

FOR OFFICIAL USE ONLY

Ordnance Pamphlet No. 4
September, 1923



AMMUNITION

INSTRUCTIONS FOR THE NAVAL SERVICE

1923

This publication is FOR OFFICIAL USE ONLY and will be handled in accordance with Art. 123, U. S. Naval Regulations, 1920.

INSTRUCTIONS GOVERNING THE CARE, PRESERVATION, STOWAGE, INSPECTION, AND TEST OF AMMUNITION.

1. Ordnance Pamphlet No. 4, published in accordance with article 74 of the Navy Regulations, 1920, covers instructions governing the care, preservation, stowage, inspection, and test of service explosives and general information about ammunitions. No attempt has been made to go deeply into the general subject of ammunition materials, as the subject is too broad for general consumption. Officers seeking more detailed information should consult standard works on explosives, consulting the list compiled under the direction of the National Council of Research. For more complete information regarding dispersion, erosion, and interior ballistics, consult ordnance pamphlets on these subjects. This publication supersedes Ordnance Pamphlets Nos. 20, "Service Explosives": 368, Part II, "Marking of Ammunition"; 21, "Pyrotechnic Signal Material," and all previous instructions regarding tests of service explosives. Practically all of the subject matter of chapter 26, Naval Instructions, 1913, is incorporated in this book, and in accordance with article 74 (b), of the Navy Regulations, 1920, still have the force and effect of orders from the Navy Department. This publication should be given a free circulation for the proper dissemination of information, so that due regard will be paid to the care, preservation, and tests of ammunition.

2. Shipment of explosives by freight or express must be packed and marked in accordance with the Interstate Commerce Commission Regulations for the Safe Transportation of Explosives, copies of which are on file at the various navy yards and stations, including naval ammunition depots. When it becomes necessary for a vessel to ship ammunition by freight or express, it is preferable to turn it in to an ammunition depot for proper packing, loading, and placarding, if such turning in is practicable, otherwise to the supply officer of a navy yard or station. Shipment of explosives by mail is positively FORBIDDEN.

Attention is invited to the following works on explosives:

Nitro Explosives	Sanford.
The Manufacture of Explosives	Guttman.
Explosives	Marshall.
High Explosives	Calver.
Explosives	Brunswick.

GENERAL INDEX.

	Page
Table of contents.....	vii
CHAPTER I. General instructions.....	1
II. Safety precautions.....	1
III. Definitions and history of explosives.....	10
IV. Black powder.....	26
V. Smokeless powder.....	29
VI. Tests of smokeless powder.....	61
VII. Surveillance ovens.....	75
VIII. High explosives.....	95
IX. Detonating substances.....	107
X. Projectiles.....	111
XI. Cartridge cases and tanks.....	157
XII. Fusee and tracers.....	171
XIII. Primers.....	195
XIV. Assembled charges.....	199
XV. Miscellaneous ammunition.....	205
XVI. Aircraft ammunition.....	221
XVII. Storage of ammunition.....	225
XVIII. Marking of ammunition.....	233
XIX. Pyrotechnics.....	245
XX. Interior ballistics.....	251
XXI. Erosion.....	269
XXII. Dispersion.....	273
XXIII. Reports.....	279
List of illustrations.....	xv

TABLE OF CONTENTS.

Subject.	Page.	Illustrations.	
		Figure.	Plate.
Chapter I.			
General Instructions.			
Sources of information.....	1		
Bureau publications.....	1		
Handling of explosives.....	1		
Ammunitions.....	2		
Damage to containers.....	2		
Charges.....	3		
Danger of leaky containers.....	3		
Handling projectiles and empty containers.....	4		
Smokeless powder.....	4		
Temperatures.....	4		
Exposure of smokeless powder to sun or high temperatures.....	5		
Wet powder.....	5		
Safety devices.....	5		
Service ammunition.....	6		
Inspection of target ammunition.....	6		
Disposition of unexpended allowance.....	6		
Use of proper containers.....	6		
Drill primers.....	6		
Small arms.....	7		
Material.....	7		
Service projectiles.....	7		
Chapter II.			
Safety Precautions.			
Extent of precautions.....	9		
Forbidden articles.....	9		
Red flag.....	9		
Safety orders.....	9		
General.....	9		
Magazine.....	10		
Ammunition.....	10		
Preparations for firing.....	10		
Steaming out oil tanks.....	16		
Use of magazines.....	16		
Ready service magazines.....	16		
Unloading guns.....	16		
Defective primers.....	17		
Immersing powder in water.....	17		

TABLE OF CONTENTS—Continued.

Subject.	Page.	Illustrations	
		Figure.	Plate.
Chapter III.			
Definitions and History of Explosives.			
Explosion and explosive.....	19		
Conditions for an explosion.....	19		
Explosive reaction.....	19		
Explosive mixture and compound.....	20		
Heat of explosion.....	20		
Sensitivity.....	20		
Classification of explosives.....	21		
Propellant and high explosive.....	21		
Requirements of an explosive.....	21		
Early history, Greek fire.....	22		
First use and development of black powder.....	22		
Nitro compounds.....	23		
Gun cotton.....	23		
Nitroglycerin.....	23		
Other nitro compounds.....	23		
Substitutes for black powder.....	23		
Early smokeless powder.....	24		
Nitrocellulose and nitroglycerine powders.....	24		
Adoption of new propellants.....	24		
Further developments.....	24		
Chapter IV.			
Black Powder.			
Composition.....	25		
Saltpeter.....	25		
Sulphur.....	25		
Charcoal.....	26		
Manufacture of black powder.....	26		
Physical properties.....	28		
Packing.....	28		
Uses.....	28		
Chapter V.			
Smokeless Powder.			
Cellulose.....	29		
Cotton.....	29		
Cellulose nitrate, soluble, insoluble.....	28		
Nitration.....	30		
Other nitrocellulose substances.....	30		
Tinters and hull shavings, purification.....	30		
Cotton fiber structure.....	31		
Sulphuric acid.....	31		
Nitric acid.....	32		
Manufacture of nitrocellulose.....	34		
Mixed acids.....	38		

TABLE OF CONTENTS—Continued.

Subject	Page	Illustrations	
		Figures	Plats
Chapter V—Continued.			
Smokeless Powder—Continued.			
Pyro purification, drowning, boiling, pulping, beaters, poaching, dewatering, dehydrating, mixing	39		
Diethylenylamine	44		
Pressing	44		
Powder dies	49	21	
Solvent recovery	49		
Drying	49		
Blending	50		
Burning of black and smokeless powder	50		
Quick and slow powders	54		
Shape of grains	55		
Double base powders	55		
Stabilizers	57		
Reworked powder	57		
Smokeless powder manufacture test	58		
Special propellants	59		
Flashless powder	59		
Chapter VI.			
Examination of Tests of Powder Aboard Ship.			
Assignment to lot	61		
Designation of lots	61		
Stability	62		
Care in carrying out tests	62		
Record of tests	63		
Prescribed tests	63		
Magazine samples	63		
Daily examination	64		
Principles of toilet paper tests	64		
Fortnightly tests	66		
Monthly tests	66		
Visual examination	67		
Surveillance test	67		
Results from tests	68		
Reports	69		
Danger point	69		
Surveillance test bottles	69		
Method of conducting tests	70		
Transportation	70		
Regulation for explosives	71		
Destruction of powder	72		
Ballistic error of powder	73		
Salvage of ammunition	73		

TABLE OF CONTENTS—Continued.

Subject	Page	Illustrations	
		Figure	Plate
Chapter VII.			
Surveillance Ovens.			
Source of supply	75		
Purpose	75		
Mark I, and Mark I, Mod. 1, ovens	75		
To connect ovens	83		
Panel	84		
To test thermometers	85		
Operation of ovens	85		
Mark II oven	86		
Operation of Mark II oven	90		
The Mark II, Mod. 2, oven	92		
Alarm device	92		
Ovens in service	94		
Chapter VIII.			
High Explosives.			
Requirements	95		
List of high explosives	96		
Gun cotton	97		
T. N. T.	98		
T. N. X.	101		
Picric acid	102		
Ammonium picrate	103		
Manufacture of explosive "D"	103		
Tetryl	104		
Amatol	104		
Nitrostarch	105		
Nitroglycerin	105		
Chapter IX.			
Detonating Substances.			
General	107		
Ignition of smokeless powder	107		
Projectile fusers	107		
Detonation	108		
Boosters	109		
Fulminate of mercury	109		
Caps for small arms	110		
Azides	110		
Chapter X.			
Projectiles.			
General	111		
Form of	111		
Exterior finish, weight	112		
Bourrelet	113		

TABLE OF CONTENTS—Continued.

Subject.	Page.	Illustrations.	
		Figs.	Plate.
Chapter X—Continued.			
Projectiles—Continued.			
Rotating band	113		
Under water attack	114		
Classification	115		
Manufacture of armor-piercing projectiles	115		
Common and class "B" projectiles	118		
Special projectiles	120		
Illuminating projectiles	120		
Smoke and gas projectiles	121		
Target projectiles	121		
Proof shot projectiles	121		
Marker projectiles	121		
Line-carrying projectiles	121		
Tabulation of characteristics	122		
Chapter XI.			
Cartridge Cases and Case Ammunition.			
Cartridge cases	157		
Manufacture of cases	157		
Care of cases	158		
List of cartridge cases	159		
Care in handling case ammunition	159		
Cartridge tanks and boxes	160		
Powder tanks	165		
Chapter XII.			
Fuses and Tracers.			
Nomenclature	171		
List of fuses	171		
Early history	174		
Concussion fuses	175		
Percussion fuses	175		
Navy base fuse	177		
Broderick fuse	177		
Driggs fuse	177		
Wilson Chase fuse	178		
Simple minor caliber fuse	178		
Ansonia & Nathan fuse	179		
Baldwin fuse	179		
Watson medium caliber fuse	179		
Simple medium caliber fuse	180		
Tracers	180		
Time fuses	180		
Fuse setters, punch, and wrench	188		

TABLE OF CONTENTS—Continued.

Subject.	Page.	Illustrations.	
		Figure.	Plate.
Chapter XIII.			
Primers.			
Function of primer.....	195		
Ignition.....	195		
Types of primers.....	195		
Manufacture.....	196		
Designation.....	196		
Drill primers.....	196		
Chapter XIV.			
Assembled Charges.			
Issue to vessels.....	199		
Ammunition orders.....	199		
Handling orders.....	199		
Loading projectiles.....	201		
Mixed filler.....	201		
Compressed charges.....	201		
Case ammunition.....	201		
Bag charges.....	202		
Ignition ends.....	202		
Assembly of bags.....	203		
Stacked charges.....	204		
Chapter XV.			
Miscellaneous Ammunition.			
Types of small arms.....	205		
Issue of small arms ammunition.....	205		
Care in handling.....	208		
Classes and grades.....	208		
Marking of small arms.....	209		
Shotgun ammunition.....	209		
Torpedo impulse charges.....	209		
Y-gun charges.....	210		
Instruction for preparation of saluting ammunition.....	210		
Stores mortar ammunition.....	212		
Variable propellant charges.....	212		
Precautions.....	212		
Rifle grenades.....	212		
Hand grenades.....	216		
Line throwing ammunition.....	219		
Chapter XVI.			
Aircraft Ammunition.			
Aero bombs.....	221		
Fragmentation bombs.....	221		
Demolition bombs.....	221		
Incendiary bombs.....	222		
Antisubmarine bomb.....	222		

TABLE OF CONTENTS—Continued.

Subject.	Page.	Illustrations:	
		Figure.	Plate.
Chapter XVI—Continued.			
Aircraft Ammunition—Continued.			
Armor-piercing bomb.....	232		
Smoke bomb.....	232		
Gas bomb.....	232		
Dummy bomb.....	232		
Care and handling of aero bombs.....	233		
Marking and painting of bombs.....	234		
Machine-gun ammunition.....	234		
Pyrotechnics.....	234		
Torpedoes.....	234		
Chapter XVII.			
Stowage of Ammunition.			
Stowage regulations.....	225		
Ready service stowage.....	228		
Location of magazines.....	228		
Safety precautions.....	228		
Care of magazines.....	228		
Wet powder.....	229		
Temperatures.....	229		
Moisture.....	229		
Refrigeration.....	229		
Necessity for cooling.....	230		
Reliability of cooling system.....	230		
Cost.....	231		
Chapter XVIII.			
Marking of Ammunition.			
General instructions.....	233		
Chapter XIX.			
Pyrotechnics.			
Pyrotechny.....	245		
Materials used.....	245		
Kind of pyrotechnics.....	245		
Rockets.....	245		
Navy rockets.....	246		
Star rockets.....	247		
Signal rockets.....	247		
Shower rockets.....	247		
Identification marks.....	247		
Smoke rockets.....	247		
Very signals.....	248		
Very stars.....	248		
Packing of stars.....	249		
Rifle light and discharger.....	249		
Blue light.....	249		
Distress signal.....	250		
Handling pyrotechnics.....	250		

TABLE OF CONTENTS—Continued.

Subject.	Page.	Illustrations.	
		Figures.	Plats.
Chapter XX.			
Interior Ballistics.			
Use of.....	251		
Extent of.....	251		
Gun requirements.....	251		
Powder.....	252		
Powder chamber.....	252		
Density of loading.....	252		
Travel of projectile.....	253		
Use of formulas.....	253		
Development of interior ballistics.....	253		
Application of formulas.....	254		
Formula used.....	254		
Problems.....	255		
Powder test sheet.....	255		
Chapter XXI.			
Erosion.			
Cause.....	269		
Appearance of steel in bore.....	269		
Heat cracks and their effect.....	269		
Elements affecting erosion.....	270		
Heat of combustion.....	270		
Chapter XXII.			
Dispersion.			
Causes.....	273		
Errors in dispersion.....	273		
Speed of primers.....	277		
Variation in projectiles.....	278		
Chapter XXIII.			
Ammunition Reports.			
Importance.....	279		
Number of reports.....	279		
Circular Letter No. A-27 of February 17, 1921.....	281		
Sample reports.....	285		
Chapter XXIV.			
Special Tests of Ammunition.			
Guncotton.....	303		
Guncotton boosters.....	303		
Drying.....	304		
Stowage.....	305		
Weekly inspection.....	306		

TABLE OF CONTENTS—Continued.

Subject	Page	Illustrations	
		Figure	Plate
Chapter XXIV—Continued.			
Special Tests of Ammunition—Continued.			
Litmus test of gun-cotton	306		
Monthly inspection	307		
Quarterly inspection	307		
Annual inspection	307		
Heat tests	308		
Heat tests outfit	308		
Operation of heat test for smokeless powder	309		
Heat test for gun-cotton	310		
Delicacy of heat test	311		
Litmus test of gun-cotton	311		
Illustrations.			
Chapter V.			
Sulphur burner	32		
Nitric-acid still	33		
Cotton-picking machine	34	3	
Cotton drier	35		
Diagrammatic sketch of nitrating process	37		I
Cotton nitrators (third floor)	36	5	
Nitrating house (second floor)	38	6	
Pyro discharge of boiling tube (first floor)	39	7	
Boiling tube	40	8	
Duplex heater, pulping machine	41	9	
Poaching tube	42	10	
Pyro screens	43	11	
Dewatering and wringing machines	43	12	
Dehydrating press	45	13	
Mixing machine	46	14	
Blocking press	46	15	
Macaroni press	47	16	
Graining press	47	17	
Grain cutter (cover in place)	47	18	
Grain cutter (cover removed)	48	19	
Sorting tables	48	20	
Powder sifter for multiperforated grains	49	21	
Solvent recovery	50	22	
Typical interior of dry house	51	23	
Blending tower	52	24	
Packing room	53	25	
Graphic progress of combustion of multiperforated grain	53		II
Combustion pressure curves	54	26	
Reworking mill	57	27	
Chapter VII.			
Mark I oven, assembled view	78	28	III
Mark I oven, disassembled view	79	29	IV
General arrangement, Mark I, Mod. 1, oven	76		III
Mark I, Mark 1, Mod. 1, wiring diagram	77		IV

TABLE OF CONTENTS—Continued.

Subject.	Page.	Illustrations.	
		Figures.	Plats.
Illustrations—Continued.			
Chapter VII—Continued.			
Mark II oven showing rheostat.....	86	30	
Mark II oven showing relay.....	87	31	
Mark II oven interior.....	88	32	
Mark II, Mod. 1, oven.....	90		V
Mark II, Mod. 1, wiring diagram.....	Appended.		IV
Mark II, Mod. 2, oven.....	90		VI
Mark II, Mod. 2, wiring diagram.....	Appended.		VII
Mark II, Mod. 1, heating unit.....	91		VIII
Chapter XI.			
Operations for 4-inch, 50-caliber cartridge case.....	158	33	
Assembly, 1-pounder, ammunition.....	160		VIII
Assembly, 3-pounder, ammunition.....	160		IX
Assembly, 6-pounder, ammunition.....	160		X
Assembly, 3"/23 field gun ammunition.....	160		XI
Assembly, 3"/23 low velocity ammunition.....	160		XII
Assembly, Davis gun ammunition, 6-pounder, 9-pounder, and 3-inch.....	160		XIII
Assembly, 3"/50 ammunition.....	160		XIV
Assembly, 4"/50 ammunition.....	160		XV
1-pounder ammunition boxes, Mark II and Mark III.....	161	34	
3"/23 cartridge tank, Mark I.....	161	35	
3"/23 ammunition boxes, Mark IV and IV, Mod. 1.....	162	36	
3"/50 ammunition boxes, Mark I, Mod. 1.....	162	37	
3"/50 ammunition tank, Mark II, with extractor.....	163	38	
4"/40 ammunition box, also used for 3"/50 illuminating projectile.....	163	39	
4"/50 cartridge tank, Mark II.....	164	40	
4"/50 cartridge boxes, Mark III and Mark III, Mod. 1.....	164	41	
6"/40 ammunition box, Mark II.....	165	42	
Miscellaneous packing boxes for primers and detonators, one copper and one sheet metal.....	166	43	
3-inch powder tanks.....	169	44	
12-inch powder tanks.....	169	45	
14-inch powder tanks.....	170	46	
16-inch powder tanks with opener and sling.....	170	47	
Chapter XII.			
Navv base fuse (53260).....	177	48	
Brodnick fuse (53163).....	177	49	
Driggs fuse (44464).....	178	50	
Wilson Chase fuse (26527).....	178	51	
Simple minor caliber fuse (54917).....	179	52	
Wateon medium caliber fuse (50210).....	179	53	
Simple medium caliber ignition fuse.....	180	54	
Bethlehem 12-second combination time and percussion fuse (53164).....	182	55	
Frankford Arsenal 15-second combination time and percussion fuse (17698).....	184	56	
Frankford Arsenal 21-second combination fuse, 1907 (46848).....	185	57	
Detonating fuse, Mark VII (51757).....	187	58	
15-second F. A. C. fuse punch and a 21-second F. A. C. fuse wrench.....	189	59	
3-hand-fuse setters.....	191	60	
Outline of different tracers.....	194		XVI

TABLE OF CONTENTS—Continued.

Subject.	Page.	Illustrations.	
		Figure.	Plate.
Illustrations—Continued.			
Chapter XIII.			
Mark X, Mod. 4, and Mark XIV primers.....	197		XVII
Mark XV lock primer and the Mark XIII case combination ignition primer.....	Appended		XVIII
Outline of primers.....	198		XVIII
Chapter XIV.			
Stacking machines, Naval Ammunition Depot, St. Juliens Creek.....	200		XIX
Loose and stacked section for 14-inch charge.....	203	61	
Chapter XV.			
Containers for small-arm ammunition aircraft and machine gun.....	206		XX
Containers for small-arm ammunition machine gun rifle.....	207		XXI
Torpedo impulse ammunition.....	210		XXII
V-gun ammunition.....	210		XXIII
Stokes trench mortar projectile.....	213		XXIV
Cross section O. B. rifle grenade.....	214	62	
Hand grenade.....	216	63	
3 and 6 pounder line-throwing projectiles.....	218	64	
Chapter XVIII.			
Powder containers.....	233		XXV
Explosive containers.....	235		XXVI
Bag gun charge containers.....	236		XXVII
Projectiles loaded and fused.....	238		XXVIII
Projectile data.....	239		XXIX
Separate case ammunition box.....	240		XXX
Fixed case ammunition box.....	241		XXXI
Fixed case ammunition box.....	241		XXXII
Fixed case ammunition box.....	241		XXXIII
Fixed case ammunition box.....	241		XXXIV
Fixed case ammunition box.....	241		XXXV
Fixed case ammunition box.....	241		XXXVI
Cartridge tank.....	241		XXXVII
Saluting ammunition box.....	242		XXXVIII
Replacement sample.....	242		XXXIX
Drill case ammunition box.....	243		XI
Drill charge ammunition containers.....	244		XII
Aircraft bombs.....	244		XIII
Chapter XIX.			
Star rockets.....	247		XLIII
Shower rockets.....	247		XLIV
Smoke rockets.....	247		XLV
Very signal pistol.....	247		XLVI
Very cartridges, assembled and sectional, showing distinguishing features.....	247		XLVII
Rifle lights, assembled and sectional, showing distinguishing features.....	247		XLVIII
Blue and red lights, assembled and sectional, showing distinguishing features.....	247		XLIX

TABLE OF CONTENTS—Continued.

Subject.	Page.	Illustrations.	
		Figures.	Plate.
Illustrations—Continued.			
Chapter XX.			
Gun design curves.....	258		I
Velocity curves.....	264		LI
Curves for M. V. 2,700 foot-seconds for 5-inch, 50-caliber gun.....	265		LII
Variation of the several elements in a 12-inch, 54-caliber gun with change of density of loading.....	267		LIII

SEPTEMBER, 1923

DEMO

dimensione ridotta

DEMO

AMMUNITION.

INSTRUCTION FOR THE NAVAL SERVICE.

Chapter I.

GENERAL INSTRUCTIONS.

1. The instructions contained in this Ordnance Pamphlet, promulgated primarily for the service afloat, shall be followed at all naval ammunition depots, naval mine depots, and other stations on shore, in so far as they are applicable. Instructions for shore and afloat.

2. The methods of caring for and handling ordnance material as set forth in—
(a) United States Navy Regulations and Instructions, and
(b) Ordnance pamphlets
shall be closely followed. Instructions for ordnance material.

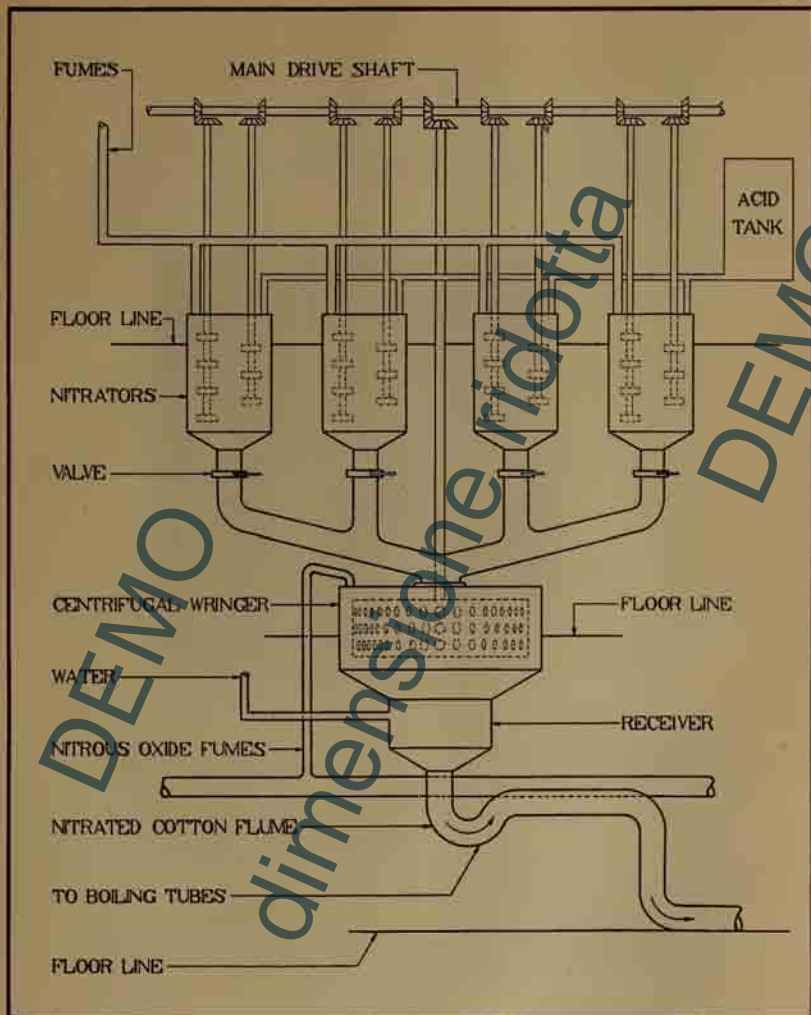
3. Detailed instructions relative to any particular class of ordnance will be found in the following publications: Detailed instructions.

- (a) Ordnance pamphlets.
- (b) Gunnery Instructions.
- (c) Ship and Gun Drills.
- (d) Landing Force Manual.
- (e) Diving Manual.
- (f) Navy General Orders, dealing with that particular subject.

When in doubt as to the meaning of any regulation or instruction concerning ordnance, an interpretation should be requested from the Bureau of Ordnance.

4. Commanding officers shall have on file a complete and up-to-date set of ordnance publications covering all ordnance material and ammunition on board the vessels under their command. Ordnance pamphlets may be obtained from the Bureau of Ordnance upon request, obtaining the pamphlet number from the index published as Pamphlet No. 0. File of ordnance publications.

5. The exercise of the utmost care and prudence in handling, inspecting, testing, preparing, assembling, and transporting all kinds of ammunition and ammunition details is enjoined upon all officers and other persons whose duties require cognizance over or actual handling of explosives during any of the above operations. Subordinates are liable to become careless and indifferent when continually engaged Handling of explosives.



Diagrammatic Arrangement of Nitrating Process

removed, and the nitrocellulose pushed down into the receiver on the first floor. Water is admitted into the receiver at two diametrically opposite points, so diverted as to give a whirling motion, thus washing the nitrated cotton down the flume which leads to the boiling tubs. (See figs. 5, 6, and 7.)

17. The efficiency of this system can readily be seen, as one man, by continuous operation of a wringer, can keep pace with four nitrators.

Mixed acids.

18. The acids used are made by mixing sulphuric and nitric acids in the proper proportions. The nitric acid from the nitric acid plant has some sulphuric acid in it for safe transportation. More is added in order to give the proper percentages



Fig. 6.—Nitrating House (2nd Floor).

of each and also the proper acidity. These are called the mixed acids. After nitration, the acids discharged by the wringer are run off for salvaging for further use. They are called the spent acids. From an analysis of the spent acids it is determined how much nitric acid and sulphuric acid must be added to make mixed acids of the correct proportions. New or fortifying acids are used for this purpose. Thus a sort of cycle is made, the acids being used over again with the addition of sufficient to replace that taken out by the nitrated cotton. When it is desired to separate the spent acids for recovery, they are transported to the acid recovery plant, which is a part of the nitric acid plant. There the nitric acid is vaporized in contact with steam, condensed and recovered. The denitrated sulphuric acid is then bleached and delivered to storage tanks.

19. The product is now a cellulose nitrate, usually called "pyrocellulose," or "pyro," containing an excess of acid, cellulose sulphates, and other impurities which may be detrimental to the stability of the final product. It is impossible to control the nitration process so that the product will contain a single nitrobody, but it is usually a mixture of nitrates of different percentages of nitrogen. Some are of the lower order of nitrocelluloses, which are not very stable, and these with the sulphates and other impurities must be removed to insure the final product having a uniform stability. Pyro purification.

20. After nitrating, the pyro contains an excess of acid which would cause the material to "fire" in air, the cotton charring and giving off dense nitrous oxide fumes. For this reason it is necessary to "drown" the product in water. In Drowning.



Fig. 7.—Pyro Discharge to Boiling Tubs (1st Floor).

the dipper system, this is done in the receiver or immersion basin, by the stream of water admitted for conveying the pyro to the tubs. By thus keeping the material in water, most of the free acid is allowed to pass off. In the pot and wringer systems of nitration, the pyro is quickly removed and dropped in tubs of water called drowning tubs. In the replacement system, where water is added, the excess acids are washed out and firing does not occur.

21. The flume from the nitrating house (fig. 8) conducts the pyro by gravity to a double row of wooden tubs, each holding about 1,200 pounds of pyro, and by means of a system of gates may discharge into any one of them direct, thus providing cheap, safe, and effective transportation of the pyro. The tubs are of two types. One is fitted with a false bottom on which the pyro rests and beneath which a perforated steam pipe injects steam for supplying the heat for boiling. Boiling.

Where the steam pipe enters it is entirely protected by wooden covers from the pyro, thus preventing the cotton from coming into contact with a hot pipe. Another and a later type is fitted with a percolator pipe so arranged that steam can not touch the pyro, but a circulation is given the contents of the tub. The pyro must be boiled for 40 hours to insure complete purification with at least four changes of water. It must be kept entirely covered during the process and the temperature of the water and ratio of steam to water such that actual boiling takes place.

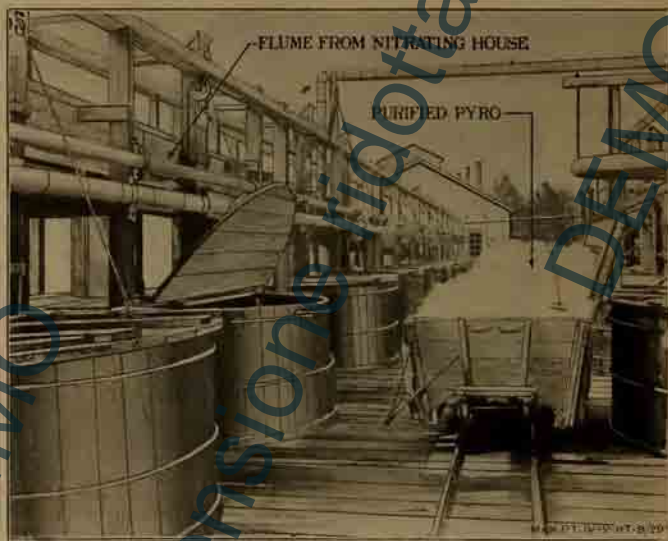
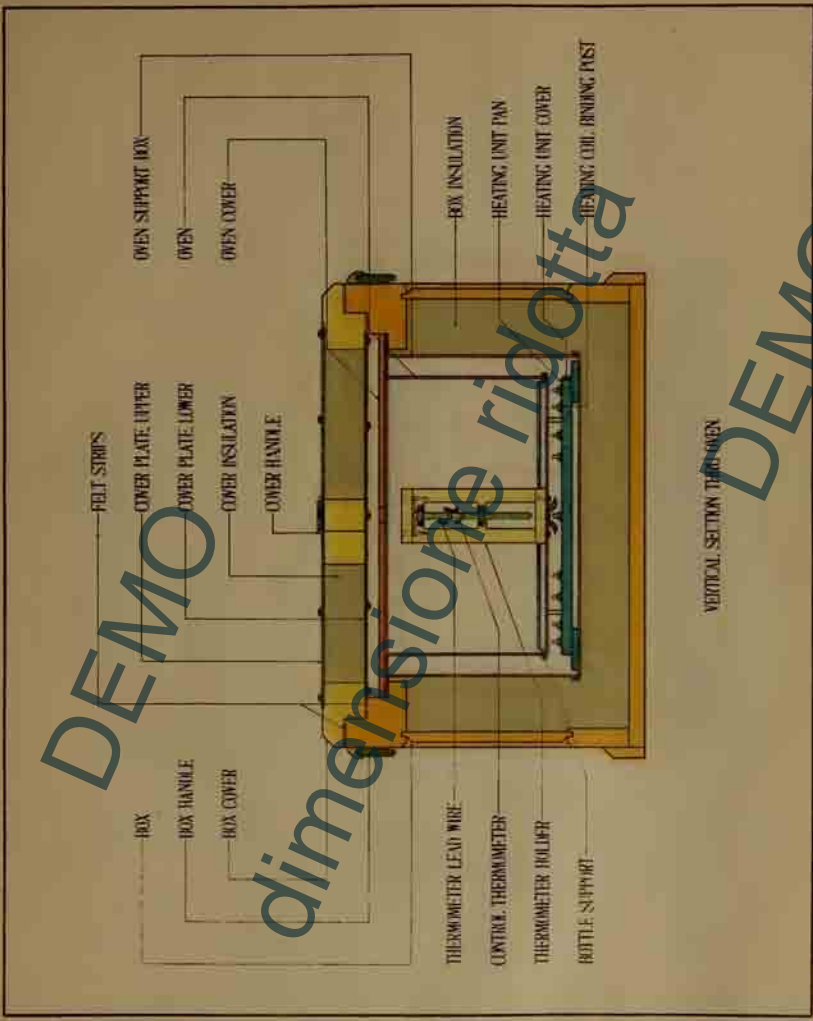


Fig. 8.—Boiling Tubs.

22. A tub is charged with the pyro, sufficient water run in to cover all the material, and steam turned on long enough to raise the temperature to 80°. The tub is then drained, refilled, and actually boiled for 16 hours. This operation is repeated three times with 8 hours actual boiling each time. On the conclusion of this treatment, the pyro is removed to a stuff chest in the pulping house for further treatment. It is most important that water of such purity be used that no additional impurities be introduced.

Pulping.

23. *Pulping.*—The treatment after nitration up to this point may be considered the preliminary purification, for only such excess acids and impurities



VERTICAL SECTION THERM OVEN

Surveillance Oven, Mark II, Mod. 1.

CASE AMMUNITION: TYPES.

7. Plate 8 shows the assembly of 1-pounder ammunition. Figure 1 is the saluting ammunition; Figure 2 is the assembly with service projectile, either nose or base fused; and Figure 3 shows the assembly of day tracer ammunition for antiaircraft guns.

Plate 9 shows the assembly of 3-pounder ammunition, Figure 1 the saluting and Figure 3 the service charges. Target practice ammunition is the same except for the loading of the projectiles, Figure 3.

Plate 10 shows the assembly of 6-pounder saluting and service ammunition. Target ammunition is the same except for the loading of the projectiles.

Plate 11 shows the assembly of 3"/23 F. G. ammunition.

Plate 12 shows the assembly of 3"/23 U. V. ammunition for the 3"/23 guns in use for submarine and antiaircraft work. For antiaircraft use, these cartridges are crimped and assembled without wads and distance pieces.

Plate 13 shows the assembly of Davis gun ammunition, 6-pounder, 9-pounder, and 3-inch.

Plate 14 shows the assembly of 3"/50 ammunition with different types of projectiles used.

Plate 15 shows the assembly of 4"/50 ammunition with different types of projectiles used.

Cartridge tanks and boxes: variety of types.

8. Case gun ammunition is issued in special tanks and boxes for safe transportation and stowage. Each type of ammunition has its own box or tank, and each ship has the magazines arranged for the standard tank or box which goes with the battery. It is important to note that different types of projectiles have nose blocks to fit, and should it be necessary to restow ammunition that has been removed from the containers, care should be exercised that cartridge cases are returned to the proper tanks or boxes, in accordance with the proper markings, and that the same blocks are used as were originally issued. This provision is more important now that ready service boxes are provided at guns for the stowage of unboxed or unboxed cartridges.

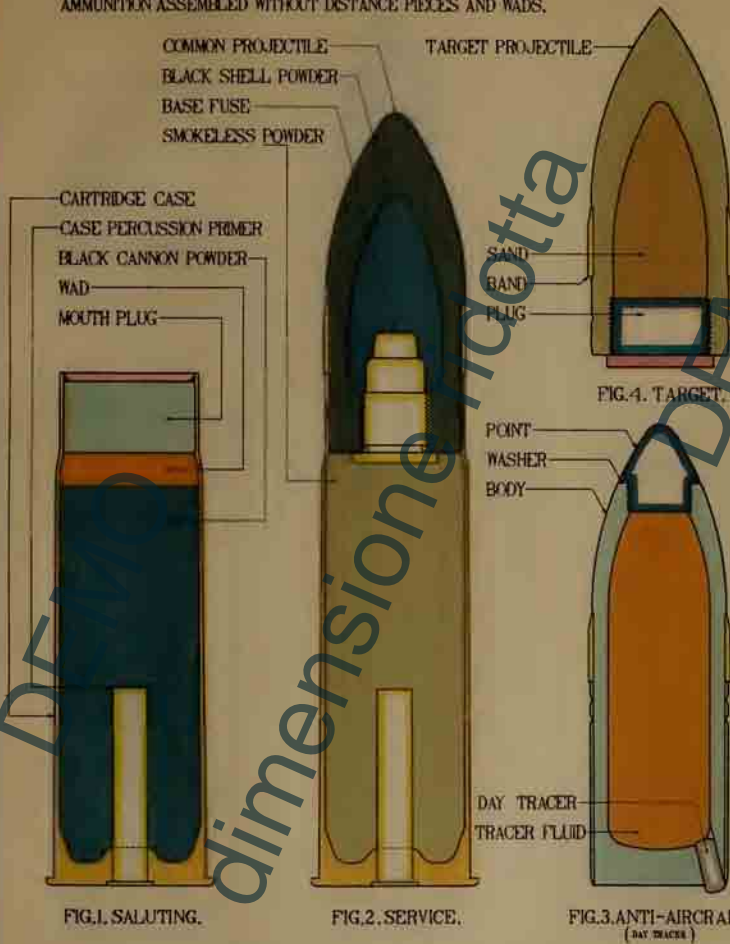
Number of cartridges in tanks or boxes.

9. As many cartridges are packed in a container as will allow easy handling.

4 inches and above.....	1 per box.
3"/50.....	4 per box.
3"/23.....	6 per box.
3"/23.....	7 per box.
6-pounder.....	11 per box.
6-pounder.....	7 per box.
3-pounder.....	16 per box.
1-pounder antiaircraft.....	100 per box.
1-pounder.....	60 per box or tank.

10. The 1-pounder ammunition box, Mark II, is shown in Figure 34. It has a transom with openings for 60 cartridges. The bottom of the box has a recess cut corresponding to each opening in the transom, and the top has a recess for

AMMUNITION ASSEMBLED WITHOUT DISTANCE PIECES AND WADS.



1-Pdr. Ammunition.

DEMO

dimensione ridotta

DEMO

COMMON PROJECTILE
 T. N. T. - B. P.
 TRACER FUSE
 DISTANCE PIECE
 WAD
 SMOKELESS POWDER

AMMUNITION ASSEMBLED WITH
 DISTANCE PIECES AND WADS.

CASE PERCUSSION PRIMER
 CARTRIDGE CASE
 BLACK CANNON POWDER
 WAD
 MOUTH PLUG

TARGET PROJECTILE

SAND
 BAND
 PLUG

FIG. 1. SALUTING.

FIG. 2. SERVICE.

FIG. 3. TARGET.

- | | | |
|-----------------------|--------------------|-------------------|
| CARTRIDGE CASE | CARTRIDGE CASE WAD | POWDER CHARGE |
| RECOIL CHARGE | GAS CHECK | ROTATING BAND |
| GREASE RETAINER | PRIMER BOSS | BASE FLUSE |
| CARTRIDGE CASE FLANGE | PRIMER ADAPTER | T. N. T. B. P. |
| LOCATING BOSS | PRIMER | COMMON PROJECTILE |



FIG. 1. 6 POUNDER.

- | | | |
|-------------------|----------------------------|-----------------------|
| DISTANCE PIECE | WAD | ROTATING BAND |
| PROPELLING CHARGE | DELAYED ACTION FLUSE | NOSE PLUG |
| LOCATING KEY | HOLES FILLED WITH PARAFFIN | FLIP NOSED PROJECTILE |
| DRIVING BAND | PRIMER | T. N. T. B. P. |
| REAR BLOCK | RECOIL CASE | |



FIG. 2. 9 POUNDER.

- | | | |
|-----------------------|-----------------|--------------------|
| VASELINE | RECOIL CHARGE | CARTRIDGE CASE |
| GREASE RETAINER | GAS CHECK RIDGE | POWDER CHARGE |
| WAD RETAINING SPRING | GAS CHECK | FLUSE |
| CARTRIDGE CASE WAD | GAS CHECK WAD | ROTATING BAND |
| CARTRIDGE CASE FLANGE | PRIMER | BLACK SHELL POWDER |
| LOCATING BOSS | PRIMER BOSS | COMMON PROJECTILE |



FIG. 3. 12.5 INCH.

- | | | |
|-----------------------|----------------|-----------------------|
| PARAFFIN | GAS CHECK | POWDER CHARGE |
| RECOIL CHARGE | GAS CHECK WAD | CARTRIDGE CASE |
| VASELINE | GAS CHECK STOP | ROTATING BAND |
| CHARGE RETAINER | PRIMER BOSS | CAST T. N. T. |
| CARTRIDGE CASE FLANGE | PRIMER | FLAT NOSE PROJECTILE |
| LOCATING BOSS | | NOSE DETONATING FLUSE |

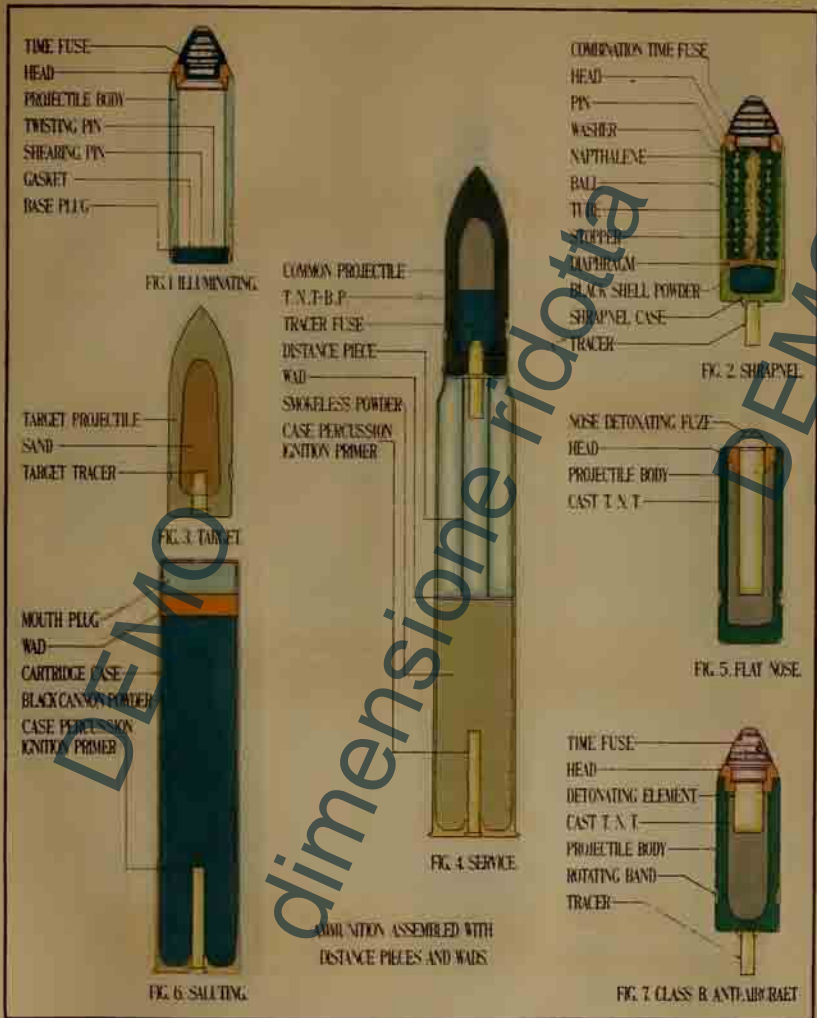


FIG. 4. NEW 3-INCH.

DEMO

dimensione ridotta

DEMO



3-Inch 50 Caliber Ammunition.



Fig. 44.—5" Powder Tanks.



Fig. 45.—12" Powder tanks.



Fig. 46.—14" Powder Tank.



Fig. 47.—16" Powder Tank.

Mechanical
fuse.

26. These conditions affecting the uniformity of time fuses are disadvantages, some of which could be reduced and others eliminated by the use of a mechanical time fuse operating by clockwork. However, it is most difficult to control the forces acting on the parts of a mechanical time fuse when fired in a high-powered gun. This problem, that of devising a mechanical fuse which will function properly, regardless of storage conditions, size of gun, initial velocity of rotation, or angles of elevation, is one still to be solved.

F. O. and L. G.
fuses.

27. There are three types of time fuses fitted to field and landing gun ammunition and shrapnel for other purposes and one type for an aircraft use. They are the

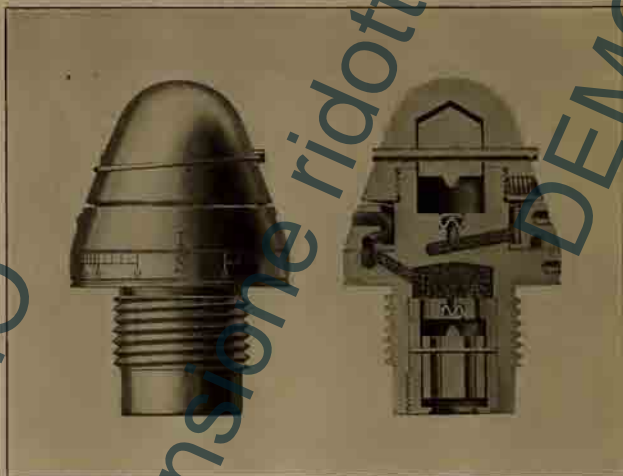


Fig. 55.—Bethlehem 12-second combination Fuse.

Bethlehem 12-second combination, the Frankford Arsenal 21-second combination, the Washington Navy Yard combination Mark IX, and the Scoville time fuse, Mark XI, Mods. 2 and 3. The first two are practically obsolete and are found only in the Mark I, Mark I Mod. 1, and Mark III shrapnel, called old shrapnel. The latest shrapnel are fitted with the Frankford Arsenal, the Washington Navy Yard, or the Scoville Mark XI Mod. 1 or 4 21-second combination fuses. The Scoville Mark XI Mod. 2 and 3 time fuses are used for shrapnel, illuminating projectiles, and high explosive projectiles for use in antiaircraft work. Time fuses without percussion elements are recognized by the red tops.

28. The Bethlehem 12-second combination time and percussion fuse is shown in Figure 55. It has plungers and wire similar to those of the usual percussion shear-wire fuse, but the time plunger is so arranged that the shock of firing not only breaks the wire but explodes the primer cap, filling the angular cavity of the fuse with flame. This flame escapes through the vent at the same time igniting the zero end of the time train; a piece of quick match, leading from the time composition to the vent, insuring ignition. The time composition, which consists of a special mixture, is loaded in the train disk under considerable pressure. The train is of the horse-shoe type and extends through an arc of 315° . The stock is graduated in quarters up to 12 seconds. As the scale is large and distinct, settings of one-eighth second can be made without difficulty. The lock pin which is removed just before setting the fuse, furnishes an additional safety in keeping the time plunger from impacting against the primer cap if the ammunition should be accidentally dropped. A spring washer firmly holds the train disk in set position and insures good contact of the time composition with the felt cushion washer, so that burning of composition takes place only on radial cross section of composition.

29. The magazine is filled with fine-grained rifle powder. The percussion element of the fuse is similar to the usual type of wire fuse, except that the plunger is provided with longitudinal flame passages, as is also the anvil that holds the primer cap, the holes in the anvil cap being covered by a thin piece of shellacked linen.

30. The fuse is made waterproof by dipping it in a bath of shellac, a thin but complete seal being thus formed.

31. *Setting.*—The lock pin is to be used as a setting tool, either end being adapted for insertion in the setting hole of the train disk, which should be moved until the index is brought in alignment with the graduation of time desired. The initial movement in setting of the disk should be right handed, as the fuse has a right-hand thread, and reverse motion might have a tendency to unscrew the same from shrapnel head.

32. *Frankford Arsenal 15-second combination time and percussion fuse.*—This fuse, shown in Figure 56, is no longer being manufactured, though a number bought from the Army are in service. The action of the fuse is as follows:

(a) *As a time fuse.*—A hole is punched through the cover, the time train, and the lead cone at the point in the cover corresponding to the number of seconds desired. Just before loading, the safety pin is removed. This allows the time plunger to rest on the fuse body, where it is held by the split ring. By shock of discharge, the split-ring spring is expanded and the plunger forced to the rear, the primer in the plunger striking the point and exploding. The flame from the primer passes through four radial holes and ignites the ring of compressed powder. The only vent for these gases is the punched hole, and they ignite the time train at that point. The latter burns and ignites the powder in the tube and the magazine. The flame from the magazine charge passes through the percussion primer plug and percussion plunger and ignites the bursting charge in the shrapnel.

Bethlehem 12-second fuse.

Frankford Arsenal 15-second fuse.

DEMOS

(2) *As a percussion fuse.*—By shock of firing the sleeve is carried to the rear. The split ring opens out and is forced back into the groove around the rear end of the plunger, where it springs into place. The plunger and sleeve are now locked together and the point exposed. On impact, both fly forward and explode the primer cap.

This fuse is set with a fuse punch, shown on Figure 59.

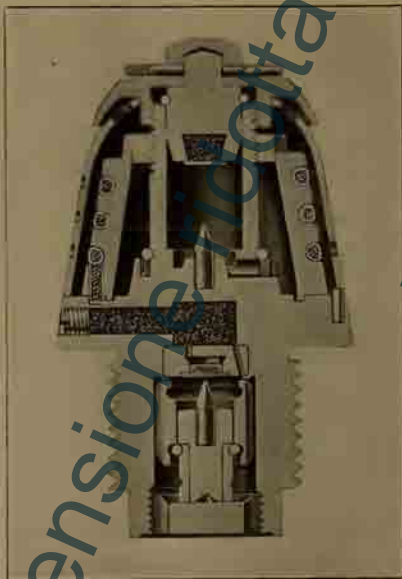


Fig. 56.—Frankford Arsenal 15-second combination Fuse.

Frankford 21-second fuse.

33. The Frankford Arsenal 21-second combination fuze, Figure 57, model 1907 M (Mark IX), is assembled as follows:

34. The body of this fuse is machined from a bronze casting. The time train rings are turned from hard-rolled rods of Tobin bronze. An annular groove in the shape of a horseshoe is milled in the lower face of each of the time-train rings. Meal powder is compressed into these grooves under a pressure of 66,000 pounds per square inch, forming a time train, the total length of which is 7 inches.

35. The time element of this fuse is composed of the following principal parts: The time or concussion plunger, the concussion resistance ring, the firing pin, the vent, leading to the upper time train, the compressed powder pellet, the upper time train, the vent, the lower time train, the compressed powder pellet, in the vent leading to powder magazine.

36. The plunger is cylindrical in shape and contains the percussion composition in a recess at its base. The weight of the plunger rests upon the concussion resistance ring, which keeps the primer from contact with the firing pin. At discharge of the gun, the resistance of the ring is overcome and the primer is exploded by contact with the firing pin.

37. As stated above, the annular grooves into which the meat powder of the time train is pressed are in the shape of a horseshoe, a solid portion being left between the ends of the groove in each ring or disk.

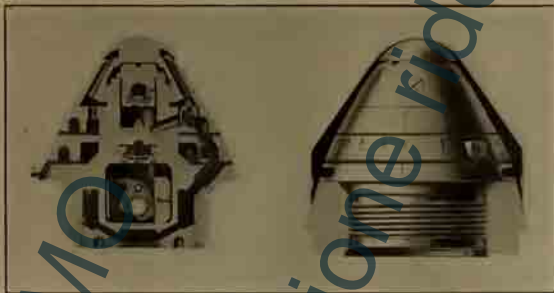


Fig. 57.—Frankford Arsenal 21-second combination Fuse.

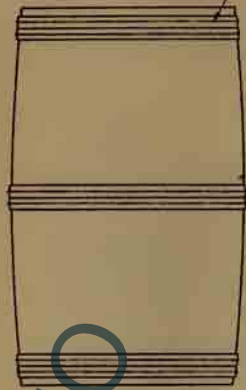
38. The upper time train ring is prevented from rotating by pins which are halved into the fuse body and the inner circumference of the ring.

39. The vent is drilled through the walls of the concussion plunger chamber, and is exactly opposite a hole in the inner surface of the upper time train leading to the end of the train from which the direction of burning is anticlockwise.

40. The hole is drilled through the upper face of the lower time train ring to the end of the lower time train groove, from which the direction of burning is clockwise. The lower time train ring is movable and is graduated on its outer edge in a clockwise direction from 0 to 21.2, each full division corresponding to 1 second time of burning in flight. These divisions are subdivided into five equal parts corresponding to one-fifth second. A radial pin is provided in the lower ring for engagement with a notch in the fuse setter for setting the fuse. A line on the lower flange of the fuse stock is the datum line for fuse settings.



KEG HEAD PAINTED BLACK, USE WHITE STENCILED LETTERS.

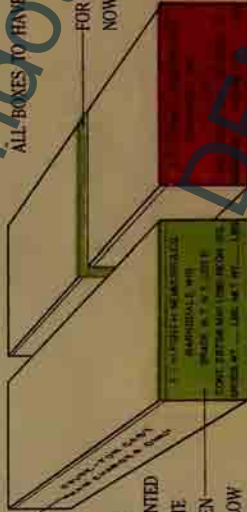


WOODEN KEG WITH WOODEN HOOPS, COPPER WIRE BOUND. KEG PAINTED NON-ACID BLACK.

FIG. 1. EXPLOSIVE D. KEG.

FOR GRADE B, TNT, PACKING BOX ONLY.

- BOX
- END PAINTED
- GRADE A, TNT. WHITE
 - GRADE B, TNT. GREEN
 - T.N.A. YELLOW
 - T.N.X. RED



ALL BOXES TO HAVE BLACK STENCILED LETTERS. FOR T.N.X. PACKING BOXES NOW IN SERVICE ONLY.

FIG. 2. HIGH EXPLOSIVE BOXES.

10. Index numbers will not be assigned to lots of black powder.

11. Containers for black powder should always indicate the kind of powder, such as—

- (a) Cannon.
- (b) Shell.
- (c) Sphero-hexagonal (torpedo impulse).

12. High explosives (Plate 26) will be supplied the ammunition depots in containers conforming to the Interstate Commerce Commission regulations, explosive "D," in wooden kegs with copper wire-bound wooden hoops; other high explosives in wooden boxes. These containers must have interior paper linings sealed on packing. The containers are not to be used again for the purpose of making shipments, but should be destroyed. They are marked to show the material, manufacturer, contract number and date, requisition number, lot number, gross and net weight, thus

E. I. duPont de Nemours & Co., Barksdale, Wis.

Grade "A" T. N. T., Lot 1

Cont. 28757, May 1, 1916, Reqn. 123.

Gross ——— Lbs. Net ——— Lbs.

13. Explosive "D" containers will be painted a nonacid black with white stenciling.

14. The boxes for other high explosives will have the ends painted a solid color with black stenciling, as follows:

Grade A, T. N. T.	White.
Grade B, T. N. T.	Green.
T. N. A.	Yellow.
T. N. X.	Red.

In addition, grade "B," T. N. T. containers will have stenciled on the side the following precautionary note:

"Crude—for cast main charges only."

This marking is very important, as grade "B," T. N. T. is intended only for use in cast main charges of torpedo war heads, mines, depth charges, and bombs, and never for use as a burster charge of a projectile or burster charge either in the cast or granular form.

NOTE.—T. N. X. containers now have green bands painted around middle of container. These need not be changed, but will assist in identifying T. N. X. containers with red ends.

15. Poison gas is shipped in containers ready for loading direct into projectiles. Special markings on each container, such as a black cross or a green cross or other geometrical figure, will denote the kind of material. These markings will be known by special arrangements between the manufacturer, the bureau, and the ammunition depots. Gas containers are to be packed in strong air-tight barrels, with heads paraffined, suitably marked with a broad red band with the number of containers

and kind and color of geometrical figure, name of manufacturer, contract number, date of loading, gross and net weight of each container.

Marking of ammunition for ships' bag gun charges.

16. All bag gun charges (Plate 27) put up in silk powder bags shall be marked with stencil on each bag in black letters, three-fourths inch high, parallel to and on the opposite side from the lacing, as follows:

- Caliber of gun (and mark if required).
- Index number of powder.
- Weight of smokeless powder contained in bag.
- Proportion bag bears to full (or experimental) charge.
- Initial velocity.
- Initials of inspector.

The letters "F. C." shall be used on the legend as an abbreviation of the words "full charge." If the bag constitutes the full charge, it is marked "F. C.," but if only part of the full charge, it is marked " $\frac{1}{2}$ F. C.," " $\frac{3}{4}$ F. C.," etc., as the case may be. Reduced charges are no longer issued to service, except for target or experimental firing, in which case the marking of the bag (and also of the identification tag and powder tank) shall read "Exp. Chg.," " $\frac{1}{2}$ Exp. Chg.," etc., as the case may be.

17. The dyed ignition ends of bag gunpowder bags shall be marked in black letters, three-fourths inch high, as follows:

Ignition grams.

18. No paint containing oil shall be used in marking bags and care must be taken not to blur the stenciling.

Powder identification tags.

19. Identification tags are to be used with all smokeless powder charges. These tags contain the following data:

- Caliber of gun.
- Index of powder.
- Weight of powder contained and proportion of full or experimental charge.
- Initial velocity.
- Weight of ignition (if ignition is contained in primer, state "primer ignition").
- Fahrenheit readings of wet and dry bulb thermometers. (See United States Naval Ordnance Manual, Pt. V, art. 202.)
- Ammunition depot (where prepared).
- Date.
- Initials of weigher.
- Initials of checker.
- Initials of gauger.
- Initials of gunner in charge.
- Initials of inspector in charge.

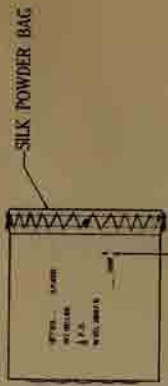


FIG. 1. POWDER BAG.



UNPAINTED
UNPAINTED
BLACK

COPPER
TANK—GALVANIZED IRON
SHEET STEEL

BLACK STENCILED LETTERS

WHITE BAND 2" WIDE

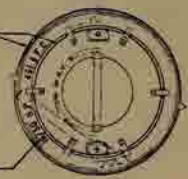


FIG. 2. POWDER TANK.

Bag Gur Charge Containers.

DEMO
dimensione ridotta
DEMO

SEPARATE CASE AMMUNITION, 6"/50, 6"/45, 6"/40, 4"7/16 ENG.,
 FOR SERVICE AMMUNITION, BOX PAINTED..... LIGHT GREEN
 FOR TARGET AMMUNITION, BOX PAINTED..... RED

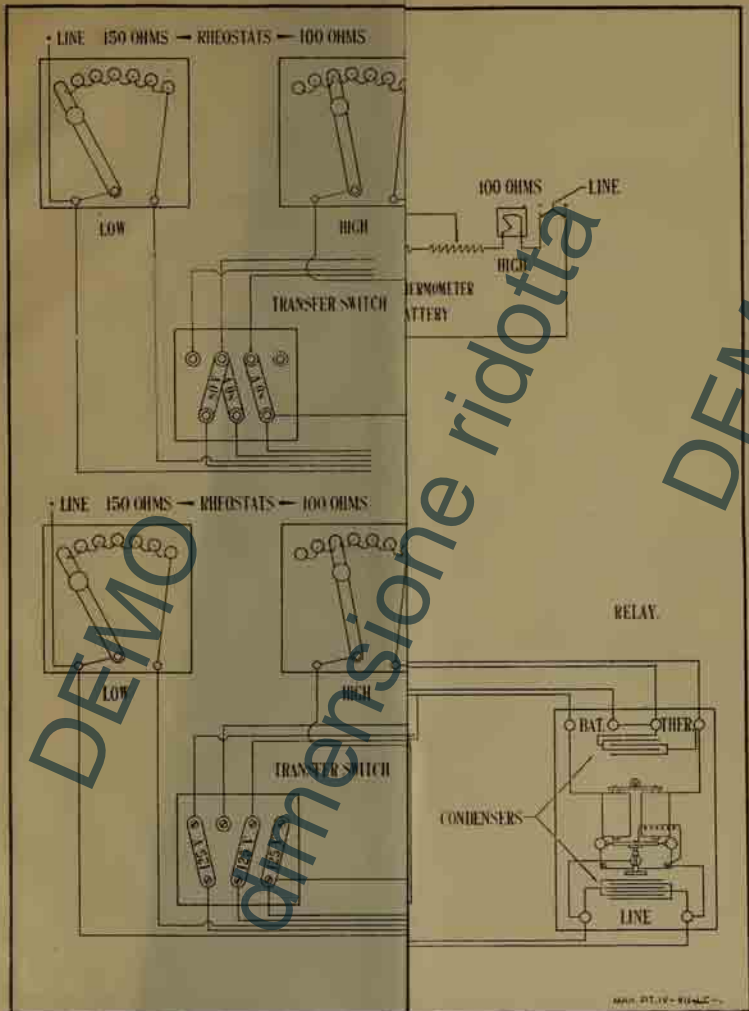
dimensioned by Ridotta



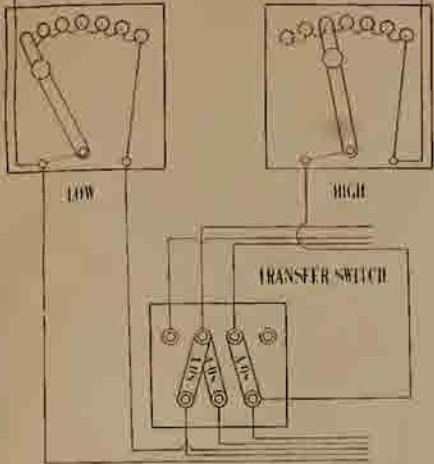
* BLACK STENCILED LETTERS

DEMO

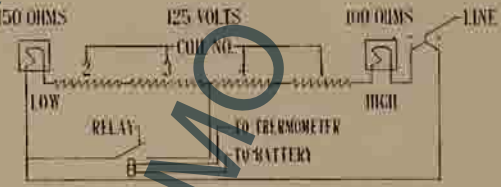
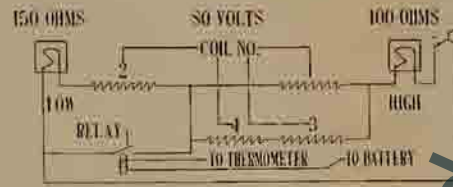
Separate Case Ammunition Box.



LINE 150 OHMS RHEOSTATS 100 OHMS LINE



80 VOLT CIRCUIT.



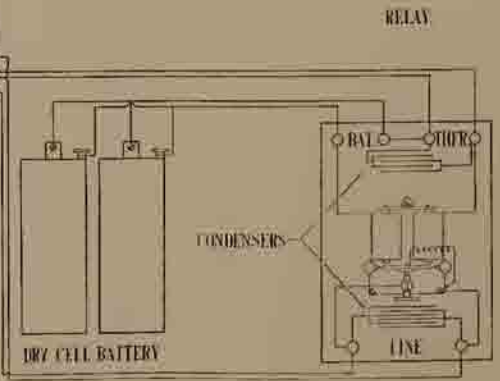
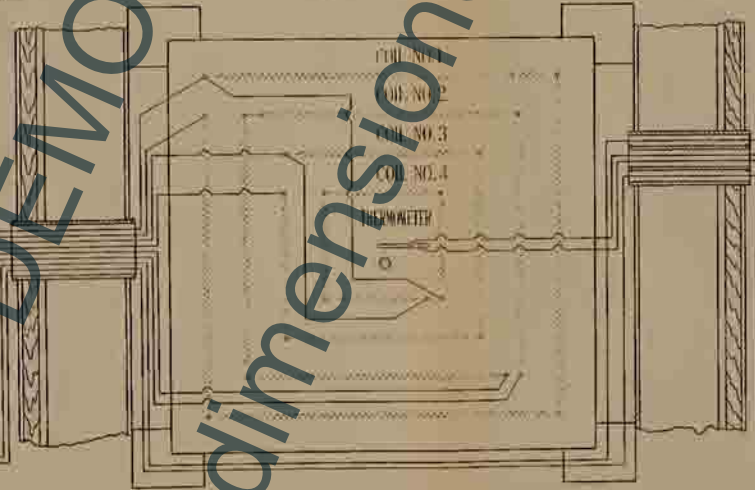
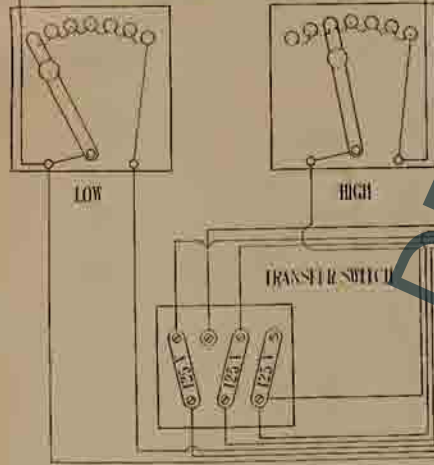
WIRING DIAGRAMS.

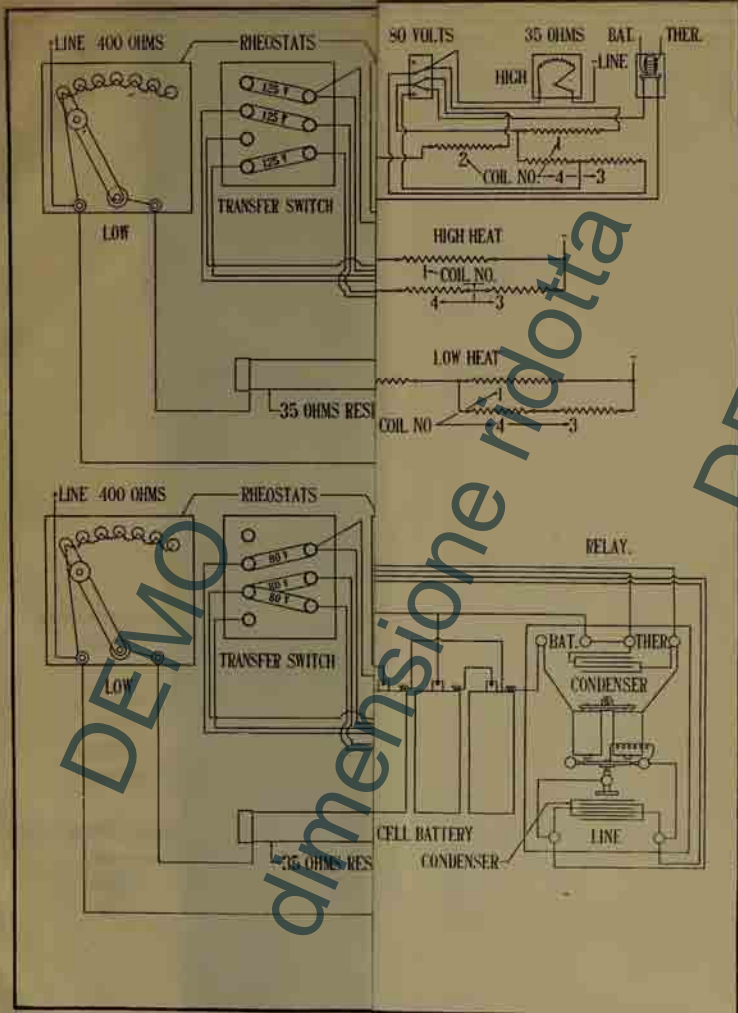
125 VOLT CIRCUIT.

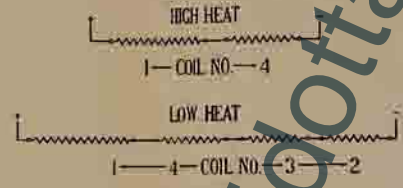
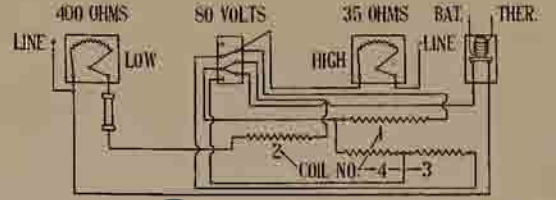
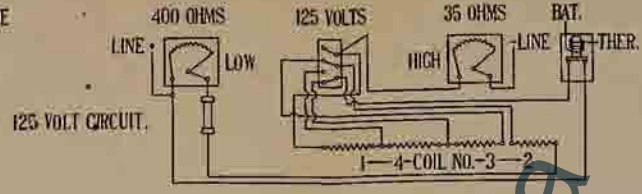
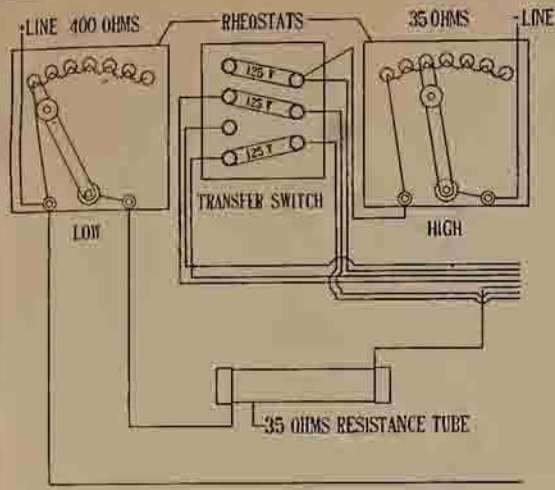
HEATING ELEMENT

BOX

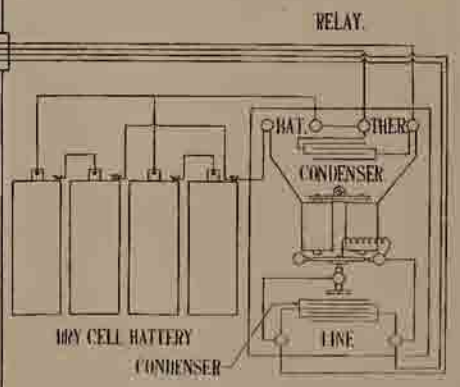
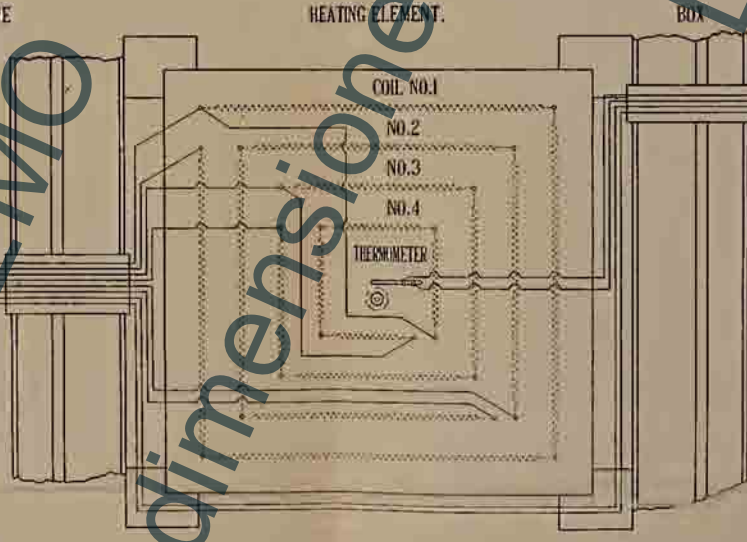
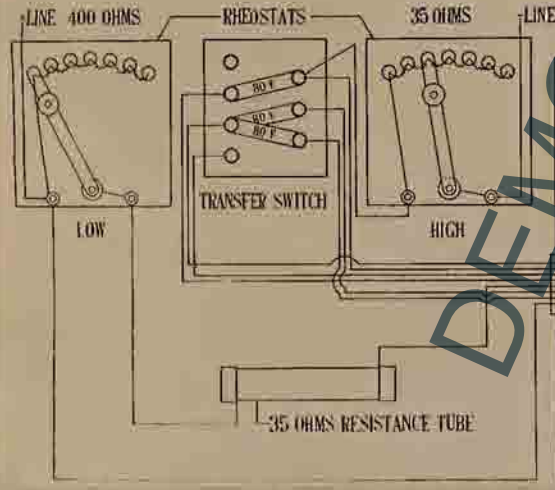
LINE 150 OHMS RHEOSTATS 100 OHMS LINE







WIRING DIAGRAMS.



DEMO

dimensione ridotta

DEMO

WINCHESTER PRIMER
 ANVIL
 PRIMER CAP
 EXPLOSIVE MIX

PERCUSSION PLUNGER
 CUP INSULATOR
 CUP
 CUP WASHER
 INSULATOR
 PLUNGER

PERCUSSION PLUNGER GROUP
 CUP WASHER
 CUP
 CUP INSULATOR
 PLUNGER
 WASHER
 INSULATOR

WINCHESTER PRIMER NO. 2½
 EXPLOSIVE MIXTURE
 PRIMER CAP
 ANVIL

PRIMER CHARGE
 IGNITION CHARGE
 PRIMER STOCK EXTENSION
 PRIMER STOCK EXTENSION WAD
 PRIMER STOCK EXTENSION PLUG
 STOCK EXTENSION WRAPPING
 IGNITION TUBE
 IGNITION TUBE WRAPPING



DEMO

dimensione ridotta

DEMO

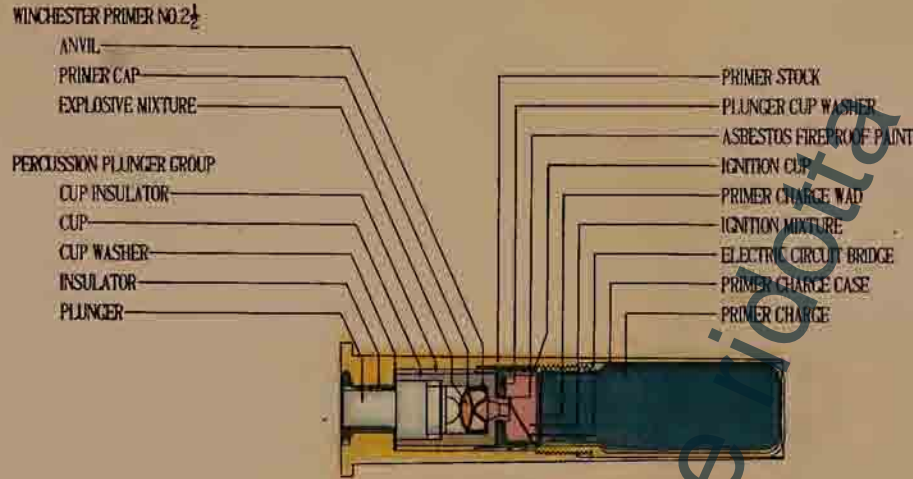


FIG. 1. LOCK COMBINATION PRIMER, MARK XV.

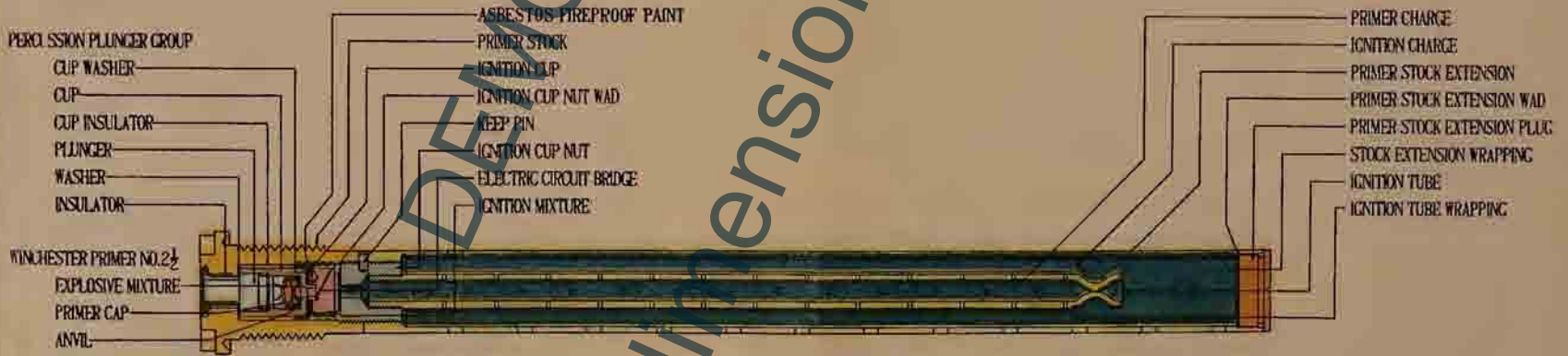


FIG. 2. CASE COMBINATION IGNITION PRIMER, MARK XIII.