RESTRICTED

JAPANESE AMMUNITION

PART III - 20 mm

1 JULY 1945

MILITARY INTELLIGENCE DIVISION, WAR DEPARTMENT
WASHINGTON, D.C.

RESTRICTED

CONTENTS

JAPANESE 20-mm AMMUNITION

Note: The word "Type" will be read for "Model" throughout this text, in accordance with the latest approved nomenclature.

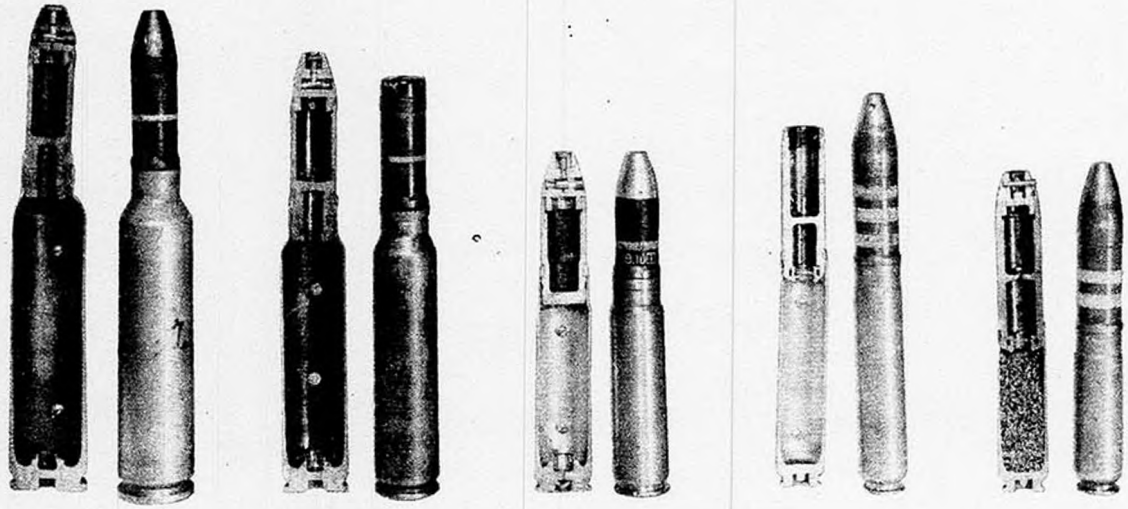
JAPANESE 20 mm (0.79 in.) AMMUNITION

Introduction:-

Japanese 20 mm ammunition recovered to date may be divided into five groups, determined by differences in cartridge case dimensions. These differences positively preclude interchangeability between the various groups. In some instances, however, the same projectile may be used with more than one type of cartridge case.

Identification of 20 mm ammunition is difficult, for in several of the groups no model number is used. In other instances, projectiles (ie: HE, AP etc.) are designated by different model numbers. In addition, other ammunition is known only to be designated by the model number of the particular weapon from which it is fired. For this reason, each group will be arbitrarily designated in this study by the weapon for which the complete round is intended.

The following photograph illustrates a representative specimen of each of the five groups.



5 4 3 2 1

(1) For Model 99 (1939) Mk I Aircraft Cannon (Navy)

(2) For Model 99 (1939) Mk II Aircraft Cannon (Navy)

(3) For HO 5 Aircraft Cannon (Army)

(4) For Model 97 (1937) AT Rifle (Army)

(5) For Model 98 (1938) AA - AT Gun (Army)

Specifications of fuzes used with 20 mm ammunition will form a separate section at the end of this study.

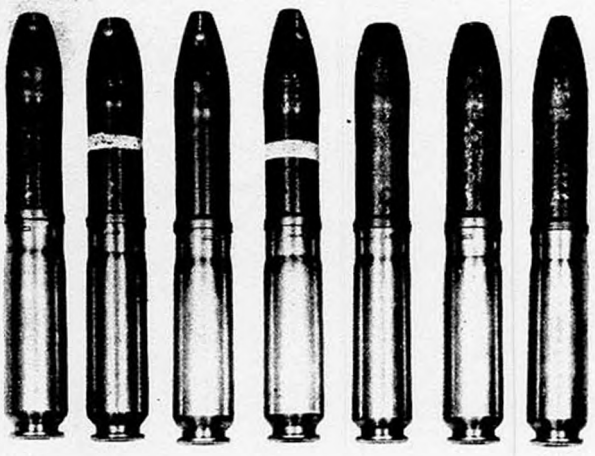
Japanese tracer elements are known to exist having the following colors:

Red
Pink
Yellow
Green

Where known, the composition and color of the tracer has been indicated with specific projectiles, but it is quite possible that one type of projectile may be fitted with any of the above colors.

Section I

MODEL 99 (1939) Mk I AIRCRAFT CANNON (NAVY) 20 mm AMMUNITION



1. General

This ammunition is a Japanese copy of the Swiss "Oerlikon" design. In addition to rounds of Japanese make, some of Swiss origin have also been recovered.

In the case of Japanese ammunition, the type (ie: HE, AP, Incendiary, etc.) is indicated by painting the projectile body a solid color. Subsequent modifications of the original type are indicated by one or more white bands around the projectile body, thus:

Original type:	No bands
Modification 1:	One 5 mm white band
Modification 2:	Two 5 mm white bands
Modification 3:	Three 5 mm white bands
Modification 4:	One 10 mm white band

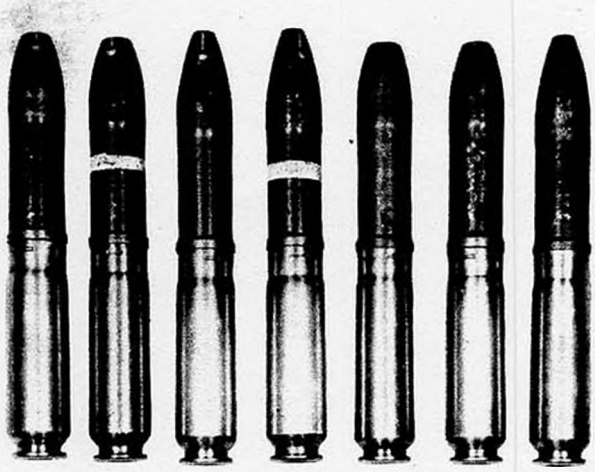
To date, all Swiss projectiles recovered have been painted a solid color without bands.

2. Weapons from which fired

This ammunition has been made only in Japanese Navy arsenals, being used in all modifications of the fixed and flexible 20 mm Model 99 (1939) Mk I Aircraft Cannon.

Section I

MODEL 99 (1939) Mk I AIRCRAFT CANNON (NAVY) 20 mm AMMUNITION



1. General

This ammunition is a Japanese copy of the Swiss "Oerlikon" design. In addition to rounds of Japanese make, some of Swiss origin have also been recovered.

In the case of Japanese ammunition, the type (ie: HE, AP, Incendiary, etc.) is indicated by painting the projectile body a solid color. Subsequent modifications of the original type are indicated by one or more white bands around the projectile body, thus:

Original type:	No bands
Modification 1:	One 5 mm white band
Modification 2:	Two 5 mm white bands
Modification 3:	Three 5 mm white bands
Modification 4:	One 10 mm white band

To date, all Swiss projectiles recovered have been painted a solid color without bands.

2. Weapons from which fired

This ammunition has been made only in Japanese Navy arsenals, being used in all modifications of the fixed and flexible 20 mm Model 99 (1939) Mk I Aircraft Cannon.

3. Specifications of cartridge case

The same cartridge case and primer are used with all types of projectiles. Examination of recovered cases, however, shows considerable variation in weight. Specifications are:

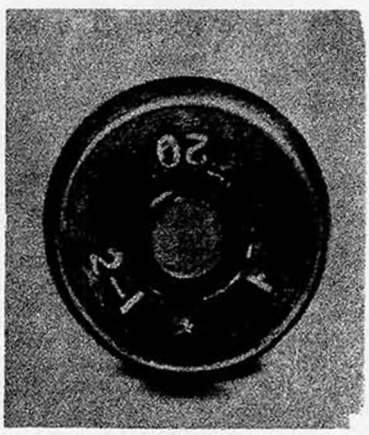
Weight empty (with primer):	2.01 oz (approx)
Length:	2.79 in.
Diameter of rim:	0.75 in.
Diameter of base:	0.87 in.
Material:	Drawn brass (70% copper, 30% zinc)
Type of primer:	Berdan with two flash holes. Primer annulus sealed with black lacquer.
Nature of propellant:	Nitrocellulose 98% Diphenylamine 0.8% Dinitrotoluene 0.95% Graphite 0.25%

Note: Japanese propellant is in the form of cylindrical grains while Swiss propellant is in flake form. Some Japanese rounds are reported to use flake powder similar to the Swiss. Both cylindrical and flake powders approximate the above mixture.

Weight of propellant: 0.48 oz

Base markings:

Japanese ammunition: Two typical base markings are shown:



4. Specifications of complete rounds

All projectiles are fixed in the cases by either three or six crimps at the cannelure. In addition, all projectiles are fitted with a single copper rotating band 4 mm (0.16 in.) wide.

The following dimensions are common to all projectiles:

Distance from rotating band to bourrelet:	1.29 in.*
Distance from rotating band to base:	0.36 in.
Diameter of body:	0.77 in.
Diameter at bourrelet:	0.79 in.
Diameter at base:	0.75 in.
Diameter of rotating band:	0.83 in.

* This figure is 1.18 inches for the API projectile.

(a) 20 mm HIGH EXPLOSIVE

The following specifications are considered to apply to the basic Japanese HE ammunition. A modification II projectile has been recovered, but examination has not revealed any apparent change in design. Japanese documents show that the projectile weighs 4.54 oz. and that it uses the same fuze and HE filling.

Ammunition of Swiss manufacture has been found to contain slightly more explosive than the Japanese round. The main difference lies in the use of the Type 1 b Fuze and 1b booster.

Japanese HE (Basic)

Weight of complete round:	6.99 oz.
Length of complete round:	5.67 in.
Weight of projectile (fuzed):	4.50 oz.
Length of projectile (fuzed):	3.23 in.
Body material:	Steel.
Composition of filling:	Pentalite (50% TNT 50% PETN)
Weight of filling:	0.35 oz.
Type of fuze:	Type II
Type of booster:	Type Ia
Color markings:	Rust brown *

* In addition, both purple and blue Japanese rounds have been reported. Swiss rounds have been recovered painted both yellow and brown.

(b) 20 mm HIGH EXPLOSIVE TRACER

It is believed that there are four modifications of the Japanese made projectile. No Swiss made projectile of this type has been recovered to date.

The body of all these projectiles (basic and modifications) contains two cavities separated by a steel septum (dividing wall). The upper cavity contains the HE filling, while the lower contains the tracer. The same HE filling and tracer mixture are used in all instances. Differences between the basic projectile and subsequent modifications are principally in the fuzes and weight of HE and tracer filling used.

(i) Japanese HE Tracer (Basic and Modification I)

Weight of complete round:	7.00 oz.
Length of complete round:	5.54 in.
Weight of projectile (fuzed):	4.51 oz.
Length of projectile (fuzed):	3.10 in.
Body material:	Steel
Composition of HE filling:	Pentalite (50% TNT, 50% PETN),
Weight of HE filling:	0.18 oz.
Composition of tracer:	Barium carbonate 74.9% Magnesium 20.1% Strontium chlorate 4.5% Iron, manganese and organic binder, a trace.
Weight of tracer filling:	0.23 oz.
Duration of tracer:	5 seconds (approx.)
Type of fuze:	Type I a.
Type of booster:	Type I a.
Color markings:	Red

(ii) Modification II uses a type I b fuze, has 0.21 oz. HE and 0.19 oz. Tracer fillings.

(iii) Modification III uses a Type II fuze and has same fillings as Modification II.

(iv) Modification IV ha been examined.

(c) 20 mm HIGH EXPLOSIVE TRACER (SELF-DESTROYING)

The projectiles are similar to the HE Tracer types except for their self-destroying feature, which is accomolished by a hole drilled through the septum of the projectile. A black powder train leads from the tracer composition, through the hole in the septum and the HE filling, to the base of the booster. If the tracer burns out before impact, the projectile is destroyed by setting off the booster.

Both Japanese and Swiss projectiles have been recovered. They are similar in design and fuzing and apparently differ only in color marking. No modifications have been reported.

Weight of complete round:	6.99 oz.
Length of complete round:	5.59 in.
Weight of projectile (fuzed):	4.50 oz.
Length of projectile (fuzed):	3.15 in.
Body material:	Steel
Composition of HE filling:	Pentalite (50% TNT, 50% PETN).
Weight of HE filling:	0.15 oz.
Composition of Tracer:	Same as HE Tracer projectiles.
Weight of Tracer filling:	0.20 oz.
Type of fuze:	Type I a.
Type of booster:	Type II.
Color markings:	Japanese - Red. Swiss - Black.

(d) 20 mm HIGH EXPLOSIVE INCENDIARY

It is believed that there are four modifications of the basic Japanese projectile. No Swiss projectile of this type has been recovered to date.

The body of all projectiles (basic and modifications) contains one cavity for the HE and incendiary filling. The base of the cavity contains TNT above which is an aluminum canister containing white phosphorus. The canister is surrounded by a graphited, flaked nitrocellulose incendiary mixture. On impact, the fuze ignites the incendiary mixture which detonates the TNT. The TNT bursts the projectile and scatters the white phosphorus, which ignites on exposure to air.

Differences between the basic projectile and subsequent modifications are principally in the fuzes and in slight changes in the shape of the cavity.

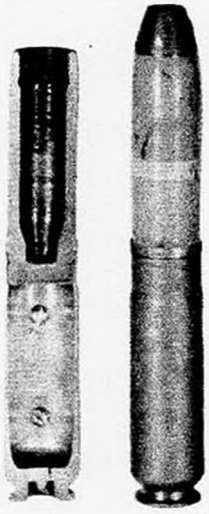
(i) Japanese HE Incendiary (Basic)

Weight of complete round:	7.00 oz.
Length of complete round:	5.67 in.
Weight of pfojectile (fuzed):	4.51 oz.
Length of projectile (fuzed):	3.23 in.
Body material:	Steel.
Composition of HE filling:	TNT.
Weight of HE filling:	0.18 oz.
Weight of white phosphorus:	0.11 oz.

Composition of incendiary mixture:

Nitrocellulose	77.9%
Sodium Nitrate	12.9%
Iron, Magnesium, Zinc	9.2%

Weight of incendiary mixture:	0.04 oz.
Type of fuze:	Type I b.
Type of booster:	Type III
Color markings:	Greenish-yellow.



(ii) Modification I has tapered cavity.
(iii) Modification II has tapered cavity and uses Type III a or III b fuze.
(iv) Modification III has tapered cavity and is reported to use Type II fuze.
(v) Modification IV is reported to have the TNT eliminated, using a larger WP canister with an incendiary pellet beneath the booster.

(e) 20 mm ARMOR PIERCING INCENDIARY

This round has an unfuzed projectile with a pointed steel body and a soft copper cap soldered to the nose. An incendiary filling is loaded into a cavity in the base of the projectile and is sealed with a threaded base plug.

Upon impact, the rear end of the projectile ruptures and the heat generated ignites the incendiary filling.

No modifications or similar Swiss ammunition have been found.

Japanese AP Incendiary

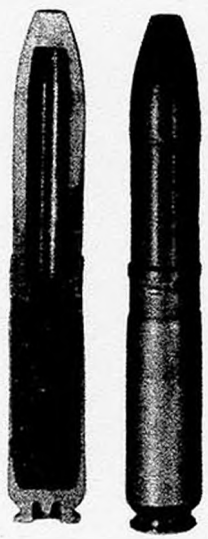
Weight of complete round:	7.13 oz.
Length of complete round:	5.59 in.
Weight of projectile:	4.64 oz.
Length of projectile:	3.15 in.
Body material:	High carbon-chromium steel.
Composition of incendiary filling:	Nitrocellulose 77.5% Sodium Nitrate 11.3% Alumimum 11.2% Zinc and Iron Trace
Weight of incendiary filling:	0.12 oz.
Color markings:	White

(f) 20 mm TRACER

The fuzeless projectile of this round has a blunt nose and a long cavity containing the tracer element. It is loaded so as to be the first round fired, its purpose being to break the muzzle cover of the cannon. It is therefore often referred to as a "bag-buster".

In addition to the basic Japanese type, Modifications II and III are known to exist, as well as a similar round of Swiss make. The weight of tracer constitutes the difference in the Japanese modifications.

(i) Japanese Tracer (Basic)



Weight of complete round:	6.93 oz.
Length of complete round:	5.67 in.
Weight of projectile:	4.44 oz.
Length of projectile:	3.23 in.
Body material:	Steel
Composition of tracer:	Same as HE tracer projectiles
Weight of tracer filling:	0.31 oz.
Duration of tracer:	16 seconds (approx)
Color Markings:	Red

(ii) Modification II has a tracer weight of 0.22 oz. and a tracer duration of approximately 7 seconds. The remainder of the cavity is packed with pulverized red clay.

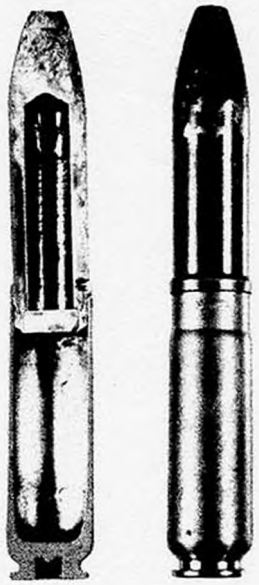
(iii) Modification III has not been examined.

(iv) The Swiss tracer projectile is painted green. It has not been examined.

(g) 20 mm PRACTICE

This ammunition has a fuzeless, blunt nose projectile of the same size and approximate weight as the fuzed rounds. The projectile has an empty cavity which is closed at the base with a crimped steel plug. No modifications have been reported.

Weight of complete round:	6.94 oz.
Length of complete round:	5.67 in.
Weight of projectile:	4.45 oz.
Length of projectile:	3.23 in.
Body material:	Steel
Color markings:	Black



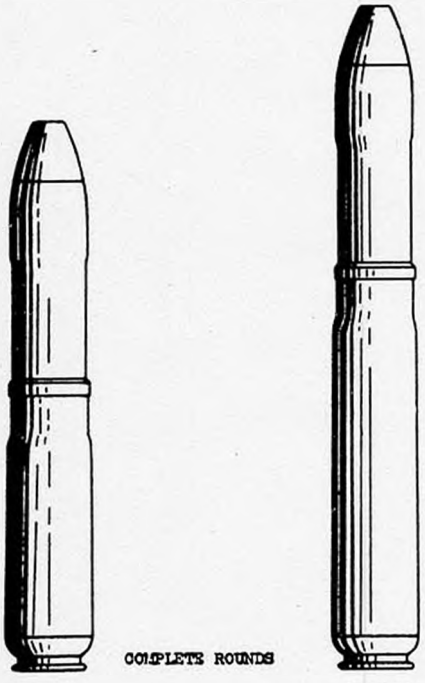
Section II

MODEL 99 (1939) MK II AIRCRAFT CANNON (NAVY)

20 mm AMMUNITION

1. General

This ammunition uses the same projectiles and fuzes as the ammunition for the MK I Aircraft Cannon described in Section 1. The cartridge case is of the same Oerlikon design, differing only in its increased length and greater propellant capacity. All ammunition recovered to date has been of Japanese manufacture.



COMPLETE ROUNDS

Mark I Mark II

2. Weapons from which fired

Similar to the shorter Oerlikon type ammunition, these rounds have been made only in Japanese Navy arsenals, being used in both the drum and belt fed modifications of the 20 mm Model 99 (1939) MK II Aircraft Cannon.

3. Specifications of cartridge case

This cartridge case is merely an elongated version of the shorter type described in Section 1, paragraph 3, and has the same dimensions of rim, base, and neck. The following specifications differ from those of the short cartridge case:

Weight empty (with primer):	2.50 oz.
Length:	3.98 in.
Weight of propellant:	0.76 oz.

A B C D

4. Specifications of complete rounds
(see figure above)

To date, the following types of this ammunition, using the long cartridge case, have been recovered:

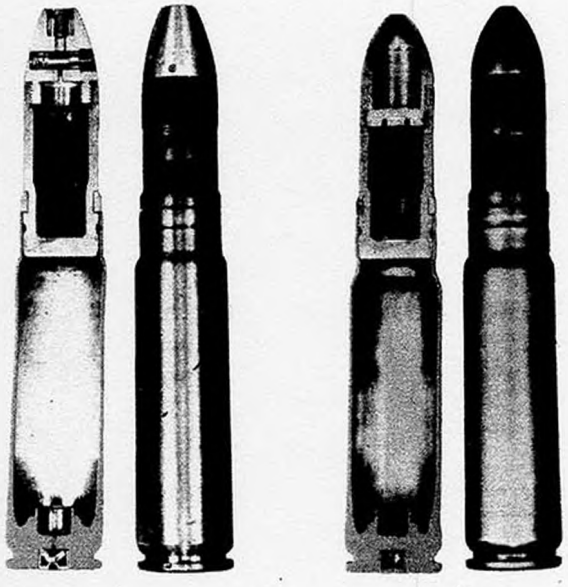
	Ammunition	Weight of complete round	Length of complete round
(a)	High Explosive	7.76 oz.	6.86 in.
(b)	High Explosive Tracer	7.77 oz.	6.73 in.
(c)	High Explosive Incendiary	7.77 oz.	6.86 in.
-	Armor Piercing Incendiary	7.90 oz.	6.78 in.
(d)	Tracer	7.70 oz.	6.86 in.

Section III

HO 5 - 20 mm AMMUNITION

1. General

The following photograph illustrates typical HO 5 rounds (ie: HE Incendiary Fuzed, HE Incendiary Fuzeless).



This ammunition is believed to be designated Model 2 (1942) and represents the most recent development by the Japanese in the 20 mm field.

The marking of the projectiles indicates a tendency for the Japanese Army to abandon its elaborate color scheme for 20 mm ammunition, and to rely on the difference in external appearance to identify the projectiles. In almost all cases, color bands are used only where no external difference exists.

2. Weapons from which fired

To date, this ammunition is only known to be used in the HO 5 Army Aircraft Cannon. Although possessing a caliber of 20 mm, the design of this weapon is practically identical to the U.S. Browning Aircraft Machine Gun Caliber .50, and as such represents a vast improvement over previous Japanese 20 mm aircraft weapons.

3. Firing data

Muzzle velocity:*

(a) 2,400 f/s with HE Incendiary Fuzed (see paragraph 5a, this section)

(b) 2,300 f/s with AP Tracer (see paragraph 5c, this section)

4. Specifications of cartridge case

The case is rimless brass, with a slight taper toward the neck.

Weight empty (with primer):	4.0 oz.	
Length:	3.69 in.	
Diameter of rim:	0.97 in.	
Diameter of base:	0.99 in.	
Material:	Brass	
Nature of propellant:	Nitrocellulose	93.9%
	Nitroglycerine	1.8%
	Stabilizer	4.3%
Weight of propellant:	0.76 oz.	
Base markings:	Arsenal symbol may appear.	

* by actual test

5. Specifications of complete rounds

Common to all projectiles of this ammunition are a deep cannelure at the base, a single rotating band with a forward slope and a pronounced bourrelet. All projectiles are fixed to the case by either 3 long or 6 short crimps. Additional common specifications are:

Diameter of body:	0.77 in.
Diameter of bourrelet:	0.79 in.
Diameter of rotating band:	0.83 in.

The following types of projectiles have been recovered:

High Explosive Incendiary (fuzed)

High Explosive Incendiary (fuzeless)

Armor Piercing Tracer

Practice

(a) 20 mm HIGH EXPLOSIVE INCENDIARY (FUZED)

To date, four versions of this round have been recovered. In all instances the same projectile body has been used. Three versions (A, B, and C) differ only in the type of fuze. The fourth version (D) differs in the type of fuze, weight of HE filling and color markings. The following data are common to all four varieties.

Length of complete round:		5.78 in. (approx)
Weight of projectile body (empty):		1.94 oz.
Length of projectile (without fuze):		1.83 in.
Length of projectile (fuzed):		2.56 in.
Distance from rotating band to bourrelet:		0.73 in.
Distance from rotating band to base:		0.47 in.
Thickness of wall:		0.11 in.
Nature of HE filling:		Cyclonite
Nature of Incendiary filling:	Barium nitrate	46.2%
	Aluminum	7.4%
	Magnesium	38.4%
	Wax	3.5%
Weight of Incendiary filling:		0.13 oz.

20 mm HE Incendiary (Fuzed) con't

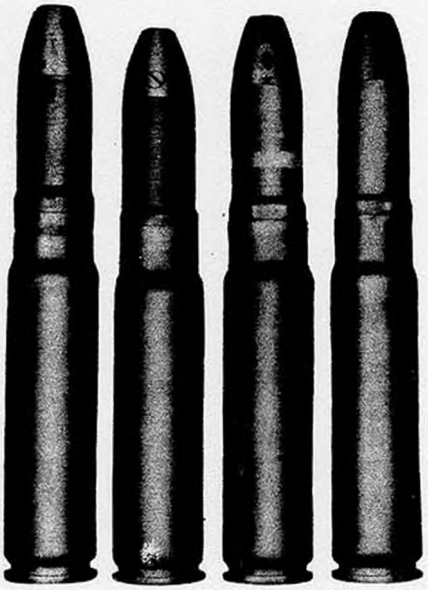
The three versions which differ only in the type of fuze employed, in each case use a one-piece aluminum fuze, contain 0.12 oz. of HE filling, and are painted black. (The differences in the three fuzes are discussed in Fuze Section.)

The fourth version has a two-piece aluminum fuze, 0.14 oz. of HE filling and is painted silver.

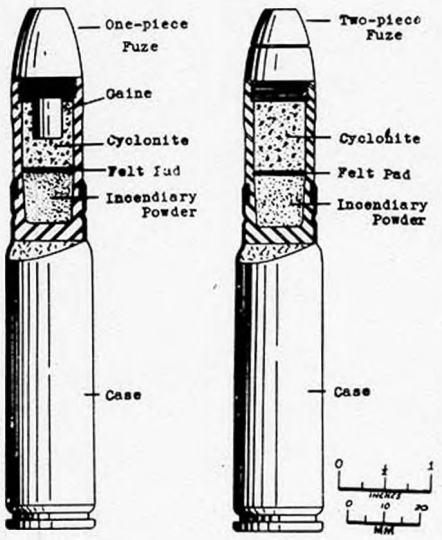
In all four varieties the same amount of incendiary charge is contained in the rear of the projectile. The HE filling is in the forward section and is separated from the incendiary filling by a felt pad.

A few specimens of the black painted projectile had a yellow band around the body. Use of this band, however, appears to be rare.

Variations in specifications of the above four modifications are shown below. Letter references apply to the photograph below illustrating this ammunition, and are arbitrary only.



A B C D



A,B,C, D

A and B (A with striker fuze--screw plug)
(B " " " --staked plug)

Weight of complete round:	7.56 oz.
Weight of complete projectile:	2.8 oz.

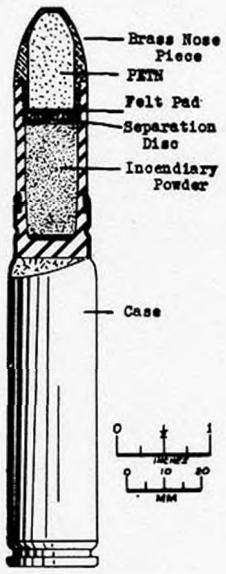
C (with one piece air-column fuze)

Weight of complete round:	7.51 oz.
Weight of complete projectile:	2.75 oz.

D (with two piece air-column fuze)

Weight of complete round:	7.52 oz.
Weight of complete projectile:	2.76 oz.

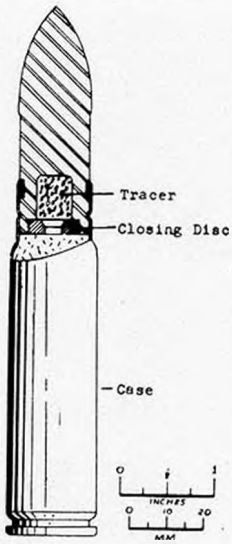
(b) 20 mm HIGH EXPLOSIVE INCENDIARY (FUZELESS)(Ma 202)



This ammunition is designated Ma 202, which indicates that it is a special type. The projectile has a brass nose piece filled with high explosive and a body containing incendiary powder. On impact, the nose crushes, detonating the high explosive, splitting the case and igniting the incendiary powder.

Weight of complete round:	7.56 oz. (approx)
Length of complete round:	5.86 in.
Weight of complete projectile:	2.8 oz. (approx)
Length of complete projectile:	2.56 in.
Length of projectile without nose piece:	1.83 in.
Thickness of wall:	0.21 in.
Nature of HE filling:	PETN.
Weight of HE filling:	0.11 oz.
Nature of incendiary filling:	Barium nitrate 46.2% Aluminum 7.4% Magnesium 38.4% Wax 3.5%
Weight of incendiary filling:	0.31 oz.
Color markings:	Black body, brass nose.

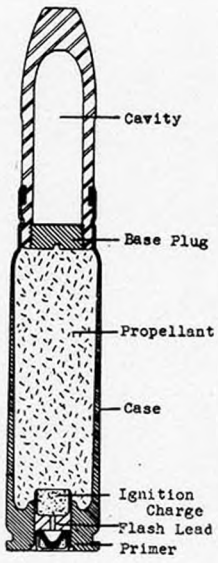
(c) 20 mm ARMOR PIERCING TRACER



The pointed steel projectile of this round has a cavity at the base in which the tracer element is sealed by a closing disc. Projectiles of three different grades of hardness (indicated by different color markings) and weights have been examined.

Weight of complete rounds,	
soft projectile:	8.73 oz.
medium projectile:	8.88 oz.
hard projectile:	8.99 oz.
Length of complete round:	5.79 in.
Weight of projectile, soft:	3.97 oz.
medium:	4.12 oz.
hard:	4.23 oz.
Length of projectile:	2.49 in.
Weight of tracer:	0.247 oz.
Duration of tracer:	8 seconds (approx)
Color of tracer:	Yellow
Color markings:	Black body
soft:	No band
medium:	Green band
hard:	Green and white bands together.

(d) 20 mm PRACTICE



This ammunition is fitted with a fuzeless projectile containing a large unfilled cavity sealed with a threaded base plug. Specifications are:

Weight of complete round:	7.61 oz.
Length of complete round:	5.78 in.
Weight of projectile:	2.85 oz.
Length of projectile:	2.56 in.
Body material:	Steel
Color markings:	Black body

Section IV

MODEL 97 (1937) 20 mm ANTITANK RIFLE

AMMUNITION

1. General

This ammunition in no way resembles the aircraft ammunition referred to in Sections 1 - 3 of this study. Characteristics which will assist in identification are the greater length of the cartridge case, its pronounced bottle neck, and the design and color marking of the projectiles. In addition, most cartridge cases recovered have been marked with Japanese characters indicating the weapon for which they are intended.

2. Weapons from which fired

Present information indicates that the same complete ammunition is fired from both the Model 97 (1937) AT Rifle and the Model 97 (1937) Aircraft Cannon. These weapons are of the same basic design differing only in minor details such as magazine, butt attachments, and mountings. In addition some of the projectiles are known to be used with the Model 98 (1938) AA-AT Gun ammunition, which, however, uses a larger cartridge case (see Section 5).

3. Firing data

(i) Muzzle velocity: 2600 f/s (approx) with Model 97 (1937) AP tracer ammunition (see paragraph 5g, this section)

(ii) Penetration: with Model 97 (1937) AP tracer ammunition (from Japanese sources):

Range (in yards)	273	547	820	1093	1367	1640	2190
Penetration (in inches)	1.18	0.91	0.71	0.59	0.47	0.39	0.36

(iii) Fragmentation: with probable Model 98 (1938) HE tracer ammunition. (See paragraph 5a, this section)

Firing Test--projectile statically fired

Size and weight of fragments	Number of Fragments	Weight of Fragments	Mean Fragment Weight	% Recovery
Over 1 oz and under 2 oz.	1	1.80 oz	1.80 oz	
Over 0.5 oz and under 1 oz	1	0.905 oz	0.905 oz	
Over 0.04 oz and under 0.125 oz	4	0.188 oz	0.05 oz	
Under 0.04 oz	94	1.05 oz	0.01 oz	
TOTALS	100			94

4. Specifications of cartridge case

This is a long, brass case characterized by a pronounced bottle neck. The rimless base is of conventional design, and in no way resembles the Oerlikon pattern of the Mark I and Mark II aircraft ammunition.

The following Japanese characters are usually stamped on the side of the case:

九七自 "97 Automatic" (Model 97 (AT Rifle)

or

旋固機 "Flexible Fixed Machine" (Model 97 (1937) Fixed or Flexible Aircraft Cannon)

In addition, characters indicating date and arsenal of manufacture will appear on the opposite side of the case. An inspection stamp is generally found on the base.

Weight empty (with primer):	4.7 oz.
Length:	4.90 in.
Diameter of rim:	1.13 in.
Diameter of base:	1.13 in.
Diameter of neck:	0.83 in.
Material of case:	Brass (60% copper, 40% zinc)
Nature of propellant:	Approximate analysis, Nitrocellulose 95% Dinitrotoluene 3.5% Diphenylamine 1.5%
Weight of propellant:	1.23 oz.

5. Specifications of complete rounds

The following types of ammunition have been recovered:

High Explosive Tracer

High Explosive Tracer (Self destroying)

High Explosive Incendiary (fuzed)

High Explosive Incendiary (fuzeless)

High Explosive Incendiary Tracer

Armor Piercing Tracer

All projectiles used with this ammunition are fitted with a single copper rotating band. Bodies are painted black, the nature of the projectile being indicated by a somewhat complicated system of color bands. Unlike the Navy system, the bands do not indicate modification numbers. In the majority of cases, when the complete ammunition is intended for use in the Model 97 (1937) AT Rifle, the model number of the projectile will be shown in white on the outside of the projectile body. Ammunition for use in the Model 97 (1937) Aircraft Cannon will probably have Japanese characters in white on the projectile body similar to those on the cartridge case.

With exception of the AP Tracer rounds, all projectiles are characterized by a straight sided body having no ogive. Projectiles are fixed to the cartridge case by three long crimps at the cannelure.

Additional characteristics common to all projectiles are:

Diameter of body:	0.77 in.
Diameter of bourrelet:	0.79 in.
Diameter of rotating band:	0.83 in.
Width of rotating band:	0.197 in.

(a) 20 mm HIGH EXPLOSIVE TRACER MODEL 98 (1938)

The projectile of this ammunition is the only HE Tracer definitely known to be used with the Model 97 (1937) AT Rifle and Model 97 (1937) Aircraft Cannon.

The body of the projectile contains two cavities separated by a steel septum. The upper cavity contains the HE filling while the lower contains the tracer. The only additional information available is as follows:

Weight of complete round:	10.7 oz.
Length of complete round:	7.5 in. (approx)
Weight of projectile (fuzed):	4.80 oz.
Weight of projectile (without fuze):	3.49 oz.
Length of projectile (fuzed):	3.19 in.
Length of projectile (without fuze):	2.46 in.
Body material:	Steel
Weight of HE filling:	0.14 oz. (approx)
Nature of HE filling:	Cyclonite
Color of tracer:	Green
Type of fuze:	Model 93 (1933)
Color markings:	Red band at bourrelet, green and yellow bands at center.

Note: Although this is the only HE Tracer projectile known definitely to be used with the Model 97 (1937) weapons, two other such projectiles are used with the Model 98 (1938) AA-AT Gun (see Section 5). It is possible therefore that they may be used also in the Model 97 (1937) cartridge. The bourrelet of all three models of HE Tracer is characterized by a sharp edge rather than the rounded edge found on other projectiles of this group.

(b) 20 mm HIGH EXPLOSIVE TRACER (SELF DESTROYING) MODEL 100 (1940)

The projectile of this round contains tracer and explosive cavities, separated by a metal septum. A small igniting charge passes through a hole in the septum connecting the two elements, thus ensuring that if the tracer burns out before impact, the HE filling will be ignited destroying the projectile.

Weight of complete round:	10.63 oz.		
Length of complete round:	7.53 in.		
Weight of projectile (fuzed):	4.67 oz.		
Length of projectile (fuzed):	3.18 in.		
Body material:	Steel		
Nature of HE filling:	Cyclonite		
Weight of HE filling:	0.16 oz.		
Composition of tracer:	* Strontium nitrate	68%	
	Strontium Carbonate	5%	
	Magnalium powder (75 Mg:25 Al)	25%	98%
Weight of tracer:	0.11 oz.		
Color of tracer;	Red		
Duration of tracer:	over 12 sec.		
Composition of tracer igniter:	Magnesium powder	12%	
	Barium peroxide	83%	
	Shellac	5%	
Weight of tracer igniter:	0.03 oz.		
Nature of HE igniter:	Black powder		
Weight of HE igniter:	0.009 oz.		
Type of fuze:	Model 100 (1940)		
Color markings:	Red at bourrelet, green and yellow bands at center.		

* Other projectiles have been recovered with different tracer compositions.

Note: Two apparent modifications of this projectile have been recovered for use with the Model 98 (1938) AA-AT Gun (see section 5, paragraph c).

(c) 20 mm HIGH EXPLOSIVE INCENDIARY (FUZED)

The projectile body contains one large cavity, the upper half of which contains the explosive and the lower the incendiary.

Weight of complete round:	10.42 oz.
Length of complete round:	7.5 in. (approx)
Weight of projectile (fuzed):	4.49 oz.
Length of projectile (fuzed):	3.32 in.
Length of projectile (without fuze):	2.37 in.
Body material:	Steel
Nature of HE filling:	Cyclonite
Weight of HE filling:	0.12 oz.
Composition of incendiary filling:	Barium nitrate 49.5% Magnesium 40 % Aluminum 10.5%
Weight of incendiary filling:	0.19 oz.
Type of fuze:	Model 93 (1933)
Color markings:	Red band at bourrelet, yellow band at center.

(d) 20 mm HIGH EXPLOSIVE INCENDIARY TRACER

This ammunition generally resembles the HE incendiary (fuzed) referred to in paragraph "c" of this section, except that the projectile body is greater in length and contains two cavities, the rear one of which houses the tracer. The only additional data available are:

Body material:	Steel
Nature of HE filling:	Cyclonite
Color of tracer:	Yellow
Type of fuze:	Model 100. (1940)
Color markings:	Red band at bourrelet, green and yellow bands at center.

(e) 20 mm HIGH EXPLOSIVE INCENDIARY (FUZELESS)

This projectile consists of a steel body with a single cavity which contains the incendiary composition. A brass nose piece, externally resembling a fuze, is screwed to the body and contains the explosive charge. The nose piece contains no mechanical parts.

The projectile is designed to be exploded by the crushing of the nose upon impact.

Weight of complete round:	9.79 oz.
Length of complete round:	7.5 in. (approx)
Weight of projectile (with nose piece):	3.86 oz.
Length of projectile (with nose piece):	3.33 in.
Length (without nose piece):	2.40 in.
Body material:	Steel
Nature of HE filling:	PETN
Weight of HE filling:	0.15 oz.
Weight of incendiary filling:	0.31 oz.
Color markings:	Red band below bourrelet

Note: The Japanese characters 二〇一 ("201") are vertically stencilled in white on the projectile, thus following a new Japanese trend in designating certain ammunition.

(f) 20 mm ARMOR PIERCING TRACER MODEL 100 (1940)

This ammunition has an unfuzed projectile with a pointed steel body containing a tracer cavity in the base.

Weight of complete round:	11.72 oz.
Length of complete round:	7.70 in.
Weight of projectile (with tracer):	5.72 oz.
Length of projectile:	3.17 in.
Body material:	Steel
Composition of Tracer:	Barium nitrate 63.4% Barium carbonate 7.5% Aluminum metal 9.2% Magnesium metal 11.9% Wax covering 6.0% 98.0%
Weight of tracer:	0.025 oz. *
Duration of tracer:	5.2 seconds(stationary)
Color of tracer:	Green
Composition of tracer igniter:	Barium peroxide Sodium chlorate Magnesium metal Wax covering.
Weight of tracer igniter:	0.014 oz.*
Color markings:	Green and white bands at center.

Recovered rounds have been found to contain a total weight of 0.074 oz. of tracer and tracer igniter, in comparison to the official Japanese weight indicated above. Other tracer compounds, producing a red flame, have been reported.

(g) 20 mm ARMOR PIERCING TRACER MODEL 97 (1937)

From available characteristics the projectile appears to be identical to the Model 100 AP Tracer referred to in paragraph (f) of this section.

In addition, there is a Model 97 (1937) Substitute AP Tracer projectile. Japanese sources state that substitute projectiles are used in peace time training.

(h) 20 mm WOODEN BLANK

This is a solid wood projectile which is probably used to secure the automatic action of gas operated machine cannon during training. This round has not been recovered todate.

Weight of complete round:	6.43 oz.
Length of complete round:	7.7 in.
Weight ofprojectile:	0.25 oz.
Exposed length of projectile:	2.76 in.

Note: The propellant used is slightly in excess of the normal charge used with combat projectiles, having a total weight of 1.3 oz.

Section V

MODEL 98 (1938) 20 mm ANTIAIRCRAFT - ANTITANK GUN

AMMUNITION

1. General

The complete ammunition closely resembles that used in the Model 97 weapons (see Section 4) and differs only in having a larger cartridge case. Positive identification of the complete rounds can be ascertained from the Japanese characters appearing on the cartridge case.

2. Weapons from which fired

As far as is known, the complete ammunition may be used only in the Model 98 (1938) AA-AT Gun.

3. Firing data

(i) Muzzle velocity: * 3120 f/s with Model 100 (1940) HE Tracer Self Destroying (see paragraph 5c, this section)

Note: Owing to similarity between all projectiles and to the use of a standard charge, it is considered that a muzzle velocity of 3000 f/s would represent an approximate figure for all types of ammunition used in the Model 98 (1938) AA-AT Gun.

(ii) Fragmentation: No tests have been conducted with Model 100 (1940) HE Tracer-Self Destroying, but owing to similarity of projectile construction it is considered that it would approximate that of Model 98 (1938) HE Tracer referred to in Section 4, paragraph 3.

* from Japanese sources

(iii) Ballistic performance: *The following data relate to the Model 100 (1940) HE Tracer-Self Destroying when used in the Model 98 (1938) AA-AT Gun.

Range (in meters)	Time of flight (in seconds)	Terminal velocity (meters/seconds)
200	0.2	812.0
400	0.5	685.8
600	0.8	573.9
800	1.2	477.7
1000	1.7	399.6
1200	2.2	344
1400	2.8	307
1600	3.5	279
1800	4.2	258
2000	5.0	241
2200	5.9	226
2400	6.8	212

Note: This table would also approximate the ballistic performance for other rounds of this group, with the possible exception of the AP Tracer ammunition. However, non self destroying projectiles will have a maximum range considerably in excess of that shown in the table.

4. Specifications of cartridge case

This case is similar to that used with the Model 97 weapons (see Section 4) except that it is of greater length and base diameter.

The following Japanese characters are usually stamped on the side of the case:

九八機 "98 Machine" (Model 98 (1938) AA-AT Gun)

* from Japanese sources

4. Specifications of cartridge case, con't

Weight empty (with primer):	7.35 oz.
Length:	5.61 in.
Diameter of rim:	1.32 in.
Diameter of base:	1.32 in.
Diameter of neck:	0.83 in.
Material of case:	Brass (60% copper 40% zinc)
Nature of propellant:	Approximate analysis, Nitrocellulose 90.8% Dinitrotoluene 7.6% Diphenylamine 1.3% Graphite 0.3%
Weight of propellant:	2.12 oz.

5. Specifications of complete rounds

The projectiles are similar to those used with the Model 97 (1937) weapons, and are probably completely interchangeable. The following have been recovered for use in the Model 98 (1938) AA-AT Gun:

High Explosive Tracer

High Explosive Tracer (Self destroying)

Armor Piercing Tracer

In addition, the projectiles of all other types of ammunition used in the Model 97 weapons (see Section 4) could be fitted to the cartridge case for the Model 98 (1938) AA-AT Gun.

(a) 20 mm HIGH EXPLOSIVE TRACER

Specimens recovered of this round have had no model number marked on the projectile. The projectile body is divided into two cavities separated by a metal septum. The explosive filling is contained in the upper and the tracer in the lower cavity. Like all other recovered HE Tracer projectiles, the bourrelet has a sharp edge.

Although the projectile body appears to be identical to the Model 98 (1938) HE Tracer (see Section 4, paragraph a), a completely different method of color marking is used, the bands being wider and differently placed.

Differing characteristics are as follows:

Weight of complete round:	14.27 oz. (approx)	
Length of complete round:	8.21 in.	
Composition of tracer:	Strontium nitrate	63.4%
	Magnesium metal	19.7%
	Aluminum metal	11.0%
	Wax	5.7%
		99.8%
Color of tracer:	Red	
Color markings:	Yellow band below bourrelet, white band above rotating band.	

(b) 20 mm EXPERIMENTAL HIGH EXPLOSIVE TRACER MODEL 100 (1940)

The projectile, with the following exceptions, appears to be identical to the Model 98 (1938) HE Tracer described in section 4, paragraph (a).

(i) The Model 100 (1940) is fitted with a Model 100 (1940) fuze, giving it an overall length of 3.19 inches and a weight of 4.45 ounces.

(ii) Tracer composition is similar to the unidentified HE Tracer projectile in paragraph (a) of this section.

The following data are also additional:

Weight of complete round: 13.9 oz.

Length of complete round: 8.21 in.

(c) 20 mm HIGH EXPLOSIVE TRACER (SELF DESTROYING) MODEL 100 (1940)

Three different versions of the projectile have been recovered for use with the Model 98 (1938) AA-AT Gun, as indicated below:

(i) Basic version. The projectile is identical to that used with the Model 97 (1937) weapons, and reported in section 4, paragraph (b).

Weight of complete round: 14.10 oz.

Length of complete round: 8.21 in.

(ii) Modification I. This ammunition is identical to basic version except that the HE filling of the projectile is Black powder instead of Cyclonite.

(iii) Modification II. This ammunition is identical to basic version except that the HE filling of the projectile consists of two pre-formed pellets. The forward one, fitting around the booster, is a pressed, grey mixture of Magnesium-Aluminum powder, Barium nitrate, and Paraffin. The rear pellet, fitting around the HE igniter is pressed Black powder.

Modification I and II are indicated by Japanese characters, in white on the projectile body, as follows:

修 Modification I

二修 Modification II

(d) 20 mm ARMOR PIERCING TRACER MODEL 100 (1940)

The projectile of this ammunition is identical to that used in the Model 97(1937) weapons. See section 4, paragraph (f), for characteristics of projectile.

Weight of complete round: 15.2 oz.

Length of complete round: 8.41 in.

(e) 20 mm WOODEN BLANK

The projectile is similar to that reported in section 4, paragraph (h). The propellant charge, however, is slightly in excess of the normal charge used with other projectiles for the Model 98 (1938) AA-AT Gun, having a total weight of 2.30 oz. This projectile has not been recovered.

Weight of complete round: 9.63 oz. *

Length of complete round: 8.35 in.

* This weight has been obtained from Japanese documents. Addition of the components indicates a weight of 0.27 oz. in excess of this figure.

Section VI

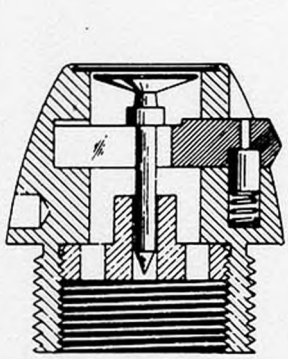
FUZES AND BOOSTERS USED WITH JAPANESE 20 mm AMMUNITION

1. Fuzes and boosters used with Model 99 (1939) Mark I and Mark II Aircraft Ammunition

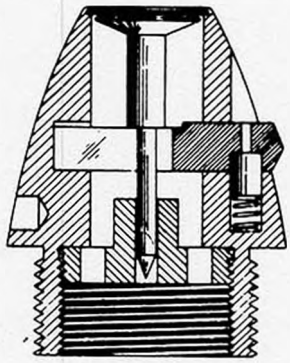
(a) Fuzes

Three types of fuzes have been recovered in this ammunition. Two of these types have one modification, thus making a total of five fuzes.

Jump-out Type (Type Ia and Ib)



Type IA

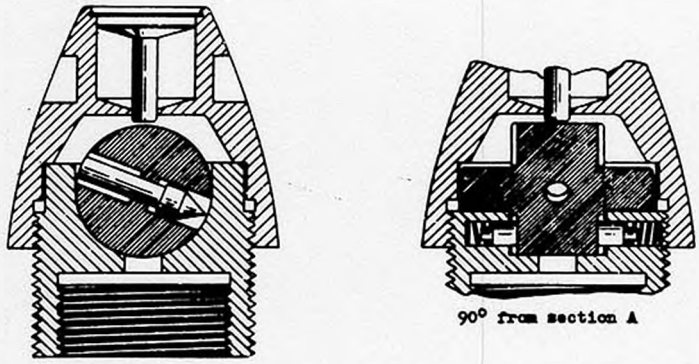


Type IB

There are two sizes of this fuze, both having the same operation. The small size will be designated Type Ia, and the large size will be designated Type Ib.

A brief description of the operation is as follows: when the projectile is fired, the force of setback causes the detent to move down against its spring. This releases the safety fork which will move outward by centrifugal force and be thrown clear of the fuze when the projectile leaves the bore of the gun. This releases the striker which is driven down into the booster on impact.

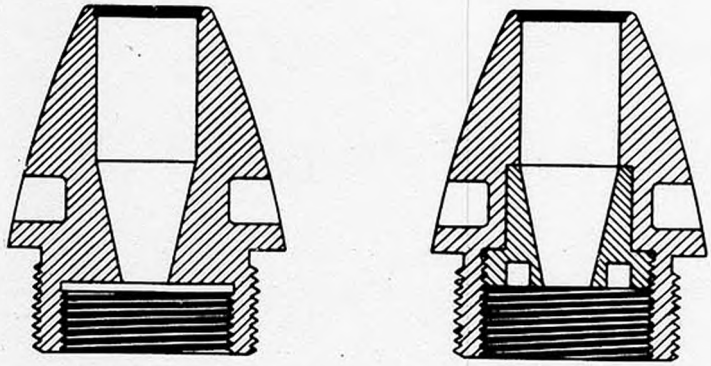
Rotor Type (Type II)



Type II

This fuze operates on the rotor principle and is unique in that the firing pin, rather than the detonator, is housed within the rotor. When the projectile is fired, centrifugal force causes the detents to move back against their springs thus releasing the rotor which turns, because of centrifugal force, until the striker is aligned with the hammer and booster. The rotor is held in this position by centrifugal force, and on impact the hammer drives the striker into the booster.

Air Column Type (Type Type IIIa and IIIb)

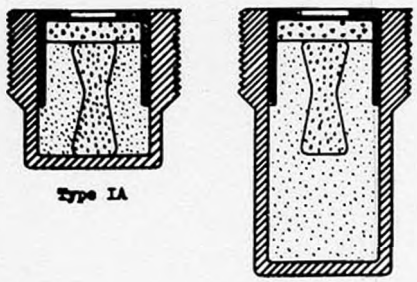


This fuze operates on the air column principle. There are two variations, differing only in the fact that Type IIIa is of one-piece construction, while Type IIIb is of two-piece construction, having an inner metal collar threaded to the body. There are no arming principles employed in this fuze. On impact the closing disc is crushed and pushed down into the air column thus compressing the air in the column and creating sufficient heat and pressure to detonate the primer.

(b) Boosters

There are three types of boosters that have been recovered so far. One of these types has a modification, thus making a total of four boosters which may be used.

Explosive Booster (Types Ia and Ib)

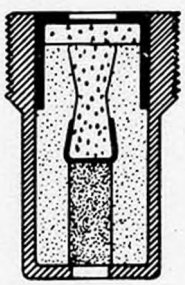


Type IA

Type IB

The main filling of this booster is PETN with a pressed lead azide pellet in the middle. Above the lead azide pellet is a layer of priming composition consisting of antimony sulfide and potassium chlorate pressed into an inverted brass cup which is pressed into the booster body. A tinfoil disc is assembled between the upper surface of the primer and the perforated cup.

Explosive Self-Destroying Booster (Type II)



Type II
(SD)

The main filling and primer of this booster are the same as for the Type I, but the booster has a flash-hole in the bottom of it and above this flash hole and connecting with the lead azide pellet is an igniter pellet of black powder. The lead azide pellet is also coated with a thin black powder covering. When the tracer in the projectile has burned out, it ignites the black powder pellets in the projectile which will in turn ignite the black powder in the fuze. This will, in turn, detonate the lead azide pellet.

Incendiary Booster (Type III)

Type III
(Inc.)

This booster is used only in incendiary projectiles, and the main filling, instead of being a high explosive, is compressed black powder. This black powder igniting charge is packed into an aluminum container above which is the same type of primer that is used in the other booster. When the fuze functions, the flame from the primer will ignite the black powder which will in turn set fire to the incendiary mixture of the projectile.

Summary

A list of the fuzed projectiles and the fuzes and boosters that are used with them is given in the following table:

	Fuze (Type)		Booster (Type)
H.E. (Jap)	II	-	Ia
H.E. (Swiss)	Ib	-	Ib
H.E.T. and H.E.T. Mod 1 (Jap)	Ia	-	Ia
H.E.T. Mod 2	Ib	-	Ia
H.E.T. Mod 3	II	-	Ia
H.E.T. (S.D.) (Jap)	Ia	-	II
H.E.T. (S.D.) (Swiss)	Ia	-	II
H.E.I. and H.E.I. Mod 1 (Jap)	Ib	-	III
H.E.I. Mod 2	IIIa IIIb		III

2. Fuzes and Boosters Used with HO 5 Aircraft Ammunition

Four varieties of fuzes are used with the HE Incendiary HO 5 ammunition. All are made of light metal alloy. In what is believed to be the order of development they are:

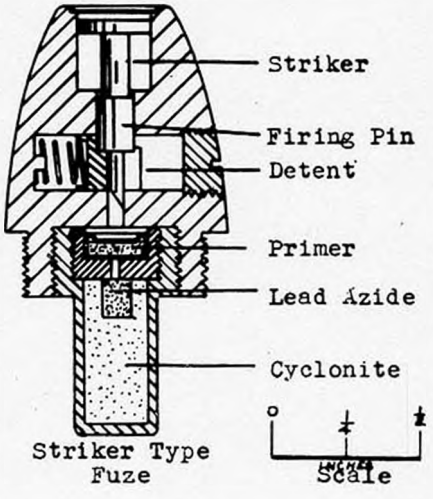
(a) Striker type with a centrifugal detent secured by a screw

(b) Striker type with a centrifugal detent secured by a staked plug.

(c) Air column type.

(d) Two-piece air column type without a booster.

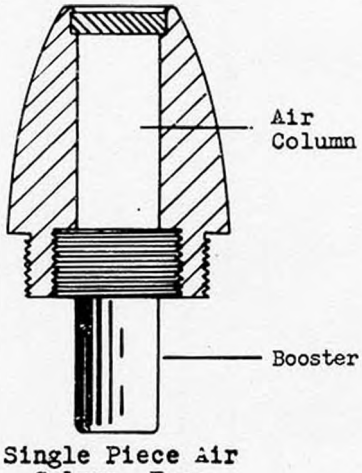
Fuze (a): has a striker held forward by a single centrifugal detent. This moves clear on rotation of the projectile and on impact the striker is driven into the primer on top on the booster. It is identical to the Model 100 20 mm fuze except that the body of the Model 100 is brass. The booster is brass and has a brass primer carrier threaded into its top. The primer mixture is contained in a copper cup crimped in the carrier. The lower part of the booster contains a lead azide core in pressed cyclonite.



Striker Type Fuze

Fuze (b): is identical to fuze (a), except that the detent hole is closed with a staked plug rather than a screw. It is known that the Type 100 fuze had been giving trouble with prematures in the bore and it is believed that the plug is an attempt to prevent premature arming.

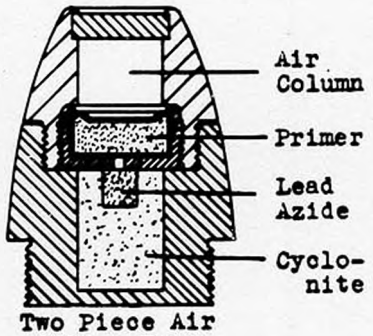
Fuze (c): is a new departure in Army Ammunition. It is an air column fuze taking the same booster as Fuzes (a) and (b).



Single Piece Air Column Fuze

2. Fuzes and Boosters Used with HO 5 Aircraft Ammunition, con't

Fuze (d): eliminates the booster by moving its contents up into the fuze body. This leaves space for about 0.02 oz more Cyclonite in the projectile. The fuze body is in two parts. The upper part contains a shorter air column and a primer in a left-hand threaded brass carrier. The lower part contains the Azide and Cyclohite.

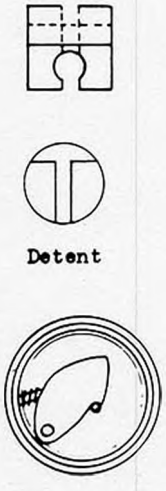


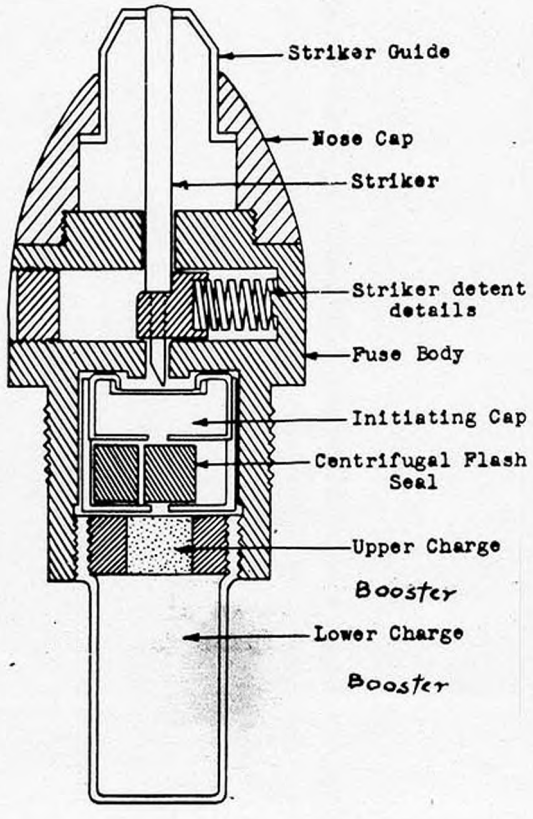
Two Piece Air Column Fuze

3. Fuzes and Boosters Used with Ammunition for Model 97 (1937) and Model 98 (1938) Guns

Two types of fuzes are used with this ammunition, the Model 93 (1933) being used with Models 97 and 98 fuzed projectiles and the Model 100 (1940) with projectiles of this model number. Instances have been encountered, however, where the Model 100 (1940) fuze has been fitted to the Model 98 (1938) projectiles.

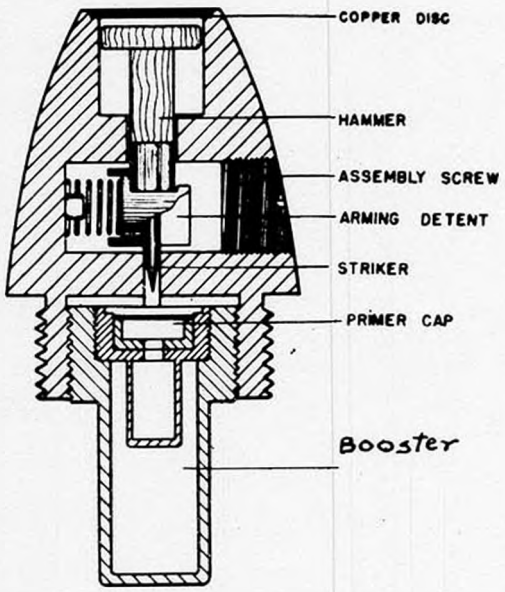
Model 93 (1933) Fuze: is of two piece brass construction with an aluminum nose cap. Supporting the firing pin is a forked detent through which the point of the firing pin protrudes. Beneath the primer is a centrifugal flash seal which provides for an interruption in the firing train. On setback, the firing pin holds the detent in, but when the projectile decelerates, the firing pin creeps forward, and centrifugal force causes the detent to move out. The flash seal is swung out by centrifugal force opening the flash hole, and on impact the firing pin is driven down.





3. Fuzes and Boosters Used with Ammunition for Model 97 (1937) and Model 98 (1938) Guns, con't

Model 100 (1940) Fuze: this is identical to the Fuze (a), used with HO 5 ammunition, except that the body is made of brass. The booster used with the Model 100 (1940) fuze is different from that used with the Model 93 (1933). Although the Model 100 (1940) is known to have been substituted for the Model 93 (1933), it is believed that any projectile originally designed for the Model 100 could not be fitted with the Model 93 (1933) fuze.



SOURCES OF INFORMATION

1. Mobile Explosives Investigation Unit No. 1; Reports Nos. 29, 58, 91, 96, 153.
2. Mobile Explosives Investigation Unit No. 4; Report No. 34 and addendum.
3. United States Pacific Fleet and Pacific Ocean Areas Weekly Intelligence Vol. 1, No. 37.
4. Headquarters United States Army Forces in South Pacific Area, Report 7 July 1943.
5. Watertown Arsenal, Ordnance Report No. 763/308.
6. Frankford Arsenal, Report T-1481.
7. Munitions Supply Laboratories, Report No. 111.
8. 43rd Chemical Laboratory Company, Project No. 10.
9. Bureau of Ordnance, Navy Department, Foreign Ordnance Report No. NR 4-307.
10. Office of Scientific Research and Development, Reports Nos. M-295, M-310.
11. 1 Anti-Gas Laboratory RAE, Report No. 55.
12. Australian Military Forces Technical Intelligence Summary, No. 9.
13. United States Army Services of Supply, Ordnance Report Nos. 18-2, 29.
14. China Burma India, Ordnance Intelligence Report Nos. 8, 9, 14, 29.
15. Commander in Chief Pacific Fleet and Pacific Ocean Areas, Bulletin No. 88-45.
16. Ordnance Intelligence Team, Report No. 7.
17. Aberdeen Proving Ground, Memorandum Report, 25 April 1944.
18. Allied Translator and Interpreter Section, Bulletins Nos. 1468, 1913. Publications Nos. 198, 256.
19. United States Army Forces Far East, Intelligence Report No. 21.
20. JICA/CBI, Report No. 6027.
21. ALUSLO, Colombo, Report 115-43.
22. Japanese Ammunition catalogue.
23. Technical Air Intelligence Center Manual No. 1.
24. Nipponese Aircraft Armament, Ordnance Intelligence Unit, Fifth Air Force.