TECHNICAL REGULATIONS
No. 1360-3A

WAR DEPARTMENT,
WASHINGTON, *July 31, 1936.*

ANTIAIRCRAFT AMMUNITION

AMMUNITION FOR 3-INCH AND 105-MM ANTIAIRCRAFT GUNS

Prepared under direction of the
Chief of Ordnance

SECTION I

GENERAL

1. **Purpose and scope.**—These regulations are intended for the using arms and the Ordnance Department. They give all necessary information regarding the construction, functioning, and identification of ammunition and its components provided for antiaircraft cannon of all types.

2. **References.**—*a.* General instructions for handling ammunition are published for the Army in TR 1370–A and personnel should be thoroughly familiar with these regulations before attempting to handle ammunition of any type. Regulations governing the handling of ammunition at establishments of the Ordnance Department are published in O. O. Form No. 7224, "Ordnance Safety Manual."

* This pamphlet supersedes TR 1360–3A, March 19, 1928.

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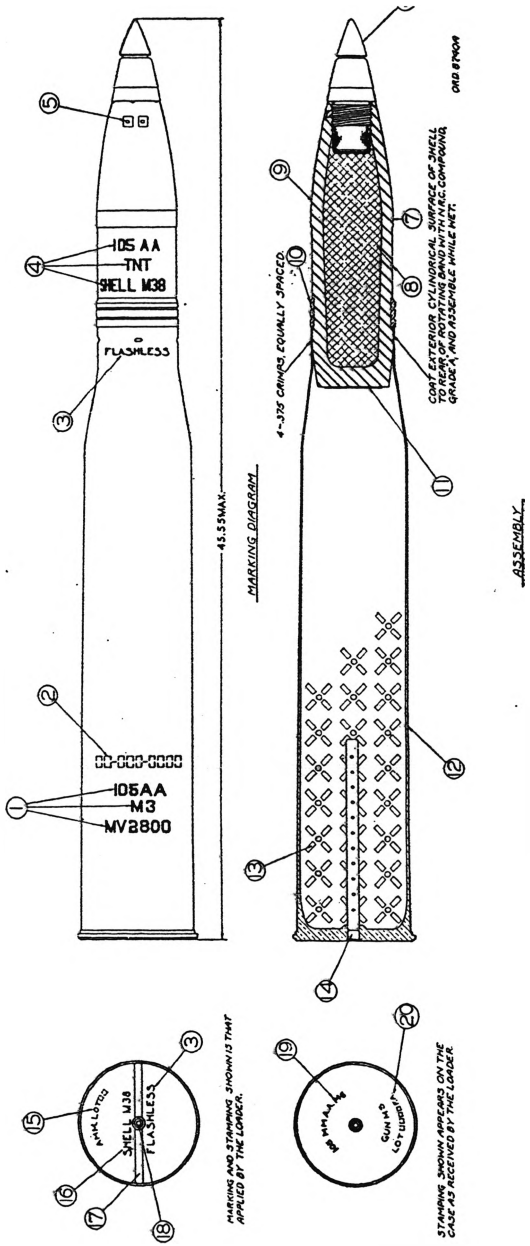

FIGURE 2.—Shell, fixed, H. E., M38, 105-mm antiaircraft gun, M3.

1. Caliber and model of cannon with velocity in feet per second. Black rectangle denotes service charge.
2. Powder lot; includes initials of manufacturer, symbol of powder, lot number, and year of manufacture.
3. "Flashless" indicates FNH powder.
4. Caliber of cannon, explosive filler, and shell model stenciled in black. Shell body painted yellow.
5. Weight zone marks.
6. Mechanical time fuze, M2.
7. Bourrelet.
8. Explosive filler (TNT).
9. 105-mm shell, M38.
10. Rotating band.
11. Base cover.
12. 105-mm antiaircraft cartridge case, M6.
13. Propelling charge.
14. 330-grain percussion primer, M21.
15. Ammunition lot number.
16. Model of shell.
17. Black stripe denotes service charge.
18. Rim of primer head stamped with model, initials of loader, lot number, and year loaded.
19. Model of cartridge case and cannon for which it is adapted.
20. Lot number of cartridge case.

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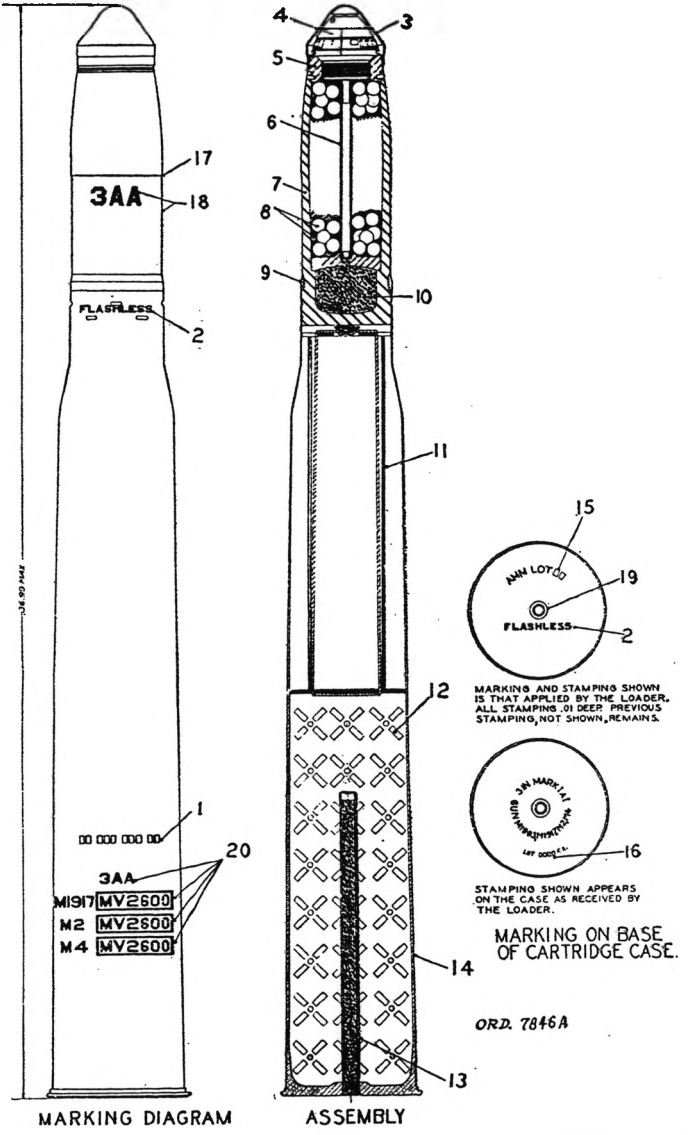


FIGURE 3.—Shrapnel, fixed, Mk. I, 3-inch antiaircraft guns, M1917, M1925MI, M2, and M4.

1. Powder lot number.
2. "Flashless" indicates FNH powder.
3. Fuze cover.
4. Fuze, antiaircraft, 21-second, Mk. IIIA1.
5. Shrapnel head.
6. Flash tube.
7. Shrapnel case.
8. Shrapnel balls (lead) and matrix (rosin).
9. Rotating band.
10. Base charge (black powder).
11. Distance wad.
12. Propelling charge.
13. Primer, percussion, M21.
14. Case, cartridge, Mk. IA1.
15. Ammunition lot number.
16. Cartridge case lot number.
17. Bourrelet.
18. Shrapnel case coated with red projectile paint, caliber of cannon stenciled in black.
19. Rim of primer head stamped with model, initials of loader, lot number, and year loaded.
20. Caliber and model of cannon with muzzle velocity in feet per second. Black rectangle denotes service charge.

SECTION III

COMPLETE ROUND DATA

7. Complete round data.—All complete rounds of 3-inch antiaircraft ammunition, together with their component weights and the guns from which they may be fired, are listed in tables I and II. Table III contains complete round data for 105-mm antiaircraft ammunition. The components which are assembled in any particular lot of ammunition may be determined by reference to the ammunition data card described in paragraph 6. For muzzle velocities of the different projectiles in the various guns see paragraph 38.

TABLE I.—*3-inch antiaircraft ammunition for mobile mounts*

Guns	Complete rounds and components	Approximate weight (pounds)
	Complete round no. 1 [1]	
3-inch antiaircraft guns, M1918 and M1918MI. (Rifling: 1 turn in 50 to 1 turn in 25 calibers.) 3-inch antiaircraft guns, M1918A1 and M1918MIA1. (Rifling: 1 turn in 25 calibers.)	Shell, fixed, H. E., Mk. I	27. 49
	Composed of:	
	Shell, H. E., Mk. I (fuzed)	15. 64
	Includes:	
	Shell body	10. 75
	Fuze, A. A., 21-second, Mk. IIIA2.	1. 25
	Fuze cover [2]	. 05
	Adapter	. 81
	Booster, Mk. X	. 81
	Explosive filler, TNT	1. 72
	Rotating band	. 16
	Base cover	. 09
	Case, cartridge, Mk. IIA1	6. 75
	Distance wad	. 19
	Propelling charge (NH powder)	4. 62
	Primer, percussion, M21	. 29
	Complete round no. 2 [1]	
3-inch antiaircraft guns, M1918 and M1918MI. (Rifling: 1 turn in 50 to 1 turn in 25 calibers.) 3-inch antiaircraft guns, M1918A1 and M1918MIA1. (Rifling: 1 turn in 25 calibers.) 3-inch antiaircraft guns, M1918A2 and M1918MIA2, and 3-inch antiaircraft guns, M1 and M3. (Rifling: 1 turn in 40 calibers.)	Shell, fixed, H. E., Mk. IX	24. 50
	Composed of:	
	Shell, H. E., Mk. IX (fuzed)	12. 74
	Includes:	
	Shell body	8. 37
	Fuze, A. A., 21-second, Mk. IIIA2.	1. 25
	Fuze cover [2]	. 05
	Adapter	. 85
	Booster, Mk. X	. 81
	Explosive filler, TNT	. 91
	Rotating band	. 46
	Base cover	. 04
	Case, cartridge, Mk. IIM2	6. 66
	Distance wad	. 19
	Propelling charge (NH powder)	4. 62
	Primer, percussion, M21	. 29

Footnotes at end of table.

TABLE I.—*3-inch antiaircraft ammunition for mobile mounts*—Continued

Guns	Complete rounds and components	Approximate weight (pounds)
	Complete round no. 3	
Fired from the same guns as complete round no. 2.	Shell, fixed, H. E., M42	24. 58
	Composed of:	
	Shell, H. E., M42 (fuzed)	12. 78
	Includes:	
	Shell body	9. 28
	Fuze, A. A., 21-second, Mk. IIIA2.	1. 25
	Fuze cover [2]	. 05
	Fuze well cup	. 02
	Booster, M20	. 81
	Set screw	. 01
	Explosive filler, TNT	. 86
	Rotating band	. 46
	Base cover	. 04
	Case, cartridge, Mk. IIM2	6. 66
	Distance wad	. 18
	Propelling charge (NH powder)	4. 67
	Primer, percussion, M21	. 29
	Complete round no. 4	
Fired from the same guns as complete round No. 2.	Shell, fixed, H. E., M42	24. 77
	Composed of the same components as complete round no. 3, except the shell is fitted with a mechanical time fuze, M43, in lieu of the 21-second antiaircraft fuze, Mk. IIIA2.	
	Complete round no. 5 [1]	
Fired from the same guns as complete round No. 2.	Shrapnel, fixed, Mk. I	27. 15
	Composed of:	
	Shrapnel, Mk. I (fuzed)	15. 30
	Includes:	
	Shrapnel case	6. 03
	Fuze, A. A., 21-second, Mk. IIIA1.[3]	1. 25
	Fuze cover [2]	. 05
	Rotating bank	. 16
	Head (adapter)	. 59
	Tubes and washer	. 11
	Shrapnel balls (253)	6. 00
	Matrix	. 46
	Diaphragm	. 48
	Base charge (black powder)	. 17
	Case, cartridge, Mk. IIA1	6. 75
	Distance wad	. 19
	Propelling charge (NH powder)	4. 62
	Primer, percussion, M21	. 29

[1] Complete rounds nos. 1, 2, 5, 6, 7, and 10, assembled prior to the adoption of the percussion primer, M21, will be found in service assembled with:

	Wt. lb.
Primer, percussion, 100-grain, M1 (or)	0. 12
Primer, percussion, 110-grain	. 08

The cartridge cases which are adapted for these primers are described in par. 31. In some cases a black powder igniter weighing 0.31 pound was assembled in rounds which contain the 100-grain percussion primer, M1.

[2] Removed before round is fired.

[3] Standard fuze is 21-second, Mk. IIIA1. 21-second Mk. III fuze will continue in use until supply is exhausted.

TABLE II.—*3-inch antiaircraft ammunition for fixed mounts*

Guns	Complete rounds and components	Approximate weight (pounds)
	Complete round no. 6 [1]	
3-inch antiaircraft guns, M1917 and M1917MI. (Rifling: 1 turn in 50 to 1 turn in 25 calibers.) 3-inch antiaircraft guns, M1917A1 and M1917MIA1. (Rifling: 1 turn in 25 calibers.)	Shell, fixed, H. E., Mk. I	29. 68
	Composed of:	
	Shell, H. E., Mk. I (fuzed)	15. 64
	Includes:	
	Shell body	10. 75
	Fuze, A. A., 21-second, Mk. IIIA2.	1. 25
	Fuze cover [2]	. 05
	Adapter	. 81
	Booster, Mk. X	. 81
	Explosive filler, TNT	1. 72
	Rotating band	. 16
	Base cover	. 09
	Case, cartridge, Mk. IA1	8. 56
	Distance wad	. 19
	Propelling charge (NH powder)	5. 00
	Primer, percussion, M21	. 29
	Complete round no. 7 [1]	
3-inch antiaircraft guns, M1917 and M1917MI. (Rifling: 1 turn in 50 to 1 turn in 25 calibers.) 3-inch antiaircraft guns, M1917A1 and M1917MIA1. (Rifling: 1 turn in 25 calibers.) 3-inch antiaircraft guns, M1917A2 and M1917A3; 3-inch antiaircraft guns, M1917MIA2 and M1917MIA3; 3-inch antiaircraft guns, M1917MII and M1925MI; and 3-inch antiaircraft guns, M2 and M4. (Rifling: 1 turn in 40 calibers.)	Shell, fixed, H. E., Mk. IX	26. 59
	Composed of:	
	Shell, H. E., Mk. IX (fuzed)	12. 74
	Includes:	
	Shell body	8. 37
	Fuze, A. A., 21-second, Mk. IIIA2.	1. 25
	Fuze cover [2]	. 05
	Adapter	. 85
	Booster, Mk. X	. 81
	Explosive filler, TNT	. 91
	Rotating band	. 46
	Base cover	. 04
	Case, cartridge, Mk. IM2	8. 50
	Distance wad	. 19
	Propelling charge (NH powder)	4. 87
	Primer, percussion, M21	. 29
	Complete round no. 8	
Fired from the same guns as complete round no. 7.	Shell, fixed, H. E., M42	26. 63
	Composed of:	
	Shell, H. E., M42 (fuzed)	12. 78
	Includes:	
	Shell body	9. 28
	Fuze, A. A., 21-second, Mk. IIIA2.	1. 25
	Fuze cover [2]	. 05
	Fuze well cup	. 02
	Booster, M20	. 81
	Set screw	. 01
	Explosive filler, TNT	. 86
	Rotating band	. 46
	Base cover	. 04
	Case, cartridge, Mk. IM2	8. 50
	Distance wad	. 19
	Propelling charge (NH powder)	4. 87
	Primer, percussion, M21	. 29

Footnotes at end of table.

TABLE II.—*3-inch antiaircraft ammunition for fixed mounts*—Continued

Guns	Complete rounds and components	Approximate weight (pounds)
	Complete round no. 9	
Fired from the same guns as complete round no. 7.	Shell, fixed, H. E., M42	26. 82
	Composed of the same components as complete round no. 8, except that the shell is fitted with a mechanical time fuze, M43, in lieu of the 21-second antiaircraft fuze, Mk. IIIA2.	
	Complete round no. 10 [1]	
Fired from the same guns as complete round no. 7.	Shrapnel, fixed, Mk. I	29. 34
	Composed of:	
	Shrapnel, Mk. I (fuzed)	15. 30
	Includes:	
	Shrapnel case	6. 03
	Fuze, A. A., 21-second, Mk. IIIA1.[3]	1. 25
	Fuze cover [2]	. 05
	Rotating band	. 16
	Head (adapter)	. 59
	Tubes and washer	. 11
	Shrapnel balls (253)	6. 00
	Matrix	. 46
	Diaphragm	. 48
	Base charge (black powder)	. 17
	Case, cartridge, Mk. IA1	8. 56
	Distance wad	. 19
	Propelling charge (NH powder)	5. 00
	Primer, percussion, M21	. 29

[1] Complete rounds nos. 1, 2, 5, 6, 7, and 10, assembled prior to the adoption of the percussion primer, M21, will be found in service assembled with:

	Wt. lb.
Primer, percussion, 100-grain, M1 (or)	0. 12
Primer, percussion, 110-grain	. 08

The cartridge cases which are adapted for these primers are described in par 31. In some cases a black powder igniter weighing 0.31 pound was assembled in rounds which contain the 100-grain percussion primer, M1.

[2] Removed before round is fired.

[3] Standard fuze is 21-second Mk. IIIA1. 21-second Mk. III fuze will continue in use until supply is exhausted.

TABLE III.—*105-mm antiaircraft ammunition*

Guns	Complete rounds and components	Approximate weight (pounds)
	Complete round no. 11	
105-mm antiaircraft gun, M3	Shell, fixed, H. E., M38	62. 19
	Composed of:	
	Shell, H. E., M38 (fuzed)	32. 90
	Includes:	
	Shell body (M38)	25. 35
	Fuze, mechanical time, M2	2. 76
	Set screw	. 01
	Explosive filler, TNT	3. 64
	Rotating band	1. 08
	Base cover	. 06
	Case, cartridge, M6	19. 00
	Propelling charge (NH)	10. 00
	Primer, percussion, M21	. 29
	Complete round no. 12	
105-mm antiaircraft gun, M3	Shell, fixed, practice, M38	61. 85
	Composed of:	
	Shell, practice, M38 (fuzed)	32. 54
	Includes:	
	Shell body (M38)	25. 35
	Fuze, mechanical time, M2	2. 76
	Explosive filler (black powder in bag).	. 50
	Inert filler (barium sulphate, paraffin, talc).	2. 79
	Rotating band	1. 08
	Base cover	. 06
	Case, cartridge, M6	19. 00
	Propelling charge (NH)	10. 00
	Primer, percussion, 100-grain, M1.	. 11
	Igniter retainer and igniter pad (3-ounce black powder).	. 20

SECTION IV

PROJECTILES

8. General.—Ammunition for antiaircraft guns is classified according to the nature of the projectile. The three types of projectiles provided for these guns are made of steel and are—

a. High explosive shell.—3-inch, Mk. I, Mk. IX, and M42; 105-mm, M38.

b. Practice shell.—105-mm, M38.

c. Shrapnel.—3-inch, Mk. I.

The above projectiles are described in detail herein under their respective paragraphs. For further information covering projectiles in general, see paragraph 29, TR 1370–A.

9. Base covers.—All projectiles containing high explosive are fitted with a base cover designed to prevent the gases from the propelling charge from coming in contact with the explosive charge of the shell through possible defects in the shell base. Base covers in service may consist of a brass plate covering a lead disk, a brass disk only, or a steel disk; the latter types being of more recent development.

10. Rotating bands.—*a. Function.*—The rotating band is a cylindrical ring of soft metal pressed into an undercut annular groove near the base of the projectile. The functions of this band are described as follows: When the gun is fired the projectile moves forward and the lands of the rifling cut their way into the soft metal of the rotating band causing it to conform in shape to the section of the rifling. As the projectile is forced through the gun barrel the twist of the rifling gives it a rotating motion. This rotation stabilizes the projectile during its flight and is an important factor in the functioning of practically all artillery fuzes. Since the rotating band is of sufficient diameter to completely fill the grooves of the

rifling, it prevents the propelling charge gases from escaping past the projectile. It further serves to center the projectile in the bore. In assembling rounds of fixed ammunition this band serves as a stop to insure proper seating of the projectile in the cartridge case.

b. Fringing.—This is caused by a small amount of the rotating band metal being forced back along the surface of the projectile when the gun is fired. If the amount of displaced metal is excessive it may form an irregular fringe on the rear edge of the rotating band and materially affect the range and accuracy of the projectile. A recess is therefore provided for this excess metal by machining a shallow annular groove in the projectile immediately to the rear of the band. All antiaircraft shell are provided with this groove except a few 3-inch antiaircraft shell, Mk. I, of early manufacture. Fringing is further prevented by cutting circumferential grooves in the surface of the rotating band.

c. Care.—Rotating bands should be protected from rough handling which might injure them in any way. A deformed rotating band will not only affect the accuracy of a projectile but might prevent the round from seating properly in the gun.

11. Bourrelet.—The bourrelet is an accurately machined surface between the shell body and its ogive. Its diameter is somewhat greater than the shell body and slightly less than the diameter between the lands of a new gun barrel. Its function is to center the projectile in the gun barrel and act as a forward bearing surface or guide for the projectile as it travels through the bore. The bourrelet should be especially protected from rust or corrosion. The minimum diametral clearance between the projectile bourrelet and the lands of a new gun barrel is approximately 0.005 inch for 3-inch antiaircraft ammunition and 0.0058 inch for 105-mm antiaircraft shell.

12. Bursting charge.—*a. High explosive.*—The explosive most commonly used in antiaircraft high explosive shell is TNT (trinitrotoluene), but 50–50 amatol (TNT plus ammonium nitrate) and tridite (picric acid plus dinitrophenol) are authorized substitutes. Average weights of bursting charge contained by the various high explosive shell are listed below:

High explosive shell	Average weight of explosive (pounds)		
	TNT	50–50 amatol	Tridite
3-inch:			
Mk. I	1. 72		
Mk. IX	. 91		
M42	. 86	0. 81	0. 89
105-mm: M38	3. 64		

Shell loaded with 50–50 amatol require a small amount of cast TNT surrounding the booster cavity. This is intended to protect the bursting charge against the penetration of moisture.

b. Low explosive.—Low explosive (black powder) is used as a bursting charge for the 3-inch antiaircraft shrapnel, Mk. I, described in paragraph 17, and the 105-mm antiaircraft practice shell, M38, described in paragraph 19. These projectiles contain 0.17 and 0.5 pound of black powder, respectively.

13. Weight zones.—In the manufacture and loading of projectiles, careful consideration is given to the weight, as a variation in this respect will obviously result in a variation in range.

a. Shrapnel.—Shrapnel ammunition is adjusted to a standard weight by the addition of more or fewer shrapnel balls. These projectiles seldom vary more than 1 percent from the normal weight, fuzed.

b. High explosive shell.—The weights of high explosive shell, however, vary over a wider range. The shell are therefore grouped within certain maximum and minimum weight limits or zones and firing tables provide the necessary corrections for firing shell of different weight. In order that this variation in weight may be noted by the service, the weight zone is indicated on each projectile by weight marks made with a prick punch in the center of ½-inch squares stenciled in black on the projectile (see figs. 1 and 2); the number of these weight marks corresponding to the weight zone of the projectile. A lot of ammunition (see par. 6) is allowed to contain shell of only one weight zone and this provides large groups of shell having uniform ballistic qualities. The maximum and minimum zone-weight limits for antiaircraft high explosive shell are prescribed by specifications and drawings. The mean weights for each group or zone and the range corrections corresponding to the differences in weight are published in the firing tables. Examples of these weight zones and weight markings are given in subsequent paragraphs.

c. Practice shell.—Practice shell are adjusted to the same weight limits as the high explosive shell by the addition of more or less inert filler. (See par. 19.)

14. 3-inch antiaircraft high explosive shell, Mk. I.—*a. Description.*—(1) This shell was developed during the World War and as no more are to be manufactured, present stocks will be issued until the supply is exhausted. The Mk. I shell is unstable in flight when fired in guns rifled 1 turn in 40 calibers. It should therefore be fired only in guns which have a rifling twist of 1 turn in 25 calibers at the muzzle. The different complete rounds into which the

Mk. I shell is assembled, together with the guns in which they may be fired, are listed in tables I and II, paragraph 7.

(2) The radius of the ogive is approximately 7 calibers,[1] and the shell retains its cylindrical shape from the rotating band to the base. The rotating band is made of copper and has an exposed width of 0.55 inch.

(3) Sample markings for high explosive shell assembled in the complete round are shown in figure 1.

b. Weights.—The weight zones into which these shell are grouped, as described in paragraph 13*b*, are listed below:

Zone no.	Weight zones—Shell, H. E., Mk. I, with 21-second antiaircraft fuze, Mk. IIIA2				Weight mark
	Over		Up to and including		
	Pounds	Ounces	Pounds	Ounces	
1	14	14	15	2	⊡
2	15	2	15	6	⊡ ⊡
3	15	6	15	10	⊡ ⊡ ⊡
4	15	10	15	14	⊡ ⊡ ⊡ ⊡

The weight of the shell, Mk. I, as fired, is shown in the above table. For approximate weights of its individual components, see tables I and II, paragraph 7.

15. 3-inch antiaircraft high explosive shell, Mk. IX.—*a. Description.*—(1) In order to increase the life of the 3-inch antiaircraft guns and to reduce the rotation of the projectile (thereby improving fuze action), the twist of the rifling in all late model, relined or retubed guns was reduced to 1 turn in 40 calibers. This change in the rifling, however, caused the Mk. I high explosive shell to become unstable in flight and it was therefore necessary to design a new high explosive shell. The shell designed to supersede the Mk. I is known as the Mk. IX. When assembled with the 21-second antiaircraft fuze, Mk. IIIA2, and the proper cartridge case, it is suitable for firing in all models of 3-inch antiaircraft guns regardless of the rifling. (See complete round data in tables I and II, par. 7.)

(2) This shell is shorter and lighter in weight and contains less high explosive than the Mk. I shell. The radius of ogive on the Mk. IX shell, however, is the same as that on the Mk. I shell

[1] By caliber is meant the diameter of the bore of the gun. A radius of ogive of 7 calibers is therefore a radius of 7 times 3 inches or 21 inches.

(7 calibers) and the shell body retains its cylindrical shape from the rotating band to the base. The rotating band is almost twice as wide as the one used on the Mk. I shell, being 1 inch in width.

(3) The high explosive shell, Mk. IX, has been superseded by the high explosive shell, M42, described in paragraph 16. Present stocks of the shell, Mk. IX, will be issued until the supply is exhausted.

(4) Sample markings for high explosive shell assembled in the complete round are shown in figure 1.

b. Weights.—The weight zones into which these shell are grouped, as described in paragraph 13*b*, are listed below:

Zone no.	Weight zones—Shell, high-explosive, Mk. IX, with 21-second antiaircraft fuze, Mk. IIIA2				Weight mark
	Over		Up to and including		
	Pounds	Ounces	Pounds	Ounces	
1	12	7¾	12	10	⊡
2	12	10	12	12	⊡ ⊡
3	12	12	12	14¼	⊡ ⊡ ⊡

The weight of the Mk. IX shell as fired is shown in the above table. For approximate weights of its individual components, see tables I and II, paragraph 7.

16. 3-inch antiaircraft high explosive shell, M42.—*a. Description.*—(1) This is essentially a modification of the 3-inch antiaircraft high explosive shell, Mk. IX, to take the M20 booster described in paragraph 21. The shell, M42, differs from the Mk. IX, which it supersedes, principally in that the M42 type is made in one piece to have the same length and contour as the Mk. IX type combined with its adapter. The inside diameter at the nose of the M42 shell is threaded to permit the assembly of the M20 booster. After the booster is seated flush with the nose of the shell it is locked in place by a set screw which extends through the shell wall near the nose and into the threaded portion of the booster body. The interior of the booster body is recessed and threaded so as to take either the 21-second antiaircraft fuze, Mk. IIIA2, or the mechanical time fuze, M43. By assembling the booster directly to the shell body and seating the fuze into the interior portion of the booster body, the requirement for an adapter in this shell is eliminated.

(2) An itemized list of the components which constitute the various complete rounds in which shell, M42, are assembled, together with the guns in which they may be fired, is given in tables I and

II, paragraph 7. Figure 1 shows the shell, M42, in cross section with the names of its principal parts. The radius of its ogive, the base cover, rotating band, and contour are identical with these components and characteristics of the high explosive shell, Mk. IX.

(3) Sample markings for the identification of high explosive shell assembled in the complete round are shown in figure 1.

b. Weights.—The weight zoning of the high explosive shell, M42, is, from a practical standpoint, the same as for the Mk. IX. To date all shell manufactured have fallen between 12.48 and 12.76 pounds and have been placed in zone I. The upper weight limit of this zone is slightly above the upper limit prescribed for the Mk. IX shell, but not sufficient to affect the use of the firing table data.

17. 3-inch antiaircraft shrapnel, Mk. I.—*a. Description.*—(1) This projectile was developed during the World War. Existing stocks of antiaircraft shrapnel are classed as limited standard and the present issue is mainly for target practice. Assembled in the complete round with the proper cartridge case, the shrapnel, Mk. I, is suitable for use in all models of 3-inch antiaircraft guns. The complete rounds into which shrapnel are assembled, together with all components, are listed in tables I and II, paragraph 7.

(2) Figure 3 shows the Mk. I shrapnel, with the names of its principal parts, assembled in the complete round. This projectile is considerably shorter than the high explosive shell, Mk. I, but the radius of its ogive is approximately the same (7 calibers). The rotating band is made of copper and has an exposed width of 0.55 inch. The shrapnel retains its cylindrical shape from the rotating band to the base and is not fitted with a base cover. The bursting or base charge consists of 3 ounces of black powder which is placed in the base of the projectile. A steel diaphragm acts as a cover for the base charge and supports the balls and matrix. The shrapnel also contains a central tube which conducts the flame from the fuze to the base charge. The filling is composed of about 253 lead balls (hardened with antimony) approximately ½ inch in diameter, averaging 42 balls to the pound. These are held in a matrix of rosin which is melted and poured into the shrapnel during the loading of the balls. A steel head closes the shrapnel case and forms an adapter for the 21-second antiaircraft fuzes, Mk. III and Mk. IIIA1.

(3) Shrapnel ammunition is marked for identification as shown in figure 3.

b. Action.—In action, the shrapnel is really a complete gun in itself. When the time fuze has burned its predetermined time, the

magazine charge of the fuze flashes through the central tube and ignites the base charge in the shrapnel. The explosion of the base charge does not rupture the case but ejects the diaphragm, balls, head, etc., from the case with a velocity of about 350 feet per second, this velocity being in addition to that of the projectile at the time of burst. The balls are projected forward in the form of a cone, due to rotational velocity. The angle of this cone depends on the relation of the angular velocity of the outermost balls in the case and their linear velocity.

c. Weights.—It is not necessary to group shrapnel into weight zones as there is seldom a variance of more than 1 percent from the normal weight. The weight is adjusted in manufacture by assembling more or fewer balls than prescribed as may be necessary. The weight of the Mk. I shrapnel as fired is 15.25 pounds. Average weights of the individual components are listed in Tables I and II, paragraph 7.

18. 105-mm antiaircraft high explosive shell, M38.—*a. Description.*—(1) The high explosive shell, M38, is of the streamline type with a tapered base and long ogive; the radius of ogive being approximately 8.3 calibers.[2] Beginning at a point approximately 1 inch below the rotating band, the cylindrical surface of the shell body tapers at an angle of 6.75° for a distance of approximately 2 inches to the base. The streamlining of the projectile is completed by the fuze which is cone-shaped and follows the general contour of the ogive. This combination of a sharp nose and tapered base reduces the air resistance and adds to the efficiency in flight.

(2) The high explosive shell, M38, is shown assembled in the complete round, together with the names of its principal parts in figure 2. The weights of its various components are listed in table III, paragraph 7. The rotating band is of gilding metal and has an exposed width of 1.42 inches.

(3) The forward opening in the shell body is 2.2 inches in diameter and is threaded inside to permit assembly of the mechanical time fuze, M2. The booster is an integral part of this fuze and a separate adapter is therefore not required. When the present supply of mechanical time fuzes, M2, becomes exhausted, the design of the high explosive shell, M38, will be altered to permit assembly of the booster, M20, and the mechanical time fuze, M43, in the same manner as shown for the 3-inch antiaircraft high explosive shell,

[2] By caliber is meant the diameter of the bore of the gun. A radius of ogive of 8.3 calibers is therefore a radius of 8.3 times 105 millimeters or 871.5 millimeters (34.3 inches).

M42, in figure 1. The high explosive shell, M38, is issued in completely assembled rounds with the fuze attached. A marking diagram for the identification of this ammunition is shown in figure 2.

b. Weights.—These shell are grouped according to weight as outlined in paragraph 13*b*. The mean average weight for each zone is published in tables of fire control for 105-mm antiaircraft guns. The average projectile weight for any particular ammunition lot is listed on the data card packed in each box of ammunition. The weight-zone identification marks on each projectile are as described in paragraph 13*b* and shown in figure 2. The average weights for all components of the high explosive shell, M38, are listed in table III, paragraph 7.

19. 105-mm antiaircraft practice shell, M38.—*a. Description.*—This shell is identical with the high explosive shell, M38, described in paragraph 18, except that it contains a practice loading instead of a high explosive filler. The bursting charge consists of 8 ounces of black powder in a bag. This charge is exploded by action of the fuze and is sufficient to rupture the forward portion of the shell, producing a cloud of white smoke. Enough inert filler (barium sulphate, paraffin, and talc) is added to fill the cavity and bring the projectile up to the desired weight. (See par. 18*b*.) A list of all components used in the assembly of complete rounds of the practice shell, M38, together with their approximate weights, is shown in table III, paragraph 7. When the present supply of practice shell, M38, becomes exhausted, the use of high-explosive shell for training will be given consideration.

b. Marking.—Practice shell, M38, are painted blue. The following representative marking is stenciled in white on the shell body:

(1) Caliber.—105 A. A.
(2) Charge.—BLACK POWDER.
(3) Model.—SHELL, M38.
(4) Type.—PRACTICE.

20. Painting and marking.—All projectiles are painted both as a means of ready identification and as a rust preventive. Projectiles containing high explosive are painted yellow. Shrapnel projectiles are painted red. Projectiles loaded for practice are painted blue. Projectiles are also stenciled to show the caliber, type, kind of filling, etc., as shown in figures 1, 2, and 3.

SECTION V

BOOSTERS

21. General.—The magazine charge contained in the fuze is black powder which is not powerful enough to detonate the high explosive shell filler. It is therefore necessary to insert a small

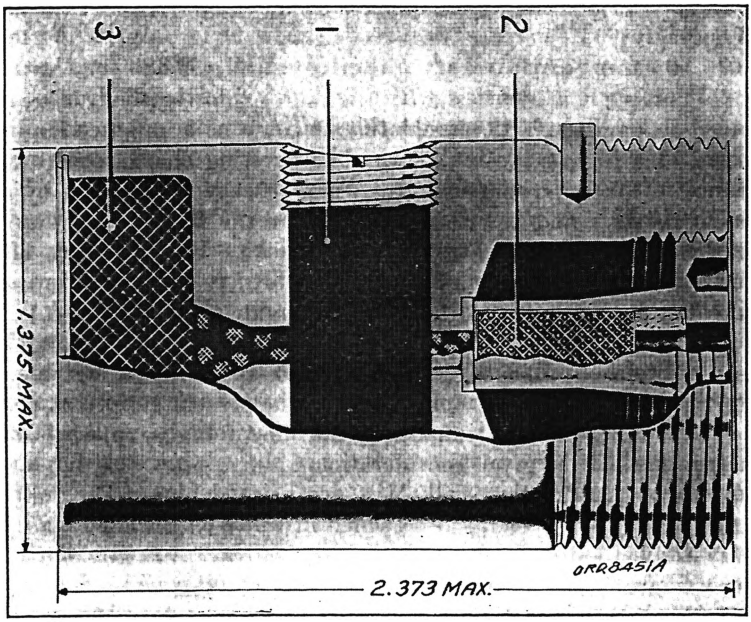


FIGURE 4.—Booster, Mk. X.

1. Interrupter. 2. Detonator. 3. Booster charge (tetryl).

charge of high explosive between the fuze and shell filler which can be detonated by the action of the fuze and which will in turn produce a detonating wave powerful enough to initiate a high order detonating of the shell filler. The booster contains this intermediary explosive charge consisting of a detonator and the booster proper. In addition, the boosters used in all high explosive antiaircraft shell contain a bore-safe device whereby the detonating train is interrupted between the detonator and the booster charge until the projectile has cleared the muzzle of the gun. This prevents premature action of the high explosive charge of the shell in the bore of the

gun, should malfunctioning of the more sensitive explosive elements of the fuze and detonator occur. It also provides a factor of safety in the handling and shipping of loaded ammunition to which the fuze is attached.

22. Antiaircraft booster, Mk. X.—*a.* The antiaircraft booster, Mk. X, will be found assembled in the 3-inch antiaircraft high explosive shell, Mk. I and Mk. IX. Figure 4 shows this booster in cross section, with the names of its principal parts. Practically all metal parts of this booster are made of brass. The interrupter (1)

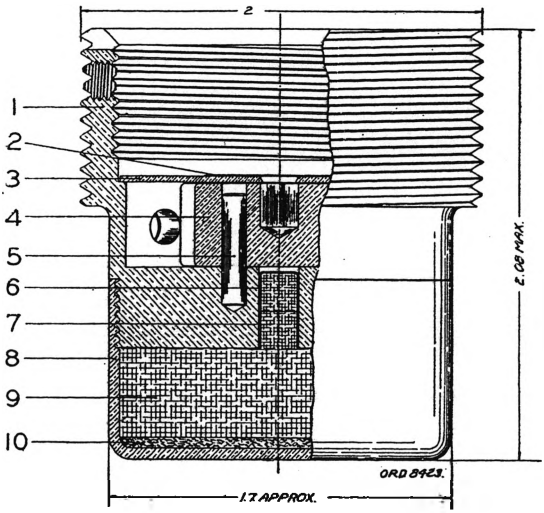


FIGURE 5.—Booster, M20.

1. Body.
2. Rotor cover disk (paper).
3. Rotor cover.
4. Rotor.
5. Rotor pivot pin.
6. Booster closing cup.
7. Pellet (tetryl).
8. Booster cup.
9. Booster carge (tetryl).
10. Booster cup disk (felt).

constitutes the bore-safe device and this is operated by the centrifugal force of rotation.

b. When the fuze has burned its predetermined time, the fuze magazine charge will explode and function the detonator (2) which contains about 12 grains of mercury fulminate. This detonates the booster charge (3). The booster charge in turn serves to detonate the explosive charge of the shell. The standard charge for the Mk. X booster consists of 170 grains of pressed tetryl.

23. Booster, M20.—*a.* The booster, M20, is assembled in 3-inch antiaircraft shell, M42. Figure 5 shows this booster (rotor in unarmed position) with the names of its principal parts.

The bore-safe feature of this booster is the rotor (4) which keeps the detonator out of alinement with the tetryl pellet (7) until it is brought in line by the action of centrifugal force. This is not fully accomplished until the projectile has left the bore of the gun. During storage and transportation the rotor is held fast by means of a stop pin which depends on the action of centrifugal force for unlocking.

b. The detonator, which contains 15 grains of mercury fulminate, is exploded by action of the time fuze. This detonates the booster charge (9) by means of the pressed tetryl pellet (7). The booster charge in turn serves to detonate the explosive filler of the shell. The booster charge of the M20 booster consists of approximately 420 grains of pressed tetryl.

SECTION VI

FUZES

24. General.—*a. Function.*—A fuze is a device inserted in a projectile for the purpose of initiating the explosion or detonation of the bursting charge at the time and under the circumstances desired. Ammunition used against aircraft requires a fuze which will function after a predetermined time and explode the projectile as it reaches the proximity of the target.

b. Permissible fuzes.—There are four fuzes authorized for use with 3-inch antiaircraft ammunition, viz, the 21-second antiaircraft fuzes, Mk. III, Mk. IIIA1, and Mk. IIIA2, and the mechanical time fuze, M43. The mechanical time fuze, M43, has been standardized for use with 105-mm antiaircraft ammunition but the mechanical time fuze, M2, will be used until the supply is exhausted. As these two fuzes are not interchangeable, a slight alteration in shell design will be necessary at that time. The projectiles with which these fuzes may be used are listed in the table below:

Projectile	Permissible fuzes				
	Mk. III	Mk. IIIA1	Mk. IIIA2	M43	M2
3-inch antiaircraft					
Shell, high-explosive, Mk. I	(1)	(1)	Yes	(2)	No.
Shell, high-explosive, Mk. IX	(1)	(1)	Yes	(2)	No.
Shell, high-explosive, M42	No	No	Yes	Yes	No.
Shrapnel, Mk. I	Yes	Yes	No	No	No.
105-mm antiaircraft					
Shell, high-explosive, M38	No	No	No	No	Yes.
Shell, practice, M38	No	No	No	No	Yes.

[1] Indicates that the fuze is for emergency use only, as directed by the Chief of Ordnance.
[2] Indicates that the fuze is not prescribed but there is no reason against its use from a standpoint safety and functioning.

c. Caution.—Fuzes will not be altered. The altering or disassembling of fuzes in the field is dangerous and is prohibited except upon specific direction of the Chief of Ordnance.

25. Fuzes, antiaircraft, 21-second, Mk. III, Mk. IIIA1, and Mk. IIIA2.—*a. Description.*—(1) *General.*—These are commonly known as powder train time fuzes and have been used almost exclusively with antiaircraft ammunition during and since the World War. The metal parts are made of brass and bronze and resemble in outward appearance the 21-second combination fuze, M1907M, used for shrapnel in 75-mm field guns. They differ from this fuze, however, in that they contain no percussion element and will therefore not function on impact. These fuzes are always assembled to the ammunition for shipment. They are protected against moisture by a waterproof cover which is removed and thrown away when the fuze is set for time.

(2) *Fuze, antiaircraft, 21-second, Mk. III.*—Figure 6 shows a view of this fuze with the waterproof fuze cover (15) in place and the fuze set for zero time of burning. It also shows a sectional view of the fuze set at zero with the names of its principal parts. The heavy magazine charge (10) of black powder in this fuze (95 grains) prohibits its use in conjunction with the booster, M20. (See (4) below.) It is suitable for use with 3-inch antiaircraft shrapnel, however, and although superseded for future manufacture by the fuze, Mk. IIIA1, existing stocks of the Mk. III fuze will be issued until the supply is exhausted. The fuze action is outlined in *b* below.

(3) *Fuze, antiaircraft, 21-second, Mk. IIIA1.*—This is a redesign of the antiaircraft fuze, Mk. III. The principal modification consists of strengthening the nose end of the fuze so that accidental

striking of the end of the fuze against the breech of the gun will not function the fuze. The fuze, Mk. IIIA1, is similar in all other respects to the Mk. III and has superseded the latter for future manufacture. The fuze, Mk. IIIA1, is standard for use in all 3-inch antiaircraft shrapnel ammunition. (See tables I and II, par. 7.)

(4) *Fuze, antiaircraft, 21-second, Mk. IIIA2.*—This is an antiaircraft time fuze, Mk. IIIA1, with the black powder magazine

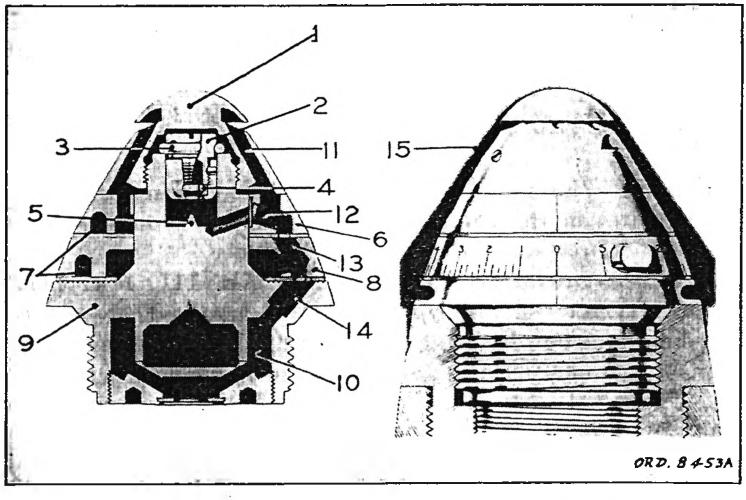


FIGURE 6.—Fuze, antiaircraft, 21-second, Mk. III.

1. Closing cap.
2. Concussion plunger.
3. Resistance ring.
4. Concussion primer.
5. Concussion firing pin.
6. Upper time train ring.
7. Powder train.
8. Lower or graduated time train ring.
9. Body.
10. Magazine charge (black powder).
11. Vents.
12. Powder pellet.
13. Powder pellet.
14. Powder pellet.
15. Waterproof cover.

charge reduced in weight from 95 to 15 grains. This weight of charge is sufficient to actuate the Mk. X and the M20 boosters. The Mk. IIIA2 fuze is prescribed for use with all 3-inch antiaircraft high explosive shell. (See tables I and II, par. 7.)

b. Action.—(1) *Zero setting.*—These fuzes can be set and reset for any time from 0 to 21.2 seconds, the maximum setting; each graduation on the lower time train ring representing approximately 1/5 second of burning time. When the setting is at zero, as shown in figure 6, the action is as follows:

When the gun is fired, the concussion plunger (2) will slip through the resistance ring (3) due to inertia or setback [3] action in the projectile. The concussion primer (4), which is held in the concussion plunger, is thus fired by striking the firing pin (5). The flame from this primer passes through a hole in the fuze body and ignites the powder pellet (12) which is in the upper time train ring (6). The flame from this pellet (12) is transmitted to the ignition pellet (13) which is located in the lower or graduated time train ring (8). The flame from this pellet (13) ignites the ignition pellet (14) in the fuze body which in turn ignites the magazine charge (10). The flame from the magazine charge ignites the booster detonator in the shell or, in the case of shrapnel, flashes through the central tube and ignites the base charge. In the above action it is readily seen that when the fuze is set at zero, the action is merely a transmission of flame from the concussion primer (4) to the magazine charge (10) by means of powder pellets. The powder train (7), which is responsible for the time feature, does not enter into this action. Attention is called to the fact that the time fuze when set at zero will cause the projectile to burst within 75 feet of the muzzle of the gun.

(2) *Time setting.*—When a time setting is desired, 15 seconds, for instance, the action is somewhat different. The lower or graduated time train ring (8) is turned counterclockwise until the 15 is in line with the lines on the body and the upper time train ring. The action of the concussion plunger (2) is the same, and the flame reaches the powder pellet (12) as previously described. This powder pellet (12) ignites the powder train (7). The powder train (7) is machined in the upper and lower time train rings in the shape of a horseshoe; that is, there is a solid section of metal at the beginning and end of the powder train. The ignition pellet (13) in the lower or graduated time train ring (8) has been moved in setting the fuze, and it is necessary that the powder train (7) of the upper time train ring burn until this pellet is reached by the flame. Then with the ignition of the pellet (13), the powder train (7) in the lower or graduated time train ring will begin to burn. When the flame reaches ignition pellet (14) in the body (9), the action is as previously described for zero setting. The gases from the burning of the powder train (7) escape to the atmosphere by means of the vents (11) in the closing cap (1).

[3] The expansion of gases from the propelling charge creates pressure in the chamber and bore of the gun which results in acceleration of the projectile. Any part of the projectile not rigidly supported will be given a relative motion toward the base of the projectile due to its own inertia and the acceleration of the projectile in the bore. This action is known as "setback."

(3) *Safe setting.*—When the lower or graduated time train ring (8) is set so that the mark "S" is in line with the lines on the body and the upper time train ring, the fuze is said to be "safe." At this setting, the solid metal section of the upper time train ring is completely covering the ignition pellet (13) in the lower or graduated time train ring and the solid metal section of the lower time train ring is completely covering ignition pellet (14) in the fuze body which leads to the magazine charge. Set at safety the upper time train may burn out entirely in case of accidental firing of the concussion primer without the flame being able to reach the lower time train or the magazine charge (10) and therefore the fuze would not function. These fuzes are always set "safe" for issue and if not used after making a setting they should be reset "safe" again before handling.

c. Care.—Every precaution should be taken to keep moisture away from these fuzes. They are protected by waterproof covers and the powder trains (7) are covered with waxed paper, but short exposure in damp places will allow moisture to enter. A piece of felt cloth is on the underside of each powder train (7) which prevents the flame of the burning powder from creeping faster than it should. If these pieces of felt become wet, the powder will absorb some of the moisture which will greatly alter the time of burning. The waterproof fuze cover should not be removed before the ammunition is required for firing. An inspection of the fuzes should then be made, and any rounds containing fuzes which show evidences of advanced corrosion should be returned to the local ordnance officer for replacement of the fuze.

d. Test of condition.—(1) *Corrosion.*—Each fuze should be examined for indication of extreme exterior corrosion. If the fuze shows any appreciable stains around the time ring the entire round will be classed as "unserviceable" and turned in.

(2) *Frictional resistance of graduated time train ring.*—When the round is to be used with weapons equipped with continuous type of fuze setters, the fuze should be tested to determine the torque necessary to turn the graduated time train ring. No fuze will be used when the torque required to turn the graduated time train ring is more than 60 inch-pounds.

(*a*) *Method of test.*—Place the ring spanner illustrated in figure 15 over the graduated time train ring so that it engages the rotating lug. Exercise the time train ring several times by hand. Apply pressure to the ring spanner through the spring balance scale and observe the reading on the scale required to move the graduated time

train ring. With a stem 5 inches long, each pound recorded on the scale equals 5 inch-pounds of setting torque. A reading on the scale of 12 pounds will therefore correspond to a setting torque of 60 inch-pounds. After testing, the fuzes should be reset to "S" (safe).

(*b*) This testing ring spanner should be improvised locally and available spring balance scales used. To obtain the desired reading, the scale must be attached to the stem of the spanner exactly 5 inches from the C/L of its ring, and the force of the scale exerted at a right angle to the stem of the spanner.

(3) The rounds to be used in fuze setters other than the continuous type need only be tested to see that the graduated time train rings are not sticking to such extent as to prevent the setting of the fuze.

(4) The sorting of fuzes and the tensioning tests should be done under the supervision of qualified ordnance personnel.

e. Marking.—These fuzes may be identified by the following stamping which appears on the bevel edge of the body:

(1) Mark number of fuze (Mk. III, Mk. IIIA1, or Mk. IIIA2).
(2) Fuze lot number.
(3) Initials or symbol of manufacturer.
(4) Month and year of loading.

26. Fuze, mechanical time, M43.—*a. Description.*—The mechanical time fuze, M43 (fig. 7), is designed to bring about an explosion of the bursting charge of a shell at a more accurately predetermined time after firing than a powder train time fuze. The antiaircraft projectiles for which this fuze is adapted are listed in the table in paragraph 24*b*. The time element of the fuze resembles a watch mechanism in general principles, differing from it in the following general respects: Instead of being driven by a main spring, it is driven by a pair of weights which make use of the centrifugal force caused by the rotation of the shell in flight. Its escapement differs from that of a watch in that it beats at a very much higher frequency and makes use of a straight escapement spring instead of the conventional spiral hair spring. The advantages of this fuze are—

(1) Greater accuracy of timing than the Mk. III type.
(2) Freedom from variation due to atmospheric conditions.
(3) Will stand long time storage without deterioration.

The mechanical time fuze, M43, differs from earlier models in external contour and in that it does not contain a booster. The booster used in conjunction with this fuze is known as the M20 and is assembled in the shell as a separate component. The external con-

tour and total weight (1.44 pounds) follow that which has recently been standardized for all point fuzes, both time and point detonating. Thus the same firing tables will be applicable for any projectile regardless of the fuze used. The powder train time fuze is also being developed in this contour so that the same fuze setter can be used with either type of time fuze.

b. Construction.—The form and external parts of this fuze are illustrated in figure 7. The external parts consist of an upper cap, lower cap, and fuze body.

(1) The upper cap (1) is an aluminum conical frustum, the base end of which is threaded for attachment to the lower cap. It is

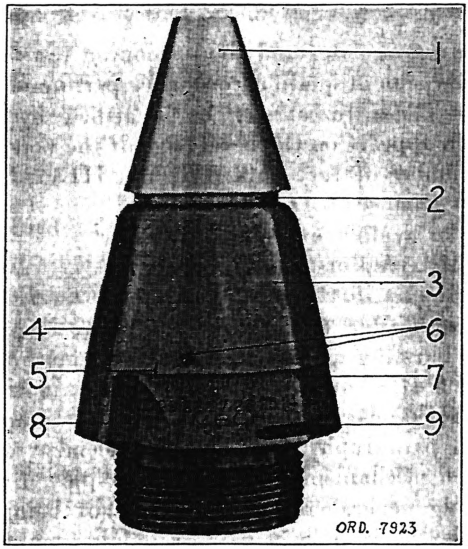


FIGURE 7.—Fuze, mechanical time, M43. (Fuze set for 29⅘ seconds.)

1. Upper cap.
2. Groove for fuze setter locking lever.
3. Lower cap.
4. Slot for fuze setter lug.
5. Register line.
6. Set screws.
7. Body.
8. Slot for fuze setter lug.
9. Fuze wrench slot.

machined so that a groove (2) is formed in which the fuze setter locking lever is engaged. This retains the fuze in the fuze setter during the setting operation and prevents the round from being removed from the fuze setter until the proper fuze setting is made. The upper cap does not contain any of the mechanical elements of the fuze.

(2) The lower cap (3) is made of brass. It is slotted (4) for the fuze setter lug and has the usual register line (5) scribed on its

surface near the slot. The lower cap forms the cover for the timing mechanism. The lower cap is assembled to the body by means of a steel wire which is placed under tension by four small steel set screws (6). These set screws are adjusted in the manufacture of the fuze to obtain the desired tension between the lower cap and body. These set screws should not be tightened or loosened without previous authority from the Chief of Ordnance.

(3) The body (7) is made of brass or aluminum and houses the timing mechanism. It is slotted (8) for the fuze setter lug and also contains transverse slots (9) for the fuze wrench. It is graduated from 1 to 30 seconds with ⅕-second subgraduations. The fuze is shipped set safe with set line on lower cap in line with edge of slot in body. If fired in this position the fuze will not function. When a time setting other than safe is desired, the lower cap is turned in a counterclockwise direction as viewed from above. The body contains a primer which functions the detonator in the M20 booster. Figure 7 shows the fuze set for action at 29⅗ seconds.

c. Marking.—This fuze may be identified by the following stamping which appears on the bevel edge of the body:

(1) Model of fuze.
(2) Fuze lot number.
(3) Initials or symbol of manufacturer.

27. Fuze, mechanical time, M2.—*a. Description.*—The action and design of this fuze are very similar to the mechanical time fuze, M43, described in paragraph 26. The principal difference in these fuzes is that the fuze, M2, has a booster assembled to the lower portion of the fuze body. It also has a larger thread size than the fuze, M43, and is assembled to the 105-mm shell, M38, without the use of an adapter. A set screw extends through the shell wall engaging the threaded portion of the fuze body, locking it in place. The booster of this fuze contains a bore-safe feature similar to the booster, M20, described in paragraph 23 *a*. The fuze body is graduated for a time setting of from 1 to 30 seconds with ⅕-second subgraduations. A register line is scribed on the surface of the lower cap near one of the fuze setter slots. This line is set at the 15-second graduation during shipment and storage. For a time setting of more or less than 15 seconds the lower cap is turned in a clockwise direction as viewed from above.

b. Use.—The mechanical time fuze, M2, has been superseded by the mechanical time fuze, M43, and the booster, M20. The mechanical time fuze, M2, will be used with the 105-mm antiaircraft shell, M38, until the supply is exhausted.

28. Fuzes, obsolete.—Limited stocks of the 3-inch antiaircraft Mk. I shell and shrapnel, which are fitted with the obsolete Mk. II type "S" (modified and unmodified) and Bartlett-Hayward antiaircraft time fuzes, may be found in storage. These obsolete types will be replaced with fuzes of suitable type (see tables of permissible fuzes in par. 24*b*) before the ammunition is fired. A supply of standard fuzes sufficient to replace all obsolete fuzes (plus 10 percent to compensate for deterioration) should be requisitioned and held in reserve. As the replacement fuzes are packed in individual, airtight, metal containers for shipment and storage, and as exposure to damp atmosphere results in rapid deterioration of these fuzes, it is not intended that the physical replacement of the obsolete fuzes be made until the ammunition is required for firing. The new fuzes should be assembled to rounds as the firing progresses, if practicable. The priority and methods for replacement of obsolete fuzes will be published by the Chief of Ordnance.

SECTION VII

CARTRIDGE CASES

29. Description.—The cartridge case is made of drawn brass (see figs. 1 and 2), and is so constructed in shape and size as to perfectly fit the powder chamber of the gun for which it is designed. A projecting rim or flange is formed at the base and the extractor of the gun engages this rim to eject the cartridge case from the gun after firing. The breechblocks of the 3-inch and 105-mm antiaircraft guns are held in the open position against the action of a closing spring by the extractor. As a round of ammunition is loaded into the gun, the rim of the cartridge case strikes the extractor, thereby releasing and closing the breechblock. The rim also acts as a stop for the round when it is loaded in the gun. The length of the case is designed to insure proper seating of the projectile in the forcing cone of the gun chamber when the gun is loaded and the breech closed. Cartridge cases have a hole drilled and counterbored in the center of the base for assembly of the primer. (See par. 34.)

30. Function.—The cartridge case serves as a container for the propelling charge. It also holds the primer and projectile in a fixed position and thus enables the complete round to be loaded into

the gun as a unit. When the gun is fired, the cartridge case acts as an obturator in preventing the propelling charge gases from escaping into the breech mechanism of the gun. The metal near the mouth of the cartridge case is thin and comparatively soft so that the pressure developed by the propelling charge expands it tightly against the walls of the gun chamber, thus preventing any leakage of gas past the cartridge case. The cartridge case metal, however, is springy enough so that when the gas pressure is released, the case will contract and can be extracted from the gun without difficulty.

31. Cartridge cases for 3-inch antiaircraft guns.—The cartridge cases provided for the 3-inch antiaircraft fixed guns are designated Mk. I, Mk. IA1, Mk. IM1, and Mk. IM2. Cartridge cases for the mobile guns are the Mk. II, Mk. IIA1, Mk. IIM1, and Mk. IIM2. The principal characteristics of these types are briefly described as follows:

a. Cartridge cases for 3-inch antiaircraft guns on fixed mounts.—(1) *Cartridge cases, Mk. I and Mk. IA1.*—These cartridge cases have an over-all length of 27.15 inches and are identical except for the size of the primer seat. The Mk. I case takes the older 110-grain percussion primer while the Mk. IA1 case will take either the 100-grain percussion primer, M1, or the percussion primer, M21 (330-grain). The cartridge cases, Mk. I and Mk. IA1, are used only with Mk. I shell and shrapnel in 3-inch antiaircraft guns of the fixed or pedestal mount types.

(2) *Cartridge cases, Mk. IM1 and Mk. IM2.*—These cartridge cases have an over-all length of 26.7 inches and are identical except for the size of the primer seat. The Mk. IM1 case takes the older 110-grain percussion primer while the Mk. IM2 will take either the 100-grain percussion primer, M1, or the percussion primer, M21 (330-grain). The cartridge cases, Mk. IM1 and Mk. IM2, can be used only with the Mk. IX and M42 high-explosive shell in 3-inch antiaircraft guns of the fixed-mount types.

(3) Cartridge cases of the above types may be found assembled in stocks of 3-inch antiaircraft ammunition now on hand. The Mk. IM2, however, is the only case for the fixed guns which is standard for future manufacture, and it will be assembled with the primer, M21, and the shell, M42.

b. Cartridge cases for 3-inch antiaircraft guns on mobile mounts.—(1) *Cartridge cases, Mk. II and Mk. IIA1.*—These cartridge cases have an over-all length of 23.65 inches and are identical except for the size of the primer seat. The Mk. II case takes the older 110-grain percussion primers while the Mk. IIA1 case will take either the

100-grain percussion primer, M1, or the percussion primer, M21 (330-grain). The cartridge cases, Mk. II and Mk. IIA1, are used only with Mk. I shell and shrapnel in 3-inch antiaircraft guns on mobile mounts.

(2) *Cartridge cases, Mk. IIM1 and Mk. IIM2.*—These cartridge cases have an over-all length of 23.08 inches and are identical except for the size of the primer seat. The Mk. IIM1 case takes the older 110-grain percussion primer while the Mk. IIM2 case will take either the 100-grain percussion primer, M1, or the percussion primer, M21 (330-grain). The cartridge cases, Mk. IIM1 and Mk. IIM2, can be used only with the Mk. IX and M42 high explosive shell in 3-inch antiaircraft guns on mobile mounts.

(3) Cartridge cases of the above types may be found assembled in stocks of 3-inch antiaircraft ammunition now on hand. The Mk. IIM2, however, is the only case for the mobile guns which is standard for future manufacture, and it will be assembled with the primer, M21, and the shell, M42.

32. Cartridge case for 105-mm antiaircraft gun.—*a.* The cartridge case provided for the 105-mm antiaircraft gun is designated M6. It has an over-all length of 30.37 inches and the inside diameter of the mouth is 4.115 inches. The primer seat will take the 100-grain percussion primer, M1, or the 330-grain percussion primer, M21, the latter being the standard primer for this ammunition. The cartridge case, M6, is used in the complete round assembly of both the high explosive and practice shell for the 105-mm antiaircraft gun. (See table III, par. 7, and fig. 2.)

b. Cartridge cases of large size, such as those for the 105-mm antiaircraft gun, sometimes show dents or deformations of considerable magnitude when ejected from the gun after firing. The cause is not definitely known and as yet the difficulty has not been entirely corrected. No report of such deformations need be made unless there is evidence of injury to the gun or appreciable escape of gas from the breech.

33. Care.—Cartridge cases can be used many times if properly cared for. They should be carefully handled since, being made of thin and comparatively soft metal, they are easily dented. Fired cartridge cases will be turned over to the local ordnance officer in accordance with AR 775–10. Shipments of cartridge cases should be carefully packed to insure that they will arrive at the depots undamaged.

SECTION VIII

PRIMERS

34. Function.—The primer is a device inserted in the cartridge case for the purpose of igniting the propelling charge. The primers assembled in antiaircraft ammunition are of the percussion type. A hole, drilled and counterbored, forms the primer seat in the center of the base of the cartridge case; the primer being forced into this seat by means of a press. The head of the primer, which contains the percussion element, is seated flush with the outside surface of the base of the cartridge case. The primer body, which contains a charge of black powder, extends into the interior of the cartridge case. (See figs. 1 and 2.) Primers of the percussion type are fired when struck by the firing pin of the gun in the same manner that a rifle or pistol cartridge is fired.

35. Types.—Three primers will be found in service assembled in rounds of antiaircraft ammunition, viz, the 110-grain percussion primer, the 100-grain percussion primer, M1, and the 330-grain percussion primer, M21. Identification marks are stamped on the rim of the primer head as shown in figures 8, 9, and 10. The three designs are described as follows:

a. Primer, M21.—(1) *Description.*—This primer is the present standard type and will be used in all future assembly of antiaircraft ammunition. It is shown with the names of its principal parts in figure 8. The body (1) is made from brass tubing and contains a charge (2) of 330 grains of loose black powder, grade A–1. The walls of the body are perforated with 46 equally spaced holes or vents (3). The body has a paper lining (4) which prevents the powder from leaking out through the vents. Joints are waterproofed with asphalt varnish. The body is threaded to the head (5) and then crimped. This primer has the same head dimensions as the 100-grain percussion primer, M1. It may therefore be assembled in 3-inch antiaircraft cartridge cases, Mk. IA1, Mk. IM2, Mk. IIA1, and Mk. IIM2. (See par. 31 and tables I and II, par. 7.) It is also standard for use in the 105-mm antiaircraft cartridge case, M6.

(2) *Action.*—The firing pin of the gun strikes the firing plug (6) with sufficient force to drive it forward and deform the primer cup (7). The percussion element charge (8) is crushed against the anvil (9) and explodes. The flame from this explosion passes for-

ward and ignites the black powder charge (2). As the forward end of the body is fitted with a closing plug (10), the flame from the black powder charge flashes through the vents (3). Distributing the flame in this manner results in uniform ignition of the propelling charge.

b. 100-grain percussion primer, M1.—(1) *Description.*—This primer was adopted to supersede the 110-grain percussion primer but it has since been superseded for use in antiaircraft ammunition by the 330-grain percussion primer, M21. The 100-grain primer, M1, is shown with the names of its principal parts in figure 9. This primer is similar to the primer, M21, the main difference being in the length of its body and the black powder charge which weighs 100 grains. The 100-grain primer, M1, has a head of larger di-

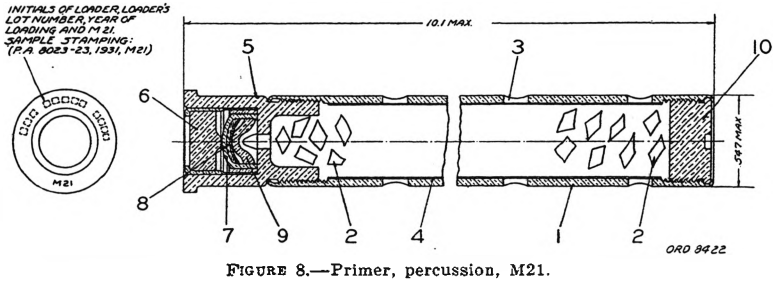


FIGURE 8.—Primer, percussion, M21.

1. Body.
2. Charge (loose black powder).
3. Vents.
4. Paper wrapper.
5. Head.
6. Firing plug.
7. Primer cup.
8. Percussion charge.
9. Anvil.
10. Closing plug.

ameter than the 110-grain percussion primer and will therefore be found assembled only in 3-inch antiaircraft cartridge cases, Mk. IA1, Mk. IM2, Mk. IIA1, and Mk. IIM2. (See note 1, table I, par. 7.) This primer will also be found assembled in complete rounds of practice shell, M38, for 105-mm antiaircraft gun, assembled prior to the adoption of the primer, M21. (See complete round no. 12, table III, par. 7.)

(2) *Action.*—The action of this primer is identical with the primer, M21. The increased length and powder charge of the latter, however, produce a more uniform ignition of the propelling charge in rounds of antiaircraft ammunition.

c. 110-grain percussion primer.—(1) *Description.*—This primer is no longer standard for manufacture but will be found in service assembled in 3-inch antiaircraft cartridge cases, Mk. I, Mk. IM1,

Mk. II, and Mk. IIM1. (See note 1, table I, par. 7.) It has never been used in the assembly of ammunition for the 105-mm antiaircraft gun. Being of smaller diameter than the 100-grain M1 and the M21 primers, it will not fit the cartridge cases drilled for the

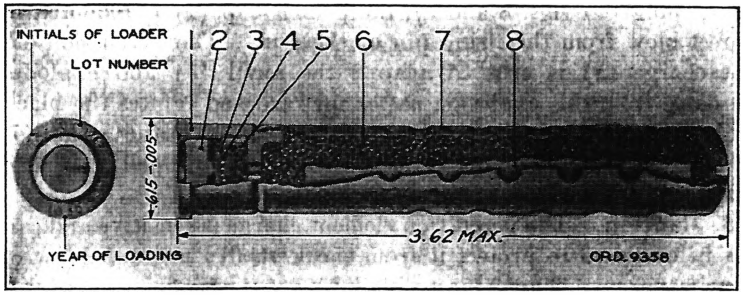


FIGURE 9.—Primer, percussion, 100-grain, M1.

1. Head.
2. Firing plug.
3. Primer cup.
4. Percussion charge.
5. Anvil.
6. Charge (loose black powder).
7. Body.
8. Paper wrapper.

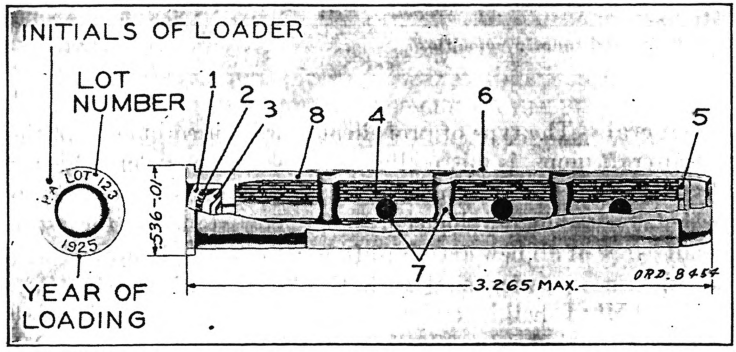


FIGURE 10.—Primer, percussion, 110-grain.

1. Primer cup.
2. Percussion charge.
3. Anvil.
4. Charge (compressed black powder).
5. Closing wad.
6. Tin-foil wrapper.
7. Vents.
8. Body.

latter. The 110-grain percussion primer is shown with the names of its principal parts in figure 10. The body (8) is made from cartridge brass and contains a charge (4) of compressed black powder, grade A–4. The flash holes or vents (7) are drilled through the body and the powder charge after the latter has been pressed in.

This results in considerable loss of powder, approximately 99 grains remaining in the finished primer. The charge is protected from moisture by a tin-foil wrapper (6) which covers the vents. The end closing wad (5) is crimped in place and shellacked.

(2) *Action.*—As the 110-grain percussion primer is not fitted with a firing plug (see figs. 8 and 9), the primer cup (1) is indented by a direct blow from the firing pin of the gun. The percussion element charge (2) is crushed against the anvil (3) and explodes. The flame from this explosion passes forward and ignites the black-powder charge (4) which in turn flashes through the vents (7) and the forward end of the primer, igniting the propelling charge in the cartridge case.

36. **Caution.**—The percussion element charge is sensitive and care must be exercised to protect it from shock at all times. A blow on the primer from a sharp object, simulating that of a firing pin, could explode a round of this ammunition with fatal consequences.

Section IX

PROPELLING CHARGE

37. **General.**—The type of propellent powder used in ammunition for antiaircraft guns is nitrocellulose smokeless powder which is "nonhygroscopic" (NH) or moisture resistant. This improved type of powder is a recent development and is now standard for use in the manufacture of all new antiaircraft ammunition. However, some of the smokeless powder used with the 3-inch antiaircraft Mk. I shrapnel and Mk. I shell is straight pyro powder which was formerly the standard type but is now only a substitute standard. The NH powder is similar in appearance to the pyro powder. Both types are affected to some extent by moisture and great care should be taken to keep the powder dry.

38. **Charge weights and muzzle velocities.**—The weights of the propellent charges vary slightly with the type of shell and shrapnel used and with the model of the gun. Average values for these weights of charge, together with the standard muzzle velocities, are shown below:

Projectile	Weight of charge (pounds)				Muzzle velocity (feet per second)		
	Fixed guns		Mobile guns		Fixed guns	Mobile guns	
	NH	Pyro	NH	Pyro		M1918	M1 and M3
3-inch antiaircraft							
High explosive, Mk. I [1]	5.00	4.60	4.63	4.00	2,600	2,400	------
High explosive, Mk. IX	4.88	4.60	4.63	4.00	2,800	2,600	2,800
High explosive, M42	4.88	4.60	4.63	4.00	2,800	2,600	2,800
Shrapnel, Mk. I	5.00	4.60	4.63	4.00	2,600	2,400	2,600
105-mm antiaircraft							
High explosive, M38	10.00	------	------	------	2,800	------	------
Practice, M38	10.00	------	------	------	2,800	------	------

[1] Cannot be fired in guns of 1 in 40 twist.

39. Assembly.—The propelling charge is contained in the cartridge case. Since this charge only partly fills the cartridge cases for 3-inch antiaircraft ammunition, a distance wad is placed between the top of the charge and the base of the projectile to keep the powder compactly around the primer. This distance wad is made of cardboard, being in the form of a cylinder with a disk at each end held in place by a piece of cord, as shown in figures 1 and 3. Distance wads are not used in ammunition for 105-mm antiaircraft guns. An application of waterproofing compound is used to seal the junction between the cartridge case and projectile.

40. Action.—*a.* A grain of powder will burn freely in the open and has none of the characteristics of an explosive unless it is confined. When the powder is confined in a chamber, burning can become very rapid, its rate being approximately proportional to the pressure of the surrounding gases.

b. The gases from the burning of the propellent powder expel the projectile from the gun. The nature of this action is controlled by the design of the grains making up the powder charge—the rate of gas generation, and thus the rate of change of pressure, being governed by this means. It is required that the projectile be propelled from the gun with the prescribed muzzle velocity, but in so doing certain limiting factors must be observed. First, from the standpoint of safety, the pressure must not exceed at any time during the travel of the projectile in the bore, the prescribed powder pressures which are normally listed in appropriate firing tables. Second, from

the standpoint of velocity uniformity and economy, the mean burning rate must be great enough to insure the complete combustion of the powder charge. To meet these conditions it has been found convenient to make the grains of powder cylindrical with a number of holes or perforations running lengthwise of the grain. Figure 11 shows the end view of such a grain of powder. The approximate

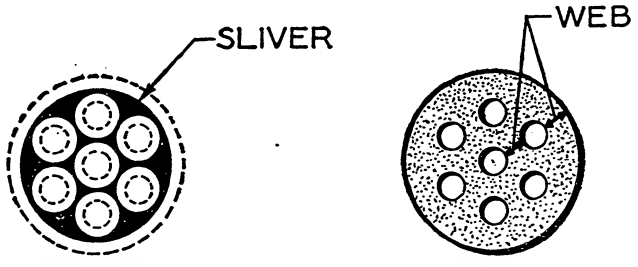


FIGURE 11.—Grain of powder.

dimensions of smokeless powder grains suitable for 3-inch and 105-mm antiaircraft guns are listed in the table below:

Caliber and model	Approximate powder grain dimensions (inch)		
	Length	Diameter	Web [1]
3-inch antiaircraft (fixed guns)	0. 437	0. 218	0. 034
3-inch antiaircraft (mobile guns)	. 437	. 218	. 039
105-mm antiaircraft gun, M3	. 510	. 225	. 040

[1] The "web" is defined as the average thickness of powder between perforations and between perforation and outer surface of the grain. (See fig. 11.)

c. By further reference to figure 11, dotted lines are seen to represent the outline of the original grain, whereas the solid black portion represents the same grain when the original web thickness is about to burn through—assuming that burning takes place at all surfaces with equal rates. It will be noted that, as the powder grain has burned in this fashion, the total surface exposed has increased in area up to the point of formation of the small triangular sections called "slivers." The increase of burning rate thus produced, even if the pressure were held constant, is a unique feature of any "progressive" powder. The slivers formed as described above are then entirely consumed before the projectile leaves the gun—provided the powder grains are of the proper design as outlined in *b* above.

SECTION X

PACKING

41. General.—Complete rounds of antiaircraft ammunition are packed in individual fiber containers which in turn are packed in a wooden box. The standard box for 105-mm antiaircraft ammunition contains 2 complete rounds and the standard box for 3-inch antiaircraft ammunition contains 4 complete rounds. Prior to the adoption of fiber containers, 3-inch antiaircraft ammunition was packed in individual metal containers, 4 complete rounds per box. A few older lots of this caliber are packed in metal-lined wooden boxes of 4 or even 6 rounds to the box. These older methods of packing, however, are now obsolete. In packing fixed rounds in wooden packing boxes, care is exercised to distribute properly the weight of the ammunition. If the rounds are packed so that all projectiles are at one end of the box, this end will have considerably more weight than the other and cause inconvenience in handling. To avoid this, the rounds are arranged so that the projectiles are distributed equally in opposite ends of the wooden packing box.

42. Fiber containers.—*a. General.*—The improved types of fiber containers for packing antiaircraft ammunition are shown together with their marking diagrams in figures 12 and 13. They are opened by removing the adhesive sealing strip (1) and slipping off the cover assembly (2). The tubular portion is made of several layers of waterproof container board. The ends are closed with metal disks (4) crimped firmly in place.

b. Fiber containers for 3-inch antiaircraft ammunition.—The two fiber containers provided for 3-inch antiaircraft ammunition are designated M20 and M28. They are of identical construction except for the over-all dimensions. (See fig. 12.) Ammunition for the 3-inch antiaircraft fixed guns is packed in fiber containers, M20, while the container, M28, is used for packing ammunition for the mobile mounts. The container, M20, weighs 6.85 pounds and the M28 weighs 6.25 pounds.

c. Fiber container for 105-mm antiaircraft ammunition.—The fiber container provided for 105-mm antiaircraft ammunition is designated M29 and is shown in figure 13. This container is used for packing complete rounds of both practice and high explosive shell. The fiber container, M29, weighs 18.25 pounds.

43. Wooden packing boxes.—*a.* The present standard packing box for antiaircraft ammunition is end opening. The cover or end is held in place by a wing nut threaded to a steel rod which extends through the box to the opposite end. A lead car seal and wire are

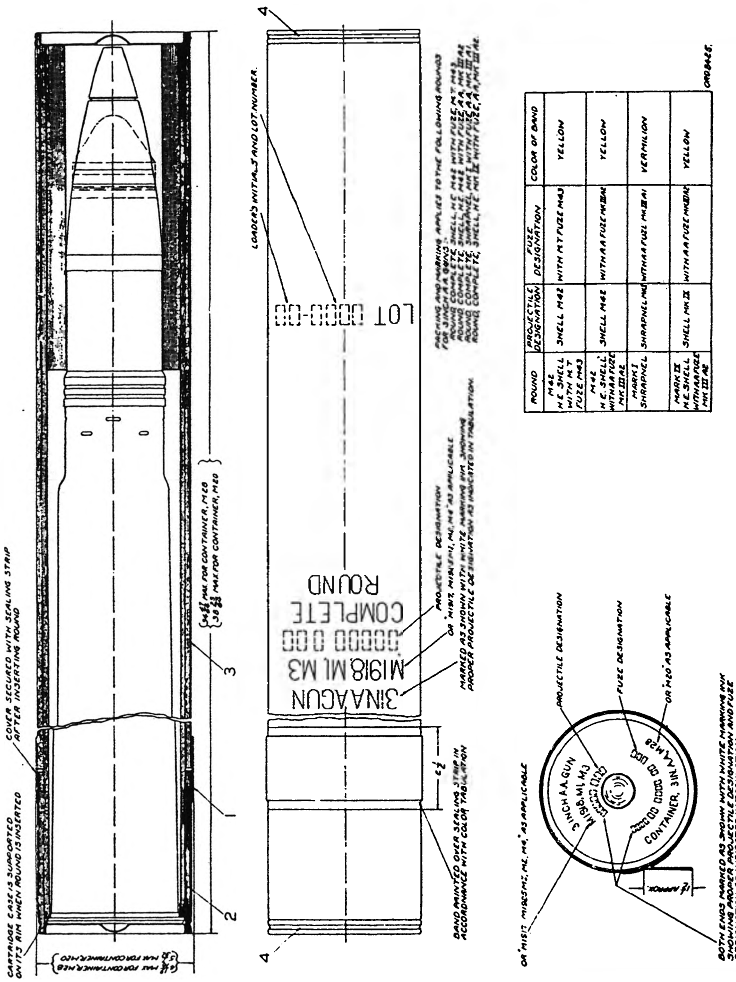
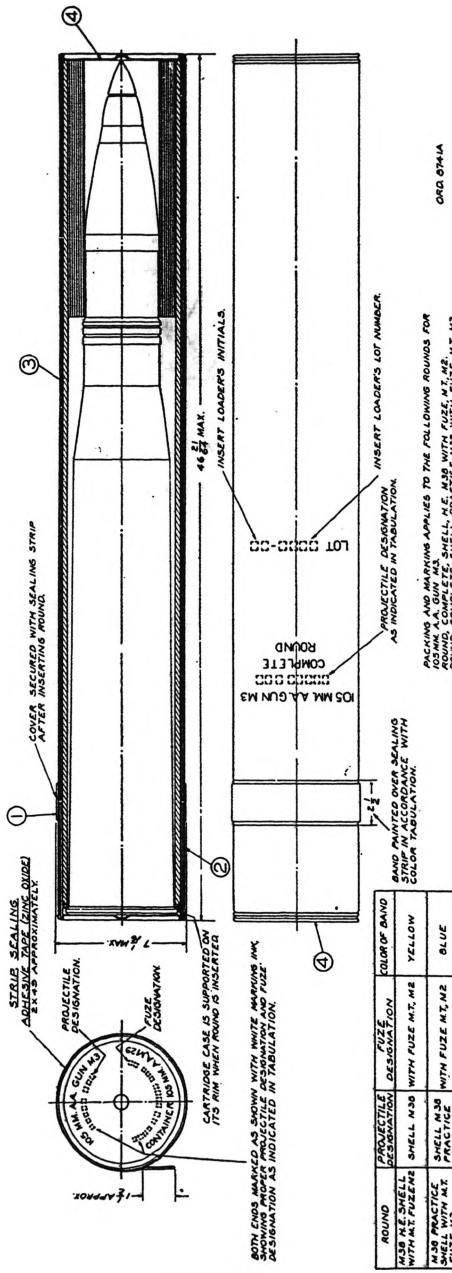


FIGURE 12.—Fiber container for 3-inch antiaircraft ammunition.

1. Adhesive sealing strip.
2. Cover assembly.
3. Body assembly.
4. Metal ends.

used to lock the wing nut in place. The cover cannot be removed without breaking the seal. Representative markings for boxes of fixed ammunition are shown in figure 14. Complete packing data covering dimensions, volume, and weights for the different types of



ROUND	PROJECTILE DESIGNATION	FUZE DESIGNATION	COLOR OF BAND
M38 H.E. SHELL WITH M.T. FUZE M2	SHELL M38	WITH FUZE M.T. M2	YELLOW
M38 PRACTICE SHELL WITH M.T. FUZE M2	SHELL M38 PRACTICE	WITH FUZE M.T. M2	BLUE

FIGURE 13.—Fiber container, M29, for 105-mm antiaircraft ammunition.

1. Adhesive sealing strip.
2. Cover assembly.
3. Body assembly.
4. Metal ends.

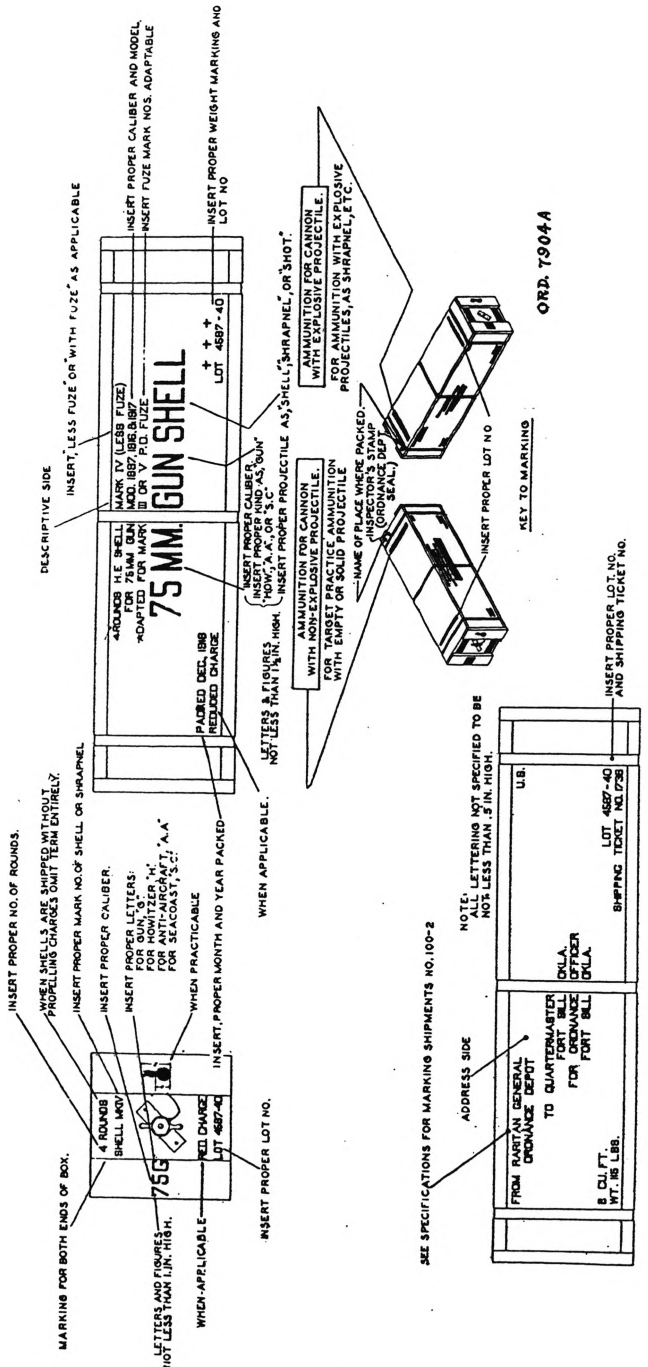


FIGURE 14.—Representative markings for ammunition packing box.

antiaircraft ammunition are published in Standard Nomenclature Lists Nos. P–4 and P–6.

b. Two boxes are provided for packing 3-inch antiaircraft ammunition. One is used for packing ammunition for the M1917, M1925MI, M2, and M4 (fixed) guns and the other is used for packing complete rounds for the M1918, M1, and M3 (mobile) guns. Both boxes are suitable for packing complete rounds of high explosive shell, Mk. IX and M42, as well as shrapnel. The box adapted for ammunition for

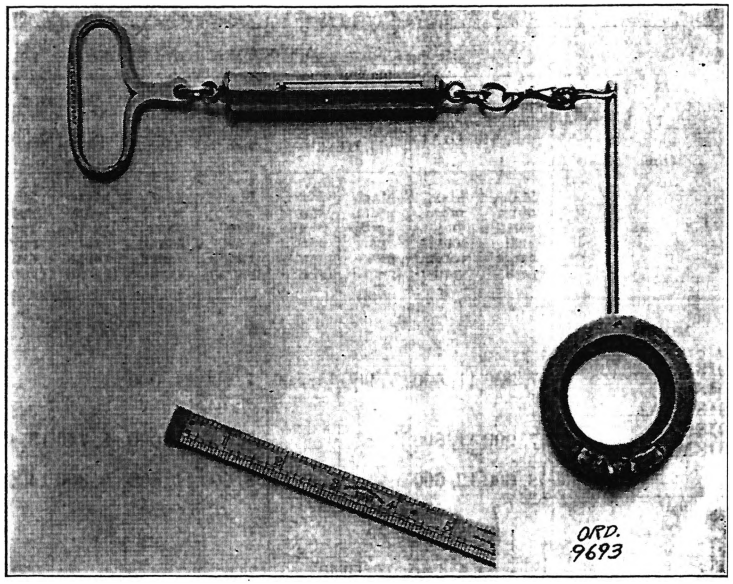


FIGURE 15.—Graduated time train ring friction tester.

the mobile guns weighs approximately 27.5 pounds empty. The box for ammunition for the guns on fixed mounts is of somewhat larger dimensions and has an empty weight of approximately 32 pounds. Each box holds 4 complete rounds.

c. The box provided for 105-mm antiaircraft ammunition is used for packing complete rounds of both high explosive and practice ammunition. It has a capacity of 2 complete rounds and weighs 50 pounds empty.

SECTION XI

DATA—MAXIMUM RANGES

44. Maximum ranges.—The maximum ranges obtained with different combinations of shell and fuzes in the various 3-inch and 105-mm antiaircraft guns are listed in the tables below.

Table of maximum ranges—3-inch antiaircraft guns

Guns	Ammunition							
	Shrapnel, Mk. I, with 21-second fuze, Mk. IIIA1		Shell, H. E., Mk. I, with 21-second fuze, Mk. IIIA2		Shell, H. E., Mk. IX or M42, with 21-second fuze, Mk. IIIA2		Shell, H. E., M42, with mechanical time fuze, M43	
	Maximum vertical range (yards)[1]	Maximum horizontal range (yards)[2]	Maximum vertical range (yards)[1]	Maximum horizontal range (yards)[2]	Maximum vertical range (yards)[1]	Maximum horizontal range (yards)[2]	Maximum vertical range (yards)[1]	Maximum horizontal range (yards)[2]
MOBILE								
M1918	7, 900	11, 800	7, 900	11, 800	7, 600	11, 000	------	------
M1918MI								
M1918A1								
M1918MIA1								
M1918A2	7, 900	11, 800	------	------	7, 600	11, 000	8, 740	13, 800
M1918MIA2								
M1	8, 600	12, 600	------	------	8, 200	11, 800	9, 300	14, 200
M3								
FIXED								
M1917	8, 600	12, 600	8, 600	12, 600	8, 200	11, 800	------	------
M1917MI								
M1917A1								
M1917MIA1								
M1917A2	8, 600	12, 600	------	------	8, 200	11, 800	9, 300	14, 200
M1917A3								
M1917MIA2								
M1917MIA3								
M1917MII								
M1925MI								
M2								
M4								

[1] Maximum vertical ranges are limited by action of the time fuze. Ranges shown are obtained with fuze set for maximum time action; gun at maximum elevation.
[2] Horizontal ranges shown are the maximum ground impact ranges obtained without the limiting factor of the time fuze.

Table of maximum ranges—105-mm antiaircraft gun, M3

Ammunition	Maximum vertical range (yards)[1]	Maximum horizontal range (yards)[2]
Shell, H. E., or practice, M38, with mechanical time fuze, M2	12, 320	19, 220

[1] Maximum vertical ranges are limited by action of the time fuze. Ranges shown are obtained with fuze set for maximum time action; gun at maximum elevation.
[2] Horizontal ranges shown are the maximum ground impact ranges obtained without the limiting factor of the time fuze.

[A. G. 062.12 (10–1–35).]

BY ORDER OF THE SECRETARY OF WAR:

MALIN CRAIG,
Chief of Staff.

OFFICIAL:
E. T. CONLEY,
Major General,
The Adjutant General.

U. S. GOVERNMENT PRINTING OFFICE: 1936

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ANTIAIRCRAFT AMMUNITION

AMMUNITION FOR 3-INCH AND 105-MM ANTIAIRCRAFT GUNS

CHANGES No. 1

WAR DEPARTMENT,
WASHINGTON, *January 3, 1939.*

TR 1360–3A, July 31, 1936, is changed as follows:

28. **Fuzes, obsolete.**—Rescinded.

[A. G. 062.12 (8–12–38).] (1938.)

BY ORDER OF THE SECRETARY OF WAR:

MALIN CRAIG,
Chief of Staff.

OFFICIAL:

E. S. ADAMS,
Major General,
The Adjutant General.

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U. S. GOVERNMENT PRINTING OFFICE: 1939

ANTIAIRCRAFT AMMUNITION

AMMUNITION FOR 3-INCH AND 105-MM ANTIAIRCRAFT GUNS

CHANGES No. 2

WAR DEPARTMENT,
WASHINGTON, *January 2, 1940.*

TR 1360–3A, July 31, 1936, is changed as follows:

24. General.

* * * * * * *

b. Permissible fuzes.—* * *

Projectile	Permissible fuzes				
	Mk. III	Mk. IIIA1	Mk. IIIA2	M43	M2
3-inch antiaircraft					
Shell, high-explosive, Mk. IX	(1)	(1)	Yes	(2)	No.
Shell, high-explosive, M42	No	No	Yes	Yes	No.
Shrapnel, Mk. I	Yes	Yes	No	No	No.
105-mm antiaircraft					
Shell, high-explosive, M38	No	No	No	No	Yes.
Shell, practice, M38	No	No	No	No	Yes.

[1] Fuzes, Mk. III and Mk. IIIA1 may be used with high-explosive shell, Mk. IX, when that shell is assembled with Mk. X boosters. This shell and fuze will not be used with any booster other than Mk. X except in an emergency and when directed by the Chief of Ordnance.

[2] Indicates that the fuze is not prescribed but there is no reason against its use from a standpoint of safety and functioning.

* * * * * * *

[A. G. 062.12 (12–26–39).] (1940.)

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

E. S. ADAMS,
Major General,
The Adjutant General.

204609°—40

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