER: Any material for use with a propelling charge to reduce its muzzle flash.

FLAT TRAJECTORY: Trajectory with little curvature, produced by a projectile with a high velocity.

FLECHETTE: Stabilized fragment having a pointed nose and finned tail; dart.

FORCE: A term, convenient in interior ballistics theory, which is defined as the product of the number of mols of gas per gram of propellant and the adiabatic-constant-volume flame temperature.

FORCING CONE: Tapered beginning of the lands at the origin of the rifling of a gun tube. The forcing cone allows the rotating band of the projectile to be gradually engaged by the rifling thereby centering the projectile in the bore.

FORM COEFFICIENT: Factor used in form functions to describe the ratio of burning surface to fraction burned.

FORM FUNCTION: Mathematical expression relating burning rate to propellant grain geometry.

FRAGMENTATION: The breaking and scattering in all directions of the pieces of a projectile, bomb, or grenade.

FULMINATE OF MERCURY: (See **MERCURY FULMINATE.**)

FUZE: Device used to initiate a detonation under the conditions desired.

G

GILDING METAL: Copper-zinc alloy (brass) used for rotating bands.

GRANULATION: Size and shape of grain of propellant.

GRAVIMETRIC DENSITY: Weight of the propellant (in lb per in.³) divided by the volume occupied by the propellant (includes the air space in and around propellant grains).

G-SERIES WAR GASES: Group of persistent blood and nerve poisons which are highly toxic and practically odorless. GA, GB, and GD are members of the G-series.

GUNCOTTON: Nitrocellulose containing 13 percent or more of nitrogen.

H

HANGFIRE: Temporary failure or delay in the action of a primer, igniter, or propelling charge. For a few seconds it cannot be distinguished from a complete failure, or misfire.

HANGFIRE TEST: Test to determine uniformity and promptness of fire of a type of ammunition.

HC MIXTURE: Solid, nonpersistent screening smoke that, when burning, produces a grayish white smoke having a sharp, acrid odor, which is toxic if released in sufficient quantities in enclosed places; used in bombs, shell, grenades, and smoke pots. The smoke is cool burning as contrasted with white phosphorous, and tends to cling to the earth.

HEAT OF COMBUSTION: Heat evolved in the complete oxidation of a substance at constant pressure and 25°C. The test is usually accomplished calorimetrically by burning a gram of sample in a combustion bomb containing one cc of water under a pressure of 30 atmospheres of pure oxygen.

HEAT OF EXPLOSION: Heat evolved in burning a sample in a combustion bomb under a pressure of 25 atmospheres of helium, or other inert gas. (Products of explosion vary with the oxygen balance of the sample.)

HEAT OF FORMATION: Heat of formation of a compound is equal to the sum of the heats of formation of the products of combustion, minus the heat of combustion of the compound. ΔH_f (reactants) = $\Sigma \Delta H_f$ (products) - ΔH_c .

HEAT OF REACTION: Heat evolved when a sample is burned in a combustion bomb in one atmosphere of helium or other inert gas. (Products of this reaction are dependent on the oxygen balance of the sample.)

HEAT SHELL: (See HIGH-EXPLOSIVE ANTI-TANK SHELL.)

HEAT TEST: Accelerated stability test of an explosive material.

HEP SHELL: (See HIGH-EXPLOSIVE PLASTIC SHELL.)

HIGH-ANGLE FIRE: Fire delivered at elevations greater than the elevation of maximum range, its range therefore decreasing as the angle of elevation is increased. Mortars deliver high-angle fire.

HIGH EXPLOSIVE: Explosive which undergoes an extremely rapid chemical transformation, thereby producing a high order detonation and shattering effect. High explosives are used as bursting charges for bombs, projectiles, grenades, mines, and for demolition.

HIGH-EXPLOSIVE ANTITANK (HEAT) SHELL: Ammunition for defeat of armour by use of a shaped charge.

HIGH-EXPLOSIVE PLASTIC (HEP) SHELL (or, SQUASH-HEAD SHELL): Shell with deformable nose, designed to contain a plastic explosive, for use against armor; shock transmitted through the armor causes the back of armor plate to spall.

HIGH-EXPLOSIVE SHELL: Projectile with a bursting charge of high explosive, used against personnel and materiel.

HYGROSCOPICITY: The tendency of a substance to absorb any available moisture from its surroundings; specifically the absorption of water vapor from the atmosphere.

HYPERVELOCITY: Muzzle velocity of an artillery projectile of 3,500 feet per second or more.

HYPERVELOCITY ARMOR-PIERCING (HVAP) AMMUNITION: Ammunition which embodies a core of hard, dense material (such as tungsten carbide) within a shell of light material, such as aluminum. Its light overall weight permits it to be fired safely at very high velocities. The velocity is rapidly lost, but at short ranges it is effective against armor.

HYPERVELOCITY ARMOR-PIERCING DISCARDING SABOT (HVAPDS) AMMUNITION: Ammunition which embodies a hypervelocity, armor-piercing, subcaliber projectile within a discarding sabot. (See SABOT.)

HYPERVELOCITY ARMOR-PIERCING DISCARDING SABOT FIN-STABILIZED (HVAPDSFS) AMMUNITION: Ammunition which embodies a hypervelocity, armor-piercing, subcaliber, fin-stabilized projectile within a discarding sabot. (See SABOT.)

I

IGNITER: Device containing a ready burning composition, usually a form of black powder, used to amplify the ignition of a propelling charge by a primer. Also sometimes used to amplify the initiation of a primer in the functioning of certain types of fuzes and burster charges.

IGNITER TRAIN: Step-by-step arrangement of charges in pyrotechnic bombs, shells, etc., by which the initial fire from the primer is transmitted and intensified until it reaches and sets off the main charge. An explosive bomb, projectile, etc., uses a similar series, called an explosive train.

IGNITIBILITY: Statement of the ease with which the burning of a substance may be initiated.

IGNITING MIXTURE: Explosive mixture used as a fuze in pyrotechnic signals.

IGNITING PRIMER: Primer designed to be initiated by flame from another primer. Sometimes used in subcaliber guns so as to permit drill or practice with the regular primer.

IGNITION CARTRIDGE: Igniter in cartridge form which may be used alone or with additional propellant increments as a propelling charge for certain mortar ammunition.

ILLUMINATING SHELL: Projectile with a time fuze that sets off a parachute flare at any desired height; used for lighting up an area.

IMPACT FUZE: Fuze designed to function on impact.

INCENDIARY: (1) Chemical agent used primarily for igniting combustible substances with which it is in contact by generating sufficient heat to cause ignition. (2) Filling for incendiary munitions such as shells, bombs, grenades, and flame throwers. (3) Munition with flammable filling and means of release and/or ignition.

INCREMENT: A package of propellant, forming part of the full propelling charge, which may be removed to reduce the velocity or range. (See MULTISECTION CHARGE.)

INITIAL AIR SPACE: Volume of gun chamber not occupied by propellant when gun is loaded for firing.

INITIAL VELOCITY: (See MUZZLE VELOCITY.)

INITIATOR: Small quantity of very sensitive and powerful explosive used to start the detonation of another less sensitive explosive. Mercury fulminate, lead azide, and tetryl are the principle high explosives used as initiators.

INSTANTANEOUS FUZE: One which will burst the projectile on the outside of a hard surface (such as a concrete emplacement) before penetration or ricochet. This fuze will give some crater on hard ground. (See SUPERQUICK FUZE.)

INTERIOR BALLISTICS: Subdivision of ballistics which deals with that part of the phenomena within the chamber and bore of a weapon associated with imparting kinetic energy to missiles. (See BALLISTICS.)

ISOBARIC ADIABATIC FLAME TEMPERATURE: Adiabatic flame temperature attained in a constant pressure system. (See ADIABATIC FLAME TEMPERATURE.)

ISOCHORIC ADIABATIC FLAME TEMPERATURE: Adiabatic flame temperature attained in a constant volume system. (See ADIABATIC FLAME TEMPERATURE.)

J

JOLT AND JUMBLE TESTS: Tests intended to simulate the shocks various components of ammunition are subjected to in transportation and handling.

JUMP: The movement which the tube of the gun describes under the shock of firing, but before the projectile leaves the muzzle. Usually expressed as an angle.

K

KINETIC ENERGY AMMUNITION: Ammunition whose effectiveness is dependent upon its high density (mass) and high velocity.

L

LANDS: Raised portion between grooves in the bore of a rifled gun.

LATERAL DEVIATION: Horizontal distance between the point of impact or burst and the gun-target line.

LEAD AZIDE: Very sensitive high explosive used in small quantities to initiate other less sensitive high explosives.

LEAFLET SHELL: Usually consists of standard-base ejection smoke shell, of any caliber, with smoke canisters removed and propaganda substituted therefor.

LIFTING PLUG: Threaded eyebolt which fits into the fuze cavity, permitting heavy shells to be handled by means of a winch.

LINEAR BURNING RATE: The distance normal to any burning surface of the propellant grain burned through in unit time. This property depends upon the chemical composition, and is not a function of geometry.

LINER: (1) Inner tube, in a cannon, which bears the rifling and which may be replaced when worn out. (2) Cone of material used as an integral part of shaped charge liner.

LIVE AMMUNITION: Ammunition containing explosives. This is in contrast to drill ammunition (dummy ammunition), which contains no explosives and is used in training.

LOADING DENSITY: Ratio of weight of propellant (in lb per in.³) to available chamber volume.

LONG-DELAY FUZE: One which will burst the projectile after complete penetration into hard ground. There is a variation in the time element in long-delay fuzes required for different uses. (This is a question to be determined by the Ordnance Dept.)

LOW EXPLOSIVE: Explosive which undergoes a relatively slow chemical transformation, thereby producing a deflagration or an explosion, the effect ranging from that of a rapid combustion to that of a low order detonation. It is suitable for use in igniter trains and certain types of propellants. (See PROPELLANT.)

LOW ORDER DETONATION: Incomplete detonation of the explosive charge in a bomb, projectile, or other similar high explosive. (See DETONATION.)

LOWER ACCEPTABLE MEAN MAXIMUM PRESSURE: For any type gun, that value of the maximum pressure which is specified in the propellant specification as the lower limit for the average of the maximum pressures that are developed by an acceptable smokeless propellant in propelling charges which will impart the specified muzzle velocity to the specified projectile. Smokeless propellant in propelling charges which in acceptance tests develops an average maximum pressure lower than this value is considered as having failed to pass the test.

M

MACH NUMBER: Ratio of the velocity of a body to that of sound in the same medium.

MACH WAVE: Supersonic shock wave.

MAGNUS FORCE: (1) Force normal to the plane of yaw, caused by the spin. (2) Force arising from interaction of a spinning body and the windstream when the body is yawing.

MAGNUS FORCE, CENTER OF: Vanishing point of Magnus moment.

MAXIMUM PRESSURE: The maximum value of the pressure exerted by the propellant gases on the walls of a gun during the firing of the round.

MAXIMUM SKY BRIGHTNESS: Worst possible sky condition for observing pyrotechnic signals; usually uniform clouds or overcast.

MEPLAT: Flat nose.

MERCURY FULMINATE: Sensitive explosive that is set off by friction, impact, or heat, and detonates. Mercury fulminate is used to set off other explosives in projectiles, mines, or bombs.

METAL FOULING: Deposit of metal, which collects in the bore of a gun, that comes from the jackets or rotating bands of projectiles.

MISFIRE: (1) Failure to fire or explode properly. (2) Failure of a primer or the propelling charge of a projectile to function, wholly or in part. Misfire may be contrasted with hangfire, which is delay in any part of a firing charge.

MULTISECTION CHARGE: Propelling charge in separate-loading or semifixed ammunition that is loaded into a number of powder bags. Range adjustments can be made by increasing or reducing the number of bags used, as contrasted with a single-section charge, in which the size of the charge cannot be changed.

MUZZLE BLAST: Sudden air pressure exerted in the vicinity of the muzzle of a weapon by the rush of hot gases and air on firing.

MUZZLE BRAKE (also called a **RECOIL BRAKE**): Device attached to the muzzle of a gun which utilizes escaping gases to reduce the effective recoil force of the gun tube on the carriage or mount. In some designs it eliminates or reduces muzzle flash.

MUZZLE FLASH: Undesirable luminous ignition of unburned propellant gases issuing from the muzzle of a gun. The gases ignite upon mixture with atmospheric oxygen.

MUZZLE VELOCITY: Speed of a projectile at the instant it leaves the muzzle of a gun.

MUZZLE WAVE: Compression wave or reaction of the air in front of the muzzle of a weapon immediately after firing.

N

NERVE GAS: (See **G-SERIES WAR GASES**.)

NITROCELLULOSE: Explosive substance formed by the nitration of cotton, or some other form of cellulose. Used as the base of most U. S. propellants. Specific grades of nitrocellulose (see **PYROCELLULOSE** and **GUNCOTTON**) depend on the degree to which the cellulose is nitrated.

NITROCOTTON: (See **GUNCOTTON**.)

NITROGUANIDINE (nitrated aminomethanamine): Used as an additional base of propellant; used as a "cool propellant" because of its low flame temperature which does not erode gun bores nor produce as much luminous flash as single base (nitrocellulose) propellants.

NITROGLYCERINE: Nitrated ester of glycerol in which the OH radicals are replaced by NO_2 ; used as primary base of British propellants and as gelatinizing agent of U. S. propellants, but not used as primary base of U. S. propellants because its high flame temperature accelerates bore erosion.

NITROGEN MUSTARD GASES: Group of blister gases similar to mustard gas with varying chemical properties and little or no odor; gases affect eyes, nose, and lungs.

NONDELAY FUZE: Fuze that functions as a result of inertia of firing pin (or primer) as missile is retarded during penetration of target. The inertia causes the firing pin to strike the primer (or primer the firing pin), initiating fuze action. This type of fuze is inherently slower in action than the superquick or instantaneous fuze, since its action depends upon deceleration (retardation) of the missile during penetration of the target.

NORMAL CHARGE: Propelling charge employing a standard amount of propellant to fire a gun under ordinary conditions, as compared with a reduced charge or a supercharge used in special circumstances.

NORMAL FORCE: (1) Component of air resistance perpendicular to the axis of the projectile in the plane of yaw (exterior ballistics). (2) Any force perpendicular to a given line or surface (general).

NORMAL IMPACT: Striking of a projectile against a surface that is perpendicular to the line of flight of the projectile.

NOSE SPRAY: (See **SPRAY**.)

NUTATION: A small periodic oscillation about the motion of precession.

O

OBTURATION: Any process that prevents the escape of gases from the tube of a weapon during the firing of a projectile.

OBTURATOR: A device for making the tube of a weapon gas-tight, preventing any escape of gas until the projectile has left the muzzle.

OGIVE: The shape of the head of the projectile, often a convex solid of revolution generated by an arc of a circle whose center lies on the side of the axis of revolution opposite to the arc.

OPTIMUM CHARGE: Web and propellant weight combination which produces maximum velocity at a specified pressure.

OVERTURNING MOMENT (of a projectile in flight): Couple about an axis through the center of gravity, perpendicular to the plane of yaw.

OXYGEN BALANCE: Ratio of self-contained oxygen to fuel in a propellant or explosive.

P

PARASHEET: Parachute-like device made from a single flat piece of material, or as few pieces as its size will permit; avoids cost of complex gore construction of parachute.

PEAK PRESSURE: Instantaneous maximum pressure developed in the gun chamber by burning propellant; pressure immediately preceding an expanding shock wave.

PERCUSSION COMPOSITION: High-explosive powder that is ignited in some types of firearms by the blow of the firing pin against the primer cap.

PERCUSSION FUZE: (See **IMPACT FUZE**.)

PERCUSSION PRIMER: Cap or cylinder containing a small charge of high explosive that may be set off by a blow. A percussion primer is used in all fixed and semifixed ammunition and in certain types of separate-loading ammunition to ignite the main propelling charge.

PERFORATION: Passage of a missile completely through an object.

PERMISSIBLE INDIVIDUAL MAXIMUM PRESSURE: For any type gun, that value which should not be exceeded by the maximum pressure developed by any individual round under any service condition.

PERMISSIBLE MEAN MAXIMUM PRESSURE: For any type gun, that value which should not be exceeded by the average of the maximum pressures developed in a series of rounds fired under any service conditions.

PHOSGENE: Colorless choking gas having an odor of new-mown hay or fresh corn; causes choking and coughing, and injuries to the lungs.

PICRIC ACID (trinitrophenol): High explosive, more powerful than trinitrotoluene, used widely in the form of mixtures with other nitro compounds.

PIEZOELECTRIC CRYSTAL: Crystalline material possessing the property that, when it is mechanically compressed or stretched in certain directions, electrical charges in direct proportion to the mechanical strain appear on the crystal surfaces.

PITCH (of rifling): Reciprocal of the twist. (See **TWIST**.)

PLANFORM: Shape of plan view of fins.

PLASTIC EXPLOSIVE: Explosive which, within normal ranges of atmospheric temperature, is capable of being molded into desired shapes.

PLUNGING FIRE: Gunfire that strikes the earth's surface at a high angle.

POINT-BLANK RANGE: Distance, to a target, that is so short that the trajectory of a bullet or projectile is practically a straight, rather than a curved, line. Point-blank range is one for which no superelevation is needed.

POINT DETONATING FUZE: Fuze, located in the nose of a projectile, which is initiated upon impact.

POWDER: Term sometimes loosely used for "propellant" or "propelling charge."

POWDER TRAIN: (1) Train, usually of compressed black powder, used to obtain time action in older fuze types. (2) Train of explosives laid out for destruction by burning.

PRACTICE AMMUNITION: Ammunition used for target practice, ammunition with a propelling charge, but with either an inert filler or a low-explosive filler to serve as a spotting charge.

PRECISION: The quality of having small dispersion about the mean.

PRECESSION: A change in the direction of the axis of a rotating body. In this handbook, precession means the slow motion without nutation.

PRESSURE, CENTER OF: The point where the resultant force caused by air resistance intersects the axis of the projectile.

PRIMACORD: Flexible fabric tube containing a filler of high-explosive PETN (pentarethritetranitrate) that is used to transmit a detonation from a detonator to a booster or bursting charge. Primacord is the trade name for the type of detonating cord currently in use.

PRIMER: Device used to initiate the functioning of an explosive or igniter train. It may be actuated by friction, blow, heat, pressure, or electricity.

PRIMER-DETONATOR: Assembly consisting of a primer and a detonator. It may also include a delay element.

PRIMER SEAT: Chamber in the breech mechanism of a gun that uses separate-loading ammunition, into which the primer is set.

PROBABLE ERROR: An error of such magnitude that the probability of making an error greater than it in any given observation is just equal to the probability of making one less than it, both probabilities being one-half.

PROCEDURE, DESIGN: Outline of steps to follow in designing an item.

PROGRESSIVE GRANULATION: Propellant grain which burns with a continually increasing surface until the grain is completely consumed.

PROJECTILE: Object, such as a bullet or shell, that is propelled from a weapon by an explosive propelling charge.

PROOF AMMUNITION: Ammunition incorporating solid, blunt-nosed, steel or cast iron shot of inexpensive manufacture; used in proof firing of guns; used to simulate the weight of projectile designed for the gun in adjusting the charge weight of propellant.

PROPAGANDA SHELL: (See LEAFLET SHELL.)

PROPELLANT: Explosive material whose rate of combustion is low enough, and its other

properties suitable, to permit its use as a propelling charge.

PROPELLING CHARGE: Explosive charge that is burned in a weapon to propel a projectile therefrom (see PROPELLANT). Burning of the confined propelling charge produces gases whose pressure forces the projectile out.

PROXIMITY FUZE: Fuze designed to detonate a projectile, bomb, mine, or charge when activated by an external influence in the close vicinity of a target.

PYROCELLULOSE: Nitrocellulose containing 12.60 percent nitrogen.

PYROCOTTON: (See PYROCELLULOSE.)

PYRO POWDER: Straight nitrocellulose powder; smokeless propelling charge consisting of a nitrocellulose that has a smaller nitrogen content than guncotton; single-base propellant.

PYROTECHNICS: Ammunition containing chemicals that produce a smoke or brilliant light in burning, used for signalling, marking, spotting, illuminating, etc.

PYROXYLIN (collodion): Nitrocellulose containing 8-12 percent nitrogen.

Q

QUALITY ASSURANCE: System of assuring that material accepted is in accordance with requirements, including inspection and test procedures, acceptance criteria, etc.

QUICKNESS (propellant burning): Rate of change of pressure within the close chamber with respect to time.

R

RAM: (1) To push into position. (2) To seat a projectile in the bore of a gun.

RAMMER: (1) Device for driving a projectile into position in a gun. It may be hand- or power-operated or a part of the receiver mechanism. (2) Tool used to remove live projectiles from the bore of a gun.

RATED MAXIMUM PRESSURE: For any type gun, that value of the maximum pressure which is specified in the propellant specification as the upper limit of average pressure which may be developed by an acceptable propellant in the form of propelling charges which will impart the specified muzzle velocity to the specified projectile. The smokeless propellant in propelling charges which, in the acceptance test, develops an average maximum pressure exceeding this value is considered as having failed to pass the test.

RELATIVE FORCE: Ratio of observed maximum pressure developed by a propellant under test to the maximum pressure developed by a standard propellant under identical test conditions.

RELATIVE QUICKNESS: Ratio of the quickness (dP/dt) of a test propellant to the quickness of a standard propellant, measured at the same initial temperature and loading density in the same closed chamber.

REMAINING VELOCITY: Speed of a projectile at any point along its path of flight. Remaining velocity is usually measured in feet per second.

RICOCHET: Glancing rebound of a projectile after impact.

RIFLE: (1) Any firearm that has rifling in the bore designed to give a spin to the projectile for greater accuracy of fire and longer range (not extensively used in this manner, except for shoulder arms). (2) Cut spiral grooves (rifling) in the bore of a gun in order to give a spin to the projectile so that it will have a greater accuracy of fire and longer range.

RIFLING: Spiral grooves in the bore of a weapon designed to give a spin to the projectile for greater accuracy and carrying power. Rifling includes both the grooves and the ridges between, called lands.

ROTATING BAND: Soft metal band around a projectile near its base. The rotating band makes the projectile fit tightly in the bore

by centering the projectile, thus preventing escape of gas, and giving the projectile its spin as it engages in the rifling.

ROUND: (1) All the parts that make up the ammunition necessary in firing one shot (also called **COMPLETE ROUND**). (2) One shot fired by a weapon.

ROUND OF AMMUNITION: (See **ROUND**.)

S

SABOT: (1) Lightweight carrier in which a subcaliber projectile is centered to permit firing the projectile in the larger caliber weapon. The carrier fills the bore of the weapon from which the projectile is fired; and its light weight permits it to be safely fired at very high velocities. It is normally discarded a short distance from the muzzle, in which case it is known as a discarding sabot.

SAFETY WIRE: Wire set into the body of a fuze to lock all movable parts into safe position so that the fuze will not be set off accidentally. It is pulled out just before loading.

SCABBING: Breaking off of fragments in the inside of a wall of hard material due to the impact or explosion of a projectile on the outside.

SCREENING SMOKE: Chemical agent which, when burned, hydrolyzed, or atomized, produces an obscuring smoke; used to deny observation and reduce effectiveness of aimed fire.

SEMIFIXED AMMUNITION: Ammunition in which the cartridge case is not permanently fixed to the projectile, so that the zoned charge within the cartridge case can be adjusted to obtain the desired range; loaded into the weapon as a unit.

SEMIFIXED ROUND: Round of semifixed ammunition.

SENSITIVITY: Measure of the response of an explosive material to initiation by heat, friction, or impact.

SEPARATED AMMUNITION: Ammunition in which the cartridge case is not fixed to the projectile, so that the zoned charge within the cartridge case can be adjusted to obtain the desired range; loaded into the weapon as a unit.

SEPARATE-LOADING AMMUNITION: Ammunition in which the projectile, propelling charge, and primer are not held together in a shell case, as in fixed ammunition, but are loaded into a gun separately.

SEPARATING BURST: Method of ejecting the contents of a projectile by means of a charge of propellant that breaks the projectile, into two approximately equal parts, along a specially designed circumferential shear joint.

SERVICE AMMUNITION: Ammunition intended for combat rather than for training purposes.

SETBACK: Rearward jerk, caused by inertia, of parts of a projectile when it is fired.

SHAPED CHARGE: An explosive so shaped and designed as to concentrate its explosive force in a single direction.

SHELL: Hollow projectile filled with explosive, or chemical or other material, as opposed to shot, which is a solid projectile.

SHELL-DESTROYING TRACER: Tracer with an igniter element, placed between the explosive in an anti-aircraft projectile and the tracer element, that is designed to detonate the explosive after the projectile has passed the target point but is still high enough to be harmless to ground troops.

SHOCK WAVE: Rapid expansion of the hot gases resulting from detonation of an explosive charge.

SHORT DELAY FUZE: One which will burst a projectile on ricochet, preferably about 6 to 10 feet above ground. Some crater effect will be obtained on hard ground.

SHOT: (1) A solid projectile. (2) Pellets, small balls, or slugs used in shotgun shells, canisters, and some other types of ammunition.

SHRAPNEL: Artillery projectile which contains small lead balls that are propelled by a powder charge in the base, set off by a time fuze. Shrapnel has been replaced almost entirely by high-explosive shells. Wounds called shrapnel wounds usually are due to shell fragments rather than to shrapnel.

SHRINKAGE: Contraction of propellant grain from wet (green) dimensions (as it comes from the graining dye) to the dry dimensions after solvent extraction and evaporation.

SIDE SPRAY: (See SPRAY.)

SIGNALING SMOKE: Any type of smoke, but usually colored smoke from a hand or rifle grenade, or from a pyrotechnic signal, used for conveying a message.

SINGLE-BASE POWDER: (See SINGLE-BASE PROPELLANT.)

SINGLE-BASE PROPELLANT: Propellant whose principle active ingredient is nitrocellulose.

SINGLE-SECTION CHARGE: Propelling charge in separate-loading ammunition that is loaded into a single bag. A single-section charge cannot be reduced or increased for changes of range, as a multisection charge can be.

SMOKE SHELL: Any projectile containing a smoke-producing chemical agent that is released on impact or burst. Also called smoke projectile. Smoke may be white or colored. (See COLORED MARKER SHELL.)

SMOKELESS POWDER: (See SMOKELESS PROPELLANT.)

SMOKELESS PROPELLANT: Propellant explosive from which there is a minimum amount of visible smoke on firing.

SMOOTH-BORE: Having a bore that is smooth and without rifling; shotguns and mortars are commonly smooth-bore.

SPALL: Fragments broken from either surface of an armor plate as the result of penetration, impact of a projectile, or detonation against the plate.

SPECIFIC DENSITY: Mass per unit volume. In interior ballistics it is usually distinguished from loading density and gravimetric density, which see.

SPIN: Angular velocity about the axis of the projectile.

SPIN-DECELERATING MOMENT: A couple about the axis of the projectile which diminishes spin.

SPIN-STABILIZATION: Method of stabilizing a projectile during flight by causing it to rotate about its own longitudinal axis.

SPRAY: Fragments of a bursting shell. The nose, side, and base sprays are the fragments thrown forward, sideways, and rearward, respectively.

SQUASH-HEAD SHELL: (See HIGH-EXPLOSIVE PLASTIC SHELL.)

SQUIB: Small pyrotechnic device which may be used to fire the igniter in a rocket or for some similar purpose; not to be confused with a detonator, which explodes. (See ELECTRIC SQUIB.)

STABILITY: Measure the ability of an explosive material to be stored for long periods.

STABILITY TEST: Accelerated test to determine the suitability of an explosive material for long-term storage.

STABILIZER: Material added to propellant colloid to inhibit, or reduce, decomposition in storage.

STACKED CHARGE: Powder charge in which the powder grains lie end to end within the powder bag.

STANDARD ATMOSPHERE: Values of temperature and pressure determined by NACA, based on the yearly averages at 40° N latitude. At sea level $T = 59^{\circ}\text{F}$; $P = 29.92$ in. Hg; lapse rate = 3.6°F per 1,000 ft altitude. Various other standards have been defined, but this is the standard used in this handbook.

STANDARD BALLISTIC CONDITIONS: Set of ballistic conditions arbitrarily assumed as standard for the computation of firing tables.

STANDARD DEVIATION: The root-mean-square of the deviations from the mean.

STANDARD TRAJECTORY: Path through the air that it is calculated a projectile will follow under given conditions of weather, position, and materiel, including the particular fuze, projectile, and propelling charge that are used. Firing tables are based on standard trajectories.

STANDOFF: Distance between a shaped charge round and its target at the instant of functioning.

STAR: Pyrotechnic signal that burns as a single light.

STAR GAGE: Instrument for measuring the diameter of the bore of a gun.

STAR SHELL: (See ILLUMINATING SHELL.)

STOWAGE: (1) Method of placing cargo in a vessel to prevent damage, shifting, etc. (2) Method of placing equipment and supplies in a vehicle to provide availability and operating room. (3) Equipment when stowed.

STRIKER: Part of the firing mechanism of a gun, mine, mortar, etc., that hits the primer; hammer or firing pin of a gun.

STRIKING VELOCITY: Speed of a projectile at the point of impact.

SUBCALIBER: Of a caliber smaller than standard.

SUPERQUICK FUZE: Fuze that functions immediately upon impact of the missile with the target. Action of this type of fuze is the quickest possible: the firing pin is driven into the primer immediately upon first contact of the missile; functions at the surfaces of the target. Also called instantaneous fuze.

SUPERSENSITIVE FUZE: Fuze that will set off a projectile when it strikes even a very light target, such as an airplane wing.

SUPPLEMENTAL CHARGE: Filler, which is normally TNT, used in deep cavitied projectiles to fill void between ordinary fuze and booster combination and bursting charge.

SURVEILLANCE: Observation, inspection, investigation, test, study, and classification of ammunition, ammunition components, and explosives in movement, storage, and use with respect to degree of serviceability and rate of deterioration.

SWELL DIAMETER: Maximum diameter of the ogive extended to the place where its generating arc is parallel to the center line.

SYMPATHETIC DETONATION: Explosion caused by the shock of another explosion nearby.

T

TERMINAL BALLISTICS: The branch of ballistics which deals with the ultimate effect produced by a projectile.

TERMINAL VELOCITY: Remaining speed of a projectile at the point in the downward path of the projectile where the projectile is level with the muzzle of the gun. The speed at the point of impact is called the striking velocity.

TETRYL: Sensitive explosive used especially in caps and boosters to detonate less sensitive explosives, and as the explosive filler in some types of projectiles.

THERMATE: Standard incendiary agent used as filling for incendiary munitions. Mixture of thermite (iron oxide and aluminum) and other oxidizing agents; it burns at about 4,300°F.

THERMIT: Thermite, commercial welding mixture of iron oxide and aluminum; used as an incendiary for some munitions.

TNT: (See TRINITROTOLUENE.)

TRACER: Element of a type of ammunition containing a chemical composition which burns visibly in flight. Tracer is used for

observation and adjustment of fire, for incendiary purposes, and for signaling. Ammunition containing tracers is called tracer ammunition.

TRAJECTORY: Path of projectile, missile, or bomb in flight.

TRAJECTORY CHART: Diagram of a side view of the paths of projectiles fired at various elevations, under standard conditions. The trajectory chart is different for different guns, projectiles, and fuzes.

TRAUZZL TEST: Method of determining relative energy available from an explosive material by measurement of the volume expansion of a lead test block.

TRIMONITE: High explosive used as a substitute for trinitrotoluene as a bursting charge. Trimonite is a mixture of picric acid and mononitronaphthalene.

TRINITROPHENOL: (See PICRIC ACID.)

TRINITROTOLUENE (TNT): High explosive widely used as explosive filler in projectiles and by engineers; trinitrotoluol.

TRINITROTOLUOL: (See TRINITROTOLUENE.)

TRIPLE-BASE PROPELLANT: Propellant whose principal active ingredients are nitrocellulose, nitroglycerin, and nitroguanidine. (See PROPELLANT.)

TRIPLE POINT: Intersection of the original shock wave, the reflected shock wave, and the Mach stem.

TUBE: The inner cylinder of a built-up gun, usually extending from the inner face of the breechblock to the muzzle.

TWIST: Inclination of the spiral grooves to the axis of the bore of a weapon. The degree of twist is the determining factor in the speed of rotation of the projectile.

V

VACUUM STABILITY TEST: (See STABILITY TEST.)

W

WAVE FRONT: Surface which is the locus of all molecules having motion in identical phase in a propagating wave.

WEB; WEB SIZE; WEB THICKNESS: Alternative terms describing the minimum distance between any two specified burning surfaces of a propellant grain.

WEB RANGE: Tolerance of web thickness to allow for manufacturing limitation.

WINDSHIELD: (See **BALLISTIC CAP.**)

WHITE PHOSPHORUS (WP): Yellow, waxy solid which ignites spontaneously when exposed to air. It is used as a filling for various projectiles as a smoke-producing agent, and has an incendiary effect. White phosphorus may be mixed with a xylene solution of synthetic rubber to form plasticized white phosphorus.

WP: (See **WHITE PHOSPHORUS.**)

Y

YAW: Angle between the axis of the projectile and the tangent to the trajectory.

INDEX

- A-3, composition, 2-157
- Abel equation of state, 4-35
- Aberdeen chronograph, 2-94
- Aberdeen Proving Grounds, 2-158
- Aberdeen Proving Grounds, Development and Proof Services, 2-126
- Absolute temperature, 4-35
- Absorber, shock, 2-175
- Absorption, selective, 2-177
- Acceleration
 - angular, 4-179
 - burning rate, 4-16
 - gas, 2-138
 - due to gravity, 4-34
 - linear, 4-179
- Acceptable (acceptance, acceptability)
 - of cases, 4-137
 - criteria, 5-1
 - gage tolerance, 5-24
 - gaging, 6-44
 - of lot, 5-12
 - probability of (Pa), 5-2
 - quality level (AQL), 5-3, 8
 - level, establishing the (AQL), 5-4
 - sampling, 5-2
 - of subplot, 6-44
 - test, 4-93
- Accessory
 - metal parts, 2-164
 - parts design, 2-177
 - parts design WP shell, 2-180
- Acids, occluded, 4-6
- Acid wash, 6-17
- Accuracy of HEP shell, 2-157
- A Damage, 2-110
- Adapter
 - fuze, 2-175
 - nose, 2-186
 - steel, 2-180
 - tapered, 2-118
- Adiabatic flame temperature, 4-87, 88
- Advantage(s)
 - of Extrusion over Forging, 6-3
 - of HEP shell, 2-156
 - for increasing twist, 4-170
 - of wrap-up cases, 6-47
- Aerodynamic
 - coefficient, 3-8
 - of a projectile, estimation of, 3-8
 - forces, 3-6
- After burnt, 4-39, 75
- After splintering, 4-75
- Age harden, 4-49, 6-46
- Agents
 - binding, 2-186
 - decoppering, 4-2
 - GB, 2-186
 - gelatinizing, 4-2
 - moistureproofing, 4-2
 - oxidizing, 2-186
 - reducing, 2-186
 - water proofing, 2-186
- Air
 - blast
 - cooling, 6-4
 - gage, 2-11
 - calibration of, 2-11
 - intensities, determination of relative, 2-11
 - burst
 - height, optimal, 2-107
 - lethal area, 2-107
 - aircraft
 - damage
 - evaluation, 2-110
 - by external blast, 2-15
 - by internal blast, 2-14
 - defeat of, 2-3
 - effect of blast on, 2-14
 - flares, 2-195
 - structures, blast against, 2-13
 - vulnerability, 2-111
 - to external blast of, 2-16
 - studies, 2-111
 - density, 3-8
 - any altitude, method of calculating, 2-198
 - foil
 - blades, rotating, 2-171
 - section, polygonal, 3-14
 - speed, drag coefficient, 2-196
- Algebraic sign of stress, 4-181
- Alignment
 - of cone and charge, 2-56
 - jib, 4-132
 - of perforations, 6-49
- Alkali metal salts, 4-3
- Alkaline wash, 6-17
- All burnt, 4-39
 - position of, 4-39
 - equations for period after, 4-45
- Allowance (allowable)
 - pressures, 2-118, 4-137
 - shear stress, 2-164
 - wear, 5-24
- Alloys, critical, 6-3
- All-plastic
 - sabot, 2-138
 - shell body, 2-175
- Altitude
 - effect on internal blast, 2-15
 - finding, 3-73
- Aluminum
 - carrier, 2-128
 - cones, 2-40
 - explosives, 2-13
 - magnesium-aluminum fuels, properties of, 2-190
 - split sleeves, 2-162
 - to-steel, closure versus, steel-to-steel, comparison of, 2-181
 - windshield, 6-35
- Amatol, 2-178

- Ammonium perchlorate explosive, 2-13
- Ammunition
 - armor-defeating, 2-156
 - armor-piercing (AP), 1-2
 - base ejection, 2-5
 - with burster charges, 2-5
 - canister, 1-3, 2-5, 150, 151
 - design, 2-162, 4-123
 - canister, 2-153
 - fixed, 4-117, 4-160
 - items, dimensioning of, 5-13
 - high-explosive, 2-3
 - antitank (HEAT), 2-4
 - plastic (HEP), 2-5
 - hypervelocity armor-piercing discarding sabot (HVAPDS), 1-3
 - kinetic energy, 2-4, 117
 - missiles for canister, 2-150
 - pyrotechnic-type, 1-3
 - recoilless, 2-153
 - semifixed, 4-117
 - semifixed and, separate-loading, 4-160
 - separate loading, 4-117
 - separated, 4-117
 - special purpose, 2-154
- Amount of Inspection, 5-1
- Amplitude
 - of nutation, 3-8
 - of precession, 3-8
- Analysis, 2-106
 - beam, 4-155, 158
 - boiler, 4-156
 - combat, 2-107
 - constrained shell, 4-154
 - evaluation of present methods of, 2-91
 - methods of data, 2-85
 - stress, 2-153, 4-178, 179
 - stress in shell, 4-189
 - by statistical method, 2-126
 - weapon system, 2-107
- Angle(s)
 - of attack, 2-123, 3-11, 12
 - small, 3-13
 - cone apex, 2-53
 - cone of dispersion, 2-153
 - of departure, 3-39
 - of fall, 2-93
 - of fire, 2-83
 - of impact, 2-137
 - index, 2-77, 79
 - Mach, 3-14
 - of obliquity, 2-156
 - sweepback, 3-11, 14
 - sweepforward, 3-11, 14
 - toleranced, 5-20
 - of yaw, 3-2
- Angular
 - acceleration, 4-179
 - velocity, 3-28
- Anisotropic material, 4-149
- Anisotropic plastic, 4-189
- Anneal(s), annealing
 - of, cartridge case mouth, 6-44
 - of cones, effect of, 2-46
 - intermediate, 6-1
 - operations (cartridge case manufacture), 6-39
 - process, 6-41
 - saltpeter, 6-39
 - stress-relief, 4-135, 6-40
- Antipersonnel fragmentation weapon(s), 2-103, 106
- Antitank projectiles, 2-4, 156
- AP shot (shell) (see also Armor-piercing), 4-153
 - AP caps, matching and soldering, 6-33
 - AP projectiles, effect of nose geometry of, 2-138
 - AP shot caps, specifications of steel for, 6-29
 - AP shot design, 2-128
 - AP and APC projectiles, comparative performance of, 2-142
- APC shell, 4-178
 - APC and AP projectiles, comparative performance of, 2-142
- Application of Metal Fragmentation Characteristics Data to Design of Shell, 2-98
- Approximating the ballistic limit, 2-126
- AR, 2-85
- Arc, Ogival, 3-87
- Area
 - of chamber, 4-34
 - fire effectiveness, 2-107
 - illumination, optimum height for, 2-195
 - lethal, 2-3, 93, 104, 106, 154
 - vulnerable, 2-101
- Arrhenius function, 2-192
- Armco iron, soft, 4-149
- Armor, 2-4, 128
 - British (CTA) cemented tank, 2-120
 - bullet proof (BP), 2-120
 - classification, 2-119
 - defeat of, 2-117
 - defeating ammunition, 2-156
 - design for defeat of, 2-4
 - face-hardened, 2-141
 - bullet-proof, (FHBP), 2-120
 - glass, 2-82
 - homogeneous, 2-36, 120, 138, 139
 - Krupp, 2-120
 - machinable quality (MQ), 2-120
 - noncemented, 2-120
 - parameters, effect of varying, 2-129
 - penetration, 2-137
 - perforation, 2-124, 125
 - plate failure, 2-119
 - types of, 2-120
 - performance of, 2-125
 - skirting, 2-137, 157
 - solid, 2-137
 - spaced, 2-49, 129, 137
 - spalling of (HEP), 2-1
 - targets, heavy, 2-145
 - thickness, effect on projectile performance, 2-129
 - U. S. Navy Class A, 2-120
 - U. S. Navy Class B, 2-120
- Armor-piercing (see also AP)
 - cap(s), 2-4, 117, 123, 137, 141, 144, 4-178
 - steel shell, 2-4
 - on, tungsten Carbide cores, effect of, 2-142
 - projectiles, 2-125, 139
 - performance of, 2-126
 - (HVAP), shell, hypervelocity, 2-117
 - shot (AP), 2-4, 117
 - comparison of HEP shell with, 2-156
 - caps, manufacture of, 6-29

- HVAP, manufacture of, 6-35
- Army Biophysics Laboratory, 2-102
- Arsenal
 - Frankford, 2-82
 - Picatinny, 2-82, 153
 - Watertown, 2-139, 142
- Artillery ammunition, 1-1
 - ammunition, design of, components of, 6-1
 - ammunition, manufacture of, 6-1
 - primer, 4-84
 - shell, 6-2
- Asbestos-filled phenolic, 2-176
- As drawn, 4-123
- Aspect ratio, 3-71
 - fins of low, 3-13
 - large, 3-12
 - low, 3-13
- ASN (Average Sample Number), 5-6
- Assembly
 - candle, 2-164, 175
 - of HVAP shot, 6-35
 - illuminant, 2-160, 182, 184
 - of projectile, 2-151
 - tail fin, 2-172
- Assessment
 - tank damage, 2-129
 - types of damage, 2-111
- Assurance, quality, 5-1
- Assymetry
- Assymetrical
 - effects of, on velocity drop and jump of finned projectiles, 3-30
 - projectiles, stability of, 3-29
- Atmosphere
- Atmospheric
 - carburizing, 6-36
 - furnace, reducing, 6-29
 - hydrogen, 6-36
 - protective, 6-36
 - moisture, 2-191
 - resistance to, 2-190
 - standard, 2-198, 3-4
- Attaching band to projectile, 4-154
- Attachment, swivel, 2-173
- Attack
 - angle(s) of, 2-123, 3-11, 12
 - Kamikaze, 2-110
 - obliquities of, 2-145
- Attenuation, wavelength, 2-193
- Attribute, 5-14
 - inspection, 5-12
- Austenitic, steel, 6-1
- Available energy for IMR powder, 2-169
- Average
 - bore diameter, 4-152
 - densities and compositions of explosives, 2-12
 - outgoing quality (AOQ), 5-3
 - outgoing quality limit (AOQL), 5-4
 - web, 4-21
- Axis
- Axial
 - moment of inertia, 3-2
 - spin, 3-29
 - of revolution, 3-84
- Baffle plate, 2-175
- Bags, cartridge igniter, 1-7
- Bags, pancake, 4-85
- Balance, oxygen, 4-3
- Ball(s)
 - point micrometer, 6-24
 - powder process, 4-7
 - steel, 2-150
- Ballistic(s)
 - cap, 2-117
 - characteristics, uniform exterior, 2-151
 - coefficient (C), 3-38, 39, 64
 - computing, 3-73
 - factors upon which it depends, 3-38
 - maximum, 3-64
 - computations, 4-24
 - effect, uniformity of, 4-20
 - equations, 4-45
 - fundamental, 4-43
 - solution of, 4-36
 - equivalence, 4-26
 - failure, 6-43, 47
 - integrator, 3-85
 - interior, 2-153, 4-1, 164
 - limit, 2-125, 127, 141, 144, 145
 - approximating the, 2-126
 - charts for, 2-128
 - estimating, 2-126, 127
 - matching, 2-6, 157, 177
 - method, 4-26
 - mortar test, 2-23
 - potential, 4-2
 - problem, exterior, 3-38
 - research laboratories, 2-36, 39, 41, 66, 68, 70, 73, 81, 94, 97, 129
 - tables, 3-39
 - uniformity, 4-1
 - wound, 2-3, 93, 154
- Ballot(ing), 3-30, 4-178, 6-35
 - forces, 4-178
 - of projectile, 4-164
- Band
 - driving, 6-17
 - flyoff, 4-154
 - land, 4-155
 - width, 4-155
 - wiping off of, 4-164
 - material, yield stress of, 4-157
 - outside diameter, determination of, 4-149
 - pre-engraved, 6-27
 - pressure, radial, 4-149, 153
 - theoretical prediction of, 4-151
 - to projectile, attaching, 4-154
 - retention, 4-154
 - calculation for, 4-154
 - rotating, 1-3, 2-163, 4-33, 153, 179, 189, 6-1, 17, 26
 - welded overlay, 2-5, 4-149, 154
 - seat, 4-155, 6-23
 - cleaning the, 6-17
 - diameter, determination of, 4-150
 - position of, 4-158
 - shearing of, 4-172
 - turning, 6-17

- uncannelured, 4-153
- width, 4-155
 - method for computing, 4-150
 - without grooves, 6-17
- Banding of shell, 6-17
- Baratol, 2-176, 178
- Bare charges, 2-10, 11, 16
- Barrelling, 4-119
- Basal porosity, 6-13
- Base
 - area, estimation of, (effect of drag), 3-67
 - of case, 4-137
 - contour of, 4-124
 - cover, 1-4
 - diameter, 3-88
 - drag, 3-70
 - coefficient, 3-71
 - estimation of drag, 3-71
 - ejection, 1-3, 2-183
 - ammunition, 2-5
 - shell, 2-160, 161, 4-1
 - smoke shell, 2-176
 - flange, 2-45
 - flat, 4-182
 - control of, 4-126
 - of HVAP shot, 6-35
 - major, 3-87
 - plate, 2-162, 164
 - fastening, 6-17
 - removable, 2-172
 - plug, 2-160, 162, 164, 170
 - shearing, 2-169, 184
 - shear stress on threads of, 2-163
 - shear threads, design of, 2-163
 - pressure, 4-36
 - reinforcement, 4-137
 - round, 4-182
 - rupture of steel cartridge cases, 4-133
 - of shell, finishing the, 6-16
 - shell, square, 3-64
 - stress in, resulting from setback of filler, 4-183
- Basic
 - angle dimensioning, 5-20, 23
 - dimension, 5-13, 23
 - problems of interior ballistics, 4-33
 - radial dimension, 5-20
- Battle salvage, 6-47
- Battlefield illumination, 2-162
- BAT weapon, 2-81
- B Damage, 2-110
- Bead, inverted, 4-134
- Beads, obturating, 4-134
- Beam analysis, 4-155, 158
- Bearing-mounted charges, 2-82
- Bearing stress of rotating band, 4-153
- Before heating, inspection of shell, 6-13
- Before splintering, 4-76
- Beginning of motion of projectile, 4-34
- Beginning of motion, time since, 4-47
- Behavior of filler, 4-189
- Bench, draw, 6-8
- Bending stress(es), 2-124
- Bent fins, 3-29
- Benzene nucleus, resonance of, 4-90
- Bergmann-Junk test, 4-93
- Bernoulli
 - equation, 2-31
 - theorem, 2-33, 34
- Beryllium copper cones, 2-46
- Bifurcation, 2-69
- Bifurcation of jet, 2-35, 64
- Big-end-up, mold, 6-29
- Billet, 6-5
 - scale and descaling, 6-6
 - separation, 6-5
- Bimetallic cones and nonconical shapes, 2-42
- Binary mixtures, 2-190
- Binder metal, 6-36
- Binding agents, 2-186
- Binomial probability distribution, 5-3
- Birkhoff, 2-64
- Black powder, 2-5, 168, 4-1
 - charge, 4-84
 - ejection charge, 2-183
 - initiator, 2-183
 - loading density versus pressure curve of, 2-183
 - pellet, 1-5
 - train, 1-4
- Blanking and cupping of cartridge case, 6-37
- Blast, blasting, 2-1, 50, 93, 156
 - against aircraft structures, 2-13
 - aircraft damage by external, 2-15
 - aircraft damage by internal, 2-14
 - aircraft, effect of, 2-14
 - contours, 2-16
 - cube, 2-11
 - damage criteria, external, 2-16
 - determination of relative intensities, 2-11
 - effect, 2-7
 - on aircraft, 2-14
 - altitude on internal
 - of case on internal, 2-14
 - evaluation, 2-11
 - explosives for, 2-12, 4-2
 - external damage criteria, 2-16
 - external vulnerability of an aircraft, 2-16
 - information to be obtained from later experimentation, 2-9
 - measurement of, 2-10
- Blast, Muzzle, 3-28, 29, 30
 - propagation of, 2-10
 - reflected, 2-9
 - shot, 6-5, 12, 13, 15
 - tube, 2-11
 - vulnerability of aircraft to external, 2-16
 - waves, 2-19
- Blended guncotton, 4-6
- Blended nitrocelluloses, 4-2
- Blending radius, 4-125
- Blowholes, 6-1
- Blow-throughs, 4-120
- Blunt
 - headed shot, 2-124
 - nose, 2-157
 - projectiles, 2-154
 - shot, 2-122
 - trailing edge, fins with a, 3-13
- Boat-tail, 3-8, 64, 67, 68, 6-21
- Boat-tail projectiles, 4-160
- Body
 - fin interference, 3-71

- of HVAP shot, 6-35
 - shell, 2-170
 - determination of critical points in, 4-178
 - of wrapped cartridge case, 6-46
- Boiler analysis, 4-156
- Boiler formula, 4-154
- Bolling of mouth, 4-122
- Bomb, closed, 4-16, 19, 33, 88
- Bombs, photo-flash, 2-178
- Bonderized, 6-24
- Bone penetration, 2-103
- Boom, 2-172, 3-29
- Booster(s), 1-5, 2-57, 63
 - black powder pellet, 1-5
 - of charge, 2-57
 - lead azide, 1-5
 - requirements, 2-10
 - sensitivity test, 2-23
 - standard, 2-177
 - tetryl, 1-5
- Bore
 - clearance, 3-4
 - diameter, average, 4-152
 - erosion, 4-1, 3
 - residue, 4-2, 3
 - safe fuze, 1-5
 - safety, 1-5
 - yaw in the, 3-28
 - effects and magnitude of initial yaw due to, 3-28
- Boundry, increment, 2-183
- Bourrelet, 1-3, 3-4, 82, 6-29
 - clearance between and rifling, 4-164
 - clearance, minimum, 4-178
 - expanding, 6-23
 - finishing, 6-17
 - ring gage, 6-24
 - tolerances of, 6-17
- Box
 - gage, 2-10
 - tests, 2-84
- Brass
 - cartridge, 6-1, 37
 - cases, manufacture of, 6-37
 - copper and alpha, 4-160
 - overworking, 4-125
 - tensile strength, 4-135
- Break(-up)
 - nick and, 6-5
 - fragments, 2-109
 - jet, 2-32
 - projectile, 2-129
 - shell, 2-144
 - two-dimensional, 2-94
 - three-dimensional, 2-94
- Breech, 4-119, 137
- Breech pressure, 2-164, 4-36, 37
- Bridge waves, 2-19
- Brinell hardness, 6-15
- Brisance values, 2-187
- Brisant, 2-181
- British
 - Armaments Design Department of the Ministry of Supply, 4-117
 - armor, cemented tank (CTA), 2-120
 - practicc, design of drawn cartridge cases, 4-117
 - method of estimating muzzle velocity of a sub-caliber projectile, 2-138
 - wear factor, 4-150
- Brittle fracture, 2-123
- Bruceton, 2-34
 - staircase method, 2-23
- Budd Co., 2-39
- Buffer cap, 2-144
 - for defeat of spaced armor, 2-144
- Bulldozer(s), 6-7, 9
- Bullet pull, 4-129
- Bullet proof armor (BP), 2-120
- Bullet proof armor, face hardened (FHBP), 2-120
- Buoyancy, center of, 6-35
- Bureau of Mines test, 2-22
- Burn, burning
 - candle, 2-173
 - characteristics, 2-190
 - cigarette, 2-170, 187
 - constant (B), 4-40
 - control of, 4-2, 3
 - dye composition, 2-183
 - equation, 4-18
 - filler, 2-178
 - flare, 2-164, 193
 - of pressed compositions, 2-189
 - progressive, 4-24, 25
 - propagatively, 2-189
- Burning, propellant, 4-16, 33, 43
 - rate, 2-187, 189, 190, 191, 4-1, 9, 22, 33, 36
 - acceleration of, 4-16
 - burning rate, control of, 4-13
 - effect of grain shape on, 4-20
 - rate equation, 4-35
 - linear, 4-16, 18, 20
 - proportional law of, 4-20
 - regressive, 4-25
 - seven-perforated grains, 4-48
 - surface, 4-6
 - constant, 4-24, 26, 27
 - control of, 4-16
 - time, 2-167
 - rotating candle, 2-162
 - type, smoke compositions, sensitivity of, 2-183
 - zone A, 2-189
 - zone B, 2-189
 - zone C, 2-189
- Burner, strand, 4-16
- Burnt, burned
 - after, 4-76
 - all, 4-39
 - fraction, 4-21
- Burst
 - explosive, 1-3
 - height, mean, 2-107
 - position of, 3-39
 - separating, 1-3
- Burster(s)
 - casing, 2-180
 - extruded-aluminum, 2-180
 - charge(s), 2-5, 160, 176, 178, 181
 - ammunition with, 2-5
 - determination of weight of, 2-178, 182
 - smoke charge, ratio of, 2-178
 - column, 2-178

- explosive, 2-160
 - materials, 2-178
 - tetryl, 2-178
 - tube, metal, 2-160, 179
- C-4, 2-157
- "C damage", 2-110
- Cabbages the nose, 6-21
- Cable, suspension, 2-175
- Calculation of
- band retention, 4-154
 - deceleration, 2-166
 - density of propellant composition, 4-89
 - geometric characteristics of projectile, 3-90
 - heat of combustion, 4-90
 - heat of explosion (Q), 4-89, 90
 - interior ballistic, 4-9
 - maximum pressure, 4-81
 - tables for, 4-47
 - muzzle velocity, tables for, 4-47
 - ogive segment, 3-85
 - thermodynamic properties of propellants, 4-87
 - web, 4-14
- Caliber, 3-38
- Calibration of air-blast gages, 2-11
- Calibration chart, standard, 4-40
- Calorimetric test, 4-89
- Cameras, Fastax high-speed, 2-94
- Candle, 2-170
- assembly, 2-164, 175
 - burning, 2-173
 - case(s), 2-187
 - strength of, 2-176
 - power, 2-167
 - minimum, 2-195
- Canister(s), 2-160, 163, 177
- ammunition, 2-5, 150, 151
 - casualty, criteria for, 2-154
 - design of, 2-153
 - missiles for, 2-150
 - optimum, pellet size, 2-153
 - preformed missiles, 2-1
 - ejection, 2-165
 - illuminating, 2-185
 - information, tactical requirement for, 2-154
 - plastic, 2-183
 - projectile, plastic, 2-152
 - shot, dispersion of, 2-154
 - smoke, 2-182, 183, 184
- Cannelure(s), 4-153, 154
- Canopy-first, 2-196
- Cans, varnish, 2-11
- Capacity, chamber, 4-9, 11, 156, 158
- Cap(s), capped
- action, theories, mechanism of, 2-141
 - armor-piercing, 2-4, 117, 123, 137, 141, 144, 178
 - ballistic, 2-117
 - buffer, 2-144
 - for defeat of spaced armor, 2-143
 - effect of skirting armor on, 2-143
 - hard, 2-144
 - material, optimum weight of, 2-143
 - monobloc shot, 6-29
 - radius of spherical, 3-3
 - shot, 2-138
 - soft, 2-144
 - steel armor-piercing shell, 2-4
- Carbide, 6-36
- cored, 2-4
 - tungsten, 2-117, 137
- Carbon, unoxidized, 4-87, 89
- Carburizing atmosphere, 6-36
- Cardboard wadding, 2-151
- Carnegie Institute of Technology, 2-37, 45, 68, 72, 78, 80
- Carrier
- aluminum, 2-128
 - discarding, 2-152
- Cartridge
- bags, 1-7
 - brass, 6-1, 37
 - case(s), 1-6, 4-117, 6-1, 2, 43, 44
 - blanking and cupping of, 6-37
 - body of, wrapped, 6-46
 - in chamber, clearance of, 4-122
 - design, 4-117, 118, 125, 129, 137
 - dimensioning of, 4-133
 - drawing of, 6-37
 - functioning, theory of, 4-118
 - hardness requirements, 4-125, 135
 - heading of, 6-37
 - head machine and stamping of, 6-39
 - internal volume of, 4-126
 - length of, 4-121, 128
 - machining operations on head and mouth of, 6-44
 - manufacture, 4-119, 133, 6-1
 - annealing operations, 6-39
 - of drawn steel, 6-41
 - of perforated, 6-49
 - of trapezoidal, wrapped steel, 6-46
 - marking on bases, 4-126
 - materials for, 4-132
 - mouth, anneal of, 6-44
 - mouth, design of, 4-123
 - neck of, 4-134
 - perforating of, 6-49
 - steel, 4-133, 6-1, 41, 44
 - tapering of, 6-37, 43
 - trend in specifications for, 4-129
 - typical calculations for, 4-126
 - volume, 4-1
 - wraparound, 4-135
 - head space, 4-122, 123
 - igniter bags, 1-7
 - ignition, 2-172
- Case(s), cased, casing(s)
- acceptability of, 4-137
 - advantages of wrap-up, 6-47
 - base of, 4-137
 - burster, 2-180
 - candle, 2-187
 - cartridge, 1-6, 4-117, 6-1, 2, 43, 44
 - manufacture, 6-1
 - of brass, 6-37
 - chamber, clearance of in, 4-121
 - charges, 2-10, 13, 16
 - comparison of steel and brass, 4-119
 - design, 4-124
 - diameter, 4-137
 - different-length in same gun, 4-120
 - effect on internal blast, 2-14

- failures due to, 4-120
- hardness of, 4-125
- moth, thickness of, 4-124
- necking, 4-129
- plastic, 2-152
- punch, stripping from, 4-124
- recovery of, 4-118
- stop, 4-121
- thin-walled, 6-1
- trapezoidal-wrapped, 6-47
- to-case variation, 4-126
- volume of, 4-137
- wrap-up, 6-47
- Casting(s)
 - centrifugal, 6-1
 - versus forging of steel shells, 6-1
 - high-explosive shells, 6-1
 - in mold, 6-1
 - notched, 2-108
 - plastics, 2-152
- Casualty
 - criteria, 2-102
 - for canister ammunition, 2-154
- Categories of damage, 2-83
- Cavity(ies)
 - charges, lined, 2-31
 - deep, 2-177
 - forge, finish of, 6-1
 - obstructions within, 2-44
 - torn, 6-13
- Cell, Kerr, 2-34
- Center
 - of buoyancy, 6-35
 - of gravity, 2-172, 3-10,86
 - location of, 3-8
 - motion of, 3-6,38
 - position of, 3-81
 - ogival arc, 3-84
 - of pressure, 2-172, 3-7,8,10,12
- Centerless grinder, 6-29
- Centerless grinding, 6-17
- Central ballistic parameter, 4-38
- Centrality, 5-14
- Centrality of holes, 5-22
- Centrifugal casting, 6-1
- Centrifugal force, 2-167, 4-178
- Chamber, 1-6, 4-117
 - area of, 4-34
 - capacity, 4-9,11,158
 - effective, 4-126
 - estimate of, 4-126
 - designs, characteristics of, 4-137
 - dimensioning of, 4-133
 - effective length of, 4-37
 - expansion, elastic, 4-120
 - gage inspection, 6-44
 - length of, 4-137
 - pressure, 2-163,172,182, 4-93
 - conditions, 2-129
 - shape of, 4-117,124
 - slope, 4-137
 - tapers, 4-134
 - volume, 2-128, 4-33
- Chamberlain Corporation, 2-158, 6-26
- Chapman-Jouguet condition, 2-30
- Characteristic(s), 2-95
 - burning, 2-190
 - cartridge case designs, 4-137
 - deep-drawing operations, 6-2
 - fragmentation, 2-94,95,97
 - of chamber designs, 4-137
 - of high explosives, 2-22
 - of pyrotechnics composition, 2-186
 - required, 2-187
 - ogive, 3-88
 - operating curve (OC), 5-2
 - propellant, 4-93
 - rotating band, 4-151
 - target, 2-85
 - uniform ballistic, 2-151
- Charge(s)
 - bare, 2-10,11,16
 - bearing-mounted, 2-82
 - black powder, 4-84
 - ejection, 2-183
 - boosting of, 2-57
 - burster, 2-5,160,176,178,181
 - cased, 2-10,13,16
 - confined, 2-49
 - diameter of, 2-189
 - double-ejection, 2-160
 - effect of shape of explosive, 2-18
 - ejection, 2-160,162,170,173,184
 - expelling, 2-5,161
 - fuze-ejection, 2-172
 - initiating, 2-177
 - length, 2-49
 - lined cavity, 2-31
 - maximum, 4-50
 - moving, 2-16
 - optimum, 4-9
 - preparation, 2-62
 - pressure curve, 4-9
 - pressure relationship, 4-9
 - propellant, 2-138,150
 - propelling, 2-72, 4-9
 - separating, 2-175
 - shape, 2-50,85
 - single ejection, 2-160
 - spotting, 2-187
 - squash, 2-157
 - static, 4-1,3
 - supplementary, 2-177
 - surface charges vs internal, 2-14
 - tetryl, 2-182
 - to-gage distance, 2-11
 - unrotated, 2-32
 - velocity curve, 4-9,10
 - velocity relationship, 4-9
 - weight of, 2-138, 4-20
 - zoned, 4-134
- Charts for ballistic limit, 2-128
- Chase Brass and Copper Company, 6-37
- Check(s)
 - dimensional, 6-40
 - gas, 4-189
 - profile, 6-24
- Chemical Corps, 2-161,172
- Chemical, chemistry
 - energy rounds, 2-88
 - flash reducers, 4-2
 - of pyrotechnic compositions, 2-186

- reactions, exothermal, 2-189
- shell (WP), sealing of, 2-180
- Chipboard, 2-172
- Chi-square tests, 2-95
- Choice of method of stabilization, 3-2
- Chopped-glass fiber, 2-175
- Chord, 3-71
 - root, 3-11
 - tip, 3-11
 - wing, 3-11
- Chrome flash, 6-37
- Chronograph, Aberdeen, 2-94
- Cigarette burning, 2-170, 187
- Circle, tolerance, 5-18,23
- Circular mēplat, 3-69
- Circumferential rupture, 6-42
- Class B armor, U. S. Navy, 2-120
- Classification, 5-5
 - of ammunition, 1-2
 - fixed, 1-1
 - semifixed, 1-1
 - separated, 1-1,2
 - separate loading, 1-1
 - armor, 2-119
 - of defects, 5-1,5
 - of explosives, 1-6
 - missiles, 2-1
 - by effect, 2-1
 - blast, 2-1
 - defeat of personnel, 2-3
 - fragmentation, 2-1
 - incendiary, 2-1
 - leaflets, 2-1
 - light, 2-1
 - poison gases, 2-1
 - penetration of armor (kinetic energy shot), 2-1
 - penetration of armor by (shaped charges), 2-1
 - preformed missiles (canister), 2-1
 - smoke, 2-1
- Cleaning band seat, 6-17
- Clearance
 - bore, 3-4
 - between bourrelet and rifling, 4-164
 - of case in chamber, 4-121,122
 - estimating, 4-121
 - initial, 4-119
 - minimum, 4-121
- Cleat, shroud, 2-171
- Clipped-delta wing, 3-27
- Closed
 - bomb, 4-16,19,33,88
 - test, 4-16,40
 - pit test, 2-94
- Closing plug, 1-2,7
- Closure steel-to-steel, comparison of aluminum-to-steel, 2-181
- Cloud(s)
 - colored, 2-176,178
 - control of colored smoke, 2-178
 - duration of, 2-177
 - pillaring of (WP), 2-181
- Coating(s), coated, 6-17
 - nitrocellulose lacquer, 6-47
 - phosphate, 6-17,21
 - protective, 4-134, 6-44
 - soap, 6-41
- Cocked centerlines, 5-15
- Coefficient(s), 3-64
 - aerodynamic, 3-8
 - ballistic (C), 3-38,39,64
 - factors upon which (C) depends, 3-38
 - maximum, 3-64
 - base drag, 3-71
 - cross-wind force, 3-10,12
 - drag (KD), 2-118,166,195,196, 3-10,38,39,64,67,68,69,70,75
 - friction, 3-10
 - drag, 3-68,71
 - form, 4-21,23,24
 - lift, 3-10,12
 - moment yawing, 3-10
 - normal force, 3-8,9,13
 - overturning moment, 3-9
 - partial drag, 3-71
 - practical drag, 3-38
 - skin friction drag, 3-10
 - slopes, lift, 3-27
 - wave drag, 3-70
 - yaw-drag, 3-5,28,69
- Coining, 4-122
- Cold
 - extrusion, 6-1,3,9
 - HE shell, 6-21
 - comparison of hot forging with, 6-24
 - tests of, 6-23
 - forming, 6-25
 - pressing, 6-36
 - shuts, 6-40,43
 - work, 6-3
 - hardening, 6-37
 - steel, 6-2,43
 - influence of hot work versus, 6-1
- Collapsing cone, 2-38
- Colloid, 4-2,6,87
- Color(ed), 2-178
 - cloud, 2-176,178
 - dye, 2-160
 - emission, 2-193
 - filters, 2-193
 - intensifiers, 2-186
 - marker, 2-160
 - shell, 2-160,176,178,182
 - design of, 2-179
 - tactical requirements, 2-176
 - smoke, 2-178
 - cloud, control of, 2-178
 - method of producing, 2-178
 - screen, 2-160
 - shell, 2-160,182
 - saturation, 2-177
 - value, 2-187
- Column
 - burster, 2-178
 - diameter, limits of propagation versus minimum, 2-182
 - of explosive, 2-182
 - strength, 2-185
- Combat
 - analysis, 2-107
 - models, 2-107
- Combustion, heat of, 4-88,89
- Compacts, sintered-iron, 4-161

- Compacting and sintering of Tungsten carbide, 6-36
- Comparative
- Comparator
- Comparing
- Comparison
 - aluminum-to-steel closure versus steel-to-steel, 2-181
 - effectiveness of full-caliber versus subcaliber steel shot, 2-138
 - explosives, 2-11
 - of HEP shell with AP shot, 2-156
 - of hot forging with cold extrusion shell, 6-24
 - magnetic, 6-45
 - hardness, 6-43
 - of peak pressure and impulse, 2-13
 - performance of AP and APC projectiles, 2-142
 - performance of KE shot, 2-145
 - of properties of pyrotechnic compositions with explosives, 2-188
 - range firings, 3-68
 - of results, 4-82
 - of spinning shell with top, 3-2
 - study of shell forging methods, 6-13
 - of steel and brass cases, 4-119
- Compatible, compatibility, 2-22,177, 4-94
 - quantitative definition of, 2-24
- Compensation, 2-35
 - rotation, 2-35
 - spin, 2-35,36,37,71,73,75,78
- Complete
 - ogive, volume of, 3-86
 - round, components of, 1-1
 - solution for pressure-time trace, 4-76
- Complex yaw, 3-3
- Component(s), 3-3
 - of, artillery ammunition, design of, 6-1
 - of complete round, 1-1
 - solids of revolution, 3-81
 - tolerances, 5-24
- Composite rigid projectile, 2-117
- Composition(s), 2-13
 - A-3, 2-157
 - composition B, 2-13,63,178
 - C-4, 2-157
 - of, average densities of explosives and, 2-12
 - burning of pressed, 2-189
 - delay fuze, 2-187
 - dye, 2-177,178
 - burning, 2-183
 - first-fire, 2-172
 - flare, 2-167
 - illuminant, 2-175
 - igniter, 2-192
 - ignitibility of, 2-192
 - photoflash, 2-187
 - pyrotechnic, 2-191
 - of standard propellants, 4-2
 - tracer, 2-192
- Compression
- Compressive
 - force, radial, 4-178
 - stress, 4-181
 - test, 4-93
 - yield stress, 2-165
 - wave, 2-123
- Compromise method of shell forming, 6-25
- Computation
- Computing
 - ballistic, 4-24
 - ballistic coefficient, 3-73
 - of ballistic limit, 2-126
 - energy of HE shell, 3-76
 - lethal area, 2-103
 - momentum of HE shell, 3-76
 - for ogive, 3-82
 - of vulnerability, 2-91
- Concentricity, 5-13,20, 6-13,33
 - symbol, 5-13,14
- Concept of optimum height, 2-193
- Conclusions on HEP performances, 2-158
- Condenser microphone gage, 2-10
- Condition(s), 5-24
 - Chapman-Jouguet, 2-30
 - maximum metal, 5-20,24
 - minimum metal, 5-20,24
 - optimum, 4-50,74
- Conductive primer mixture, 1-7
- Conductivity, electrical, 4-2,3
- Conductivity, thermal, 2-189
- Cone(s)
- Conic(al), 3-65,69
 - aluminum, 2-40
 - angle, optimum, 2-54
 - angle, effect on penetration under rotation, 2-66
 - apex angle, 2-53
 - beryllium copper, 2-46
 - bimetallic, 2-42
 - and nonconical shapes, 2-42
 - and charge, alinement of, 2-56
 - collapse, 2-58
 - collapsing, 2-38
 - of dispersion, 2-150
 - angle of, 2-153
 - double-angle, 2-43
 - electroformed, 2-39
 - copper, 2-46
 - effect of annealing of, 2-46
 - forcing, 4-33,121,162
 - frustums, 3-88
 - glass, 2-38
 - head, 3-65
 - lead, 2-41
 - liners, 2-31
 - malformed, 2-39
 - sharp apex, 2-55
 - steel, 2-41
 - tail, 2-172,175
 - wall thickness, 2-53
 - zinc, 2-41
- Confine(d), (ment), 2-31,57,181, 4-16
 - charges, 2-49
 - of explosion, 2-109
- Consideration of liner parameters, 2-49
- Consistent muzzle velocity, 2-152
- Consistent notation, 4-16
- Consolidation, degree of, 2-189
- Constant
 - burning (B), 4-40
 - surface, 4-24,26,27
 - grains, 4-48
 - distortion (Hencky-Von Mises), 4-185,186
 - form function, 4-78

- gas, 4-35
- Gurney, 2-98
- Constituents of pyrotechnic compositions, 2-186
- Constrained-shell analysis, 4-154
- Continuous-sampling plans, 5-10
- Contour(s)
 - blast, 2-16
 - of base, 4-124
 - of case, internal, 4-124
- Control(led), (ling)
 - of colored smoke cloud, 2-178
- burning, 4-2,3
 - rate, 4-13
 - surface, 4-16
- of flatness of base, 4-126
- fragmentation, 2-3,107,108,109,111
 - methods of, 2-108
 - ring, 2-110
- scale, 6-42
- web dimensions, 4-13
- Cook, 2-93,106
- Cooling, air-blast, 6-4
- Coordinates, toleranced, 5-17
- Copper
 - and alpha brasses, 4-160
 - cones, electroformed, 2-41
 - gage pressure, 4-40
 - gasket, 6-27
 - liners, 2-32,46
- Coppering, 4-3
- Cord, 4-23
 - propellant, 4-24
 - equations for, 4-27
- Core(s), 6-36
 - high-explosive, 2-160,176
 - tungsten carbide, 2-123,128, 6-35
- Corner form coefficient, 4-21
- Corner's treatment, 4-21
- Corps, Chemical, 2-161
- Cost of shell manufacturing plant, 6-24
- Cover, base, 1-4
- Covolume, 4-17,37,47,88
- Crack(s), (ing), 2-123, 6-17
 - season, 6-40
 - shearing, 6-5
- "Cranz, law of", 2-32
- Crimp(ing), 4-33,132, 6-44
 - effect of method of, 4-132
 - groove, 4-132
 - design, 4-122
 - press-type, 4-132
 - rubber-die, 4-132
- Criteria
- Criterion
 - acceptance, 5-1
 - for, canister ammunition casualty, 2-154
 - casualty, 2-102
 - damage, 2-93
 - external blast damage, 2-16
 - Hencky-Von Mises, 4-187
 - homogeneity, 5-1
 - incapacitation, 2-104
 - lethal area, 2-154
 - lethality, 2-93,101,111
 - protection, 2-128
 - sampling plan, 5-2
- selection of propellant materials, 4-2
- of shaped charge effectiveness, 2-82
- Sterne's, 2-102
- yield, 4-181,185
 - theories, 4-185
 - utilization, 4-178
- Critical
 - alloys, 6-3
 - defects, 5-5
 - opening velocity, 2-196
 - points in, body of shell, determination for, 4-178
 - range, 6-27
 - of steel, 6-1
 - relative humidity, 2-191
 - temperatures, 6-12,14
 - velocity, 2-126
- Cropping, 6-13
- Cross, 3-3
 - rolls, 6-7
 - slide, 6-27
 - wind force, 3-3,5,7,10,29,30
 - coefficient, 3-10,12
 - damping factor, 3-6,10
- Crusher gage, 4-94
- Crush-up of nose, 2-5
- Crush-up, shell, 2-157
- Cryolite, 4-2
- Cube, blast, 2-11
- Cumulative probability, 2-154
- Cup(ping), 6-1,7,8,41
 - of, cartridge case, blanking and, 6-37
 - and draw, 6-37,47
 - expanding, 4-150
 - glazed-board, 4-122
 - preparation for, 6-41
 - obturing, 2-173
- Curve(s)
- Curvature
 - charge-pressure, 4-9
 - charge-velocity, 4-9,10
 - design, 4-10
 - normal error, 2-100
 - probability, 2-126,127
 - radius of longitudinal, 3-81
 - stress-strain, 4-118, 6-2
 - of trajectory, 3-11
 - web-velocity, 4-10
 - web-charge, 4-10
- Cutting
 - off base of HEP shell, 6-27
 - flame, 6-5,14
- Cyclotol, 2-40,178
- Cylinder(s)
- Cylindrical, 3-69
 - liner, 2-69,71
 - right circular, 3-1
 - tapered, 6-46
- Damage, 2-36,82,129
 - assessment, types of, 2-111
 - tank, 2-129
 - categories of, 2-83
 - A, 2-110
 - B, 2-110

- C, 2-110
- F, 2-83
- K, 2-83,110
- KK, 2-110
- M, 2-83
- criteria, 2-16,93
 - external blast, 2-16
 - region I, 2-16
 - region II, 2-16
 - region III, 2-16
- evaluations, 2-129
 - aircraft, 2-110
- external blast to (aircraft), 2-15
- fuel, 2-111
- to gun, 4-178
- internal blast (aircraft), 2-14
- probability of, 2-108,111
 - estimates, 2-88
- qualitative description of shaped charge, 2-84
- structural 100A, 2-15
- test ranking, 2-13
- threshold, 2-16
- Damping factor(s), 3-4,6,30
 - cross-wind force, 3-6,10
 - magnus moment, 3-6,10
 - spin-decelerating moment, 3-6
 - yawing moment, 3-6
- Danger
 - of resonance between pitching period and rolling period, 3-29
 - of too much spin (magnus moment), 3-29
- Data
- Datum
 - dimensions, 5-13
 - fragmentation, 2-105
 - hole, 5-20
 - method of dimensioning tapers, 5-24
 - required to design cartridge case, 4-120
 - surface, 5-14
 - symbol, 5-13
- Dead metal, 6-42
- Decarburization, 6-36
 - surface, 6-33
- Deceleration
 - calculation of, 2-166
 - efficiency, 2-165
 - parachute, 2-166
 - design of small, 2-166
- Decelerator, 2-164,165,166
- Decompose in, storage (must not), 4-2
- Decomposition rate, 4-2
- Decoppering agent, 4-2
- Decrease hygroscopicity, 4-2
- Deep cavity, 2-177
- Deep-drawing operations, characteristics, 6-2
- Defeat
 - of aircraft, 2-3
 - of armor, 2-117
 - of spaced buffer caps for, 2-144
 - of spaced caps for, 2-143
 - of fortification, 2-4
 - of personnel, 2-3
 - of shaped charge weapons, 2-82
 - of tank, 2-129
 - of target, 2-93
- Defects
 - classification of, 5-1,5
 - critical, 5-5
 - major, 5-5
 - minor, 5-5
 - surface, 6-41
- Deficiency, oxygen, 4-89
- Definition
 - of lots, 5-1
 - of perforation, 2-125
- Deflection dispersion, 2-107
- Deformation
 - elastic, 4-150,178
 - during nosing, 6-17
 - permanent, 4-185,178
 - plastic, 4-133,178,186, 6-43
 - projectile, 2-141
 - of shell, 4-178
- Degree of consolidation, 2-189
- Degree of nitration, proper, 4-6
- Degressive, 4-9
 - degressive shapes, 4-23
- Delay fuze, 1-4
 - composition, 2-187
- Degreasing, washing and, 6-17
- Delta wing, 3-27
- Demarre formula, 2-125,137
- Density(ties), 4-87
 - air, 3-8
 - average compositions of explosives and, 2-12
 - compositions of explosives and average, 2-12
 - fragment, 2-106
 - gas, 4-35
 - jet, 2-38
 - loading, 2-11,14, 4-1,33
 - function, 4-48
 - Ordnance Corps standard, 3-38
 - of propellant composition, calculated, 4-89
 - relative, 2-198
- Departure, angles of, 3-39
- Dependent locational symbol, 5-15
- Dependent locational tolerance(s), 5-13,17,19
- Deployment methods, parachute, 2-166,196
- Depth of cannellure, 4-154
- Depth of penetration, 2-78
- Derivation of equations, OSRD 6468 method, 4-42
- Derivation of optimum height, 2-193
- Derivative, time, 3-6
- Deriving shell stress formulas, 4-178
- Descent rates, 2-171
- Description
 - of notched casings, 2-109
 - of notched-wire method, 2-109
 - of test methods, 2-22
- Design, 2-6
 - accessory parts, 2-177
 - AP shot, 2-128
 - ammunition, 2-162, 4-123, 6-1
 - of canister, 2-153
 - of base plug (optimum), 2-162
 - of base plug shear threads, 2-163
 - cartridge case, 4-117,118,124,129
 - data required, 4-117,120
 - mouth of, 4-123
 - of colored marker shell, 2-179
 - crimping groove, 4-122
 - curves, 4-10

- for defeat of armor, 2-4
 - of dies, 4-7,13
 - of drawn cartridge case, 4-117
 - British practice, 4-117
 - ejection charge, 2-167,181
 - equipment (new), 4-121
 - filler, 2-177
 - flange, 4-122
 - grain, 4-13
 - gun, 4-119,124
 - chamber, 4-117
 - of illuminating shell, 2-162
 - of mortar-type, 2-172
 - and use of, factors affecting the, 2-162
 - of liquid-filled shell burster, 2-186
 - mortar ammunition, problems of, 2-172
 - optimum, 2-93
 - parameters, effect on penetration, 2-39
 - parachute, 2-162
 - small deceleration, 2-166
 - pyrotechnic, 2-193
 - parallel, 5-11
 - pin plates, 4-13
 - for precision, 3-1
 - primers, standard, 4-84
 - procedure, 2-3
 - projectile, 2-2,128,129
 - for gun already made, 3-1
 - for Q. F. guns, German, 4-123
 - rifling, 4-169
 - rotating band, 4-149,153,180
 - of shaped charge missile, 2-47
 - of shell, application of metal fragmentation characteristics data to, 2-98
 - shell metal parts, 2-162,177
 - propaganda shell, 2-184
 - signal smoke shell, 2-182
 - split-sleeve, 2-164
 - visibility, 2-193
 - for volume, 4-117
 - of web dimensions, 4-9
 - WP shell, 2-180
 - accessory parts, 2-180
 - wraparound, 4-135
- Desirable properties of liner, 2-38
- Desired bullet pull, methods of achieving, 4-132
- Detection of gun battery, 4-3
- Deterioration in penetration, 2-78
- Deterioration of propellant, 4-93
- Determine(ation), (ing), 2-129
 - of band outside diameter, 4-149
 - of band-seat diameter, 4-150
 - critical points in body of shell, 4-178
 - of effective width of band, 4-150
 - effect of yaw, 3-75
 - grain design, 4-9
 - internal volume of cartridge case, 4-126
 - initial velocity factors, 3-72
 - lethality, 2-106
 - of maximum forces acting on shell during firing, 4-178
 - of rifling twist, 4-173
 - of relative air-blast intensities, 2-11
 - of web range, 4-10
 - of weight of burster charge, 2-178,182
 - weight of tetryl burster required, 2-178
- Deterrent material, 4-3
- Detonation
- Detonator(s), 1-6
 - electric, 1-6, 2-57
 - front, 2-30,31
 - high order, 1-5
 - lead azide, 1-5
 - low order, 2-183
 - mercury fulminate, 1-5
 - premature, 2-180, 4-178, 6-13
 - propagation, 2-24
 - rate, 2-24
 - tetryl, 1-5
 - velocity, high, 2-157
 - wave, 2-30,81,182
- Development and Proof Services, Aberdeen Proving Grounds, 2-126
- Development of fundamental equations, 4-34
- Development of HEP shell, 6-26
- Deviation
 - from mean, 4-137
 - standard, 2-127, 3-8,10, 5-12
- Diagrams, vulnerability, 2-141
- Dial indicator, 5-13,14
- Diameter
 - base, 3-88
 - case, 4-137
 - of charge, 2-189
 - flange, 4-137
 - nose, 3-87
 - pin circle, 4-14
 - rifling, 4-152
 - swell, 3-69,81,84,87,88
- Diametral
 - taper, 3-83
 - tolerance, 5-13,19,20
- Dibutylphthalate, 4-2
- Die(s), 4-14, 6-9
 - design of, 4-13
 - piercing, 6-7
 - ring, 6-7,8,9
 - tapered, 6-8
 - tungsten carbide, 6-37
- Differential expansion, 2-181
- Different-length cases in same gun, 4-120
- Difficulties, extraction, 4-132,134
- Difficulties, ignition, 4-50
- Dimension(s)
 - basic, 5-13,23
 - angular, 5-20
 - radial, 5-20
 - chamber, 4-133
 - datum, 5-13
 - reference, 5-13
 - of shell forgings and shapes, 6-5
- Dimensional(ing)
 - of ammunition items, 5-13
 - basic angle, 5-23
 - of cartridge case, 4-133
 - mouth, 4-124
 - of chamber, 4-133
 - checks, 6-40
 - control, 5-13
 - of grain, 4-7
 - radial, 5-20
 - of rifling, 4-169

- tapers, datum method of, 5-24
- Dimensionless factor (K), 2-178
- Dimensionless parameter, 4-39
- Dinitrotoluene, 4-2
- Diphenylamine, 4-2,6
- Direction of future designs, 2-170
- Disadvantage(s)
 - of HEP shell, 2-156
 - for increasing twist, 4-170
- Discarding
 - carrier, 2-152
 - method of releasing, 2-119
 - pctal, 2-119
 - sabot, fin-stabilized, 2-4
 - sabot, shot, 2-4,118
- Discussion of fragmentation patterns, 2-100
- Disking, 2-122,124
- Dispersion, 2-39, 4-137
 - of canister shot, 2-154
 - cone of, 2-150
 - angle of, 2-153
 - deflection, 2-107
 - excessive, 4-129
 - of fragments, 2-137
 - of filler, 2-178
 - fuzc, 2-107
 - gases, nonpersistent, 2-185
 - gases, persistent, 2-185
 - missile, 2-152
 - radial, 2-150
 - range, 2-107
 - of smoke signal, 2-183
- Displacement, water, 2-180
- Dissociative equilibrium, 4-87
- Distance
 - charge-to-gage, 2-11
 - standoff, 2-49
 - wadding, 1-7
- Distortion, (Hencky-Von Mises) constant, 4-185
- Distribution
 - area method, 2-88
 - binomial probability, 5-3
 - error, 2-110
 - fragment weight, 2-93
 - hypergeometric, 5-2
 - poisson, 5-3
- Diverging yaw, 3-4
- Double
 - angle cones, 2-43
 - angle nose, 2-124
 - base propellant, 1-6, 4-1,93
 - ejection charge, 2-160
 - ejection system, 2-171
 - sampling, 5-5
 - wedge profile, 3-71
 - wedge, symmetrical, 3-71
- Drag, 2-58, 3-5,7,10,11,38
 - estimation of, 3-64
 - effect of base area, 3-67
 - effect of head curvature, 3-65
 - effect of head length, 3-65
 - effect of méplat diameter, 3-67
 - effect of shell length, 3-68
 - effect of yaw, 3-69
 - increase in, 3-67
 - interference, 3-70
 - estimation of, 3-71
 - minimum, 3-64
 - variation in, 3-67
- base, 3-70
 - estimation of, 3-71
 - coefficient, 3-71
- coefficient (K_D), 2-118,166,195,196, 3-10,38,39,64, 67,68,69,70,75
- estimating, 3-74
 - of fin-stabilized projectiles, 3-70
- partial, 3-71
- practical, 3-38
- versus air speed, 2-196
- friction, 3-68,70
 - estimation of, 3-71
 - coefficient, 3-71
- force, 2-195,196
- formula, 2-196
- skin friction, 3-10
 - coefficient, 3-10
- stabilize, 2-4,5
- wave, 3-70
 - estimation of, 3-70
 - coefficient, estimating the, 3-76
- Draw(ing)
- Drawn, 4-124,132, 6-1,8,42
 - bench, 6-8
 - of cartridge case, 6-37
 - design of, 4-117
 - British practice, 4-117
 - steel, manufacture of, 6-41
 - copper liners, 2-68
 - cup and, 6-37,47
 - number of, 4-125
 - insufficient, 4-125
 - pierce and, 6-7,8
 - successive, 6-1
 - taper, 4-135
- Drift firings, 3-10
- Driving
 - band, 6-17
 - face force — (no friction), 4-153
 - face force — (with friction), 4-153
- Drop(s)
 - tear, 6-13
 - velocity, 3-5,28,30
- Dry-soap lubricated, 6-37
- Ductile(ity)
 - failure, 2-120
 - good, 6-4
 - jet, 2-52
 - perforation, 2-129
- Du Pont, 2-37,60
- Duration of cloud, 2-177
- Dye(s)
 - composition, 2-177,178
 - colored, 2-160
 - organic, 2-178
 - for smokes, 2-186
- Ears, 6-37
- Ease of extraction, 4-121,134, 6-1
- Eccentric, 5-13,21
 - loading forces caused by, 4-178

- of mouth, 4-124
- of projectile, 4-137
- ramming, 4-178
- shell, 3-30
- Economics of shell forging, 6-12
- Edge, 6-37
 - leading, 3-11,13,14
 - trailing, 3-11,13,14
- Effect(s) of
 - altitude on internal blast, 2-15
 - annealing of cones, 2-46
 - armor-piercing caps on tungsten carbide cores, 2-142
 - armor thickness on projectile performance, 2-129
 - blast, 2-7
 - on aircraft, 2-14
 - case on internal blast, 2-14
 - classification of missiles by, 2-1
 - cone angle on penetration under rotation, 2-66
 - design parameters on penetration, 2-39
 - estimation of drag
 - base area on, 3-67
 - head curvature on, 3-65
 - head length on, 3-65
 - méplat diameter, 3-67
 - shell length, 3-68
 - yaw, 3-69
 - erosion, 4-163
 - of gage tolerance on component tolerance, 5-24
 - of grain shape on burning rate, 4-20
 - gun on extraction, 4-119
 - initial yaw due to bore clearance, 3-28
 - effect of liner
 - material on penetration under rotation, 2-68
 - shape on penetration under rotation, 2-69
 - thickness on penetration under rotation, 2-67
 - method of crimping, 4-132
 - moisture, protection against, 2-192
 - moisture on shelf life, 2-191
 - effect, Munroe, 2-110
 - nose, 2-157
 - geometry of AP projectiles, 2-138
 - geometry of tungsten carbide cores, 2-139
 - on HEP shell performance, 2-157
 - obliquity, 2-123
 - rotation, 2-34
 - on penetration, 2-66
 - on shaped charge jets, 2-63
 - scale, 2-125
 - second order, 4-33,36
 - secondary, 2-156
 - shaped charge, 2-18,57,59
 - shock wave, 2-9
 - skirting armor on cap, 2-143
 - skirting plate, 2-137
 - spaced armor on HEP shell, 2-157
 - specific surface of reactants, 2-190
 - spit-back (flash-back) tubes, 2-46
 - standoff on penetration under rotation, 2-68
 - tapered walls on penetration, 2-43
 - thick-thin, 2-72
 - transport, 2-72
 - varying armor parameters, 2-129
 - varying projectile parameters, 2-137
 - velocity, 2-123
 - water sprays on hot forgings, 6-12
 - yaw, determining, 3-75
- Effective
 - chamber capacity, 4-126
 - ejection pressure, 2-163
 - fragments, 2-107
 - length of chamber, 4-37
 - mass of projectile, 4-36
 - width of band (determination of), 4-150
- Effectiveness
 - area fire, 2-107
 - comparative, full-caliber vs subcaliber steel shot, 2-138
 - pyrotechnic composition radiation, 2-193
 - shaped charge, 2-48
 - against tanks, 2-82
 - weapon, 2-106
 - wounding, 2-98
- Efficiency, deceleration, 2-165
- Efficiency, point of optimum, 4-75
- Eichelberger, 2-32
- Ejection
 - base, 2-183
 - canister, 2-165
 - charge, 2-160,162,170,173,184
 - design, 2-167,181
 - black-powder, 2-183
 - powders, 2-171
 - pressure, 2-169
 - effective, 2-163
 - second, 2-164,166
 - velocity, 2-163,164
- Elastic
 - chamber expansion, 4-120
 - deformation, 2-9, 4-150,178
 - expansion of gun, 4-119
 - limit, 6-43
 - modulus of, 2-165
 - recovery, 4-118, 6-43
 - setback, 4-125
 - stress state, 4-187,188
 - stress waves, 2-157
- Electric
 - conductivity, 4-2,3
 - detonators, 1-6, 2-57
 - fuze, 2-57,63
 - primer, 1-7
- End squeeze, 6-6
- Enamel seam sealer, 2-151
- Electroformed cones, 2-39,41,46
- Element, percussion, 4-84
- Eliminating spin degradation, 2-81
- Elliptic integral, 3-27
- Elongation
 - factor, 2-178
 - percentage, 4-136, 6-43
 - low, 6-44
- Emission
 - color, 2-193
 - fragment, 2-101
- Energy
 - available IMR powder, 2-169
 - balance equation, 4-33,35,36,37,43
 - computing of HE shell, 3-76
 - equation, 4-37
 - allowing for friction, 4-37
 - including heat loss, 4-37

- maximum, 4-185
- of motion, 4-43
- muzzle, 3-38,72
- of propellant, 4-87
- propellant gases, 3-73
- radiant, 2-187,189
- relative, 4-88
- specific limit, 2-124
- strain, 2-182
- Engines, peripheral jet, 2-82
- Engraving, 2-152, 4-151,152,153
 - pressure, 4-150
 - rifling, 4-153
 - rotating band, 4-164
- Equation(s)
 - ballistic, 4-45
 - solution of, 4-36
 - Bernoulli's, 2-31
 - burning, 4-18
 - rate, 4-35,43
 - for cord propellant, 4-27
 - derivation of OSRD 6468 method, 4-42
 - energy balance, 4-33,35,36,37,43
 - allowing for friction, 4-37
 - including heat loss, 4-37
 - form-function, 4-43
 - Hill-Mott-Pack, 2-33
 - of interior ballistics, 4-22,33,35
 - Lame, 4-182
 - of motion, 4-36,38,42
 - modified, 4-37
 - projectile, 4-34
 - of shell, 3-4
 - Mott, 2-94,98
 - for multiperforated grain, 4-28
 - for period after all powder burned, 4-45
 - for single-perforated propellant, 4-27
 - solution of RD38, 4-37
 - for specific surface, 2-190
 - for strip propellant, 4-27
 - of state, 2-30, 4-33,34,42,43,88
 - Abel, 4-35
 - van der Waals, 4-35
 - virial, 4-34
- Equilibrium, dissociative, 4-87
- Equipment, designing new, 4-121
- Equivalence, ballistic, 4-26
- Equivalent rotating band geometry, 4-155
- Erratic pressures, 4-11
- Erosion, 4-162,163
 - bore, 4-1,3
 - causes of, 4-164
 - effects of, 4-163
 - methods used to control, 4-169
 - of rifling, 4-162
- Error distribution, 2-110
- Establishing acceptable quality level, (AQL), 5-4
- Establishing web size, 4-13
- Estimate(s)
 - acrodynamic coefficients of projectile, 3-8
 - ballistic limit, 2-127
 - base drag, 3-71
 - chamber capacity, 4-126
 - minimum, 4-125
 - clearance, 4-121
 - damage probability, 2-88
 - drag, 3-64
 - coefficient, 3-74
 - fin-stabilized projectiles, 3-70
 - effect of, 3-69
 - base area, 3-67
 - head curvature, 3-65
 - head length, 3-65
 - méplat diameter, 3-67
 - shell length, 3-68
 - yaw, 3-69
 - friction drag, 3-71
 - interference drag, 3-71
 - wave drag, 3-70
 - coefficient, 3-76
- Ethyl centralite, 4-2
- Eutectic, 6-36
- Evaluation
 - blast, 2-11
 - damage, 2-129
 - aircraft, 2-110
 - fragmentation effectiveness (parameters required), 2-93
 - of present methods of analysis, 2-91
- Example by Le Duc system, 4-81
- Example for optimum loading density, 4-50
- Excessive dispersion, 4-129
- Exothermal chemical reactions, 2-187,189
- Expansion
 - bourrelet, 6-23
 - cups, 4-150
 - differential, 2-181
 - of gun (elastic), 4-119
 - permanent, 4-118
 - wrapped cartridge case (rough rolling and), 6-39
- Expelling charge, 2-5,161
- Experiment(al, 2-73
 - case design (notes on), 4-126
 - to determine penetration, 2-102
 - firings, 4-84
 - results with fluted liners, 2-73,76
 - shell (ring-type), 2-97
- Explosion
 - confinement of, 2-109
 - heat of, 4-2,3,87,89
 - premature, 6-17
 - temperature test, 2-23
- Explosive(s)
 - average densities and compositions, 2-12
 - for blast, 2-12
 - blasting, 4-2
 - burst, 1-3
 - shell, 2-160
 - burstcr, 2-160
 - classification of, 1-6
 - high, 1-6
 - low, 1-6
 - column of, 2-182
 - comparison of, 2-11
 - pyrotechnic compositions with, 2-188
 - filler, pinching of, 2-158
 - fluting of, 2-81
 - initiation of, 2-61
 - liquid, 2-62
 - pellets, 2-82
 - plastic, 2-156
 - pressed, 2-95

- ratios, 2-178
- react with, 6-17
- in shaped charges, 2-59
- solid, 2-63
- train, 2-177
 - primer, 1-6
- types
 - aluminum, 2-13
 - ammonium perchlorate, 2-13
 - HBX, 2-13
 - Medina, 2-13
 - MOX, 2-13
 - Pentolite, 2-13
 - RDX, 2-13,14
 - Silas Mason, 2-178
 - TNT, 2-13
 - Torpex, 2-13
 - Tritonal, 2-13
- wave propagation, 2-7
- Extension, plastic, 4-118
- Exterior ballistics
 - problem, 3-38
 - sample of, 3-73
 - of sabot, 2-119
- External blast
 - damage criteria, 2-16
 - vulnerability of aircraft, 2-16
- Extraction, 4-119, 6-40
 - difficulties, 4-132,134
 - ease of, 4-121,134
 - effect of gun, 4-119
 - free, 4-117
 - factors influencing, 4-118
 - grooves, 1-7
 - stiff, 4-119
- Extractor(s)
 - gun, 4-117,122
 - pockets, 4-119
- Extruded-aluminum burster casing, 2-180
- Extrusion, 4-6, 6-3,21
 - over, advantages of forging, 6-3
 - cold, 6-1,3,9
 - to length, 6-21
 - process, French, 6-7
 - rearward, 6-8
 - for shell manufacture, 6-2
- F damage, 2-83
- Fabric, tensile strength of, 2-198
- Face, 6-27
 - hardened armor, 2-119,141
 - bullet proof (FHBP), 2-120
- Factor
 - damping, 3-4,6,30
 - dimensionless (K), 2-178
 - elongation, 2-178
 - form, 3-38,39,65,66,69, 4-23
 - overturning couple, 3-2
 - overturning moment, 3-8
 - righting moment, 3-30
 - shock-load, 2-198
 - stability, 3-2,5,6,8
- Factors (affecting)
 - ballistic coefficient, 3-38
 - design and use of illuminating shell, 2-162
 - freedom of extraction, 4-118
 - initial velocity, 3-72
 - liner performance, 2-36
 - luminous intensity, 2-189
 - parachute design, 2-195
 - penetration of subcaliber projectiles, 2-137
 - pyrotechnic compositions, 2-187
 - range, 3-38
 - time of flight, 3-38
- Failure
 - armor plate, 2-119,120
 - ballistic, 6-43,47
 - ductile, 2-120
 - due to case, 4-120
 - due to gun causing hard extraction, 4-120
 - the gun tube, 4-162
 - to penetrate, 2-123
 - of shell under stress, 4-178
- Fall, angle of, 2-93
- False ogive, 2-117
- Fastax high-speed cameras, 2-94
- Fastening base plate, 6-17
- Felt wadding, 2-172
- FFAR (shell), 2-85
- Fiber, chopped-glass, 2-176
- Field interchangeability, 2-182
- Figure of merit, 2-103,106
- Filler(s), 2-5,150
 - behavior of, 4-189
 - burning of, 2-178
 - design, 2-177
 - propaganda shell, 2-184
 - dispersion of, 2-178
 - flechette-type, 2-150
 - liquid, 2-6,161,185
 - loading (WP), 2-180
 - pinching of explosive, 2-158
 - setback (SP), 4-179,181,182,189
- Fillets, rotation of, 3-81
- Fillet, volume of partial, 3-85
- Film, protective, 2-192
- Filters, colored, 2-193
- Fin(s)
 - bent, 3-29
 - with blunt trailing edge, 3-13
 - interference, 3-71
 - low aspect ratio, 3-13
 - rectangular, 3-12,71
 - stabilize(d), 3-1
 - discarding sabot, 2-4
 - hypervelocity, 2-4
 - shell, 2-82,175, 3-10,28,70, 4-189
 - estimation of drag coefficients of, 3-70
 - lift of, 3-12
 - ensure static stability, lift of, 3-11
 - at subsonic velocities, 3-12
 - sweptback, 3-13
 - supersonic speeds, thin, 3-12
 - supersonic speeds, three-dimensional, 3-12
 - thin, pointed, short, 3-13
 - wedge-type, 3-71
- Final head, 6-43
- Final inspection, 6-39,44,45
- Finding
 - altitude, 3-73

- horizontal range, 3-73
- maximum range, 3-73
- Finish(ing), 6-20
 - base of shell, 6-16
 - bourrelet, 6-17
 - cavity, forge, 6-1
 - HEP shell, 6-27
 - machining, 6-15
 - microsurface, 2-180
 - surface, 6-27
- Fire(s)
 - angles of, 2-83
 - closed-chamber, 4-40
 - drift, 3-10
 - effectiveness, area, 2-107
 - experimental, 4-84
 - first, 2-192
 - forces during, 4-178
 - determination of maximum forces acting on shell, 4-178
 - low-temperature, 4-129
 - percussion, 4-126
 - range, 3-65
 - tables, 2-177
 - terminal ballistic, 2-83
- Fireman, 2-34
- Firestone Tire and Rubber Co., 2-36,37,68,78,81
- First, 2-3,4
 - fire(s), 2-192
 - composition, 2-172
 - nonhygroscopic, 2-192
 - flash, 4-3
 - hit, 6-21
 - moment about plane, 3-81
 - order theory, 2-34
 - round hit, 2-47
 - round probability of kill, 2-4
- Fit
 - interference, 4-121
 - least-square, 4-20
 - press, 4-132,180
 - web to gun, 4-9
- Fixed ammunition, 4-117,160
- Five-second incapacitation, 2-102
- Flame
 - action primer, 1-6
 - cutting, 6-5,14
 - temperature, 4-35
 - adiabatic, 4-87,88
 - isobaric, 4-88
 - isochoric, 4-88
- Flange
 - base, 2-45
 - design, 4-122
 - diameter, 4-137
 - stepped, 4-123
 - thickness, 4-123,133
 - types of, 4-122
 - roller, 6-46
- Flare(s), 2-160,187
 - aircraft, 2-195
 - burning, 2-164,193
 - composition, 2-167
 - parachute, 2-161
- Flareback, 1-7
- Flash, 4-1,3,11
 - chrome, 6-37
 - first, 4-3
 - metal dust, 2-187
 - muzzle, 4-3
 - less propellant, 1-6
 - radiographs, 2-69,73,93
 - reducers, chemical, 4-2
 - second, 4-3
 - tube, 2-183
- Flashlessness, 4-2,11
- Flat
 - base, 4-182
 - projectiles, 4-160
 - plate, 2-166
 - spin, 3-30
- Flatness of base, control of, 4-126
- Flattening of lands, 4-178
- Flechette(s), 1-3, 2-150
 - loading of, 2-150
 - type filler, 2-150
- Flight
 - stability in, 4-170, 6-35
 - time of, 3-4
 - minimum, 3-38,64
 - spin, versus, 3-10
 - whipping of casing in, 2-185
- Flow, plastic, 2-120,123,143, 4-118
- Flute(s)
 - liner, 2-35,69,71,72,75,82,108,109
 - experimental results with, 2-73,76
 - mechanism of spin compensation by, 2-72
 - methods for manufacturing, 2-80
 - performance of, 2-80
 - tolerances of, 2-80
 - nonideal, 2-78
 - nonlinear, 2-80
 - types of, 2-76
- Fluting, 6-43
 - of explosive, 2-81
 - spiral, 2-36
- Flyoff, band, 4-154
- Foilmeter, 2-10
- Force(s), 4-87
 - acting on shell, 4-178
 - during firing, 4-178
 - summary of, 4-181
 - determination of maximum, 4-178
 - in handling, 1-8
 - propellant gas pressure, 4-179,181
- aerodynamic, 3-6
- balloting, 4-178
- centrifugal, 2-167, 4-178
- cross-wind, 3-3,5,7,10,29,30
 - coefficient, 3-10,12
 - damping factor, 3-6,10
- drag, 2-195,196
- driving face (no friction), 4-153
- driving face (with friction), 4-153
- eccentric loading, 4-178
- inertial, 4-178
- normal, 3-7
 - coefficient, 3-13
- propellant, 4-88
- radial compressive, 4-178
- relative, 4-16,19
- setback, 2-108,109,162, 4-178,179

- shear, 2-162
- in shell wall resulting from rotation (tension), 4-181
- stresses in shell, resulting from, 4-181
- tangential, 4-179
 - inertia, 4-178
 - on rotating band, 4-181
 - at given section of shell, 4-181
- Forcing cone, 4-33,121,162
 - slope of, 4-126
- Forging, 6-3
 - advantages of extrusion over, 6-3
 - finish of cavity, 6-1
 - heat, 6-9
 - hot, 6-1,25
 - inspection of shell after, 6-13
 - shell, 6-4,6
 - steel, casting versus, 6-1
 - French extrusion method, 6-9
 - thick-and-thin, 6-7
 - upsetter, 6-9
- Form, 4-21
 - coefficient, 4-21,23,24
 - corner, 4-21
 - factor, 3-38,39,65,66,69, 4-23
 - function, 4-16,18,21,23,25,26,27
 - constants, 4-78
 - equation, 4-43
 - for seven perforated propellant (simplified), 4-25,26
 - of nitrocellulose, 4-2
- Formation
 - heat of, 4-89
 - of nitrocellulose, 4-90
 - jet, 2-31,32
- Forming
 - cold, 6-25
 - punch, 6-26
 - tool, 6-16
- Formula
 - boiler, 4-154
 - Demarre, 2-137
 - drag, 2-196
 - Gurney, 2-98
 - of interior ballistics, 4-39
 - for maximum pressure, 4-41
 - penetration, 2-125
 - Ritter's, 2-165
 - simple beam, 4-154
 - solids of revolution, 3-81
 - stress (deriving), 4-178
 - stress (summary of), 4-184
 - thick-cylinder, 4-180
 - two-dimensional, 3-12
- Formulation, 4-1
- Fortification, defeat of, 2-4
- Fouling, metal, 4-149
- Four-wheeled planimeter, 3-85
- Fraction burned, 4-21
 - of powder, 4-47
 - of web, 4-17
- Fracture, brittle, 2-123
- Fragments, 2-14,85,95,112,154
- Fragmentation, 2-1,50,93,94,156
 - characteristics, 2-94,95,97
 - control(ld), 2-3,107,108,109,110,111
- data, 2-105
- effect, secondary, 2-5
- effectiveness, parameters needed to evaluate, 2-93
- Kirkwood-Brinkley's theory, 2-9
- nature of, 2-93
- patterns, 2-93
 - discussion of, 2-100
- tests, 2-23,94,106
- weapons, antipersonnel, 2-103,106
- Frankford Arsenal, 2-82, 4-129,133,134,137,160,169
- Franklin Institute, 4-137
- Free
 - body stress analysis, 4-188
 - extraction, 4-117,118
 - flight system, 2-195
 - run projectile, 4-164
 - space, initial, 4-38
- Free Flight Aerodynamics Branch of the Exterior Ballistics Laboratory, 3-65
- French extrusion method of forging shell, 6-7,9
- Friction
 - coefficient, 3-10
 - drag, 3-68,70
 - estimation of, 3-71
 - coefficient, 3-68,71
 - projectile, 4-33
 - sensitivity, 2-23,187
- Front
 - detonation, 2-30,31
 - shock, 2-7
- Frustums, 3-81
 - conic, 3-88
 - volume of, 4-126
- Fuel damage, 2-111
- Fuel tank vulnerability, 2-112
- Function
 - Arhennius, 2-192
 - density of loading, 4-48
 - form, 4-16,18,21,23,25,27
 - pressure, 4-48
 - of rotating band, 4-149
 - of skirting plate, 2-137
 - of special purpose shell, 2-160
 - of stability factor, 3-31
 - travel, 4-48
 - velocity, 4-48
- Functional
- Functioning
 - parachute, 2-163
 - premature, 4-162,164
 - tests, 4-129,137
 - theory of cartridge case, 4-118
 - time, fuze, 2-157
- Fundamental
 - ballistic equation, 4-43
 - equations of interior ballistics, 4-33
 - development of, 4-34
- Furnace
 - induction, 6-33
 - reducing atmosphere, 6-29
- Future designs, direction of, 2-170
- Fuze(s), 1-1,4
 - adapter, 2-175
 - black powder train, 1-4
 - boresafe, 1-5
 - delay, 1-4

- dispersion, 2-107
- ejection charge, 2-172
- electrical, 2-63
- functioning time, 2-49,157
- impact, 1-4
- magnetic, 2-57
- nondelay, 1-4
- point-detonating, 1-4,5, 2-177
- proximity (VT), 1-4, 2-177,184
- for shaped charge missiles, 2-63
- spitback (flash-back), 2-63
- superquick, 1-4
- time, 1-4, 4-1
 - mechanical, 2-177,183,184
- VT, 1-4, 2-177,184
- Fuzing
 - of high-velocity rounds, 2-63
 - of low-velocity rounds, 2-63
- Gafarian, 3-14
- Gage, 2-10, 6-20
 - acceptance, 6-44
 - air-blast, 2-11
 - calibration of, 2-11
 - blast cube, 2-11
 - blast tube, 2-11
 - bourrelet ring, 6-24
 - box, 2-10
 - condenser microphone, 2-10
 - crusher, 4-94
 - dial indicating, 5-13
 - distance, charge-to-, 2-11
 - foilmeter, 2-10
 - GO, 5-5,24
 - NOT GO, 5-5,12
 - head thickness, 6-45
 - icosahedron, 2-100
 - inspection, chamber, 6-44
 - mechanical, 2-10
 - NOT GO, 5-5,24
 - papter blast, 2-85
 - meter, 2-10
 - peak-pressure, 2-10
 - piezoelectric, 2-10, 4-16,94
 - pressure, copper, 4-40
 - pull-over, 4-163
 - resistance, 2-10
 - snap, 6-24
 - thread, 6-24
 - tolerances, 5-24
 - varnish cans, 2-11
- Gain twist, 4-170
- Gas(es)
 - acceleration, 2-138
 - check, 4-189
 - constant, 4-35
 - density, 4-35
 - evolution, 4-1
 - internal energy of, 4-35
 - kinetic energy of, 4-36
 - muzzle, 4-3
 - nonpersistent, 2-186
 - dispersion, 2-185
 - obturate, 2-172
 - persistent, 2-186
 - dispersion, 2-185
 - relative energy in, 4-87
 - temperature, 4-47
 - volume, 4-87
 - calculated for organic chemical constituent, 4-87
 - calculated for propellant composition, 4-87
 - wash, 4-120
- Gasket, copper, 6-27
- GB agents, 2-186
- Gelatinizing agents, 4-2
- General form functions, 4-26
- Generator, piezoelectric, 2-63
- Geometric
 - components of projectile, 3-89
 - calculations of, 3-90
 - density of loading, 4-46
- Geometry
 - grain, 4-3,9,26
 - nose, 2-140
 - projectile, 3-69,81
- German designs for Q. F. guns, 4-123
- Gilding-metal, 2-152, 4-149,160
- Glazed-board cup, 4-122
- Glass
 - armor, 2-82
 - cones, 2-38
 - filled phenolic, 2-175
- GO and NOT GO gaging, 5-5,12,24, 6-20
- Good ductility, 6-4
- Government inspection
 - intermediate, 6-44
 - and marking of shells, 6-24
- Graham, 3-12,13
- Grain, 4-20
 - design, 4-13
 - determination of, 4-9
 - dies, design of, 4-7
 - dimensioning of, 4-7
 - geometry, 4-3,9,26
 - green, 4-7
 - (seven-perforated), multiperforated, 4-13,21,24,26, 36,48
 - shape, 4-7
 - burning rate, effect of, 4-20
 - shrinkage of, 4-13
 - single perforated, 4-22,23
 - propellant, 4-16,20,93
 - surface, 4-6
 - constant-burning, 4-48
- Granulation, 4-1
 - propellant, 4-9,16
- Gravity, acceleration due to, 4-34
- Gravity, center of, 2-172, 3-10,86
- Green grains, 4-7
- Gregg, 2-102
- Grinding, centerless, 6-17,29
- Grommet, 1-4
- Groove(s)
 - bands without, 6-17
 - crimping, 4-132
 - extracting, 1-7
 - rifling, 4-155
 - rings, 2-3,108
 - wire, 2-108
- Ground

- burst (lethal area), 2-106
- impact, 2-177
- Gun
 - battery, detection of, 4-3
 - chamber design, 4-117
 - damage to, 4-178
 - design of, 4-119,124
 - extractors, 4-117,122
 - high-pressure, 4-125
 - of infinite length, 4-80
 - and mount, weight of, 3-72
 - optimum, 4-50
 - separate loading, 4-117
 - shell, recoilless, 6-4
 - stress limits, 4-1
 - tank, 4-50
 - tapered-bore, 2-4,118
 - tube, failure of, 4-162
- Guncotton, 4-2,6
 - blended, 4-6
- Gurney, 2-93,94,106
 - constant, 2-98
 - formulas, 2-98
 - Sarmousakis scaling formula, 2-95
- Gyration, radius of, 2-165, 4-153
- Half-weight, 2-98
- Handling, forces acting on projectiles in, 1-8
- Hangfires, 4-84
- Hard
 - caps, 2-144
 - extraction (failures due to gun causing), 4-120
 - spot, 4-125
- Hardening
 - age, 4-149, 6-46
 - strain, 6-21
 - work, 4-119, 6-24
 - cold, 6-37
- Hardness, 4-119
 - Brinell, 6-15
 - of cartridge case, 4-125
 - requirements, 4-135
 - of HEP shell, 6-27
 - loss of, 6-43
 - test for, 6-15
 - magnetic comparator, 6-43
- Harvard tables (use of), 3-85,86,87,88,89
- HBX, 2-13
- Hencky-Von Mises criterion, 4-187
- Hencky-Von Mises theory (constant distortion or), 4-185,186
- Head
 - conical, 3-65
 - final, 6-43
 - machining and stamping of cartridge case, 6-39
 - ogival, 3-65
 - ogivo-conical, 3-64
 - thickness, 4-133
 - gage, 6-45
- Heading of cartridge case, 6-37
- Heat
 - capacity, mean, 4-87,88
 - of combustion, 4-88,89
 - calculated, 4-90
 - of explosion, 4-2,3,87,89
 - calculation of (Q), 4-89,90
 - for organic chemical constituent, 4-87
 - for propellant composition, 4-87
 - forging, 6-9
 - of formation, 4-89
 - of nitrocellulose, 4-90
 - loss, energy equation including, 4-37
 - of reaction, 2-189, 4-89
 - sensitivity to, 2-187,192
 - of pyrotechnic compositions, 2-192
 - specific, 4-35
 - test (100° C), 2-22
 - test (115° C), 4-93
 - treatment, 6-3,4,14,33,43
 - none required, 6-47
 - sidewall, 6-43
- HEAT shell, 2-32,58, 3-70,85
- Heavy armor targets, 2-145
- Height, 3-64
 - of ogive, 3-65
 - optimum, 2-195
- HE shell, 4-153
 - cold extrusion of, 6-21
 - computing energy of, 3-76
 - computing momentum of, 3-76
 - forging of, 6-4
 - machining of, 6-14
- HEP shell, 1-3, 2-5,156,158
 - accuracy of, 2-157
 - action, 2-158
 - advantages and disadvantages, 2-156
 - comparison of with armor-piercing shot, 2-156
 - cutting-off base of, 6-27
 - development of, 6-26
 - theory, status of, 2-158
 - finishing of, 6-27
 - fuzing requirements, 2-157
 - hardness of, 6-27
 - one-piece, 2-158
 - performance, 2-157
 - conclusions on, 2-158
 - effect of nose on, 2-157
 - effect of spaced armor on, 2-157
 - theory of, 2-156
 - principles of, 2-157
 - spalling of armor, 2-1
- Hexagonal planform, 3-14
- High
 - detonation velocity, 2-157
 - explosive(s), 1-6
 - characteristics of, 2-22
 - core, 2-160,176
 - shell, 1-2, 2-3, 3-10, 6-7,17
 - antitank (HEAT), 1-2, 2-4
 - casting, 6-1
 - plastic (HEP), 2-5,156
 - notch sensitivity, 4-129
 - obliquity, 2-124
 - order detonation, 1-5
 - pressure guns, 4-125
 - pressure, sporadic, 4-84
 - speed cameras (Fastax), 2-94
 - speed jet, 2-31
 - sulfur steel, 6-2
 - (objections to), 6-4

- velocity rounds, fuzing of, 2-63
- yield, 6-44
- Hill-Mott-Pack equation, 2-33
- Hirschfelder interior ballistic system, 4-18,20,21
 - solution by, 4-48
- Hitchcock, 3-9,10
- Hit, first, 6-21
- Hit, second, 6-21
- Hole(s)
 - centrality of, 5-22
 - datum, 5-20
 - primer, 6-43
 - vent, 4-84
- Hollow jet, 2-64
- Homogeneity criteria, 5-1
- Homogeneity of lot, 5-2
- Homogeneous armor, 2-36,120,138,139
- Hoop stress, 4-179
 - tensional, 2-163
- Horizontal range, finding, 3-73
- Hospitalization of shells, 6-18
- Hot
 - and-cold water tested, 6-29
 - forged stock, 6-2
 - forging, 6-1,25
 - comparison with cold extrusion of shell, 6-24
 - effect of water sprays on, 6-12
 - pressing, 6-36
 - tops, 6-29
 - work versus cold work on steel, influence of, 6-1
- Howitzers, obturating problem in, 4-134
- HVAP
 - shot, 2-128, 6-35,36
 - assembly of, 6-35
 - base of, 6-35
 - body of, 6-35
 - windshield of, 6-35
 - projectiles, 4-153
- HVAPDS
 - round, 2-137
 - shot, 2-118, 6-36
 - projectile, 2-138
- HVAPDSFS
 - projectiles, 2-128
 - shot, 2-119
- Hydraulic piercing, 6-7
- Hydrogen atmosphere, 6-36
- Hydrostatic pressure, 4-186
- Hydroxide, metal, 2-191
- Hygroscopicity, 2-22
 - decrease, 4-2
 - test, 4-94
- Hypergeometric distribution, 5-2
- Hypervelocity, 2-4,118
 - armor-piercing shell (HVAP), 2-117
 - manufacture of, 6-35
 - discarding sabot ammunition (HVAPDS), 1-3
 - fin-stabilized shot (HVAPDSFS), 1-3
 - discarding sabot, fin-stabilized shell, 2-4
 - projectiles, 2-123
- Hypothetical shell, lethality of, 2-106
- Icosahedron gage, 2-100
- Igniter compositions, 2-192
- Igniter sticks, 4-84
- Ignitibility, 2-191,192
- Ignition
 - cartridge, 2-172
 - charges, 1-7
 - difficulties, 4-50
 - interval, 4-84
 - temperature, 2-187,189
 - time-to-, 2-192
- Illuminant
 - assembly, 2-160,182,184
 - composition, 2-175
- Illuminating
 - canister, 2-185
 - shell, 2-160,161,164,182,185,187,195
 - design of, 2-162
 - elements of mortar-type, 2-172
 - factors affecting use of and, 2-162
 - metal parts of, 2-162
 - optimum height of, 2-162
- Illumination
 - battlefield, 2-162
 - intensity, 4-3
 - maximum, 2-195
- Immediate incapacitation, probability of, 2-102
- Impact, 2-117
 - angle of, 2-137
 - fuze, 1-4
 - ground, 2-177
 - resistance, 6-4
 - sensitivity to, 2-187
 - rifle bullet, 2-23
 - test, 2-22
 - velocity, 2-5,93
- Impaired penetration, 2-38
- Implied requirement, 5-15,22
- Importance of slow roll, 3-29
- Improper heat treatment, 2-123
- Impulse, 2-16,72
 - comparison of peak pressure and, 2-13
 - positive, 2-7,9,10,11,13,14,19
- IMR powder, 2-168
 - available energy for, 2-169
- Incapacitation
 - criterion, 2-104
 - probability of immediate, 2-102
 - types of, 2-102
 - A, 2-102
 - B, 2-102
 - K, 2-102
 - five-second, 2-102
- Incendiary, 2-1
- Incident wave, 2-8,9
- Incipient plastic flow, 4-186
- Incipient plastic stress state, 4-188
- Increase in drag, 3-67
- Increasing twist, 4-172
 - advantages, 4-170
 - disadvantages, 4-170
- Increment(s), 1-7
 - boundary, 2-183
 - propellant, 2-172
- Indentation pressure, 4-152
- Independent
 - locational tolerance, 5-13
 - symbol, 5-15

- tolerance, 5-21
- Index, 2-77
 - angle, 2-77,79
 - lethality, 2-103,106,107
 - of satisfactory ignition, 4-84
- Indicator, dial, 5-14
- Induction furnace, 6-33
- Inertia(l)
 - forces, 4-178
 - tangential, 4-178
 - moments of, 3-86,89
 - polar, 4-179
 - of shell, 3-4
- Influence of hot work versus cold work on steel, 6-1
- Information-bearing leaflets, 2-183
- Infrared, 2-189
- Initial
 - clearance, 4-119
 - free space, 4-38
 - shot start pressure, uniform, 4-149
 - velocity, 3-38
 - factors determining, 3-72
 - fragment, 2-106
 - prediction of, 2-98
 - yaw, 3-5,28, 4-164,178
 - magnitude and effects of, due to bore clearance, 3-28
- Initiating charge, 2-177
- Initiation
 - of explosive, 2-61
 - peripheral, 2-62
- Initiator
 - black powder, 2-183
 - test, 2-23
- Inspection, 6-5,18
 - amount of, 5-1
 - chamber gage, 6-44
 - final, 6-39,44,45
 - government and marking of shells, 6-24
 - methods of, 5-1, 6-40
 - by attributes, 5-5,12
 - lot-by-lot sampling, 5-1
 - 100-percent, 6-44
 - by variables, 5-12
 - visual, 6-20,24
 - personnel required, 6-47
 - in process of manufacture, 6-13,19,23
 - of shell forgings, 6-13
 - of wrapped case, 6-48
- Insufficient number of draws, 4-125
- Integral, elliptic, 3-27
- Integrator, 4-126
 - ballistic, 3-85
- Intensifiers, color, 2-186
- Intensity
 - illumination, 4-3
 - luminous (candlepower), 2-187,190,191
 - factors affecting, 2-189
- Intensities, determination of relative air-blast, 2-11
- Interacting wave front theory, 2-157
- Interchangeability, field, 2-182
- Interference(s)
 - drag, 3-70
 - estimation of, 3-71
 - fin, 3-71
 - body, 3-71
- fit, 4-121
 - minimum, 2-180
 - ratio, 4-152
 - recommended, 4-123
 - zero, 4-169
- Interior ballistics, 2-153, 4-1,164
 - basic problems of, 4-33
 - calculations, 4-9
 - equations of, 4-22,33,35
 - summary of, 4-39,46
 - properties, 4-16
 - systems of, 4-18,33
- Intermediate anneals, 6-1
- Intermediate inspection, government, 6-44
- Internal
 - contour of case, 4-124
 - contour of shell, 2-185
 - energy of gas, 4-35
 - mouth diameter, 4-124
 - volume of cartridge case (determine), 4-126
- International heat test (75° C), 2-22
- Interpolator, transparent, 4-17
- Interpolation, linear, 3-88
- Interval of burning of propellant, 4-43
- Interval, ignition, 4-84
- Inverted bead, 4-134
- Inverted piercing, 6-8
- Iron
 - powder, 4-161
 - sintered, 4-149,161
 - sulfide, 6-4
- Isobaric adiabatic flame temperature, 4-88
- Isochoric adiabatic flame temperature, 4-88
- Jaeger, 3-13
- Jet, 2-58
 - bifurcation of, 2-35
 - breakup, 2-32
 - density, 2-38
 - ductility, 2-52
 - engines, peripheral, 2-82
 - formation, 2-31,32
 - high speed, 2-31
 - hollow, 2-64
 - radiographic studies, 2-68
 - shaped charge, 2-38,85
 - velocity, 2-63
 - water, 6-6
- Jib, alining, 4-132
- Joint press, 6-17
- Joint, shear, 2-160
- Jominy tests, 6-29
- Jump, 3-6,28,30
 - finned projectiles, assymetry effects on, 3-30
 - measurement of, 3-6
- K damage, 2-83,110
- KK damage, 2-110
- Kamikaze attack, 2-110
- Kelley, 3-12
- Kent, 4-36
- Kerr cell, 2-34

- KI-starch test, 4-93
- Kill, 2-110
 - first-round probability of, 2-3,4
- Kinetic energy
 - ammunition, 2-1,4,85,117
 - of gas, 4-36
 - of powder, 2-137
 - of projectile, 4-9,33,35
 - shot, comparative performance of, 2-145
 - shot, penetration of armor, 2-1
- Kirkwood-Brinkley's theory, 2-9
- Knurling rollers, 6-16
- Krupp armor, 2-120
- Labyrinth seal, 4-134
- Lagerstrom, 3-12,13
- Lamé, equations by, 4-182
- Lamellar pearlite, 6-29
- Laminae, 2-192
- Land(s), 3-4, 6-35
 - band, 4-155
 - width, 4-155
 - flattening of, 4-178
 - rifling, 4-155
 - wear of, 4-164
- Lapin, 3-14
- Late collapse, 2-69
- Law(s)
 - of Cranz, 2-32
 - of mass action, 2-190
 - Newton's, 4-34
 - sealing, 2-9,16,65
- Lead
 - azide, 1-5
 - carbonate, 4-3
 - cones, 2-41
- Loading edge, 3-11,13,14
- Leaflets, 2-1
 - information-bearing, 2-183
- Leaflets, propaganda, 2-184,185
 - rolls, 2-184
 - method of reinforcing, 2-184
 - surrender, 2-183
 - warning, 2-183
- Leakage, 2-6
 - propellant gases, 2-180
- Least-square fit, 4-20
- Le Due system, 4-33,80,81
- Length
 - cartridge case, 4-121,128
 - tolerance of, 4-121
 - of chamber, 4-137
 - extrusion to, 6-21
 - gun of infinite, 4-80
 - ogival, 3-87
 - are, 3-82
 - of swell diameter, 3-85
- Lesells' and Associates, 2-158
- Lethal area, 2-3,93,104,106,154
 - air-burst, 2-107
 - computation, 2-103
 - criteria, 2-154
 - ground-burst, 2-106
- Lethality, 2-4,36,71,119,153
 - criteria, 2-93,101,111
 - determination, 2-105,106
 - of hypothetical shell, 2-106
 - index, 2-103,106,107
- Licberman, 2-69
- Lift(ing)
 - coefficient, 3-10,12
 - slopes, 3-13,27
 - of fins to ensure static stability, 3-11
 - of finned projectile, 3-12
 - plug, 1-4
- Light, 2-1
 - characteristics of pyrotechnic compositions (factors which affect), 2-187
 - output, 2-170
 - signal color, 2-193
- Limit(s)
 - ballistic, 2-125,127,141,144,145
 - approximating the, 2-126
 - elastic, 6-43
 - to length of shell, 3-1
 - pressure, 4-1,9,11
 - of propagation vs. minimum column diameter, 2-182
 - signal smokes (terminal effects), 2-182
 - tolerance, 5-11,18
 - velocity, 2-125
 - web, 4-11
- Linear
 - acceleration, 4-179
 - burning rate, 4-16,18,20
 - interpolation, 3-88
 - shaped charges, 2-82
- Liner(s), 2-108
 - conical, 2-31
 - copper, 2-32,46
 - drawn, 2-68
 - cylindrical, 2-69,71
 - desirable properties of, 2-38
 - fluted, 2-35,69,71,72,75,82,108,109
 - materials, 2-85
 - effect on penetration under rotation, 2-68
 - selection of, 2-50
 - method of attaching, 2-55
 - parameters, consideration of, 2-49
 - performance, 2-36
 - factors affecting, 2-36
 - measures of, 2-36
 - shape, 2-52
 - effect on penetration under rotation, 2-69
 - shaped charge, 2-52
 - soft porous, 2-109
 - steel, 2-32,61
 - thickness, effect on penetration under rotation, 2-67
 - trumpet-shaped, 2-69
- Lined cavity charges, 2-31
- Lines-first, 2-196
- Lines, Lucder's, 6-44
- Linfoot, 2-94
- Liquid
 - explosives, 2-62
 - fillers, 2-6,161,185
 - filled shell, 2-160,185
 - burst, design of, 2-186
 - saltpeter, 6-37

- Litmus-paper test, 6-40
- Loaded, press, 2-156
- Loading
 - density, 2-11,14, 4-1,33
 - maximum, 4-50
 - optimum, 4-50
 - vs. pressure curve of black powder, 2-183
 - of propellant, 4-164
 - flechettes, 2-150
 - geometric density, 4-46
 - mortar shell, 4-178
 - tool, 6-41
 - WP filler, 2-180
- Location of center of gravity, 3-88
- Locational tolerance symbols, 5-13
- Longitudinal stress, 4-182,189
- Longitudinal tensile stress, 4-179
- Long-term surveillance, 2-175
- Loose rotating bands, 6-26
- Loss
 - of hardness, 6-43
 - in obturation, 4-163
 - in penetration, 2-57
 - in shot-start pressure, 4-163
- Lot
 - acceptability of, 5-12
 - definition of, 5-1
 - homogeneity of, 5-2
 - by-lot sampling inspection, 5-1
 - size, sample-size-to-, 5-6
 - tolerance percent defective (LTPD), 5-3
- Low
 - aspect ratio, 3-13
 - explosives, 1-6
 - notch toughness, 6-4
 - order detonation, 2-183
 - oxygen balance, 4-3
 - percentage elongation, 6-44
 - temperature firing, 4-129
 - temperature stress relieving, 6-43
 - velocity rounds (fuzing of), 2-63
- Love, 4-36
- Lueder's lines, 6-44
- Luminous intensity (candlepower), 2-187,190,191
 - factors affecting, 2-189
- Lupersol, 2-192
- Luther, 3-13

- M damage, 2-83
- M1 propellant, 4-1
- M2 propellant, 4-2
- M15 propellant, 4-2
- Mach
 - angle, 3-14
 - number, 3-4,9,12,13,39,65,68,71
 - stem, 2-9
 - wave, 2-9,19
- Machinable quality armor (MQ), 2-120
- Machining, 6-1
 - finish, 6-15
 - of HE shells, 6-14
 - outside of, rough, 6-14
 - preparation for, 6-14
 - operations on head of cartridge case, 6-44
 - operations on mouth of cartridge case, 6-44
- Magnaflux test, 6-33
- Magnesium-aluminum fuels, properties of aluminum and, 2-190
- Magnetic
 - comparator, 6-45
 - hardness, 6-43
 - fuzes, 2-57
 - hardness test, 6-43
- Magnitude of initial yaw due to bore clearance, 3-28
- Magnus moment, 3-8,29
 - damping factor, 3-6,10
- Main body taper, 4-121
- Major base, 3-87
- Major defects, 5-5
- Malformed cones, 2-39
- Malfunctions, 6-47
 - caused by twisting of shroud lines, 2-166
- Mandrel, 6-9
- Manganese sulfide, 6-4
- Manufacture
 - armor-piercing shot and caps, 6-29
 - artillery ammunition, 6-1
 - cartridge case, 4-119,133
 - annealing operations, 6-39
 - brass, 6-37
 - perforated, 6-49
 - steel, drawn, 6-41
 - trapezoidal-wrapped, 6-46
 - of HEP shell, 6-26
 - of hypervelocity armor-piercing shot (HVAP), 6-35
 - inspection in process of, 6-23
 - of shell during closing, 6-19
 - of nitrocellulose, 4-6
 - progress in techniques, 6-1
 - of propellants, 4-6
 - steel shells, pierce-and-draw process of, 6-2
 - of tungsten carbide cores, 6-36
- Marker, colored, 2-160
- Marking
 - on bases of cartridge cases, 4-126
 - of shells, 6-18
 - government inspection and, 6-24
- Martensite structure, 2-143
- Mass
 - action, law of, 2-190
 - fragment, 2-109,111
 - presented area, relation between, 2-99
 - of projectile, 3-38
- Matching
 - ballistic, 2-6,157
 - and soldering AP caps, 6-33
 - weight, 2-180
- Material(s)
 - anisotropic, 4-149
 - burst, 2-178
 - for cartridge cases, 4-132
 - deterrent, 4-3
 - liner, 2-85
 - rotating bands, 4-149
 - properties required of, 4-149
 - stabilizing, 4-1
- Mathematical statement of Von Mises yield condition, 4-187
- Matrix, use of, 2-150
- Maximum

- ballistic coefficient, 3-64
- charge, 4-50
- energy, 4-185
 - theory, 4-185
- illumination, 2-195
- likelihood, method of, 2-95,127
- loading density, 4-50
- metal conditions, 5-20,24
- pressure, 4-16,19,20,26,39,40,48,94,188
 - attainable, 4-33
 - calculate, 4-81
 - tables for, 4-47
 - formula for, 4-41
 - position of, 4-45,47
 - propellant, 4-180,188
 - rated, 4-11,50
 - ratio of, 4-88
 - time of, 4-45,48
- range, 3-38,64
 - finding, 3-73
- shear
 - stress, 4-185
 - theory, 4-185,187
 - (Tresca's rule of flow), 4-185
- sky brightness, 2-193
- square, 6-8
- velocity, 4-9,50
 - permissible, 4-156
 - muzzle, 2-128
- McMillen, 2-102
- Mean, 5-12
 - burst height, 2-107
 - deviation from, 4-137
 - dimension of ogive, 3-2
 - heat capacity, 4-87,88
 - calculated for organic chemical constituent, 4-88
 - calculated for propellant composition, 4-88
- Measurements
 - of blast, 2-10
 - of jump, 3-6
 - of liner performance, 2-36
 - piezoelectric, 4-94
 - of presented area of fragment, 2-100
 - of sensitivity, 4-93
 - of stability, 4-93
 - wind tunnel, 3-9,71
- Mechanical gage, 2-10
 - time fuze, 2-177,183,184
- Mechanism
 - of cap action (theories), 2-141
 - recoil, 3-72
 - of spalling, 2-157
 - of spin compensation (by fluted liners), 2-72
 - Medina explosives, 2-13
- Meplat (flat nose), 3-67
 - circular, 3-69
 - diameter, effect on estimation of drag, 3-67
- Mercury fulminate, 1-5
- Merit, figure of, 2-103,106
- Metal
 - binder, 6-36
 - burst tube, 2-160,179
 - case, solid-drawn, 4-120
 - dead, 6-42
 - dust flashes, 2-187
 - fouling, 4-149
 - fragmentation characteristics data to design of
 - shell, application of, 2-98
 - gilding, 2-152, 4-149,160
 - hydroxide, 2-191
 - oxide, 2-191
 - parts
 - accessory, 2-164
 - of illuminating shell, 2-162
 - signal-smoke shell design, 2-182
 - setback of, 4-181
 - sabots, 2-138
 - salts, alkali, 4-3
- Metallurgy, powder, 6-1
- Meter, paper blast, 2-10
- Method(s), 4-149
 - analysis
 - of data, 2-85
 - evaluation of present, 2-91
 - by, statistical, 2-126
 - of arming, 1-5
 - ballistic, 4-26
 - Bruceton staircase, 2-23
 - bullet pull, of achieving desired, 4-132
 - of producing colored smoke, 2-178
 - comparative study of shell forging, 6-13
 - of computing
 - air density at any altitude, 2-198
 - ballistic limits from firing data, 2-126
 - band width, 4-150
 - muzzle velocity of a subcaliber projectile,
 - British, 2-138
 - of crimping (effect of), 4-132
 - of controlling fragmentation, 2-108
 - of dimensioning mouth of case, 4-124
 - distributed area, 2-88
 - used to control erosion, 4-169
 - of forging shell, French extrusion, 6-9
 - of imparting rotation, 2-119, 4-149
 - of inspection, 5-1
 - liner, of attaching, 2-55
 - liners, for manufacturing fluted, 2-80
 - of maximum likelihood, 2-95,127
 - of reinforcing leaflet rolls, 2-184
 - of releasing and discarding carrier, 2-119
 - test, 4-93
 - description of, 2-22
 - of shell forming (compromise), 6-25
 - shock velocity, 2-11
 - of stabilization, 3-1
 - stochastic, 2-107
 - up-and-down, 2-127
 - vulnerable area, 2-88
 - of weight control (shell manufacture), 6-17
- Methyl violet test, 4-93
- Micrometer, ball point, 6-24
- Microsurface finish, 2-180
- Midwest Research Laboratories, 2-82
- Minimum
 - bourrelet clearance, 4-178
 - candlepower, 2-195
 - chamber capacity (estimating), 4-125
 - clearance, 4-121
 - drag, 3-64
 - interference, 2-180
 - metal conditions, 5-20,24
 - permissible yield stress, 4-156

- stress in shell wall, 4-158
- time of flight, 3-38,64
- Minor defects, 5-5
- Misfires, 4-84
- Missile(s), 2-150
 - for canister ammunition, 2-150
 - classification of, 2-1
 - effect by, 2-1
 - design of shaped charge, 2-47
 - dispersion, 2-152
 - preformed, 2-1
 - secondary, 2-4
- Mixed zone, 2-127
- Mixtures, binary, 2-190
- Mixture, pyrotechnic, 2-192
- Models, combat, 2-107
- Modifications of shape of shell, 3-64
- Modified equation of motion, 4-37
- Modulus
 - elasticity, 2-165
 - rigidity, 4-186
 - Young's, 4-118
- Moisture
 - atmospheric, 2-191
 - proofing agents, 4-2
 - protection against effects, 2-192
 - on shelf life, effect of, 2-191
- Mold, big-end-up, 6-29
- Mold casting in, 6-1
- Moles of gas, number of, 4-87
- Molybdenum disulfide, 2-181
- Molykote, 2-181
- Moment
 - inertia, 3-86,89
 - axial, 3-2
 - polar, 3-81,89, 4-179
 - of shell, 3-4
 - transverse, 3-2,10,28,81,90
 - first about plane, 3-1
 - Magnus, 3-8,29
 - damping factor, 3-10
 - overturning, 3-2,7,10,11,29
 - coefficient, 3-9
 - factor, 3-8
 - righting, 3-7,10,11
 - factor, 3-28,30
 - spin-decelerating, 3-8
 - coefficient, 3-10
 - damping factor, 3-6
 - transverse, 3-89, 4-178
 - yawing, 3-3,8,10
 - coefficient, 3-10
 - damping factor, 3-6
- Momentum
 - of HE shell (computing), 3-76
 - muzzle, 3-38,72
 - of projectile, 3-72
 - of propellant gases, 3-72
 - recoil, 3-72
- Monobloc
 - projectiles, 2-141
 - shot, 2-117,138
 - capped, 6-29
- Morikawa, 3-14,27
- Mortar ammunition
 - forgings, 6-4
 - illuminating, design elements of, 2-172
 - loading, 4-178
 - special design problems of, 2-172
 - spin-stabilized, 2-173
- Motion
 - of center of gravity, 3-6,38
 - energy of, 4-43
 - equation of, 3-4, 4-36,38,42
 - of projectile, 4-33
 - of spinning shell, 3-2
 - start of, 2-73, 4-43
- Mott, 2-93,94,106
 - equation, 2-94,98
 - reliability of, 2-95
 - scaling formula, 2-95
- Mouth
 - anneal of cartridge case, 6-44
 - bolting of, 4-122
 - diameter, internal, 4-124
 - eccentricity of, 4-124
 - thickness at, 4-133
- Moving charge, 2-16
- MOX explosives, 2-13
- Mullins Manufacturing Corporation, 6-21
- Multichek gage, 6-24
- Multiperforated grain (seven-perforated), 4-13,21,24
 - (equations for), 4-28
- Multiple
 - punching, 6-49
 - sampling, 5-6
 - wall shell, 2-108,109
- Multipurpose shell, 2-161
- Munk's theoretical values, 3-9
- Munroe effect, 2-110
- Murphy, 3-9,10
- Murray-Ohio Corporation, 6-46
- Must not decompose in storage, 4-2
- Muzzle
 - blast, 3-28,29,30
 - energy, 3-38,72
 - rotational, 4-150
 - flash, 4-3
 - reduce, 4-2
 - gases, 4-3
 - momentum, 3-38,72
 - pressure, 4-11
 - velocity, 2-118,129,153, 3-39,72, 4-26,40,48,129, 137,173,189
 - consistent, 2-152
 - of subcaliber projectile (British method of estimating), 2-138
 - tables for calculation of, 4-47
- National Defense Research Council, 2-37
- National Pneumatic Company, 6-29
- Nature of fragmentation, 2-93
- Naval Ordnance Laboratory, 2-60
- Naval Ordnance Test Station, 2-37
- Navy star shell, 2-173
- Neck of cartridge case, 4-134
- Necking case, 4-129
- Newton's laws, 4-34
- Nick and break, 6-5
- Nitration, proper degree of, 4-6

- Nitrocellulose, 1-6, 4-1,2,6,13
 - blended, 4-2
 - forms of, 4-2
 - heats of formation of, 4-90
 - lacquer coatings, 6-47
 - manufacture of, 4-6
- Nitroglycerin, 4-1,2
 - propellants, 4-1,84
- Nitroguanidine, 1-6, 4-2
 - propellants, 4-93
- Nomograph, 4-17
- No heat treatment required, 6-47
- Non-
 - cemented armor, 2-120
 - deformable projectiles, 2-137
 - delay fuze, 1-4
 - hygroscopic first-fire, 2-192
 - ideal flute, 2-78
 - linear flutes, 2-80
 - persistent gas, 2-186
 - dispersion, 2-185
 - undercut seat, 4-154
- Normal
 - error curve, 2-100
 - force, 3-7
 - coefficient, 3-8,9,13
 - stresses, 4-181
- Nose
 - adapter, 2-186
 - blunt, 2-157
 - cabbage of, 6-21
 - charge, single, 2-175
 - crush-up of, 2-5
 - diameter, 3-87
 - double-angle, 2-124
 - geometry, 2-140
 - AP projectile (effect of), 2-138
 - tungsten carbide cores (effect of), 2-139
 - notching, 6-17
 - pointed, 2-124
 - radius of projectile, 3-82
 - truncated conical, 2-139
 - truncated ogival, 2-124
 - tapping, 6-16
- Nosing, 6-23
 - deformation during, 6-17
 - of shell, 6-14
- NOT GO gage, 5-24
- NOT GO, GO-and-, 6-20
- Notation, consistent, 4-16
- Notch(es), (ed), (ing), 6-41
 - casings, 2-108
 - castings (description of), 2-109
 - (or grooved) rings, 2-108
 - (or grooved) wire, 2-3,108,109
 - nose, 6-17
- Notch sensitivity, 4-129,133, 6-43
- Notes on cartridge case designs, 4-125,126
- Nubbin, 6-27
- Number, 3-4
 - of draws, 4-125
 - of fragments, 2-93
 - Mach, 3-4,9,12,13,39,65,68,71
 - of moles of gas, 4-87
 - Reynolds, 3-68
- Nutation, 3-3
 - amplitude of, 3-8
 - angular velocity, 3-29
 - yaw, 3-6
- Nylon shrouds, 2-167
- Objections to high sulfur content steel, 6-4
- Objectives in shell forging, 6-7
- Obliquities of attack, 2-145
- Obliquity, 2-125,137,138,141
 - angle of, 2-156
 - effect of, 2-123
 - high, 2-124
- Obscuration, target, 4-3
- Obstructions within the cavity, 2-44
- Obturation, 1-7, 2-152, 4-117,134,149,150,152, 6-1, 40
 - beads, 4-134
 - cup, 2-173
 - gases, 2-172
 - loss in, 4-163
 - problem in howitzers, 4-134
- Obturator, rubber, 2-152
- Occluded acids, 4-6
- Office of Scientific Research and Development, 2-66, 68
 - OSRD 6468 method, derivation of equations, 4-42
- Offsets, 2-36
- Ogival
 - arc, 3-87
 - center of, 3-84
 - length of, 3-82
 - radius of, 3-69
 - heads, 3-65
 - length, 3-87
 - radius, 3-8,67
 - solid of revolution, 3-87
 - zone, volume of, 3-86
- Ogive, 1-3, 2-49,128, 3-64,69,81
 - arc, radius of, 3-82
 - characteristics, 3-88
 - computations for, 3-82
 - false, 2-117
 - height of, 3-65
 - mean dimension of, 3-82
 - pointed, 3-87
 - radius of, 2-139
 - secant, 3-64,65,81,87
 - segment, 3-85
 - calculation of, 3-85
 - shape, 2-58
 - shell, volume of thin, 3-86
 - tangent, 3-65,81,87,88
 - volume of complete, 3-86
- Ogivo-conical head, 3-64
- Olin Mathieson Chemical Corporation, 4-7
- One, 6-7
 - piece HEP shell, 2-158
 - shot method, 6-7
 - shot piercing process, 6-7
 - shot press, 6-7
- 100-percent inspection, 6-44
- Opening of parachute, stages in, 2-196
- Opening velocity, critical, 2-196
- Operating characteristic, curve (OC), 5-2

- Operations, characteristic deep-drawing, 6-2
- Operations in the machining of shells, sequence of, 6-14
- Optimum
 - air-burst height, 2-107
 - base plug, design of, 2-162
 - charge, 4-9
 - cone angle, 2-54
 - conditions, 4-50,74
 - design, 2-93
 - efficiency, point of, 4-75
 - gun, 4-50
 - height, 2-195
 - for area illumination, 2-195
 - concept of, 2-193
 - derivation of, 2-193
 - of illuminating shell, 2-162
 - ignition, requirement for, 4-85
 - loading density, 4-50
 - example for, 4-50
 - pellet size (canister ammunition), 2-153
 - standoff distance, 2-38,49
 - visibility, 2-177
 - warhead size, 2-14
 - web, 4-10,11
 - weight of cap material, 2-143
- Ordnance
 - Ammunition Command, 4-7
 - Board, 4-119
 - Committee Minutes (OCM), 2-2
 - Corps standard density, 3-38
 - Department, 4-7,169
- Organic
 - chemical constituent, gas volume (n) calculated for, 4-87
 - mean heat capacity $\bar{\gamma}$ calculated for, 4-88
 - heat of explosion (Q) calculated for an, 4-87
 - relative energy in gas calculated for, 4-88
 - dye, 2-178
- Origin of rifling, 4-173
- Oscillatory projectile motion, 3-2
- Output, light, 2-170
- Ovality, 4-122, 5-13
- Overcoming deficiencies of conventional long artillery primers (proposals made for), 4-84
- Overlay bands, welded, 6-17,26
- Overturning
 - couple factor, 3-2
 - moment, 3-2,7,10,11,29
 - coefficient, 3-9
 - factor, 3-8
- Overworking brass, 4-125
- Oxidations, exothermal, 2-187
- Oxide, metal, 2-191
- Oxidizing agents, 2-186
- Oxygen balance, 4-3
- Oxygen deficiency, 4-89

- Painting of shells, 6-19
- Pancake bags, 4-85
- Panel test, 2-94
- Panzerfaust, 2-83
- Paper blast gages, 2-85
- Paper blast meter, 2-10

- Parachute, 2-160,173
 - deceleration, 2-166
 - deployment, 2-166
 - methods, 2-196
 - design, 2-162
 - factors affecting, 2-195
 - pyrotechnic, 2-193
 - flares, 2-161
 - functioning, 2-163
 - shaped, 2-195
 - stages in opening of, 2-196
 - standard flat, 2-195
 - suspension system, 2-196
 - types of, 2-195
- Parallel axis (or plane) theorem, 3-89
- Parallel design, 5-11
- Parallelism, symbol for, 5-14
- Parameter(s)
 - central ballistic, 4-38
 - dimensionless, 4-39
 - needed to evaluate fragmentation effectiveness, 2-93
- Parasheet, 2-195
- Partial drag coefficients, 3-71
- Partial randomness of sampling, 5-2
- Particle size, 2-106,189
- Particle velocity, 2-7,30
- Parts design, accessory, 2-177
- Parts design, shell metal, 2-177
- Patterns, fragmentation, 2-93
- Peak, 4-20
 - penetration, 2-68
 - pressure, 2-7,9,10,11,13,14,16,19, 4-1,20,38
 - gage, 2-10
 - impulse and comparison of, 2-13
- Pearlite, lamellar, 6-29
- Pearlitic structure, 2-143
- Pellet
 - black powder, 1-5
 - explosive, 2-82
 - size, optimum (canister ammunition), 2-153
- Penetrate, failure to, 2-123
- Penetrated, thickness of plate, 2-137
- Penetration, 2-32,34,35,36,40,41,45,46,49,53,58,60, 62,63,66,71,74,80,81,83,117,122,128,138
 - armor, 2-137
 - kinetic energy shot, 2-1
 - by shaped charges, 2-1
 - bone, 2-103
 - depth of, 2-78
 - deterioration in, 2-78
 - effect of design parameters on, 2-39
 - effect of rotation upon, 2-66
 - experiments to determine, 2-102
 - fall-off, 2-64
 - formula, 2-125
 - impaired, 2-38
 - loss in, 2-57
 - peak, 2-68
 - performance, 2-70,137
 - power, 2-78
 - rate of, 2-33
 - rotational, 2-68
 - effect of cone angle on, 2-66
 - effect of liner shape on, 2-69
 - effect of standoff, 2-68

- effect of liner thickness on, 2-67
- spin versus optimum, 2-4
- subcaliber projectiles, factors limiting, 2-137
- sufficient residual, 2-85
- Pentolite, 2-13,40
- Percentage elongation, 4-136, 6-43
- Percentage oxygen deficiency, 4-89
- Percussion
 - element, 4-84
 - firing, 4-126
 - primer, 1-7, 2-172
- Perforate, 2-125
- Perforated cartridge cases, manufacture of, 6-49
- Perforation, 2-82,85
 - alignment of, 6-49
 - armor, 2-124,125
 - of cartridge case, 6-49
 - definition of, 2-125
 - ductile, 2-129
 - probability of, 2-88
 - punching type of, 2-129
- Performance
 - of armor plate, 2-125
 - of armor-piercing projectiles, 2-126
 - of, AP and APC projectiles, comparative, 2-142
 - of fluted liners, 2-80
 - HEP shell, 2-157
 - effect of nose, 2-157
 - theory of, 2-156
 - of kinetic energy shot, comparative, 2-145
 - liner, 2-36
 - factors affecting, 2-36
 - penetration, 2-70,137
 - shaped charge, 2-62
 - of wrapped case, 6-47
- Peripheral initiation, 2-62
- Peripheral jet engines, 2-82
- Permanent deformation, 4-178,185
- Permanent expansion, 4-118
- Permissible tolerance zone, 5-17
- Perpendicularity, 5-21
 - of surface, 5-15
 - symbol for, 5-14
- Persistent gas, 2-186
 - dispersion of, 2-185
- Personnel, defeat of, 2-3
- Personnel needed, inspection, 6-47
- Petal, discarding, 2-119
- Petal, retained, 2-119
- Petalling, 2-120
- Phenolic
 - asbestos-filled, 2-176
 - glass-filled, 2-175
 - type plastic, 2-175
- Phillips, 3-14
- Phosphate coating, 6-17,21
- Phosphate, zinc, 6-3
- Photoflash bombs, 2-178
- Photoflash composition, 2-187
- Phthalates, 4-6
- Picatinny Arsenal, 2-82,153,176, 4-16,137,182
- Picatinny test, 2-22
- Pickled, 6-21
- Pickled, shot-blasted, 6-3
- Pickling, 6-41
- Pidduck, 4-36
- Pierce-and-draw process of manufacturing steel shells, 6-2,5,7,8,29
- Piercing
 - die, 6-7
 - drawing after, 6-8
 - hydraulic, 6-7
 - inverted, 6-8
 - press, 6-7,8
 - primer hole, 6-43
 - process, one-shot, 6-7
 - progressive, 6-9
 - punch, 6-7
- Piezoelectric
 - gage, 2-10, 4-16
 - generator, 2-63
 - measurements, 4-94
- Pillaring of WP cloud, 2-181
- Pin(s)
 - circle diameter, 4-14
 - plate, 4-14
 - design of, 4-13
 - shear, 2-5,160,161,164,172,175,184
 - size, 4-13
 - twist, 2-161
- Pinching of explosive filler, 2-158
- Pipe, 6-13,17
- Pit
 - sand, 2-94
 - sawdust, 2-94
 - water, 2-94
- Plane detonation wave, 2-31
- Plane of yaw, 3-7
- Planform, hexagonal, 3-14
- Planimeter, four-wheeled, 3-85
- Plans sampling, continuous, 5-10
- Plastic
 - anisotropic, 4-189
 - canister, 2-183
 - projectile, 2-152
 - casings, 2-152
 - deformation, 4-133,178,186, 6-43
 - explosives, 2-156
 - extension, 4-118
 - flow, 2-120,123,143, 4-118
 - incipient, 4-186
 - phenolic-type, 2-175
 - plug, 4-122
 - rotating bands, 4-154
 - sabot, 2-119
 - shell, manufacture of high-explosive, 6-26
 - strain, 4-118
 - stress state, 4-188
- Plasticity theory, 4-150,187
- Plate
 - baffle, 2-175
 - base, 2-164
 - flat, 2-166
 - skirting, 2-129
 - pin, 4-14
 - vibrations, 2-123
- Plug(s), 2-124
 - base, 2-160,162,164,170
 - closing, 1-2,7
 - lifting, 1-4
 - plastic, 4-122
 - white metal, 4-122

- Plugging, 2-122
- Pockets, extractor, 4-119
- Pocket, primer, 6-43
- Point(ed)
 - detonating fuze, 1-5, 2-177
 - of maximum pressure, 4-47
 - noses, 2-124
 - ogive, 3-87
 - of optimum efficiency, 4-75
 - at which powder all burned, 4-45
 - stagnation, 2-31,33
 - triple, 2-9
 - V-0, 2-126
 - V-50, 2-126
 - V-100, 2-126
 - yield, 2-153, 4-118, 6-23
- Poison gases, 2-1
- Poisson distribution, 5-3
- Poisson's ratio, 4-155
- Polar moment of inertia, 3-81,89, 4-179
- Polygonal airfoil section, 3-14
- Poor velocity uniformity, 4-84
- Porosity, 2-196
 - basal, 6-13
- Position
 - of all burnt, 4-39
 - of band seat, 4-158
 - of burst, 3-39
 - of center of gravity, 3-81
 - of maximum pressure, 4-45
 - under head, 4-122
- Positive impulse, 2-7,9,10,11,13,14,19
- Potassium sulfate, 4-2
 - potential, ballistic, 4-2
- Powder(s)
 - all burned, point at which, 4-45
 - black, 2-168, 4-1
 - burned, fraction of, 4-47
 - ejection, 2-171
 - gas, kinetic energy of, 2-137
 - IMR, 2-168
 - iron, 4-161
 - metallurgy, 6-1
 - process, Ball, 4-7
 - smokeless, 4-1
- Power, penetrating, 2-78
- Practical drag coefficient, 3-38
- Precession, 3-3
 - amplitude of, 3-8
 - yaw, 3-6
- Precision, design for, 3-1
- Precup, 6-41
- Prediction of initial fragment velocity, 2-98
- Pre-engraved rotating band, 2-152, 6-27
- Pre-engraved shells, 3-10
- Preignition zone, 2-189
- Preformed fragments, 2-108
- Preformed missiles, 1-3, 2-1,150
- Preheading, 6-43
- Premature(s), 2-183
 - detonation, 4-178,180, 6-13
 - explosion, 6-17
 - functioning, 4-162,164
- Preparation
 - charge, 2-62
 - for cupping, 6-41
 - of shell for machining, 6-14
 - of slug, 6-21
- Presented area of fragment, measurement of, 2-100
- Press(ed), (ing)
 - cold, 6-36
 - compositions, burning of, 2-189
 - explosives, 2-95
 - fit, 2-180, 4-132
 - surface, 2-180
 - hot, 6-36
 - loaded, 2-156
 - one-shot, 6-7
 - piercing, 6-7,8
 - type crimping, 4-132
- Pressure, 4-47
 - acting on projectiles during firing (summary of), 4-181
 - allowable, 2-118, 4-137
 - base, 4-36
 - breech, 2-164, 4-36,37
 - center of, 2-172, 3-7,8,10,12
 - chamber, 2-129,163,172, 4-93,182
 - curve of black powder, loading density vs., 2-183
 - ejection, 2-163,169
 - engraving, 4-150
 - erratic, 4-11
 - force resulting from propellant gas, 4-179,181
 - function, 4-48
 - hydrostatic, 4-186
 - indentation, 4-152
 - limitations, 4-1,9,11
 - maximum, 4-16,19,20,26,39,40,48,94
 - allowable, 4-188
 - attainable, 4-33
 - propellant, 4-180,188
 - rated, 4-9,50
 - muzzle, 4-11
 - peak, 2-7,9,10,11,13,14,16,19, 4-1,20,38
 - propellant, 4-189
 - relative, 4-94
 - setback, 2-164
 - on shell wall resulting from rotation of filler, 4-180,181
 - space average, 4-36,76
 - stagnation, 2-34
- Prevailing shell steel specifications, 6-4
- Prime requirement, 5-15
- Primer(s), 1-1,7, 4-33
 - artillery, 4-84
 - conductive mixture, 1-7
 - design, standard, 4-84
 - electric, 1-7
 - explosive train, 1-6
 - flame action, 1-6
 - hole, 4-133, 6-43
 - piercing, 6-43
 - percussion, 1-7, 2-172
 - pocket, 6-43
 - stab action, 1-6
 - tube, 4-84
- Principle(s)
 - of HEP shell, 2-157
 - separating burst, 2-174
 - shearing stresses, 4-185
 - of similitude, 2-125
 - stresses of shell, 4-182,185

- Probability
 - of acceptance (P_a), 5-2
 - cumulative, 2-154
 - curve, 2-126,127
 - damage, 2-108,111
 - of immediate incapacitation, 2-102
 - of kill, first-round, 2-3,4
 - of perforating, 2-88
 - single-shot, 2-106,107
- Problem(s)
 - exterior ballistic, 3-38
 - sample, 3-73
 - of interior ballistics, basic, 4-33
 - of propellant ignition, 4-84
 - sample, 3-31
- Procedure(s)
 - design, 2-3
 - inspection, 6-40
 - test, 6-5
- Process
 - anneal, 6-41
 - Ball powder, 4-7
 - of manufacture, inspection in, 6-23
 - one-shot, 6-7
 - pierce-and-draw, 6-5,29
- Producing colored smoke, method of, 2-178
- Profile
 - check, 6-24
 - double wedge, 3-71
 - of finish-machined rotating bands, 4-154
 - of rifling, 4-155,169
 - single wedge, 3-71
- Progress in manufacturing techniques, 6-1
- Progressive, 4-9
 - burning, 4-24,25
 - piercing, 6-9
 - shapes, 4-23
 - stress, 4-163
 - cracks, 4-162
- Projectile, 1-1
 - antitank, 2-4,156
 - armor-piercing, 2-125,139
 - assembly of, 2-151
 - balloting of, 4-164
 - blunt-nosed, 2-154
 - boat-tail, 4-160
 - breakup, 2-129
 - calculations of geometric characteristics, 3-90
 - composite rigid, 2-117
 - deformation, 2-141
 - design, 2-2,128,129
 - intended for gun already made, 3-1
 - eccentricity of, 4-137
 - equation of motion, 4-34
 - fin-stabilized, 4-189
 - during firing, forces and pressures acting on (summary of), 4-181
 - flat-base, 4-160
 - free run, 4-164
 - friction, 4-33
 - geometric components of, 3-89
 - geometry, 3-69,81
 - hypervelocity, 2-123
 - HVAP, 4-153
 - HVAPDS, 2-138
 - HVAPDSFS, 2-128
 - kinetic energy, 4-9,33,35
 - mass of, 3-38
 - effective, 4-36
 - momentum of, 3-72
 - monobloc, 2-141
 - motion of, 4-33
 - beginning of, 4-34
 - oscillatory, 3-2
 - nondeformable, 2-137
 - nose radius of, 3-82
 - parameters, effect of varying, 2-137
 - performance of armor-piercing, 2-126
 - performance, effect of armor thickness on, 2-129
 - requirements for gun, 2-2
 - shattered, 2-123
 - skirted, 2-118, 4-124
 - solid geometry, 3-85
 - spin-stabilized, 3-64
 - squeeze-bore, 2-4
 - subcaliber, 1-3, 2-4,118,137
 - T33 (FAP), 2-138
 - T33 (FAPT), 2-138
 - tapered back, 4-189
 - torque (T) applied to, 4-179
 - total volume behind, 4-34
 - travel of, 4-44,47
 - tumbling of, 4-164
 - typical, 3-39
 - velocity of, 4-20,35,44
 - weight of, 4-50
 - weight distribution in, 4-189
 - yaw of inside gun, 4-149
- Propaganda, 2-160
 - disseminating shell, 2-5,160,161,183,185
 - filler design, 2-184
 - shell metal parts design, 2-184
 - leaflets, 2-184,185
- Propagate, 2-178
- Propagation
 - of blast, 2-10
 - detonation, 2-24
 - difficulties, 2-181
 - explosive wave, 2-7
 - vs. minimum column diameter, limits of, 2-182
- Propagatively, burn, 2-189
- Propellant(s), 1-6, 4-1
 - M1, 4-1
 - M2, 4-2
 - M15, 4-2
 - burning of, 4-16,33
 - calculation of thermodynamic properties, 4-87
 - gas volume (n), 4-87
 - heat of explosion (Q), 4-87
 - mean heat capacity, 4-88
 - relative energy, 4-88
 - characteristics, 4-93
 - charge, 2-138,150
 - composition, calculated density of, 4-89
 - cord, 4-24
 - double base, 1-6, 4-1,93
 - deterioration of, 4-93
 - energy of, 4-87
 - flashless, 1-6
 - force, 4-88
 - gases, energy of, 3-73
 - gases, leakage of, 2-180

- gases, momentum of, 3-72
- gas pressure, force resulting from, 4-179,181
- grain, 4-16,20,93
- granulation, 4-9,16
- ignition, problems of, 4-84
- increments, 2-172
- loading density of, 4-164
- manufacture of, 4-6
 - relative costs of, 4-7
- materials, criteria for selection of, 4-2
- nitrocellulose, 1-6
- nitroglycerine, 4-1,84
- nitroguanidine, 1-6, 4-93
- pressure, 4-189
 - maximum, 4-180
- released at muzzle, unburnt, 4-76
- residue, 4-1
- single base, 1-6, 4-1,93
- slow-burning, 2-175
- smokeless, 1-6
- strip, 4-24
- thermochemical, characteristics of, 4-89
- triple base, 1-6, 4-2
- Pyrotechnic
 - compositions, 2-191
 - characteristics of, 2-186
 - required, 2-187
 - chemistry of, 2-186
 - constituents of, 2-186
 - with explosives, comparison of properties, 2-188
 - factors affecting, 2-187
 - heat sensitivity of, 2-192
 - properties of typical, 2-187
 - radiation effectiveness of, 2-193
 - mixture, 2-192
 - reaction mechanism of, 2-192
 - parachute design, 2-193
 - solid-state chemistry of, 2-190
 - type ammunition, 1-3
- Propelling charge, 1-1,6, 4-9
- Proper degree of nitration, 4-6
- Properties
 - of aluminum and magnesium-aluminum fuels, 2-190
 - interior ballistic, 4-16
 - rheological, 4-189
 - of rotating band materials, 4-149,160
 - of sintered iron, 4-161
 - of typical pyrotechnic compositions, 2-187
- Proportional law of burning rate, 4-20
- Proposals made for overcoming deficiencies of conventional long artillery primers, 4-84
- Protective
 - atmosphere of hydrogen, 6-36
 - coatings, 4-134, 6-44
 - criterion, 2-128
 - film, 2-192
 - against moisture, 2-192
- Proving ground tests, 6-40
- Proximity fuze (VT), 1-4
- Pseudo-ratio of specific heats, γ , 4-47
- Psychological warfare, 2-183
- Psychological Warfare Service, 2-184
- Pugh, 2-32,34,81
- Pull, bullet, 4-129
- Pull-over gage, 4-163
- Punch(ing), 6-9
 - forming, 6-26
 - multiple, 6-49
 - piercing, 6-7
 - type of perforation, 2-129
- Purdue University, 4-161
- Pyramid rolls, 4-136
- Pyrocellulose, 4-2,6
- Pyroxylin (collodion), 4-2,6
- Qualitative description of shaped charge damage, 2-84
- Quality
 - assurance, 5-1
 - average outgoing (AOQ), 5-3
 - level acceptable, 5-8
 - level acceptance (AQL), 5-3
 - limit average outgoing (AOQL), 5-4
- Quantitative definition of compatibility, 2-24
- Quench, 6-43
- Quenching, 6-14
- Quickmatch, 2-172,183
- Quickness, relative, 4-9,16,18
- RDX, 2-13,14
- Radial
 - band pressure, 4-149,153
 - reduction of, 4-169
 - compressive force, 4-178
 - dimensioning, 5-20
 - dispersion, 2-150
 - stresses, 4-182
- Radiant energy, 2-187,189
- Radiation effectiveness of pyrotechnic compositions, 2-193
- Radiographs, flash, 2-69,73,93
- Radiographic jet studies, 2-68
- Radius
 - blending, 4-125
 - of gyration, 2-165, 4-153
 - of longitudinal curvature, 3-81
 - ogival, 2-139, 3-8,67
 - arc, 3-69,82
 - of spherical cap, 3-83
 - toleranced, 5-20
- Raisers, stress, 6-41,43
- Raketenpanzerbüchse, 2-83
- Ramming, eccentric, 4-178
- Randomness, of sampling, 5-2
- Range
 - critical, 6-27
 - steel, 6-1
 - dispersion, 2-107
 - finding horizontal, 3-73
 - firings, 3-65,68
 - maximum, 3-38,64,73
 - spark, 3-67,70
 - and time of flight, factors governing, 3-38
 - web, 4-9,11
- Ranking, damage test, 2-13
- Rarefaction wave, 2-7
- Rate(s)

- burning, 2-187,189,190,191, 4-1,9,22,33,36
 - equation for, 4-43
- decomposition, 4-2
- descent, 2-171
- detonation, 2-24
- reaction, 2-189,190,192
- penetration, 2-33
 - of yawing, 3-8,10
- Rated maximum pressure, 4-9,11
- Ratio
 - aspect, 3-71
 - of burster charge to smoke charge, 2-178
 - explosive, 2-178
 - interference, 4-152
 - of maximum pressures, 4-88
 - Poisson's, 4-155
 - of specific heats, 4-88
 - t/d, 2-122,125
- RD38 system, solution by, 4-33,36,48
 - sample solution by use of, 4-40
- React with explosive, 6-17
- Reactants, effect of specific surface of, 2-190
- Reaction
 - heat of, 2-189, 4-89
 - mechanism of pyrotechnic mixtures, 2-192
 - rate, 2-190,192
 - temperatures, 2-187
 - time to, 2-192
- Rearward extrusion, 6-8
- Recessed, 6-27
- Recoil
 - mechanism, 3-72
 - momentum, 3-72
 - system, 3-72
- Recoilless
 - ammunition, 2-153
 - gun shell, 6-4
 - rifles, 2-5,156
 - weapons, 2-157, 6-49
- Recommended interferences, 4-123
- Recovery
 - of case, 4-118
 - elastic, 4-118, 6-43
 - solvent, 4-7
- Recrystallization, 6-43
 - temperature, 6-41
- Rectangular
 - fin, 3-12,71
 - wing, 3-13,27,71
- Red shortness, 6-4
- Reduce
 - bore residue, 4-2
 - muzzle flash, 4-2
 - radial band pressure, 4-169
 - smoke, 4-2
 - velocity, 2-169, 4-48
 - viscosity, 4-6
- Reducing agents, 2-186
- Reducing-atmosphere furnace, 6-29
- Reefing, 2-196
- Reference dimension, 5-13
- Reflect(-ion)
 - blast, 2-9
 - shock, 2-31
 - wave, 2-8,9
 - strong shock (Mach Waves), 2-8
 - weak shock, 2-8
- Region I, 2-16
- Region II, 2-16
- Region III, 2-16
- Regression of surfaces, 4-35
- Regressive burning, 4-25
- Reinforcement, base, 4-137
- Relation
 - charge-pressure, 4-9
 - charge-velocity, 4-9
 - between mass and presented area of fragment, 2-99
- Relative
 - costs of propellant manufacture, 4-7
 - density, 2-198
 - energy, 4-88
 - calculated for propellant composition, 4-88
 - in gas, 4-87
 - calculated for organic chemical constituent, 4-88
 - force, 4-16,19
 - humidity, critical, 2-191
 - pressure, 4-94
 - quickness, 4-9,16,18
- Release wave, 2-45
- Releasing and discarding carrier, method of, 2-119
- Reliability of Mott equation, 2-95
- Relief, stress, 6-44
 - anneal, 6-23
- Remaining
 - velocity, 3-4
 - of fragments, 2-99
 - web, 4-23
- Removable base plate, 2-172
- Repose, yaw of, 3-2,4
- Representative shrinkage data, 4-14
- Reproducibility of results, 2-126
- Required characteristics of pyrotechnic compositions, 2-187
- Requirement(s)
 - booster, 2-10
 - for canister information, tactical, 2-154
 - colored marker shell, tactical, 2-176
 - for gun projectiles, 2-2
 - HEP fuzing, 2-157
 - implied, 5-15,22
 - for optimum ignition, 4-85
 - prime, 5-15
 - secondary, 5-15
 - WP shell, sealing, 2-186
- Residual velocity, 2-126
- Residue, bore, 4-3
- Residue propellant, 4-1
- Resistance
 - to atmospheric moisture, 2-190
 - gage, 2-10
 - impact, 6-4
 - to setback, 2-184
- Resonance, 3-29
 - of benzene nucleus, 4-90
 - between pitching period and rolling period (danger of), 3-29
- Results
 - comparison of, 4-82
 - reproducibility of, 2-126
 - zone of mixed, 2-125

- Retained-petal, 2-119
- Retardants, 2-186
- Retardation, 3-38
- Retention, band, 4-154
- Revolution
 - axis of, 3-84
 - solid of, 3-88
 - surface of, 3-69
- Reynolds number, 3-68
- Rheological properties, 4-189
- Ricochet, 2-124
- Riel, R. H., 2-128
- Rifle bullet impact sensitivity, 2-23
- Rifles, recoilless, 2-5,156
- Rifling
 - design, 4-169
 - diameter, 4-152
 - dimensioning of, 4-169
 - engraved, 4-153
 - erosion of, 4-162
 - grooves, 4-155
 - land, 4-155
 - origin of, 4-173
 - profile of, 4-155,169
 - standard forms, 4-169
 - twist of, 4-169,170,179,189
 - determination of, 4-173
 - typical values of, 4-172
 - uniform, 4-153
 - wear of, 4-149
 - worn, 4-162
- Right circular cylinders, 4-81
- Righting moment, 3-7,10,11
 - factor, 3-28,30
- Rigidity, modulus of, 4-186
- Ring
 - die(s), 6-7,8,9
 - gage, bourrelet, 6-24
 - grooved, 2-3,108
 - method of controlling fragmentation, 2-110
 - notched, 2-108
 - sabot, 2-119
 - shear, 2-175
 - split, 2-162
 - type experimental shell, 2-97
- Risks, sampling, 5-2
- Ritter's formula, 2-165
- Rockets, 3-10
- Rolled strip, 6-1
- Roller, flanging, 6-46
- Rollers, knurling, 6-16
- Rolling, 4-6
- Rolls
 - cross, 6-7
 - leaflet, 2-184
 - pyramid, 4-136
 - serrated, 6-6
- Root chord, 3-11
- Root thickness, 3-71
- Rostoker, 2-32
- Rotary trim, 6-42
- Rotating, 2-32
 - airfoil blades, 2-171
 - band, 1-3, 2-163, 4-33,153,179,189, 6-1,17,26
 - bearing stress of, 4-153
 - characteristics, 4-151
 - design of, 4-149,153,180
 - engraving of, 4-164
 - function of, 4-149
 - geometry, equivalent, 4-155
 - loose, 6-26
 - materials, properties of, 4-149,160
 - materials used for, 4-149
 - plastic, 4-154
 - pre-engraved, 2-152
 - profile of finish-machined, 4-154
 - shearing of, 4-153,172
 - tangential force on, 4-181
 - wear of, 4-150
 - welded overlay, 2-5
 - width of, 4-124
 - candle, burning time of, 2-162
 - shaped charges, 2-32,65
- Rotation
 - compensation, 2-35
 - effect of, 2-34
 - of filler, pressure on shell wall resulting from, 4-180,181
 - of filler, stress in base resulting from, 4-183
 - of filler, stress in shell wall resulting from, 4-183
 - of fillets, 3-81
 - methods of imparting, 2-119, 4-149
 - muzzle energy, 4-150
 - penetration, 2-66,68
 - of wall, stress resulting from, 4-182
 - tension in shell wall resulting from, 4-180,181
- Rough
 - machining outside of shell, 6-14
 - rolling and expanding wrapped cartridge case, 6-39
 - turning, 6-12
- Roughness, surface, 6-16
- Round(s)
 - base shell, 4-182
 - chemical energy, 2-88
 - fin-stabilized, 2-82,175
 - HVAPDS, 2-137
 - kinetic energy, 2-85
 - vs. square slugs, 6-8
- Rubber-die crimping, 4-132
- Rubber obturators, 2-152
- Rupture, circumferential, 6-42
- Sabot, 1-3, 2-4,138
 - all-plastic, 2-138
 - discarding, 2-118
 - exterior ballistics, 2-119
 - metal, 2-138
 - plastic, 2-119
 - ring, 2-119
- Sachs' theory, 2-9
- Safety, bore, 1-5
- Saltpeter anneals, 6-39
- Saltpeter, liquid, 6-37
- Salvage, 6-44
 - battle, 6-47
- Sample
 - problems, 3-31
 - of exterior ballistics, 3-73
 - by use of RD38 system, 4-40
 - randomness of, 5-2

- size to lot size, 5-6
- Sampling, 6-5
 - acceptance, 5-2
 - double, 5-5
 - inspection, standard tables, 6-44
 - multiple, 5-6
 - plan criteria, 5-2
 - risks, 5-2
 - single, 5-5
 - by variables, 5-12
- Sand
 - pit, 2-94
 - test for liquids, 2-23
 - test for solids, 2-23
- Sarmousakis, 2-93,94,95
- Satisfactory ignition, index of, 4-84
- Saturation, color, 2-177
- Sawdust pit, 2-94
- Sawing, 6-5
- Scale
 - control, 6-42
 - and descaling, billet, 6-6
 - effect, 2-125
- Scaling, 2-75
 - formula, Gurney-Sarmousakis, 2-95
 - formula, Mott, 2-95
 - laws, 2-9,16,65
- Schmidt, 3-9,10
- Schroedter, 3-13
- Scoop, 2-124
- Screen, colored smoke, 2-160
- Screen, velocity, 2-94
- Screening, 5-12
- Seal, labyrinth, 4-134
- Sealing of chemical (WP) shell, 2-180,186
- Sealing lip, short, 4-150
- Seam sealer, enamel, 2-151
- Season cracking, 6-40
- Seat, band, 4-155, 6-23
 - nonundercut, 4-154
 - undercut, 4-154
- Secant ogive, 3-64,65,81,87
- Second
 - ejection, 2-164,166
 - flash, 4-3
 - hit, 6-21
 - order effects, 4-33, 4-36
- Secondary
 - effect, 2-5,156
 - missile, 2-4
 - requirement, 5-15
- Section of shell, tangential force at given, 4-181
- Segment, ogive, 3-85
- Selection of
 - liner material, 2-50
 - propellant materials (criteria for), 4-2
 - weapon type and size, 2-47
- Selective absorption, 2-177
- Semi-annual, 6-37
- Semifixed ammunition, 4-117,160
- Sensitivity, 2-23
 - of burning-type smoke compositions, 2-183
 - friction, 2-23,187
 - heat, 2-187,192
 - pyrotechnic compositions, 2-192
 - to impact, 2-187
 - test, 2-22
 - rifle bullet, 2-23
 - measure of, 4-93
 - notch, 4-129,133, 6-43
 - to static, 2-187
- Separate loading ammunition, 4-117,160,178
- Separate loading gun, 4-117
- Separated ammunition, 4-117
- Separating
 - burst, 1-3
 - principle, 2-174
 - shell, 2-160
 - charge, 2-175
- Separation, billet, 6-5
- Sequence of operations in machining of shells, 6-14
- Serrated rolls, 6-6
- Service ammunition, 1-2
 - blank, 1-2
 - drill, 1-2
 - practice, 1-2
 - proof, 1-2
- Service velocity, 4-9,10
- Setback, 2-5,150,176, 4-189
 - elastic, 4-125
 - filler, 4-179,181,182,189
 - stress in base resulting from, 4-183
 - stress in shell wall resulting from, 4-183
 - forces, 2-108,109,162, 4-178,179
 - of metal parts, 4-181
 - stress in shell wall resulting from, 4-183
 - pressure, 2-164
 - resistance to, 2-184
 - of shell walls, 4-179,189
 - stresses, 2-119
 - weight, 2-164,175,185
- Setter, tire, 6-17
- Seven-perforated propellant grains, 4-26,36,48
 - burning of, 4-48
 - form functions for, 4-25,26
- Shape(s)
 - of chamber, 4-117,124
 - charge, 2-50
 - degressive, 4-23
 - and dimensions of shell forgings, 6-5
 - of explosive charge, effect of, 2-18
 - grain, 4-7
 - liner, 2-52
 - ogive, 2-58
 - parachutes, 2-195
 - progressive, 4-23
 - of shell, modifications of, 3-64
- Shaped charge(s), 2-85
 - ammunition, 2-1
 - damage, qualitative description of, 2-84
 - effect, 2-57,59
 - on explosive, 2-18
 - effectiveness, 2-48
 - criterion of, 2-82
 - against tanks, 2-82
 - explosives in, 2-59
 - jet, 2-38,85
 - effect of rotation upon, 2-63
 - linear-, 2-82
 - liners, 2-52
 - missile, design of, 2-47
 - missiles, fuzes for, 2-63

- performance, 2-62
- penetration of armor by, 2-1
- rotating, 2-32,65
- weapons, defeat of, 2-82
- Shaping, wave, 2-61
- Shapiro, 2-95
- Sharp apex cone, 2-55
- Sharp-nosed shot, 2-122
- Shatter, 2-123,126,144
 - gap, 2-4
- Shattered projectile, 2-123
- Shear
 - force, 2-162
 - joint, 2-160
 - pins, 2-5,160,161,164,172,175,184
 - rings, 2-175
 - stresses, 2-31, 4-181,183
 - allowable, 2-164
 - maximum, (Tresca's rule of flow), 4-185
 - rotating band, 4-153
 - on threads of base plug, 2-163
 - threads, 2-5,160,164,184
 - design of base plug, 2-163
- Shearing, 2-120, 6-5
 - base plug, 2-169,184
 - cracks, 6-5
 - of rotating band, 4-172
 - stresses, principal, 4-185
- Sheet, trapezoidal, 6-39
- Shelf life, effect of moisture on, 2-191
- Shell, 2-160, 3-1, 6-1,2
 - APC, 2-4, 4-178
 - banding of, 6-17
 - base-ejection, 2-160,161, 4-1
 - smoke, 2-176
 - body, 2-170
 - all-plastic, 2-175
 - breakup, 2-94,144
 - capped steel armor-piercing, 2-4, 4-178
 - casting high-explosive, 6-1
 - colored marker, 2-160,176,178,182
 - colored smoke, 2-160,182
 - crush-up, 2-157
 - deformation of, 4-178
 - development of, HEP, 6-26
 - design of colored marker, 2-179
 - design of illuminating, 2-162
 - design of liquid-filled burster, 2-186
 - design, WP, 2-180
 - during closing (manufacture) inspection of, 6-19
 - during firing, determination of the maximum forces acting on, 4-178
 - eccentric, 3-30
 - equations of motion of, 3-4
 - explosive-burst, 2-160
 - fin stabilized, 3-10,28,70
 - finishing of HEP, 6-27
 - forces acting on, 4-178,181
 - forging, 6-6
 - economics of, 6-12
 - inspection of, 6-13
 - after, inspection of, 6-13
 - methods, comparative study of, 6-13
 - mortar, 6-4
 - objectives in, 6-7
 - shapes and dimensions of, 6-5
 - forming, compromise method of, 6-25
 - high-explosive (HE), 1-2, 3-10, 4-153, 6-7,17
 - high-explosive antitank (HEAT), 1-2, 2-32,58,85, 3-70
 - high-explosive plastic (HEP), 1-3, 2-156,158
 - hardness of, 6-27
 - hospitalization of, 6-18
 - hyper-velocity, armor-piercing (HVAP), 2-117
 - incendiary, 2-1
 - illuminating, 2-160,161,164,182,185,187,195
 - internal contour of, 2-185
 - leaflet distributing, 2-1
 - lethality of hypothetical, 2-106
 - light-producing, 2-1
 - limit to length of, 3-1
 - length, estimation of drag effect of, 3-68
 - liquid-filled, 2-160,185
 - machining of HE, 6-14
 - manufacture, extrusion for, 6-2
 - manufacture of HEP, 6-26
 - manufacture, methods of weight control, 6-17
 - manufacture, pierce-and-draw process of, steel, 6-2
 - manufacturing plant, cost of, 6-24
 - marking of, 6-18
 - metal parts design, 2-162,177
 - moments of inertia, 3-4
 - motion of spinning, 3-2
 - multipurpose, 2-161
 - multiple-wall, 2-109
 - nosing of, 6-14
 - painting of, 6-19
 - performance, HEP, 2-157
 - poison gas, 2-1
 - pre-engraved, 3-10
 - propaganda disseminating, 2-5,160,161,183,185
 - filler design, 2-184
 - metal parts design, 2-184
 - ring-type (experimental), 2-97
 - rough machining outside of, 6-14
 - round base, 4-182
 - separate-loading, 4-178
 - separating burst, 2-160
 - shape modifications of, 3-64
 - smoke, 2-1,161
 - WP, 2-179
 - special purpose, 2-160
 - function of, 2-160
 - spin-stabilized, 2-35, 3-39
 - spinning, 3-4
 - square base, 3-64
 - squash-head, 2-157
 - steel, military specification for, 6-5
 - stress in, 2-153, 4-177,184,185
 - resulting from forces, 4-181
 - under stress, failure of, 4-178
 - thin-walled, 4-154, 6-26
 - unsatisfactory, 6-15
 - velocity relative to air velocity of, 3-10
 - volumic of thin ogive, 3-86
 - wall pressure on resulting from rotation of filler, 4-180,181
 - walls, setback of, 4-179
 - wall, stress in minimum, 4-158
 - wall stress in resulting from rotation of filler,

- Sodium orthosilicate wash, 6-21
- Sodium stearate soap lubricant, 6-3
- Soft
 - (Armco) iron, 4-149
 - caps, 2-144
 - porous liner, 2-109
- Solem, 2-95
- Solid
 - armor, 2-137
 - drawn metal case, 4-120
 - explosives, 2-63
 - geometry of projectiles, 3-85
 - of revolution, 3-88
 - component, 3-81
 - formulas for, 3-81
 - ogival, 3-87
 - volume of, 3-81
 - shot, 2-117
 - state chemistry of pyrotechnics, 2-190
- Solution
 - of ballistic equation, 4-36
 - after burnt, 4-39
 - for pressure-time trace (complete), 4-76
 - by RD38 system (Hirschfelder), 4-37,40,48
- Solvent recovery, 4-7
- Sources of terminal ballistic data, 2-83
- Space average pressure, 4-36,76
- Space, cartridge head, 4-122,123
- Spaced armor, 2-49,129,137
 - caps for defeat of, 2-144
 - on HEP shell, effect of, 2-157
- Spall(ing), 1-3, 2-120,121,156
 - of armor (HEP), 2-1
 - mechanism of, 2-157
- Span, 3-11,71
- Spark range, 3-67,70
- Spatial distribution, fragments, 2-101
- Special
 - design problems of mortar ammunition, 2-172
 - purpose shell, 2-154,160
 - function of, 2-160
 - treatment steel (STS), 2-120
- Specific
 - heat, 4-35
 - ratio of, 4-88
 - pseudo-ratio of, 4-47
 - limit energy, 2-124
 - surface, 2-190,192
 - reactants, effect of, 2-190
 - equation for, 2-190
 - volume, 4-37
- Specifications, 4-137
 - for cartridge cases, trend in, 4-129
 - specifications for shell steel, 6-4,5,29
- Spheroidized, 6-41
- Spin, 3-8, 4-149,173
 - axial, 3-29
 - compensation, 2-35,36,37,71,73,75,78
 - by fluted liners (mechanism of), 2-72
 - other than fluted liners, 2-81
 - lawnmowers, 2-81
 - shear-formed liners, 2-81
 - spiral staircases, 2-81
 - danger of too much (Magnus Moment), 3-29
 - decelerating moment, 3-8
 - coefficient, 3-10
 - damping factor, 3-6
 - degradation, eliminating, 2-81
 - flat, 3-30
 - stabilization, 3-1
 - stabilized shell, 2-35, 3-39,64
 - mortar, 2-173
 - vs. flight time, 3-10
 - vs. optimum penetration, 2-4
- Spinning shell, 3-4
 - with a top, comparison of, 3-2
- Spiral flutings, 2-36
- Spiral wrapping, 4-135, 6-1
- Splintering, after, 4-76
- Splintering, before, 4-76
- Splinters, unburned, 4-25
- Spit-back (flash-back)
 - fuze, 2-63
 - tube, 2-37,54
 - effect of, 2-46
- Split
 - rings, 2-162
 - sleeves, 2-164,166,171,175,185
 - aluminum, 2-162
 - design, 2-164
 - steel tubes, 2-5
- Sponginess, 6-17
- Sporadic high pressures, 4-84
- Spotting charge, 1-2, 2-187
- Spray, side, 2-106
- Sprays on hot forgings, effect of water, 6-12
- Spreiter, 3-13
- Square
 - base shell, 3-64
 - maximum, 6-8
 - slugs, round vs, 6-8
- Squash charge, 2-157
- Squash-head shell, 2-157
- Squeeze-bore projectile, 2-4
- Squeeze, end, 6-6
- Squeezing, 6-1
- Squidding, 2-195
- Stab-action primer, 1-6
- Stability, 1-8, 2-157,191, 4-2,189
 - of asymmetrical projectiles, 3-29
 - condition, statement of, 3-4
 - factor, 3-2,5,6,8
 - functions of, 3-31
 - in flight, 4-170, 6-35
 - measure of, 4-93
 - of pyrotechnic compositions (factors which affect), 2-187
 - static, 3-10
 - vs. standoff, 2-4
 - of symmetrical shell, 3-11
- Stabilization, 4-6
 - methods of, 3-1,2
 - drag, 2-4,5
 - fin, 3-1
 - spin, 3-1
- Stabilizing materials, 4-1,2
- Stages in opening of parachute, 2-196
- Stagnation point, 2-31,33
- Stagnation pressure, 2-34
- Staircase method, Bruceton, 2-23
- Stamping of cartridge case, head machining and, 6-39
- Standard

- atmosphere, 2-198, 3-4
- boosters, 2-177
- calibration chart, 4-40
- deviation, 2-127, 3-8,10, 5-12
- flat parachute, 2-195
- primers design, 4-84
- propellants, compositions of, 4-2
- rifling forms, 4-169
- sampling inspection tables, 6-44
- Standoff, 2-33,34,35,36,38,40,41,49,66,82
 - optimum, 2-38,49
 - on penetration under rotation, effect of, 2-68
 - stability vs., 2-4
 - time of flight vs., 2-4
- Stanford Research Institute, 2-158
- Star shell, Navy, 2-173
- Start of forward slope, 4-137
- Start of motion, 4-43
- State
 - of deformation, elastic, 4-178
 - equation of, 2-30, 4-33,34,42,43,88
 - of stress, elastic, 4-187
- Statement of stability condition, 3-4
- Static
 - charge, 4-1,3
 - sensitivity to, 2-187
 - stability, 3-10
 - lift of fins to ensure, 3-11
 - tests, 2-16
 - compression, 2-165
 - yield stress, 4-185
- Statistical method, analysis by, 2-126
- Status of HEP shell development and theory, 2-158
- Status of wound ballistics, 2-102
- Steady-state suspension, 2-195
- Steel
 - adapter, 2-180
 - austenitic, 6-1
 - balls, 2-150
 - cartridge cases, 4-133, 6-1,41,44
 - base rupture of, 4-133
 - trapezoidal-wrapped, 4-135
 - cold-worked, 6-2,43
 - cones, 2-41
 - critical range of, 6-1
 - liners, 2-32,61
 - high sulfur content, 6-2
 - objections to, 6-4
 - shells, casting vs. forging of, 6-1
 - special treatment (STS), 2-120
 - specifications, shell, 6-4,29
 - to-steel, comparison of aluminum to steel closure vs., 2-181
- Stellite, 6-27
- Stem, Mach, 2-9
- Stepped flange, 4-123
- Sterne's criterion, 2-102
- Sticks, igniter, 4-84
- Stiff extraction, 4-119
- Stochastic methods, 2-107
- Stock, hot-forged, 6-2
- Stop, case, 4-121
- Storage, 1-8
 - must not decompose in, 4-2
- Strain(s)
 - energy, 2-182
- hardening, 6-21
 - plastic, 4-118
 - stretcher, 6-44
- Strand burner, 4-16
- Strength
 - of candle case, 2-176
 - column, 2-185
 - ultimate, 6-41
 - yield, 4-134,149, 6-2,41
- Stress(es), 2-153
 - algebraic sign of, 4-181
 - bending, 2-124
 - in base resulting from rotation of filler, 4-183
 - in base resulting from setback of filler, 4-183
 - compressive, 4-181
 - failure of shell under, 4-178
 - formulas, deriving shell, 4-178
 - formulas, summary of, 4-184
 - hoop, 4-179
 - limits, gun, 4-1
 - longitudinal, 4-182,189
 - normal, 4-181
 - principal, 4-182,185
 - progressive, 4-162,163
 - radial, 4-182
 - raisers, 6-41,43
 - relief, 6-44
 - anneal, 4-135, 6-23,40
 - low-temperature, 6-43
 - taper, 6-43
 - setback, 2-119
 - shear, 2-31, 4-181,183
 - maximum, 4-185
 - in shell (analysis of), 2-153, 4-177,178,179,188,189
 - principle, 4-181,185
 - resulting from rotation, 4-182
 - summary of, 4-184
 - wall resulting from rotation of filler, 4-183
 - wall resulting from setback of filler, 4-183
 - wall resulting from setback of metal parts, 4-183
 - sidewall, 2-153
 - strain curves, 4-118, 6-2
 - state, elastic, 4-188
 - state, plastic, 4-188
 - tangential, 4-182
 - tensile, 4-181
 - ultimate, 2-178
 - yield, 2-178, 4-119
- Stretcher strains, 6-44
- Striking velocity, 2-126,128,137
- Strip propellant, 4-24
 - equations for, 4-27
- Strip, rolled, 6-1
- Stripping case from punch, 4-124
- Structural damage (100A), 2-15
- Structure, martensite, 2-143
- Structure, pearlitic, 2-143
- Studies, aircraft vulnerability, 2-111
- Subcaliber projectile, 1-3, 2-4,118,128,137,165
 - factors limiting penetration of, 2-137
 - subcaliber steel shot, comparative effectiveness of full-caliber vs., 2-138
- Sublot, acceptability of each, 6-44
- Subsonic velocities, finned projectiles at, 3-12
- Successive draws, 6-1

- Sufficient residual penetration, 2-85
- Summary,
 - of causes of case failure, 4-120
 - of equations, interior ballistics, 4-39,46
 - summary of stresses acting on projectile during firing, 4-181
 - of stress in shell, 4-184
 - of tabulated values, 4-87
- Superquick fuze, 1-4
- Supersonic speeds, thin fins at, 3-12
- Supersonic speeds, three-dimensional fins at, 3-12
- Supersonic velocity, 3-9
- Supplementary charges, 2-177
- Surface
 - burning, 4-6
 - charges vs. internal charges, 2-14
 - datum, 5-14
 - decarburization, 6-33
 - defects, 6-41
 - finish, 6-27
 - grain, 4-6
 - perpendicularity of, 5-15
 - press-fit, 2-180
 - regression of, 4-35
 - of revolution, 3-69
 - roughness, 6-16
 - shock, 2-30
 - specific, 2-190,192
 - equation for, 2-190
- Surrender leaflets, 2-183
- Surveillance, long-term, 2-175
- Surveillance test (65° C), 4-93
- Suspension
 - cable, 2-175
 - steady-state, 2-195
 - system, 2-170
 - parachute, 2-196
- Sweepback angle, 3-11,14
- Sweepforward angle, 3-11,14
- Swell diameter, 3-69,81,84,87,88
 - length of, 3-85
- Sweptback fins, 3-13
- Swivel, 2-164,166
 - attachment, 2-173
- Symbol
 - concentricity, 5-13,14
 - datum surface, 5-13
 - dependent locational, 5-15
 - independent, 5-15
 - locational tolerance, 5-13
 - for parallelism, 5-14
 - for perpendicularity, 5-14
- Symmetrical double wedge, 3-71
- Symmetrical shell, stability of, 3-11
- Symmetry, 5-14
- System
 - double-ejection, 2-171
 - free-flight, 2-195
 - of interior ballistics, 4-33
 - Le Duc, 4-80
 - RD38 (Hirschfelder), 4-20,33,36
 - recoil, 3-72
 - single-ejection, 2-171
 - suspension, 2-170
 - two-shock, 2-9
- T33 projectile (FAP), 2-138
- T33 projectile (FAPT), 2-138
- T34/85 Russian tank (vulnerable areas), 2-89
- T/D ratio, 2-122,125
- TNT, 2-13
- Tables
 - ballistic, 3-39
 - for calculation of maximum pressure, 4-47
 - for calculation of muzzle velocity, 4-47
 - firing, 2-177
 - Harvard, 3-85,87,88,89
 - standard sampling inspection, 6-44
- Tabulated values, summation of, 4-87
- Tack-welded, 6-46
- Tactical
 - requirement for canister information, 2-154
 - requirements, colored marker shell, 2-176
 - requirements, WP smoke shell, 2-180
 - use, signal smokes, 2-182
- Tail
 - boat, 3-64,67,68, 6-21
 - cone, 2-172,175
 - fin assembly, 2-172
- Talini test (110° C), 4-94
- Tangent
 - ogive, 3-65,81,87,88
 - lines connecting two arcs (slope of), 3-83
- Tangential
 - (inertia) forces, 4-178,179
 - at given section of shell, 4-181
 - on rotating band, 4-181
 - stresses, 4-182
- Tank
 - damage assessment, 2-129
 - defeat of, 2-129
 - guns, 4-50
- Taper(s)
 - chamber, 4-134
 - datum method of dimensioning, 5-24
 - diametral, 3-83
 - draw, 4-135
 - main body, 4-121
 - stress relief, 6-43
- Tapered
 - adapter, 2-118
 - back projectiles, 4-189
 - bore gun, 2-4,118
 - cylinder, 6-46
 - die, 6-8
 - walls, effect on penetration of, 2-43
- Tapering, 4-124, 6-43
 - of cartridge case, 6-37,43
- Tapping, nose, 6-16
- Target(s)
 - characteristics, 2-85
 - defeat of, 2-93
 - heavy armor, 2-145
 - obscuration, 4-3
- Taschengurts, 2-196
- Tear drops, 6-13
- Temperature
 - absolute, 4-35
 - critical, 6-12,14
 - flame, 4-35
 - ignition, 2-187,189
 - recrystallization, 6-41

- reaction, 2-187
- tempering, 6-14
- Tempering temperatures, 6-14
- Tensile
 - strength brass, 4-135
 - strength of fabric, 2-198
 - strength of shroud line, 2-198
 - stress, 4-181
 - longitudinal, 4-179
- Tension
 - in shell wall resulting from rotation, 4-180,181
 - test, 4-185
 - hoop stress, 2-163
- Terminal
 - ballistic data, sources of, 2-83
 - ballistic firings, 2-83
 - effects' limitations of signal smokes, 2-182
 - velocity, 2-195
- Test(s)
 - acceptance, 4-93
 - ballistic mortar, 2-23
 - Bergmann-Junk, 4-93
 - booster sensitivity, 2-23
 - box, 2-84
 - Bureau of Mines, 2-22
 - calorimetric, 4-89
 - chi-square, 2-95
 - closed bomb, 4-16
 - closed-pit, 2-94
 - of cold-extruded shell, 6-23
 - compression, 4-93
 - explosion temperature, 2-23
 - fragmentation, 2-23,94,106
 - functional, 4-129,137
 - hardness, 6-15
 - heat (75° C International), 2-22
 - heat (100° C), 2-22
 - heat (115° C), 4-93
 - hygroscopicity, 4-94
 - impact sensitivity, 2-22
 - initiator, 2-23
 - Jominy, 6-29
 - KI-starch, 4-93
 - litmus-paper, 6-40
 - magnaflux, 6-33
 - magnetic hardness, 6-43
 - methods, 2-22, 4-93
 - methyl violet, 4-93
 - sand for liquids, 2-23
 - sand for solids, 2-23
 - static, 2-16
 - compression, 2-165
 - surveillance (65° C), 4-93
 - Taliani (110° C), 4-94
 - tension, 4-185
 - Trauzl, 2-24
 - total volatiles, 4-94
 - panel, 2-94
 - Picatinny, 2-22
 - test procedures, 6-5
 - proving ground, 6-40
 - up-and-down, 2-126
 - vacuum stability, 2-22, 4-94
 - velocity measurement, 2-94
- Tetryl, 1-5, 2-178,181
 - burster, 2-178
 - required, determining weight of, 2-178
 - charge, 2-182
- Tetrytol, 2-181
- Theory
 - Bernoulli's, 2-33,34
 - of cartridge case functioning, 4-118
 - constant distortion, of Hencky-Von Mises, 4-186
 - first-order, 2-34
 - of HEP shell performance, 2-156
 - status of HEP shell development and, 2-158
 - interacting wave front, 2-157
 - Kirkwood-Brinkley's, 2-9
 - maximum energy, 4-186
 - maximum shear, 4-185,187
 - mechanism of cap action, 2-141
 - parallel axis (or plane), 3-89
 - plasticity, 4-150,187
 - Sachs', 2-9
 - thin-walled shell, 4-156
 - yield criteria, 4-185
 - zero-order, 2-31
- Theoretical prediction of radial band pressure, 4-151
- Theoretical values, Munk's, 3-9
- Thermal conductivity, 2-189
- Thermochemical characteristics of propellants, 4-89
- Thermodynamic properties of propellants, calculation of, 4-87
- Thick and thin, 6-37
- Thick(ness)
 - of case mouth, 4-124,133
 - cone wall, 2-53
 - cylinder formula, 4-180
 - flange, 4-123
 - of plate penetrated, 2-137
 - root, 3-71
 - thin effect, 2-72
 - and-thin forgings, 6-7
 - web, 4-11,21,24
- Thin
 - fins at supersonic speeds, 3-12
 - pointed, short fins, 3-13
 - thick and, 6-37
 - walled case, 6-1
 - wall shell, 4-154, 6-26
 - walled theory, 4-156
- Thompson, 2-125
- Thread(s)
 - gage, 6-24
 - shear, 2-5,160,164,184
- Three-dimensional breakup of shell, 2-94
- Three-dimensional fins at supersonic speeds, 3-12
- Threshold, damage, 2-16
- Thresholds, visibility, 2-193
- Throner, 2-37
- Time
 - since beginning of motion, 4-47
 - burning, 2-167
 - derivative, 3-6
 - of flight, 3-4
 - factors governing, 3-38
 - minimum, 3-38,64
 - vs. standoff, 2-4
 - fuzes, 1-4, 4-1
 - functioning, 2-49,157
 - to-ignition, 2-192
 - of maximum pressure, 4-45,48

- to-reaction, 2-192
- Tin, 4-3
- Tip chord, 3-11
- Tire-setter, 4-154, 6-17
- Toggle joint press, 6-17
- Tolerance(s), 2-39
 - acceptance gage, 5-24
 - of bourrelet, 6-17
 - circle, 5-18,23
 - component, 5-24
 - dependent locational, 5-13,17,19
 - diametral, 5-13,19,20
 - gage, 5-24
 - effect of on component, 5-24
 - of fluted liners, 2-80
 - independent locational, 5-13,21
 - of length of case, 4-121
 - limits, 5-11,18
 - percent defective lot (LTPD), 5-3
 - weight, 2-152
 - work gage, 5-24
 - zone, 5-24,25
- Toleranced
 - angle, 5-20
 - coordinates, 5-17
 - radius, 5-20
- Tolerancing, 5-13
- Tool
 - forming, 6-16
 - loading, 6-41
 - waving, 6-16
- Torn cavities, 6-13
- Torpex, 2-13
- Torque (T) applied to projectile, 4-179
- Total
 - radial stress, 4-182
 - volatiles test, 4-94
 - volume behind projectile, 4-34
- Toughness, low notch, 6-4
- Tracer(s), 1-4, 2-187
 - compositions, 2-192
- Trailing edge, 3-11,13,14
- Train, explosive, 2-177
- Trajectory, curvature of, 3-11
- Transparent interpolator, 4-17
- Transport effect, 2-72
- Transverse
 - moment, 3-89, 4-178
 - of inertia, 3-2,10,28,81,90
 - wave, 2-123
 - weakness, 6-4
- Trapezoidal sheet, 6-39
- Trapezoidal-wrapped cases, 4-135, 6-47
- Trauzl test, 2-24
- Travel function, 4-48
- Travel of projectile, 4-44,47
- Treatment, heat, 6-3,4,14,33,43
 - improper, 2-123
- Trcsca's rule of flow (maximum shear), 4-185
- Triacetin, 4-2
- Trim, rotary, 6-42
- Trimming, 6-42
- Triple base propellant, 1-6, 4-2
- Triple point, 2-9
- Tritonal, 2-13
- Trumpet-shaped liners, 2-69
- Truncated
 - conical nose, 2-139
 - nosed shot, 2-117
 - ogival nose, 2-124
- Tube, 4-23
 - blast, 2-11
 - flash, 2-183
 - metal burster, 2-160
 - primer, 4-84
 - spit-back, 2-37,54
 - effect of, 2-46
 - split steel, 2-5
- Tuck, 2-64
- Tumbling (velocity retardation), 2-166
- Tumbling of projectile, 4-164
- Tungsten carbide, 2-117,137
 - compacting and sintering of, 6-36
 - core, 2-123,128, 6-35
 - effect of armor-piercing caps on, 2-142
 - effect of nose geometry of, 2-139
 - manufacture of, 6-36
 - dies, 6-37
- Turning, band, 6-17
- Turning, rough, 6-12
- Twist, 2-173
 - gain, 4-170
 - increasing, 4-172
 - pin, 2-161
 - rifling, 4-169,170,179,189
 - uniform, 4-170
 - zero, 4-172
- Twisting of shroud lines, malfunctioning caused by, 2-166
- Two
 - dimensional breakup of shell, 2-94
 - dimensional fragment breakup, 2-106
 - dimensional formula, 3-12
 - shock system, 2-9
- Type(s)
 - of armor plate failure, 2-120
 - of damage assessment, 2-111
 - of flanges, 4-122
 - of flutes, 2-76
 - of incapacitation, 2-102
 - A, 2-102
 - B, 2-102
 - K, 2-102
 - of parachutes, 2-195
 - of perforation, punching, 2-129
 - of projectiles, 1-2
- Typical
 - calculations for cartridge case, 4-126
 - smoke compositions, 2-179
 - projectiles, 3-39
 - of rifling twist, 4-172
- Ultimate strength, 6-41
- Ultimate stress, 2-178
- Unburnt propellant released at muzzle, 4-76
- Unburned splinters, 4-25
- Uncannelured band, 4-153
- Undercut scat, 4-154
- Under head position, 4-122,125
- Uniform

- ballistic characteristics, 2-151, 4-1,20
- initial (shot start) pressure, 4-149
- twist rifling, 4-153,170
- U. S. Naval Ordnance Laboratory, 2-95
- U. S. Navy "Class A" armor, 2-120
- U. S. standard sieve, 2-190
- Unoxidized carbon, 4-87,89
- Unrotated charges, 2-32
- Unsatisfactory shells, 6-15
- Unyawed symmetrical wings, 3-14
- Up-and-down method, 2-127
- Up-and-down testing, 2-126
- Upsetter forging, 6-7,9
- Use of Harvard tables, 3-86
- Use of matrix, 2-150
- Utilization of yield criteria, 4-178

- V-0 point, 2-126
- V-50 point, 2-126
- V-100 point, 2-126
- Vacuum stability test, 2-22, 4-94
- Value, color, 2-187
- Values, brisance, 2-187
- Van der Walls equation, 4-35
- Variables, sampling by, 5-12
- Variation, case-to-case, 4-126
- Variation in drag, 3-67
- Varnish cans, 2-11
- Vector yaw, 3-2
- Velocity, 3-8, 4-47
 - angular, 3-28
 - critical, 2-126
 - opening, 2-196
 - drop, 3-5,28,30
 - drop and jump of finned projectiles (asymmetry effects of on), 3-30
 - effect of, 2-123
 - ejection, 2-163,164
 - function, 4-48
 - fragment, 2-93,99,111
 - high detonation, 2-157
 - of impact, 2-5,93
 - initial, 3-38
 - jet, 2-63
 - limit, 2-125
 - maximum, 4-9,50
 - permissible, 4-156
 - measurement test, 2-94
 - method, shock, 2-11
 - muzzle, 2-118,129,153, 3-39,72, 4-26,40,48,129, 137,173,189
 - maximum, 2-128
 - consistent, 2-152
 - nutational angular, 3-29
 - particle, 2-7,30
 - projectile, 4-20,35,44
 - reduction, 2-169, 4-48
 - remaining, 3-4
 - residual, 2-126
 - retardation (tumbling), 2-166
 - screen, 2-94
 - service, 4-9,10
 - of shell relative to air, 3-10
 - shock-wave, 2-11
 - striking, 2-126,128
 - supersonic, 3-9
 - terminal, 2-195
 - uniformity (poor), 4-84
- Vent holes, 4-84
- Vibrations, plate, 2-123
- Virial equation, 4-34
- Viscosity reduction, 4-6
- Visibility
 - design for, 2-193
 - optimum, 2-177
 - thresholds, 2-193
- Visual inspection, 6-20,24
- Volume
 - cartridge case, 4-1,137
 - chamber, 2-128, 4-33
 - of complete ogive, 3-86
 - designed for, 4-117
 - gas, 4-87
 - of frustums, 4-126
 - of ogival zone, 3-86
 - of partial fillet, 3-85
 - solid of revolution, 3-81
 - specific, 4-37
 - of thin ogive shell, 3-86
- Von Mises yield condition, mathematical statement of, 4-186,187
- VT fuze, 2-177,184
- Vulnerability, 2-14,88,110
 - aircraft, 2-111
 - to external blast, 2-16
 - area, 2-101
 - method, 2-88
 - computation of, 2-91
 - diagrams, 2-141
 - fuel tank, 2-112

- Wadding
 - cardboard, 2-151
 - distance, 1-7
 - felt, 2-172
- Walls, 3-12
 - setback of, 4-189
 - multiple, 2-108
- Warfare, psychological, 2-183
- Warhead size, optimum, 2-14
- Warning leaflets, 2-183
- Wash, 6-6
 - acid, 6-17
 - alkaline, 6-17
 - gas, 4-120
 - sodium orthosilicate, 6-21
- Washing and degreasing, 6-17
- Water
 - displacement, 2-180
 - jets, 6-6
 - pit, 2-94
 - proofing agents, 2-186
- Watertown Arsenal, 2-139,142,152, 4-150,151
- Wave(s), 2-30
 - blast, 2-19
 - bridge, 2-19
 - compression, 2-123
 - detonation, 2-30,81,182

- plane, 2-31
- drag, 3-70
 - estimation of, 3-70
 - coefficient, 3-70
 - estimating, 3-76
- elastic stress, 2-157
- front theory, interacting, 2-157
- incident, 2-8,9
- Mach, 2-9,19
- propagation, explosive, 2-7
- rarefaction, 2-7
- reflected, 2-8,9
 - of strong shock (Mach Waves), 2-8
 - of weak shock, 2-8
- release, 2-45
- shaping, 2-61,70
- shock, 2-7,14,19,72,93,156,157,177
 - effect of, 2-9
- transverse, 2-123
- Wavelength attenuation, 2-193
- Waving tool, 6-16
- Weakness, transverse, 6-4
- Weapon(s)
 - antipersonnel fragmentation, 2-103,106
 - BAT, 2-81
 - effectiveness, 2-106
 - recoilless, 2-157, 6-49
 - system analysis, 2-107
 - type and size, selection of, 2-47
- Wear
 - allowance, 5-24
 - factor, British, 4-150
 - of lands, 4-164
 - of rifling, 4-149
 - of rotating band, 4-150
- Web, 4-7,9,20,24,36,43
 - average, 4-21
 - calculations, 4-9,14
 - charge curve, 4-10
 - dimensions, control of, 4-13
 - dimensions, design of, 4-9
 - to gun, fitting, 4-9
 - limits, 4-11
 - optimum, 4-10,11
 - range, 4-9,11
 - determination of, 4-10
 - remaining, 4-23
 - size, 4-22
 - establishing, 4-13
 - thickness, 4-11,21,24
 - velocity curve, 4-10
- Wedge, symmetrical double, 3-71
- Wedge-type fins, 3-71
- Weight
 - of burster charge, determination of, 2-178,182
 - of tetryl burster required, determining, 2-178
 - charge, 2-138, 4-20
 - weight control, methods of (shell manufacture), 6-17
 - distribution in projectile, 4-189
 - of gun and mount, 3-72
 - matching, 2-180
 - of projectile, 4-50
 - setback, 2-164,175,185
 - of shell, 3-64
 - tolerances, 2-152
- Weiss, 2-93
- Welded overlay rotating bands, 2-5, 4-149,154, 6-17, 26
- Welded, tack, 6-46
- Whipping of casing in flight, 2-185
- White metal plug, 4-122
- WP shell (white phosphorous), 2-160,161,179,186
 - cloud, pillaring of, 2-181
 - shell design, 2-180
 - accessory parts design, 2-180
 - sealing requirements, 2-186
 - tactical requirements, 2-180
 - filler loading, 2-180
- Width of rotating band, 4-124,155
- Windshield, 2-117, 3-86, 4-178
 - aluminum, 6-35
 - of HVAP shot, 6-35
- Wind tunnel measurements, 3-9,71
- Wing(s), 3-13
 - chord, 3-11
 - clipped-delta, 3-27
 - delta, 3-27
 - rectangular, 3-13,27,71
 - unyawed symmetrical, 3-14
- Wiping off of band lands, 4-164
- Wire, notched, 2-3,108
- Withdrawal easy, 6-1
- Wood, 3-9
- Work
 - cold, 6-3
 - gage tolerances, 5-24
 - hardening, 4-119, 6-24
- Worn rifling, 4-162
- Wound ballistics, 2-3,93,154
 - status of, 2-102
- Wounding effectiveness, 2-98
- Wrapped cartridge case(s), 4-135, 6-47
 - body of, 6-46
 - design, 4-135
 - rough rolling and expanding, 6-39
 - inspection of, 6-48
 - performance of, 6-47
 - spiral, 4-135, 6-1
 - trapezoidal, 4-135, 6-47
 - steel, manufacture of, 6-46
- Wrinkles, 6-43
- Yaw, 3-7,8,12,69
 - angle of, 3-2
 - in bore, 3-28, 4-149
 - complex, 3-3
 - determining effect of, 3-75
 - diverging, 3-4
 - drag coefficient, 3-5,28,69
 - initial, 3-5,28, 4-164,178
 - nutational, 3-6
 - plane of, 3-7
 - precessional, 3-6
 - of repose, 3-2,4
 - vector, 3-2
- Yawing
 - moment, 3-3,8,10
 - coefficient, 3-10
 - damping factor, 3-6

rate of, 3-8,10

Yield

- condition, mathematical statement of Von Mises, 4-187
- criteria, 4-181,185
- theories, 4-185
- utilization of, 4-178
- function, Von Mises, 4-186
- high, 6-44
- point, 2-153, 4-118, 6-23
- strength, 4-134,149, 6-2,41
- stress, 2-178, 4-119
 - of band material, 4-157
 - compressive, 2-165
 - minimum permissible, 4-156
 - static, 4-185

Young's modulus, 4-118

Zamac 5 (zinc alloy), 2-37

Zero

- interference, 4-169
- order, 2-32
- theory, 2-31
- twist, 4-172

Zinc

- alloy, Zamac 5, 2-37
- cones, 2-41
- phosphate, 6-3

Zobel, 3-10

Zone

- A (burning), 2-189
- B (burning), 2-189
- C (burning), 2-189
- charges, 4-134
- firing, 1-2,7
- mized, 2-127
- of mixed results, 2-125
- pre-ignition, 2-189
- tolerance, 5-24,25
- permissible, 5-17

ARTILLERY AMMUNITION — GENERAL

TYPES AND CLASSIFICATION OF COMPLETE ROUNDS

1-1. Complete Rounds. The term "artillery ammunition" refers to ammunition, excepting rockets and shotgun shells, used in weapons having a bore diameter of more than 0.60 inch. A complete round of artillery ammunition comprises all of the components necessary to fire a weapon once and to cause the projectile to function at the desired time and place. These components are, in general, the projectile, the fuze, the propelling charge, and the primer. Dependent upon both the type of propelling charge and the method of loading into the weapon, complete rounds of artillery ammunition are known as fixed, semifixed, separate loading, or separated. Figure 1-1 illustrates these types of ammunition and their component parts.

1-2. Components of a Complete Round.

Projectile. The projectile is the effect-producing assembly which is ejected from the weapon by the gas pressure developed by the burning propelling charge. Other terms used in specific nomenclature of certain items, in place of "projectile," are "shell" and "shot."

Fuze. A fuze is a mechanical or electrical device assembled to a projectile to cause it to function at the time and under the circumstances desired.

Propelling Charge. The propelling charge consists of a quantity of propellant in a cartridge case, cloth bag, or both.

Primer. A primer is used to initiate the burning of a propelling charge. It consists essentially of a small quantity of sensitive explosive and a charge of black powder.

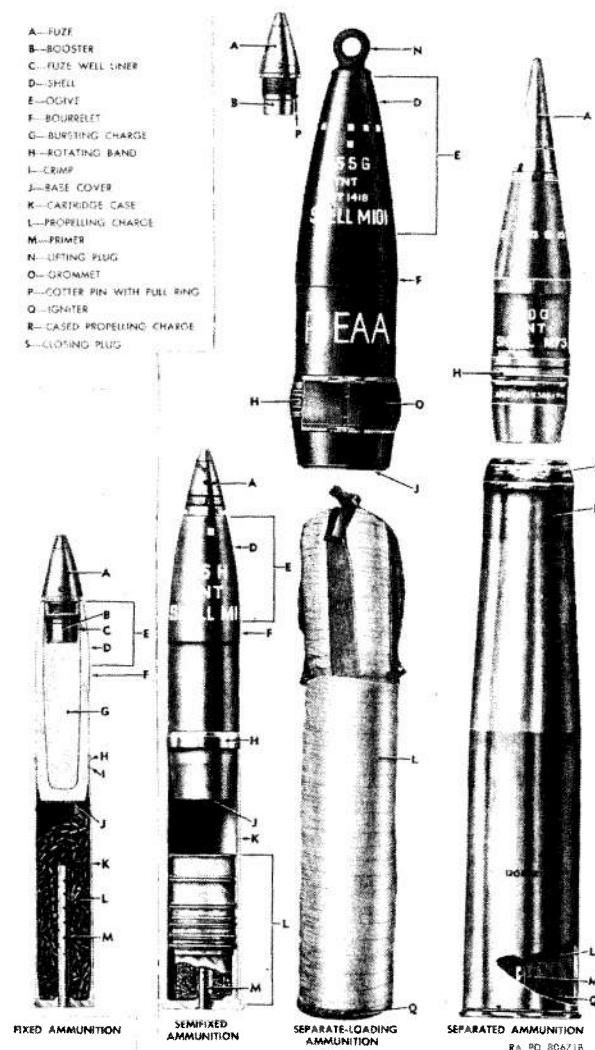


Figure 1-1. Ammunition terms — complete rounds

1-3. Fixed Ammunition. Complete rounds in which the propelling charge is fixed, that is, not adjustable, and which are loaded into the weapon in one operation, are known as "fixed" ammunition. As usually designed, the propelling charge is loose in the cartridge case, which is crimped rigidly to the projectile. In a few cases, however, the charge is contained

in a bag inside the cartridge case. For certain calibers, rounds of fixed ammunition are termed "cartridges."

1-4. Semifixed Ammunition is characterized by an accessible propelling charge, which may be adjusted for zone firing. Like fixed ammunition, it is loaded into the weapon as a unit. The cartridge case is a free fit over the projectile. The propelling charge is divided into bagged sections, each containing a definite quantity of propellant.

1-5. In Separate-Loading Ammunition, the separate components — projectile, propelling charge, and primer — are loaded into the weapon separately, because the ammunition is too heavy and bulky to be handled as a unit. Ammunition larger than 105-mm caliber falls into this category.

1-6. Separated Ammunition is characterized by the arrangement of the propelling charge and the projectile for loading into the gun. The propelling charge, contained in a primed cartridge case that is sealed with a closing plug, and the projectile, are loaded into the gun in one operation. Separated ammunition is used when the ammunition is too large to handle as a fixed unit.

1-7. Classification of Ammunition. Ammunition may be classified according to use as service, practice, blank, or drill. In addition, it may be classified according to type of filler as explosive, chemical, or inert.

1-8. Service Ammunition is used in combat. Dependent upon the type of projectile, it may be high-explosive (HE), high-explosive antitank (HEAT), armor-piercing (AP), armor-piercing capped (APC, with or without explosive filler), hypervelocity armor-piercing (HVAP, HVAPDS, or HVAPDSFS), high-explosive plastic (HEP), incendiary, illuminating, marking, propaganda, chaff, or liquid-filled shell.

1-9. Practice Ammunition is fired for effect in simulated combat, and is also used in training in marksmanship. The projectile in this type of ammunition may have a small quantity of low-explosive filler to serve as a spotting charge, or the filler may be inert. The projectile may be an empty cast-iron shell.

1-10. Blank Ammunition is provided in small and medium calibers for saluting and simulated fire. This ammunition has no projectile.

1-11. Drill Ammunition is used for training in handling and loading. It is completely inert.

1-12. Proof Ammunition. Proof ammunition is used for testing of guns and propellant charges. The projectile is ordinarily a blunt-nosed solid steel shot of the same weight as the high-explosive projectile which is to be fired from the gun. The propellant charge weight is adjusted to give the pressure desired for the test that the round is designed for.

TYPES OF PROJECTILES

1-13. High-Explosive (HE) Shell have projectiles of forged steel, comparatively thin walls, and a large bursting charge of high explosive. HE shell are used against personnel and materiel targets, producing blast effect and fragmentation at the target. HE shell may have a time-, impact-, inertia-, or proximity-type fuze, according to the action desired.

1-14. High-Explosive Antitank (HEAT) Shell. This is a special shell used against armored targets. Its effect is dependent upon the formation of an ultra-high-velocity jet of metal caused by the action of the hollow charge on the metal liner.

1-15. Armor-Piercing (AP) Ammunition. The armor-piercing projectile has a nose of forged high-carbon nickel-chrome steel, and is intended to penetrate the armor of a tank by the energy of impact. The nose may be ogival, or blunt truncated, and must be hard enough to penetrate armor, yet tough enough to withstand cracking or shattering upon impact; it may have an aluminum windshield to provide better ballistic characteristics. The body of an AP shot must be capable of withstanding bending stresses, and also the gouging action of the edges of the hole. The base must have enough strength to smash through the plate if caught by the side of the hole, or should be so designed that it will break off from the body without injuring the forward part.

1-16. Hypervelocity Armor-Piercing (HVAP) Shot is lighter than the other armor-piercing projectile of the same caliber, and it is fired

at higher velocities. The HVAP shot has a pointed cylindrical core of tungsten carbide. The core has great density and hardness. This type of projectile is obsolescent and is being replaced by more modern types, such as HVAPDS.

1-17. Hypervelocity Armor-Piercing Discarding Sabot (HVAPDS) Ammunition. This type of ammunition consists of a subcaliber projectile comprising a carbide core in a light alloy or steel sheath. The subcaliber projectile is placed inside a full-caliber carrier (called a "sabot") designed to impart velocity and spin to the projectile. As it leaves the gun, the sabot is discarded by the action of centrifugal force, air resistance, or both, allowing the projectile to proceed toward the target unimpeded. Generally made of aluminum, magnesium-zirconium alloy, or plastic, sabots are of three types: pot type, petal type, and latch type. (See Section 2.)

1-18. Hypervelocity Armor-Piercing Discarding Sabot Fin-Stabilized (HVAPDSFS) Shot. The HVAPDSFS shot is a fin-stabilized kinetic energy projectile designed for extremely high muzzle velocities. It is characterized by an extremely high length-over-diameter ratio. Its long thin appearance has led to its being referred to as the "arrow" projectile. It may be fired from either rifled or unrifled barrels by means of a sabot. It is currently in the development stage and has given some very promising results.

1-19. High-Explosive Plastic (HEP) Shell are unique in antitank warfare, as they attempt to defeat tanks without penetrating the armor. The explosive is made in a molded plastic form and flattens out when the projectile strikes the target. The detonation of the explosive on the face of the armor causes a rupture on the opposite side. This ruptured portion is known as a spall, which causes damage inside the tank, dependent on the velocity and mass of the spall. The mass and velocity of the spall depends on the quality and thickness of the armor, and the mass, type, and shape of the explosive filler. This shell has not yet been fully developed, and little of the theory is known. A more complete description of available theory and design is given in Section 2.

1-20. Canister Ammunition consists of slugs (small cylinders from bar stock), steel balls, or flechettes (stabilized fragments with pointed nose and finned tail), contained by various methods within the shell. The canister projectile consists of a heavy steel base, designed to withstand the firing stresses, and a thin steel tube packed with preformed missiles. As the canister projectile leaves the weapon, the steel case containing the missiles is split open by centrifugal force, and the missiles are distributed in a random pattern. The missiles inflict damage, since a velocity is imparted to them by a propellant charge. A more complete description of canister packing and design is given in Section 2.

1-21. Pyrotechnic - Type Ammunition comprises a group of shells which perform varied functions, but possess certain design similarities. These shells, which are fired from mortars, howitzers, or guns, are made to function by base ejection, separating burst, or explosive burst. In general, they are modifications of the HE shell of the same caliber. Pyrotechnic-type ammunition, grouped together by design similarity, include: illuminating shell, propaganda shell, colored smoke shell, and chaff shell; WP shell, and liquid-filled shell; and colored marker shell. The complete description and design of these shells is given in Section 2.

PROJECTILE COMPONENTS

1-22. The Ogive is the curved portion of the projectile from the point to the bourrelet. The curve of the ogive is usually the arc of a circle whose center is located in a line perpendicular to the axis of the projectile, and whose radius generally is 6 to 11 calibers in length.

1-23. The Bourrelet is an accurately machined cylindrical surface, of diameter slightly larger than the body, that bears on the lands of the bore. The bourrelet centers the projectile in the bore and guides it in its travel through the bore.

1-24. The Rotating Band is a cylindrical ring of comparatively soft material, usually copper, gilding metal, or soft iron, pressed into a knurled or roughened groove near the base of the projectile. When the gun is fired, the

rotating band is engraved by the rifling and imparts spin to the projectile. The band may also be welded to the projectile by the "welded overlay" method.

1-25. Base Cover. Shell containing high explosives usually are provided with a base cover to prevent the hot gases of the propelling charge from coming in contact with the explosive filler of the projectile through possible flaws in the metal of the base.

1-26. Body. The main portion of the projectile ordinarily is called the body. The term "body diameter," however, is used to designate the dimension of the cylindrical portion of the projectile between the bourrelet and the rotating band. In order to prevent contact with the bore, the body diameter is smaller than the diameter of the bourrelet or the rotating band.

1-27. Tracer. For observation of fire, some shell are fitted with a tracer in the base. In some antiaircraft gun projectiles, the tracer ignites a pellet that, after burning a prescribed number of seconds, detonates the explosive filler, should the fuze fail to operate against a target. This type of tracer is known as "shell destroying" (SD).

1-28. Lifting Plug and Grommet. The lifting plug and grommet do not play any part in the firing of the projectile but are included on the larger caliber shell merely for shipping and handling purposes. The lifting plug is an eye bolt that fits into the threaded fuze cavity in the nose of the shell and permits the shell to be handled by means of a winch. The grommet is a rubber-lined steel covering placed over the rotating band to protect it from damage resulting from rough handling. Both are removed before the projectile is used.

FUZES, BOOSTERS, AND DETONATORS

1-29. Introduction. A fuze is a device used with ammunition to cause it to function at the time desired, and under the circumstances desired. Artillery fuzes are classified according to their location on the projectile as base detonating or point detonating. They also are classified according to their method of functioning, as time, impact, or proximity (VT), or may be a combination of these.

1-30. Time Fuzes usually contain a graduated time element in the form of a compressed black powder train, or a mechanism with a gear train like a clock, which may be set to function at a predetermined time after firing.

1-31. Impact Fuzes are classified according to the quickness of action after impact as superquick, nondelay, or delay. See figure 1-2 for action of ammunition at the target according to the quickness of action. Superquick fuzes produce a burst immediately upon impact, before any penetration occurs, thus giving maximum surface effect. Nondelay fuzes are inertia-operative, and burst the projectile on a hard surface before complete penetration or ricochet. Delay fuzes allow penetration of material targets before bursting, or allow air bursts in ricochet fire. The time of action of impact fuzes is measured from the instant of its impact on a target, whereas the time of action of time fuzes is measured from the instant the weapon is fired. An impact fuze intended to function on impact with a very light material target, such as an airplane wing, is called supersensitive.

1-32. Proximity (VT) Fuzes. In effect, VT (Variable Time) fuzes are automatic time fuzes. Without "setting" or adjustment, they detonate the missiles that carry them on approach to the target. Artillery VT fuzes are essentially combination self-powered radio transmitting and receiving units. In flight, the armed fuze broadcasts radio waves. Unlike radar waves, the radio waves are sent continuously and are nondirectional. The radio wave fronts, which are reflected back from airplane, ground, or water to the moving missile, interact with the transmitted wave. When this interaction of transmitted and reflected waves, which results in ripples or beats, reaches a predetermined intensity, it trips an electronic switch. The switch then permits an electric charge that is stored in the firing capacitor to flow through an electric firing squib. The VT fuzes can be used only in deep-cavity shell.

1-33. General Description of Fuzes. In general, modern fuzes consist of a connected series (train) of small explosive charges, together with a striker or firing-pin device for initiating the action of the first charge in the train. The mechanism and explosive elements are held in a body or housing. In modern point-detonating

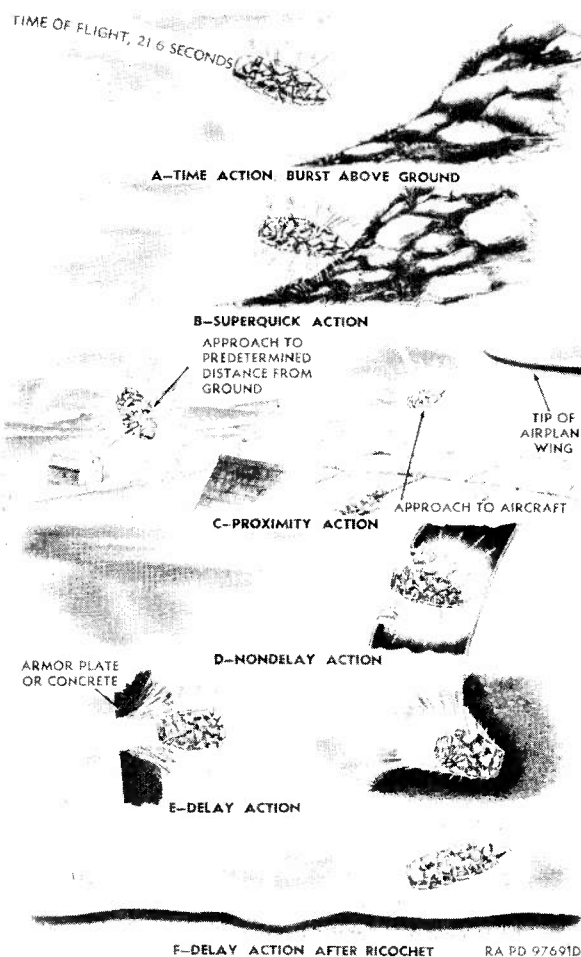


Figure 1-2. Action of ammunition at the target

(PD) fuzes, the housing is shaped for best ballistics. In impact fuzes now in use, the explosive train usually consists of a small but highly sensitive explosive charge, such as lead azide, in turn followed by a still larger and still less sensitive explosive charge, such as tetryl. Such charges function by successive detonation—hence the term detonating fuzes.

When delay action is desired by the use of a black powder pellet, the initial charge is a primer mixture, which passes a flame to the black powder and, in turn, to a detonator. Black powder is used exclusively in the time train of powder-train time fuzes, and for the magazine charge of both powder-train and mechanical types of time fuzes. Black powder that has been compressed to great density

burns slowly, the rate of combustion decreasing as the density increases. In the functioning of a fuze, each charge by its action initiates the next charge in the train. The final charge in the fuze causes the detonation of the booster, which in turn detonates the bursting charge of the shell.

1-34. Bore Safety. To prevent accidental arming during handling and shipping, safety devices, such as a safety wire or a cotter pin, are used when required. In certain types of fuzes, the mechanisms are arranged so that the fuzes are said to be "boresafe" (detonator-safe). A boresafe fuze is one in which the explosive train is interrupted so that, while the projectile is still in the bore of the weapon, premature action of the bursting charge is prevented if any of the more sensitive elements (primer or detonator) function.

1-35. Methods of Arming. A fuze is said to be armed when it is ready to detonate the shell, that is, when all parts are in, or are free to move to, their proper positions in order that the fuze may operate in its intended manner. The principal forces used in arming fuzes are inertia and centrifugal force. In some fuzes, both of these forces are used to activate safety devices; in others, only one is used. Centrifugal force occurs in spinning projectiles. This force may be utilized to actuate gear trains and to move safety devices into their proper positions in fuzes and boosters.

1-36. Boosters. Since the bursting charges of high-explosive shell are relatively insensitive to shock, a comparatively large detonating charge is necessary to ensure a high order detonation of the bursting charge. The use of more sensitive explosives, such as mercury fulminate or lead azide, in the quantities required for the purpose would create excessive hazards in handling and firing; therefore, such explosives are used only in small amounts as initiating and intermediate detonating charges. A separate charge of somewhat less sensitivity, usually tetryl, is provided for detonating the high-explosive charge of the shell. Because its function is to increase or "boost" the effectiveness of the explosive train, this charge is known as a booster charge. The booster charge may be incorporated in the fuze itself, or may be encased in thin metal or plastic which is screwed permanently to the fuze and handled as a unit with the fuze.

1-37. Detonators. A detonator is used in the explosive train to create or transmit a detonation wave to the booster charge, booster lead, or burster. Three types of detonators are used. One contains a primer mixture as the upper layer, for initiation by stab action of a firing pin. Another contains lead azide as the upper layer, for initiation either by flame action from a separate primer, delay pellet, time-train ring, or by detonation of a separate detonator. The third type contains a fine wire or other high-resistance electric circuit in contact with a heat-sensitive primer mixture. Passage of an electric current through the resistance circuit generates heat, which initiates detonation in the primer mixture. Most detonator cups and disks are made of aluminum.

EXPLOSIVES FOR AMMUNITION

1-38. General. To deliver the projectile at the target, and to cause it to function properly on arrival, it is necessary to employ different kinds of explosives, each of which has a specific function in a round of ammunition. The characteristics of the various types of explosives are given in Section 2. The arrangement of a series of explosives, beginning with a small amount of sensitive explosive and ending with a large amount of comparatively insensitive explosive, is called an explosive train.

1-39. Classification of Explosives. Explosives are divided into two basic groups — propellants (low explosives) and high explosives. The propellant reacts by burning, at a rate which depends upon such factors as pressure, grain form, grain size, and composition. The high explosive is used for its detonating properties, which result from the motion of a detonation wave traveling through the high-explosive charge at an extremely high velocity.

1-40. Propellants are used to eject the projectile from the weapon at a prescribed velocity. Those currently used have a nitrocellulose and/or nitroguanidine base. These propellants are distinguished by such terms as single base (those with nitrocellulose), double base (with nitrocellulose and nitroglycerin), or triple base (nitrocellulose, nitroglycerin, and nitroguanidine). Propellants may be called flashless and/or smokeless, but these terms are relative, not absolute.

1-41. High Explosives, because of their extremely rapid rate of detonation, have a powerful disruptive action. The high explosives that are most sensitive to impact are used as initiators in primers or detonators, whereas the high explosives less sensitive to impact are used as bursting charges in shell.

PROPELLING CHARGES

1-42. General. Propelling charges consist of the propellant (essentially nitrocellulose plus other ingredients) with an igniter of black powder, assembled in a suitable container. Generally, in fixed, semifixed, and separated rounds, the full igniter charge is present in a tube attached to the percussion element of the primer. In certain cases, however, such as ammunition for the 75-mm rifle, a supplementary igniter charge is located in the forward end of the cartridge case. In separate-loading rounds, the igniter charge is assembled in a bag sewed to the base end of the propelling-charge bag, and in some cases includes a core running through the center of the propelling-charge bag. See figure 1-1 for representative types of propelling charges.

To control the burning of propellant powder to obtain the desired performance in a particular weapon, the powder is manufactured in several types of grains. For a complete description of the various propellants, their grain types and their characteristics, refer to Section 4.

1-43. Flashless and Smokeless Characteristics. Whether the ammunition upon firing has flashless or smokeless characteristics, or both, depends chiefly upon the chemical composition of the propellant, the design of the ignition system, and the characteristics of the weapon in which the ammunition is fired. Variable factors that must be allowed for in the original design of the flashless-smokeless ammunition are firing temperature, degree of wear of weapon, and weather conditions.

1-44. A Cartridge Case, made of drawn brass or steel, serves as the container for the propelling charge in the instance of fixed and semifixed artillery ammunition. The case has a profile and design to conform to the chamber of the weapon for which the case is intended. The head of the case is relatively thick and has a flange to permit mechanical extraction and to

seat the round in the gun. These rounds used in automatic guns usually have cartridge cases with extracting grooves instead of flanges or rims. The cartridge case holds the primer, the propelling charge, and the projectile (except for separated types), so that the assembly can be inserted into the weapon in one operation. A secondary function is to provide for obturation. The case is sufficiently thin to be expanded by the pressure of the burning gases to a tight fit against the side of the weapon chamber, thereby preventing the escape of gas to the rear.

1-45. The Propelling Charge in a Round of Fixed Ammunition is usually loose powder in the cartridge case. In some instances, where the charge is not large enough to fill the case completely, a distance wadding, usually a cardboard disk and cylinder or felt pads, is inserted in the neck of the cartridge case, between the powder charge and the base of the projectile. In some instances, the same function may be served by enclosing the charge in a cloth bag inside the case. Where the primer charge is insufficient for satisfactory ignition of the propelling charge, a supplementary igniter charge of black powder may be attached to the distance wadding to supplement the primer ignition.

1-46. The Propelling Charge in a Round of Semifixed Ammunition is in cartridge bags in the cartridge case. Since the cartridge case is loosely fitted to the projectile, some of the bags of powder may be removed prior to firing to provide for zone firing.

1-47. The Propelling Charge in Separated Ammunition. In "separated" ammunition, the separately loaded propelling charge is loosely contained in a cartridge case, which is closed by a "closing plug" made of palmetto pulp, plastic, or cork. An igniter may be placed around the primer to ensure proper ignition.

1-48. Mortar Propelling Charges are made up of several removable parts or "increments" to provide for zone firing. Each increment consists of a charge of smokeless propellant encased in a cotton bag. The bag has a buttonhole at each end to enable it to be fastened to the cartridge housing of the mortar round. The round, as received in the field, has the maximum number of increments fastened to it. The gunner adjusts for zone firing by removing the increments that are not desired.

1-49. Cartridge Bags form a suitable and convenient means of containing the smokeless powder charge in separate-loading ammunition. Cartridge-bag cloth normally is made of silk; bags made of rayon sometimes are used to replace silk. Only certain ash-free grades of this fabric are suitable; other grades might leave smoldering fragments in the bore of the cannon after firing. The products of combustion of smokeless powder are inflammable when mixed with the requisite amount of air. A reignition of gases known as a "flareback" could occur in the presence of these smoldering particles.

Cartridge igniter bags are made of silk, and the cloth is similar to cartridge-bag cloth, except that it is more closely woven in order to prevent the black ignition powder from sifting through. To date no suitable substitutes for silk have been found.

For a further discussion of the propelling charges, and a description of propelling charges for particular guns, refer to Section II, chapter 3, of reference 3, and also Section 4 of this handbook.

1-50. Primers and Ignition Charges. A primer is used in a propelling-charge explosive train as the component that initiates burning of the propelling charge by a flame. Such primers vary in size and complexity, depending upon their type and the quantity of propelling charge to be ignited. For example, the propelling charge of 20-mm rounds is so small, relatively, that the primer is merely a sensitive element assembly that is inserted directly into the primer pocket of the cartridge case. In larger caliber rounds, the primer contains a sensitive element of primer mixture or other explosive, plus a primer charge of black powder to ensure proper ignition of the larger propellant charges. Where sufficient black powder cannot be loaded into the primer body to ensure proper ignition, a separate bag of black powder, called an igniter charge assembly, is placed with the propellant.

Primers may be classified by method of ignition as percussion, initiated by a sharp blow from a firing pin in the weapon; or electric, initiated by sending a small electric current through a resistance wire embedded in an explosive, or through a conductive primer mixture.

GENERAL DESIGN REQUIREMENTS

.. Unique Functioning. The unique function ammunition must be considered in the design of complete rounds and their components. Practically all ammunition items are required to function only once. This one time, they must function as intended, with a very high degree of certainty. Usually, they are used without any previous preparation or adjustment, after subjection to handling and storage that may have gone on for periods of years, sometimes under very adverse conditions.

This peculiarity of function imposes certain design requirements of a restrictive nature, such as:

1. Ruggedness
2. Corrosion prevention
3. Prevention of deterioration of materials.

On the other hand, this peculiarity makes it possible to neglect certain other factors that ordinarily must be given consideration, such as:

1. Wear
2. Fatigue
3. Permanent deformation of certain parts as a normal consequence of its functioning.

1-52. Quantity Production Requirements. Another general characteristic of nearly all ammunition components is that they are made in large quantities. Quantity production makes it economical to provide special tools, automatic or semi-automatic machines, and other special mass production equipment for their manufacture, loading, assembly, inspection, testing, and the like. In the design of ammunition components, their forms, dimensions, and tolerances must be kept in mind for mass production purposes.

1-53. Forces Acting on Projectiles in Handling. Normally, projectiles are subject to rough handling. They may be dropped, or they may roll and tumble against each other, both in shipment and in use. Some of the areas of the projectile that may be subject to damage as a result of this handling are listed below, together with the nature of the damage that might be expected.

1. Rotating bands — indentations or scars.
2. Fins — breaking or bending.
3. Setback arming devices becoming armed.
4. Explosive elements — primers and detonators are liable to detonation if subjected to severe shock deformation or movement.
5. Chemical fillers — leakage.

Such damage can be minimized by proper choice of materials, by the avoidance of sharp corners or edges subject to breakage, and by proper packing.

1-54. Design Considerations From Storage Requirements. Since ammunition may be stored for long periods of time, under adverse conditions of temperature and humidity, the following factors must be considered.

1. Malfunctioning or loss of accuracy caused by extremes of temperature.
2. Malfunctioning or loss of accuracy resulting from exposure to dust or sand.
3. Malfunctioning or loss of accuracy resulting from exposure to rain or snow, and immersion in water.
4. Stability of explosives and other chemically reactive material.
5. Resistance of metal parts to corrosion.
6. Resistance of nonmetallic materials to deterioration.

BIBLIOGRAPHY

1. Hayes, T. J., "Elements of Ordnance," John Wiley and Sons, New York, 1938.
2. Ammunition, General, TM 9-1900, War Department Technical Manual, June 1945.
3. Artillery Ammunition, TM 9-1901, Department of the Army Technical Manual, September 1950.

ENGINEERING DESIGN HANDBOOK SERIES

The Engineering Design Handbook Series is intended to provide a compilation of principles and fundamental data to supplement experience in assisting engineers in the evolution of new designs which will meet tactical and technical needs while also embodying satisfactory producibility and maintainability.

Listed below are the Handbooks which have been published or submitted for publication. Handbooks with publication dates prior to 1 August 1962 were published as 20-series Ordnance Corps pamphlets. AMC Circular 310-38, 19 July 1963, redesignated those publications as 706-series AMC pamphlets (i.e., ORDP 20-138 was redesignated AMCP 706-138). All new, reprinted, or revised handbooks are being published as 706-series AMC pamphlets.

<u>General and Miscellaneous Subjects</u>		<u>Ballistic Missile Series</u>	
<u>Number</u>	<u>Title</u>	<u>Number</u>	<u>Title</u>
106	Elements of Armament Engineering, Part One, Sources of Energy	281(S-RD)	Weapon System Effectiveness (U)
107	Elements of Armament Engineering, Part Two, Ballistics	282	Propulsion and Propellants
108	Elements of Armament Engineering, Part Three, Weapon Systems and Components	284(C)	Trajectories (U)
110	Experimental Statistics, Section 1, Basic Concepts and Analysis of Measurement Data	286	Structures
111	Experimental Statistics, Section 2, Analysis of Enumerative and Classificatory Data	<u>Ballistics Series</u>	
112	Experimental Statistics, Section 3, Planning and Analysis of Comparative Experiments	140	Trajectories, Differential Effects, and Data for Projectiles
113	Experimental Statistics, Section 4, Special Topics	160(S)	Elements of Terminal Ballistics, Part One, Introduction, Kill Mechanisms, and Vulnerability (U)
114	Experimental Statistics, Section 5, Tables	161(S)	Elements of Terminal Ballistics, Part Two, Collection and Analysis of Data Concerning Targets (U)
134	Maintenance Engineering Guide for Ordnance Design	162(S-RD)	Elements of Terminal Ballistics, Part Three, Application to Missile and Space Targets (U)
135	Inventions, Patents, and Related Matters	<u>Carriages and Mounts Series</u>	
136	Servomechanisms, Section 1, Theory	341	Cradles
137	Servomechanisms, Section 2, Measurement and Signal Converters	342	Recoil Systems
138	Servomechanisms, Section 3, Amplification	343	Top Carriages
139	Servomechanisms, Section 4, Power Elements and System Design	344	Bottom Carriages
170(C)	Armor and Its Application to Vehicles (U)	345	Equilibrators
270	Propellant Actuated Devices	346	Elevating Mechanisms
290(C)	Warheads--General (U)	347	Traversing Mechanisms
331	Compensating Elements (Fire Control Series)	<u>Materials Handbooks</u>	
355	The Automotive Assembly (Automotive Series)	301	Aluminum and Aluminum Alloys
<u>Ammunition and Explosives Series</u>		302	Copper and Copper Alloys
175	Solid Propellants, Part One	303	Magnesium and Magnesium Alloys
176(C)	Solid Propellants, Part Two (U)	305	Titanium and Titanium Alloys
177	Properties of Explosives of Military Interest, Section 1	306	Adhesives
178(C)	Properties of Explosives of Military Interest, Section 2 (U)	307	Gasket Materials (Nonmetallic)
210	Fuzes, General and Mechanical	308	Glass
211(C)	Fuzes, Proximity, Electrical, Part One (U)	309	Plastics
212(S)	Fuzes, Proximity, Electrical, Part Two (U)	310	Rubber and Rubber-Like Materials
213(S)	Fuzes, Proximity, Electrical, Part Three (U)	311	Corrosion and Corrosion Protection of Metals
214 (S)	Fuzes, Proximity, Electrical, Part Four (U)	<u>Surface-to-Air Missile Series</u>	
215(C)	Fuzes, Proximity, Electrical, Part Five (U)	291	Part One, System Integration
244	Section 1, Artillery Ammunition--General, with Table of Contents, Glossary and Index for Series	292	Part Two, Weapon Control
245(C)	Section 2, Design for Terminal Effects (U)	293	Part Three, Computers
246	Section 3, Design for Control of Flight Characteristics	294(S)	Part Four, Missile Armament (U)
247(C)	Section 4, Design for Projection (U)	295(S)	Part Five, Countermeasures (U)
248	Section 5, Inspection Aspects of Artillery Ammunition Design	296	Part Six, Structures and Power Sources
249(C)	Section 6, Manufacture of Metallic Components of Artillery Ammunition (U)	297(S)	Part Seven, Sample Problem (U)