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U. S. NAVAL TECHNICAL MISSION TO JAPAN
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From: Chief, Naval Technical Mission to Japan.
To : Chief of Naval Operations.

Subject: Target Report - Japanese Naval Projectile Fuzes.

Reference: (a)"Intelligence Targets Japan" (DNI) of 4 Sept. 1945.

1. Subject report, covering Target O-17 of Fascicle O-1 of reference (a), is submitted herewith.

2. The investigation of the target and the target report were accomplished by Comdr. G. R. Dolan, RN, assisted by Lt.(jg) K. Lamott, USNR, as interpreter and translator.

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Captain, USN

JAPANESE NAVAL PROJECTILE FUZES

"INTELLIGENCE TARGETS JAPAN" (DNI) OF 4 SEPT. 1945

FASCICLE O-1, TARGET O-17

FEBRUARY 1946

U.S. NAVAL TECHNICAL MISSION TO JAPAN

SUMMARY

ORDNANCE TARGETS

JAPANESE NAVAL PROJECTILE FUZES

It seems to be a fair criticism of Japanese naval projectile fuze design to say that until World War II the designs were usually over-elaborate yet tended to underestimate the importance of safety.

During the war, difficulties in production and the influx of scientific university graduates into ordnance fuze design appeared to influence fuze design towards greater simplification. At the same time, many problems that arose as a result of service experience and the demands of higher naval authorities were attacked and solved competently and in some cases with originality

Some German information on fuze design was available up to the beginning of World War II, and foreign influence is apparent in the clock work mechanism of the Japanese Time Mechanical Fuze and in the use in some fuzes of Schnerder, Mauser and Vickers' designs. It is suspected that their fine shutter, centrifugally operated, safety and arming device is derived from German sources.

During the war, there was little if any connection or exchange of information on fuze design between Japan and Germany.

During the last few years, projectile fuze design was devoted chiefly to the following investigations:

1. Explosive Trains

a. Development of a detonator (primary initiator of mercury fulminate 20%, potassium perchlorate 40%, and antimony sulphide 40%).

b. Development of non-gaseous powders for powder trains to replace black powder.

These investigations started in 1937. A fairly comprehensive list of different powders tried is given in Enclosure (A). The barium oxide (BaO_2) mixtures were not entirely satisfactory owing to either hygroscopic characteristics or because they became fluid during combustion and were affected by centrifugal forces when in flight. Better results were obtained by covering the BaO_2 with a mixture of raw rubber, pine-resin, and pauloronia oil.

A mixture of lead oxide (Pb_3O_4), barium chromate ($BaCrO_4$) and silicon (Si) and also No. 14 in the table in Enclosure (A) gave good results (though the former was low in calorific value). The most successful powder, however, was No. 15 in the table in Enclosure (A). It worked accurately at barometric pressures between 10mm, as measured by a mercury barometer, and 10 atmospheres. Combustion was

retarded 3% at 21,000 revolutions per minute and the burning speed at low temperatures varied 0.05% per degree centrigrade down to -20°C. A storage test at 35°C in humidity of 80% for six months was successful. The purity of the lead oxide and lead chromate (which was made from $Pb(AC)_2$) was important, and an igniting power of silicon and lead oxide was required.

These results were a definite advance in original research.

2. Time Mechanical Fuzes

Variation of components to meet the varying characteristics of acceleration, etc., in different guns, and the design of sub-assembly to function on impact against light duralumin plate.

3. Rocket Fuzes

Design and improvement of rocket fuzes "ab initio".

Other research projects which did not involve so much time but which were interesting in many respects were the development of anti-submarine fuzes and the improvement of rifle grenade fuzes.

Of particular interest was the employment of a non-gaseous powder column as a safety and arming device in Type 3 small percussion fuze, Mk II. The procedure for inspection and proof in relation to the designs appears to have been quite sound.

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LIST OF ENCLOSURES

LIST OF ILLUSTRATIONS

REFERENCES

Japanese Personnel Interviewed:

Technical Captain AKAGAWA. In charge of fuze group of Ammunition Section of the Navy Technical Department of the Navy Ministry, TOKYO.

Technical Commander TAKAGI of the First Naval Technical Research Laboratory. Experienced in explosive components of fuzes from research and production angles.

Technical Lieutenant Commander HATTORI of the First Naval Technical Research Laboratory. Fuze designer, chiefly concerned in bomb fuze design and machine gun ammunition.

Mr. HATTORI of the Hattori Clock Company, with members of his staff including engineers responsible for design and production of Time Mechanical Fuzes.

Technical Lieutenant NISHIDA of Kure Naval Arsenal. Employed throughout World War II on fuze design and testing.

Mr. SUZUKI (Technical Engineer). Employed at First Naval Technical Laboratory. Experienced in research work on fuzes, principally bomb fuzes.

Related Intelligence Reports:

Proximity Fuzes - NavTechJap Report, "Japanese Ordnance Fuzes", Index No. O-18.

Japanese Army Fuzes, Ammunition Development and Production (covering fuzes, mines, grenades, projectiles and bombs) - Army Technical Intelligence Report No. 5, "Japan".

Fuzes for Guided Missiles - ATIG Report No. 262 - "Fuzing System of Heat-Homing Bomb"; ATIG Report No. 114 - "Japanese Radio Controlled Flying Bomb I-GO".

Photo Electric Cell Fuze - NavTechJap Report, "Description and Operation of Japanese Type 3 Photoelectric Fuze", Index No. O-24.

Fuzes for Aircraft Rockets - ATIG Report No. 307 - "Aircraft Rockets".

Fuzes for Aircraft Ammunition - ATIG Report No. 308 - "Bombs, Fuzes, Ammunition, and Pyrotechnics".

INTRODUCTION

An attempt was made to cover the development of fuze design in the Japanese Imperial Navy with respect to projectile and rocket fuzes. At the first interrogation conducted, Technical Captain AKAGAWA, stated that all fuze drawings and all books or pamphlets on fuzes had been destroyed in August 1945.

It became necessary, therefore, to interrogate various Japanese technical officers and civilians, with the assistance of an interpreter, and to gradually build up a picture of Japanese fuzes and their development as a whole.

The Japanese habit of using the same Japanese technical word to mean two or more different things in different contexts, and the practice of different branches of the services using different words to mean the same thing, combined with an unsystematic method of nomenclature and several different ways of describing dates, all helped to confuse the picture with unimportant detail.

Several reports on various fuze investigations and trials, containing drawings and pamphlets, were discovered in a warehouse at YOKOSUKA. The whole contents of this warehouse are being shipped to the United States for investigation. The few pamphlets found to date have been sent to the Washington Document Center and are listed in a later section of this report.

The small schematic diagrams included in this report have been removed from an elementary pamphlet obtained from Technical Lieut. NISHIDA of Kure Arsenal. All the information with the diagrams has been translated and transferred to the figures in this report.

No fuze drawings are known to have been found except a few manufacturing drawings of components which have been listed and forwarded to the Washington Document Center and the drawing of a Type 13 Mk I fuze which is included in this report as Enclosure (B).

As it was impracticable to obtain samples of fuzes (in all but a few types) to break down for examination before writing this report, its contents are based almost entirely on the statements of Japanese officers and civilians.

It is hoped that this report will give a sufficiently broad picture of projectile fuze development, so that, with the statistics included herewith, and examination of samples sent to the United States, all necessary information on Japanese naval projectile fuzes will be available.

THE REPORT

Part I - GENERAL REMARKS

In the Imperial Japanese Navy, fuzes were designated apparently without any system until about 1944. As a result, during the war when there was a large influx of inexperienced personnel in the Japanese establishments, confusion was very prevalent. In an attempt to correct this, a new system of designation of fuzes was developed and put into use. This system, although better in itself than the previous confusion, did not, in fact, cure the trouble. The reason for this was that all the older personnel continued to use the names with which they were familiar and the new personnel used either the new designation or the old designation, depending upon whom they had worked with.

The new classification and designation of fuzes adopted in 1944 attempted to show by the type number of the fuze what the function of the fuze was; and to some degree attempted to show in what type of guns the fuze was used by the model number or the mark number. Here again some confusion arose as the mark was supposed to be an obsolete term but was, at times, used instead of the word model.

Projectile fuzes are classed as follows: (1) Percussion Fuzes (P.F.) -- (a) Instantaneous (I.P.F.); (b) Delay (D.P.F.); (c) Double Acting (D.A.P.F.). (2) Time Fuze (T.F.) -- (a) Mechanical (M.T.F.); (b) Powder (P.T.F.); (c) Chemical (C.T.F.). (3) Combination Fuze (C.F.) -- combinations of above two. (4) Time Tube (T.T.).

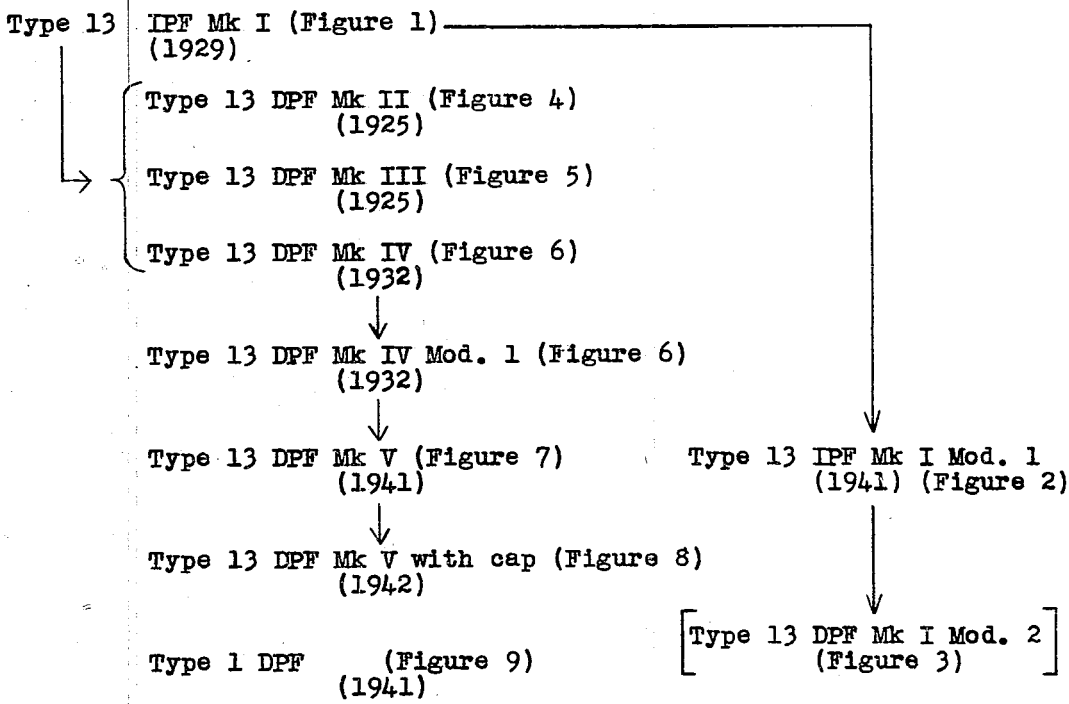
In the new designation, the following meanings were given to type numbers: Type 5 - Special Fuzes for Rockets; Type 4 - Mechanical Time Fuzes; Type 3 - Powder Time Fuzes; Type 13 - Base Fuzes. In the case of time fuzes, the model numbers had the following meanings: Model 0 - used in major caliber guns; Model 1 - Old Type Projectiles; Model 2 - for Type 98 Guns; Model 3 - for new projectiles with 13 caliber radius head; Model 4 - for Army type projectiles; Model 5 - for Type 5 Guns.

In general, the Japanese fuze design was sound up to a point, but perhaps they slightly underestimated the necessity for safety. For example, although they employed safety devices to prevent the striker or mechanical parts from functioning until after the fuze had been fired, they did not consider the possibility of the explosive train being initiated by the detonator through some accident, and until 1944 took no precaution to seal any flash from the detonator. That year, after recovering a British gaine, they designed a gaine to use with their time mechanical fuze and with this gaine they placed a shutter between the detonator and the train of explosive.

There were, however, some interesting features in some of the fuzes; their base fuze for A.P. projectiles was of simple design and its delayed arming feature appears to be sound and effective. It consisted of five shutters that opened progressively. (It is quite possible that the Japanese obtained the idea of this shutter from the Germans). In the case of the time mechanical fuse, it is considered from a visual examination of some examples that these were well constructed and probably should have given as good an accuracy as Allied fuzes. Actually a lesser degree of accuracy was demanded by the Japanese in specification requirements and it is considered that the degree of accuracy demanded was not sufficient for effective fire. Details of development and functioning of fuzes will be given in succeeding paragraphs.

Part II - BASE FUZES

The general development of Japanese base fuzes is shown by the brief chart that follows. The name of the fuze, its date of adoption into service and the reference to figures in the report are given. The fuze shown in square brackets [ ] is one that was only developed in the experimental stages but was not yet adopted for service.



Type 13 IPF Mk I Mod. 1 (Figure 2) fuze gave trouble owing to the breakdown of mercury fulminate during storage resulting in blinds. The fuze was improved by altering the initiating powder to a mixture of mercury fulminate and lead azide. This flashed to lead azide and tetro.

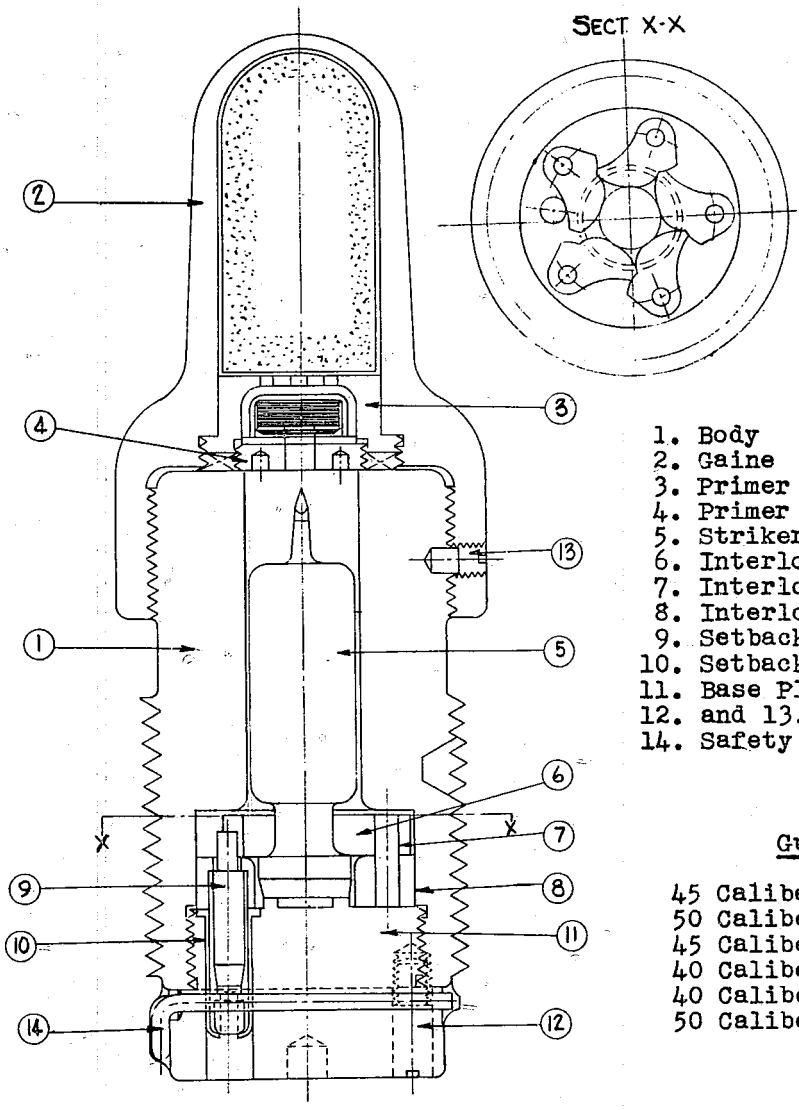
Type 13 IPF Mk I (Figure 1) was the fundamental design from which delay base fuzes for larger caliber guns were developed. These were Type 13 DPF Mk II, Mk III and Mk IV (see Figures 4, 5, and 6 respectively). These differed from the Type 13 IPF Mk I only as far as the delay setting was concerned. The delays, which consisted of black powder, were 0.08, 0.2, and 0.4 seconds respectively. These fuzes were used for a long time without any essential modification except in the case of Type 13 DPF Mk IV which was altered to Type 13 DPF Mk IV Mod. 1 (see Figure 6). This modification consisted of having some black powder inserted in a channel from the first detonator to the relay in order to make ignition of the relay more certain.

When the 18" Type 94 (so-called 40cm gun) was designed, it was necessary to make several alterations to the base fuze. They are as follows:

1. The booster was reduced in size in order to avoid the possibility of it being fractured on hitting the armor.
2. The second detonator was made smaller and of a different shape, thereby giving a better surface contact with the booster.
3. The connecting screw between the booster and the fuze was altered in shape.

Type 13 Mark 1 Instantaneous Base Fuze

Figure 1



Date Adopted: 1924

Total Wt: 955.4 gm±1.5%

1. Body
2. Gaine
3. Primer
4. Primer Retaining Plug
5. Striker
6. Interlocking Delay Pawls
7. Interlocking Pawl Pin
8. Interlocking Pawl Seat Ring
9. Setback Pin
10. Setback Pin Spring
11. Base Plug
12. and 13. Set Screw
14. Safety Pin

Guns Used With

45 Caliber Type "AN"	20cm
50 Caliber Type 41	15cm
45 Caliber Type 41	15cm
40 Caliber Type 41	15cm
40 Caliber Type "AN"	15cm
50 Caliber Type 3rd yr	14cm

Explosive Components

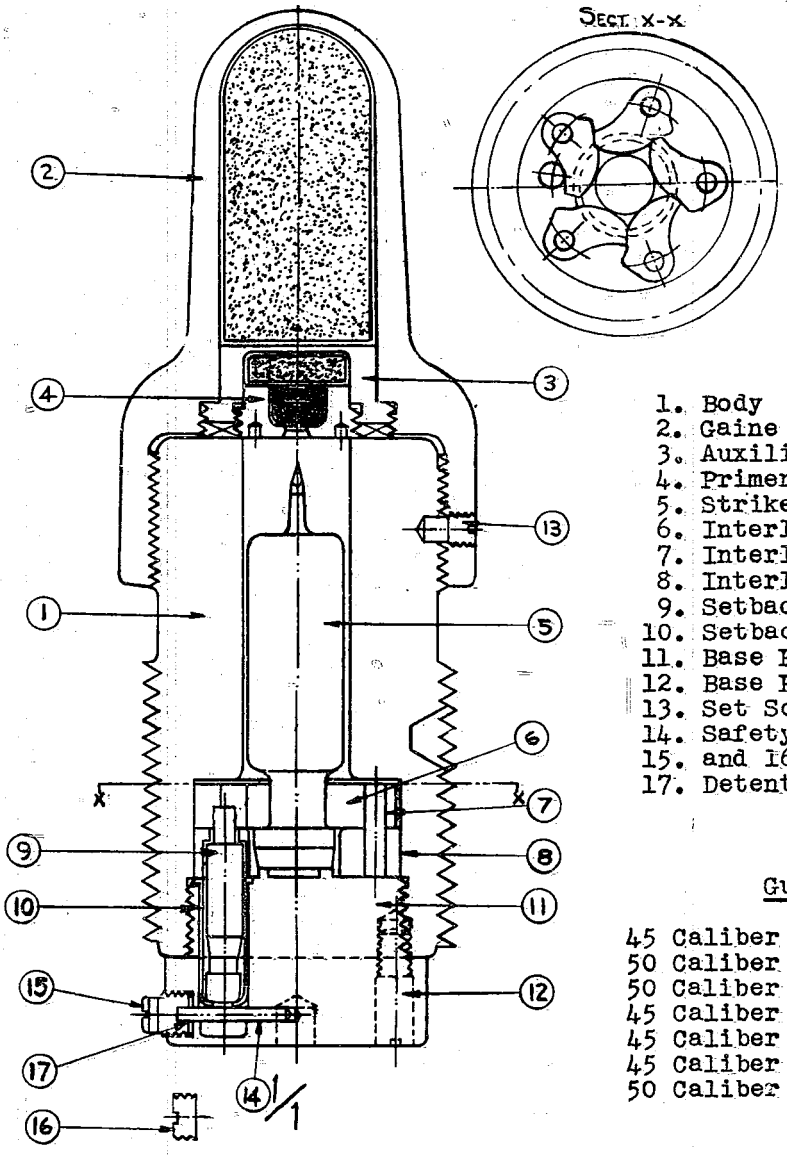
Primer - Mercury Fulminate	1.4 gm
Gaine - Shimose	16.5 gm

Projectiles Used With

45 Caliber 20cm Gun, A.P. Shell Mod 1
45 Caliber 20cm Gun, Common Shell Mod 1
15cm Gun, Common Shell Mk 3 Mod 1
15cm Gun, Common Shell Mk 2 Mod 1
40 Caliber 15cm Gun, Common Shell Mod 1
50 Caliber 14cm Gun, A. P. Shell Mod 1
50 Caliber 14cm Gun, A. P. Shell Mod 2

Type 13 Mark 1 Modification 1 Instantaneous Base Fuze

Figure 2



Date Adopted: Dec. 1941

Total Wt: 957 gm ±1.5%

1. Body
2. Gaine
3. Auxiliary Booster
4. Primer
5. Striker
6. Interlocking Delay Pawls
7. Interlocking Pawl Pin
8. Interlocking Pawl Seat Ring
9. Setback Pin
10. Setback Pin Spring
11. Base Plug
12. Base Plug Stop Screw
13. Set Screw
14. Safety Pin
15. and 16. Plug
17. Detent

Guns Used With

45 Caliber Type "Armstrong"	20cm
50 Caliber Type "Vicars"	15cm
50 Caliber Type 41	15cm
45 Caliber Type 41	15cm
45 Caliber Type "Armstrong"	15cm
45 Caliber Type 41	15cm
50 Caliber Type 3rd yr	

Explosive Components

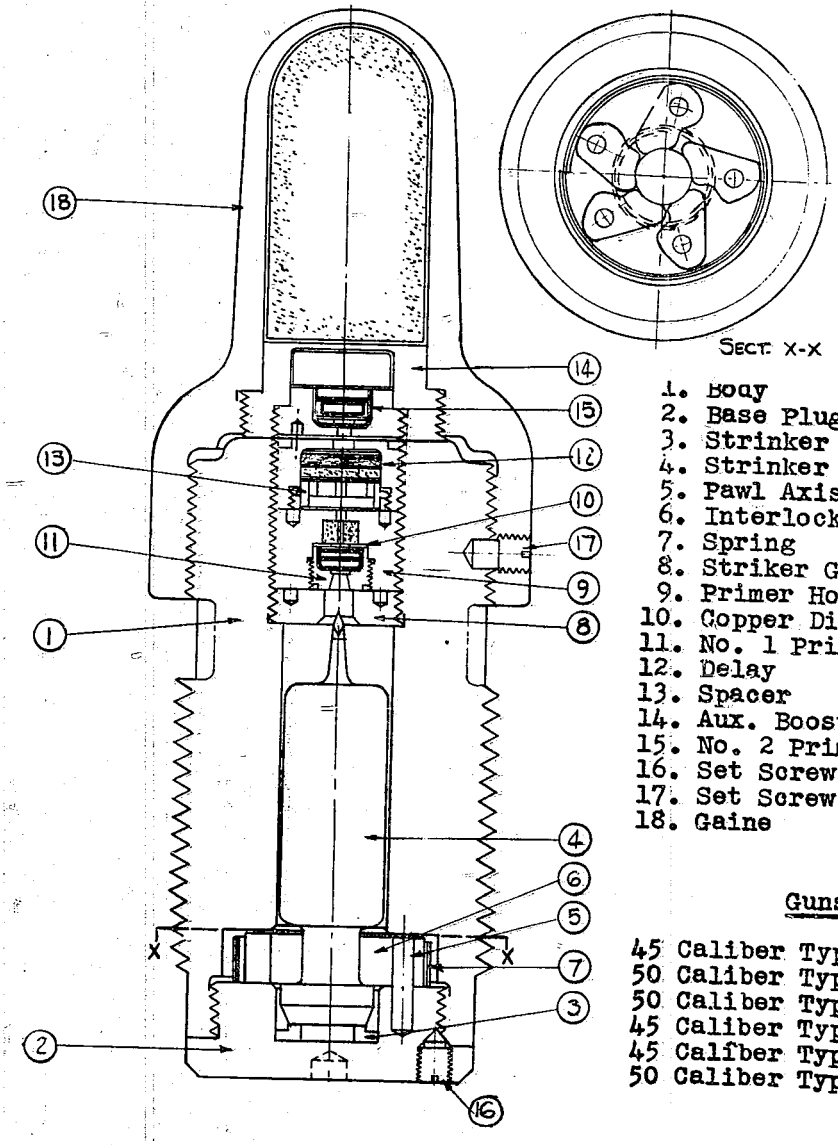
Primer - Explosive Powder	0.13 gm
Lead Azide	0.1 gm
Tetryl	0.1 gm
Aux. Booster - Tetryl	1.0 gm
Gaine - Shimose	20.0 gm

Projectiles Used With

40 Caliber 15cm Gun, H.E. Shell Mod 1
15cm Gun, H.E. Shell Mk 3 and 4
14cm Gun, Capped H.E. Shell Mod 1
14cm Gun, Capped H.E. Shell Mod 2
14cm Gun, Capped H.E. Shell Mk 1

Type 13 Mark 1 Modification 2 Short Delay Fuze (Experimental)

Figure 3



Total Wt: 957 gm

Delay Time: .03 seconds

1. Body
2. Base Plug
3. Strinker Seat
4. Strinker
5. Pawl Axis
6. Interlocking Arming Delay Pawls
7. Spring
8. Striker Guide
9. Primer Holder
10. Copper Disc
11. No. 1 Primer
12. Delay
13. Spacer
14. Aux. Booster
15. No. 2 Primer
16. Set Screw
17. Set Screw
18. Gaine

Guns Used With

45 Caliber Type "Armstrong"	12cm
50 Caliber Type "Vicars"	15cm
50 Caliber Type 41	15cm
45 Caliber Type 41	15cm
45 Caliber Type "Armstrong"	15cm
50 Caliber Type 3rd yr	14cm

Explosive Components

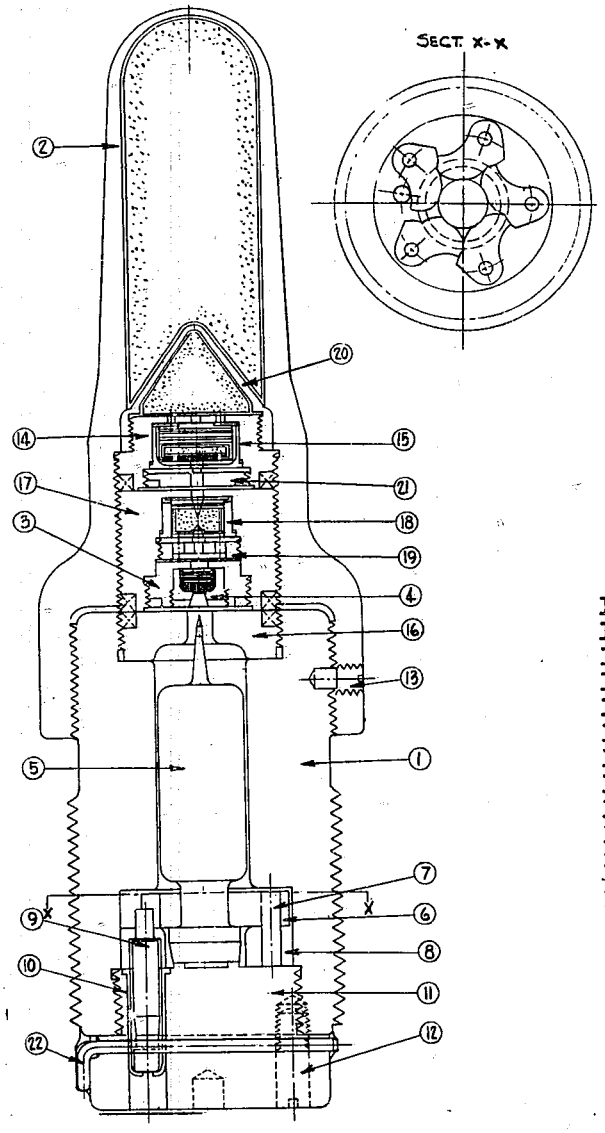
No. 1 Primer - 3 Component Explosive Charge	—
Black Powder	—
Delay - Black Powder	—
Explosive Powder	—
Relay - Fine Black Powder	0.08 gm
No. 2 Primer - Tetryl	0.10 gm
Lead Azide	0.10 gm
Aux. Booster - Tetryl	1.0 gm
Gaine - Shimose	30.0 gm

Projectiles Used With

40 Caliber 15cm Gun, H.E. Shell Mod 1
15cm Gun, Mk 3 and 9 H.E. Shell
14cm Gun, Capped H.E. Shell Mod 1
14cm Gun, Capped H.E. Shell Mod 1
14cm Gun, Mk 1 H.E. Shell

Type 13 Mark 2 Short Delay Base Fuze

Figure 4



Date Adopted: Dec. 1925

Total Wt: 1373±1.5%

Delay Time: .08 seconds

1. Body
2. Gaine
3. No. 1 Primer
4. Primer Holder
5. Striker
6. Interlocking Arming Delay Pawls
7. Interlocking Pawl Pin
8. Interlocking Pawl Seat Ring
9. Setback Pin
10. Setback Pin Spring
11. Base Plug
12. Base Plug Stop Screw
13. Set Screw
14. No. 2 Primer
15. Primer Holder
16. Striker Seat Ring
17. Delay Holder
18. Delay
19. Spacer
20. Aux. Booster
21. Primer Retaining Plug
22. Safety Pin

Guns Used With

50 Caliber Type 3rd yr 20cm

Explosive Components

No. 1 Primer - 3 Component Explosive Charge	0.035	gm
Black Powder ...	0.015	gm
Delay - Black Powder	—	
No. 2 Primer - Tetryl	0.45	gm
Lead Azide	0.35	gm
Aux. Booster - Granular Shimose..	2.17	gm
Gaine - Shimose	29.0	gm

Projectiles Used With

50 Caliber 20cm Gun, Capped AP Shell

Type 13 Mark 3 Short Delay Fuze

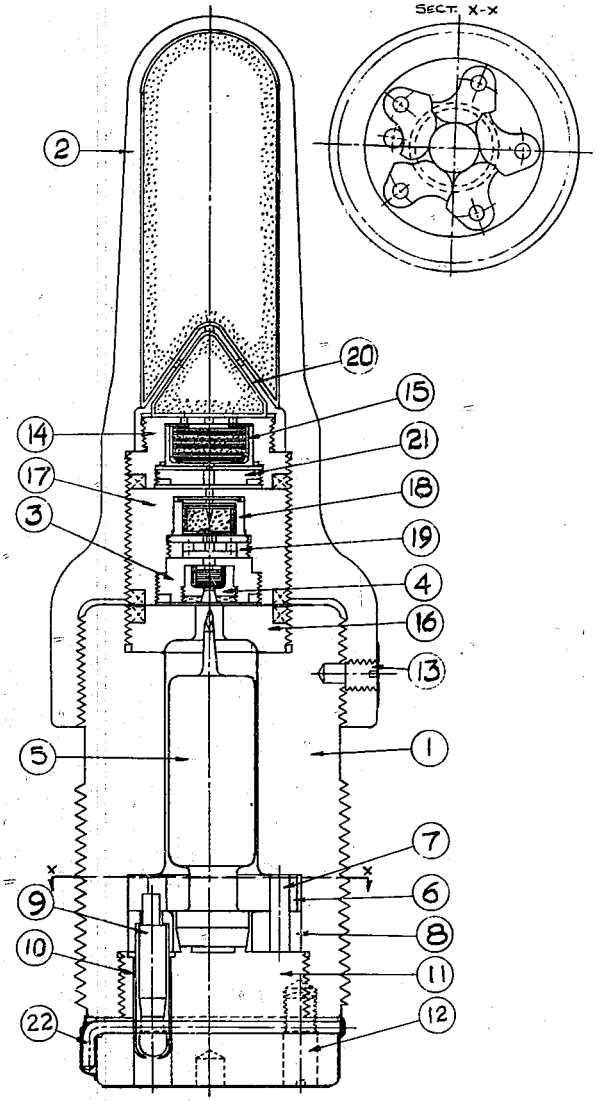


Figure 5

Date Adopted: Dec. 1925

Total Wt: 1373 gm ± 1.5%

Delay Time: 0.2 seconds

1. Body
2. Gaine
3. No. 1 Primer
4. Primer Holder
5. Striker
6. Interlocking Arming Delay Pawls
7. Interlocking Pawl Pin
8. Interlocking Pawl Seat Ring
9. Setback Pin
10. Setback Pin Spring
11. Base Plug
12. Base Plug Stop Screw
13. Set Screw
14. No. 2 Primer
15. Primer Holder
16. Striker Seat Ring
17. Delay
18. Delay Holder
19. Spacer
20. Aux. Booster
21. Primer Retaining Plug
22. Safety Pin

Guns Used With

45 Caliber Type 3rd yr	40cm
45 Caliber Type "Vicars"	36cm
45 Caliber Type 41	36cm

Explosive Components

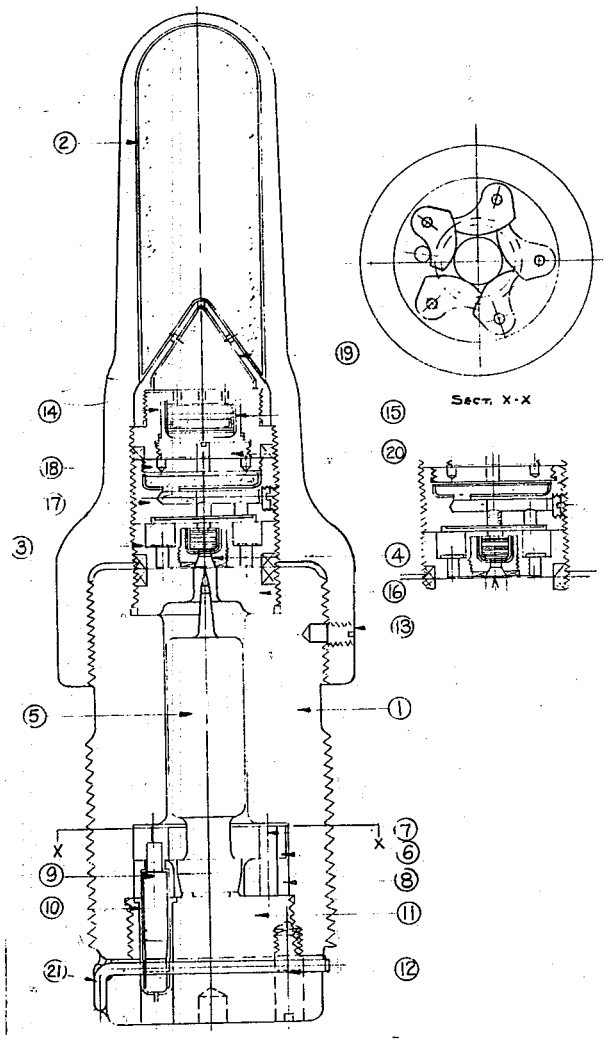
No. 1 Primer - 3 Component Explosive Charge	0.035 gm
Black Powder	0.015 gm
Delay - Black Powder	—
No. 2 Primer - Tetryl	0.45 gm
Lead Azide	0.35 gm
Aux. Booster - Granular Shimose	2.17 gm
Gaine - Shimose	29.0 gm

Projectiles Used With

40cm Gun, AP Shell Mk 5
36cm Gun, AP Shell Mk 5

Type 13 Mark 4 Short Delay Base Fuze
(Also Mark 4 Mod 1)

Figure 6



Date Adopted: Jan 1932
(Mod 1 - June, 1932)

Total Wt: 1355 gm ± 1%

Delay Time: 0.4 seconds

1. Body
2. Gaine
3. No. 1 Primer
4. Primer Holder
5. Striker
6. Interlocking Arming Delay Pawls
7. Interlocking Pawl Pin
8. Interlocking Pawl Seat Ring
9. Setback Pin
10. Setback Pin Spring
11. Base Plug
12. Base Plug Stop Screw
13. Set Screw
14. No. 2 Primer
15. Primer Holder
16. Striker Seat Ring
17. Delay
18. Ignition Chamber Cover
19. Aux. Booster
20. Retaining Plug
21. Safety Pin

Guns Used With

45 Caliber Type 3rd yr	40cm
45 Caliber Type "Vicars"	36cm
45 Caliber Type 41	36cm
50 Caliber Type 3rd yr	20cm
50 Caliber Type 3rd yr Mk 2	20cm

Explosive Components

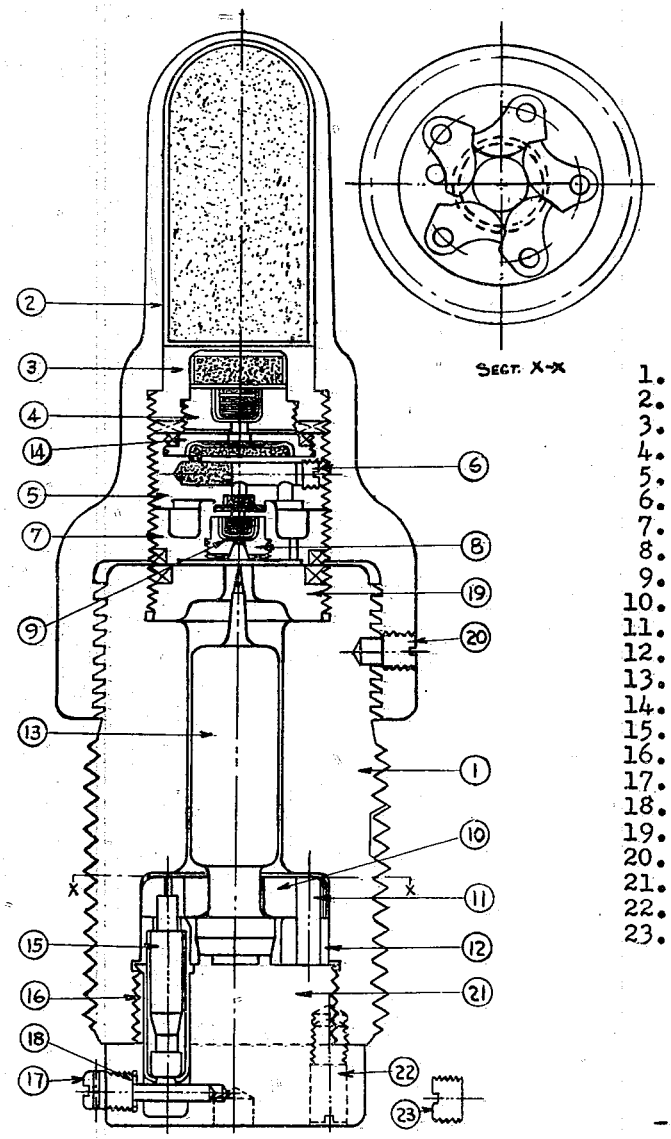
No. 1 Primer - 3 Component Explosive Charge	0.035 gm
Black Powder	0.015 gm
Delay - Black Powder	0.08 gm
Ignition Charge - Black Powder	0.9 gm
No. 2 Primer - Lead Azide	0.35 gm
Tetryl	0.45 gm
Aux. Booster - Granular Shimose	2.17 gm
Gaine - Shimose	29.0 gm

Projectiles Used With

	40cm Gun, T88 AP Shell
	40cm Gun, T91 AP Shell
	36cm Gun, T88 AP Shell
	36cm Gun, T91 AP Shell
Mk 2	20cm Gun, T91 AP Shell
50 Cal	20cm Gun, T88 AP Shell

Type 13 Mark 5 Short Delay Base Fuze

Figure 7



Date Adopted: Oct. 1941

Total Wt: 1289 gm ± 1%

Delay Time: 0.4 seconds

1. Body
2. Gaine
3. Aux. Booster
4. No. 2 Primer
5. Delay Train
6. Delay Filling Plug
7. No. 1 Primer
8. Primer Holder
9. Copper Cup
10. Interlocking Arming Delay Pawls
11. Interlocking Pawl Pin
12. Interlocking Pawl Seat Ring
13. Striker
14. Ignition Chamber
15. Setback Pin
16. Setback Pin Spring
17. Plug
18. Detent
19. Striker Seat Ring
20. Set Screw
21. Base Plug
22. Base Plug Stop Screw
23. Plug

Guns Used With

T94 40cm

Explosive Components

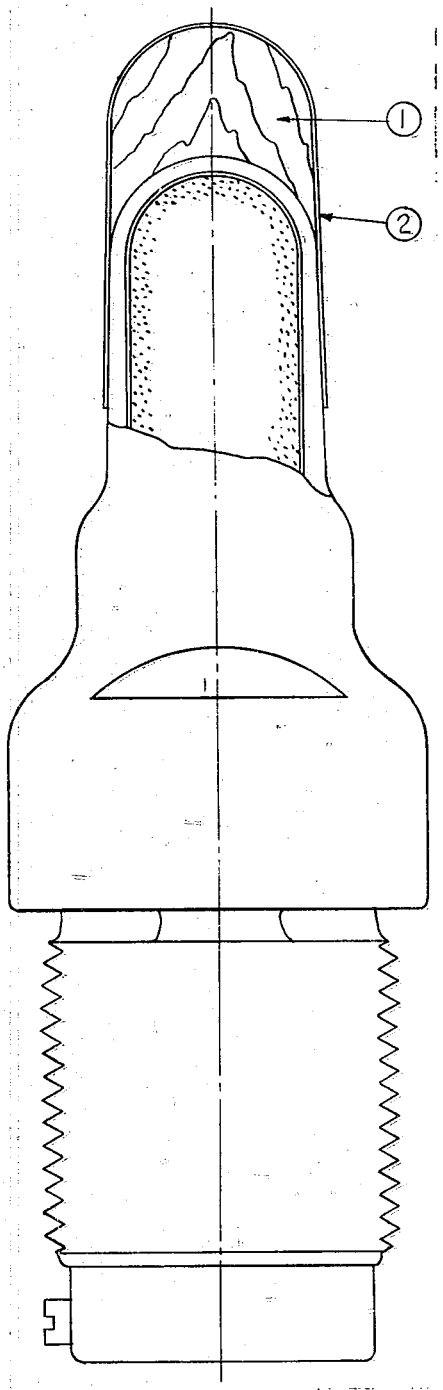
No. 1 Primer - 3 Component Explosive Charge ..... 0.04 gm
Black Powder .....0.014 gm
Delay - Black Powder
Ignition Charge - Black Powder ..... 0.48 gm
No. 2 Primer - Lead Azide ..... 0.10 gm
Tetryl ..... 0.14 gm
Aux. Booster - Tetryl ..... 1.0 gm
Gaine - Shimose ..... 21.0 gm

Projectiles Used With

T94 40cm Gun, T91 AP Shell

Type 13 Mark 5 (with Cap) Short Delay Base Fuze

Figure 8



Date Adopted: Jan. 1942

Total Wt: 1293 gm ± 1%

Delay Time: 0.4 seconds

1. Wooden Seat
2. Booster Cap

(Except for the above this Fuze is the same as Type 13 Mark 5)

Guns Used With

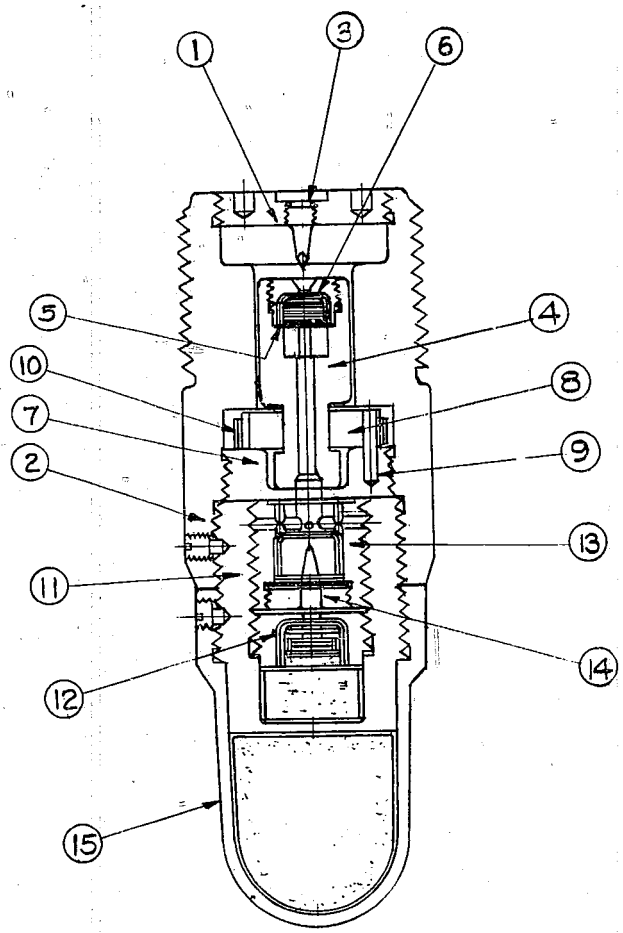
45 Caliber Type 3rd yr	40cm
45 Caliber Type "Vicars"	36cm
45 Caliber Type 41	36cm

Projectiles Used With

40cm Gun	Type 91 AP Shell
40cm Gun	Type 1 AP Shell
36cm Gun	Type 91 AP Shell
36cm Gun	Type 1 AP Shell

Type 1 Short Delay Base Fuze

Figure 9



Date Adopted: Oct. 1941

Total Weight: 265.5 gm

Delay Time: 0.1 seconds

1. Base Plug
2. Body
3. Firing Pin
4. No. 1 Primer
5. Foil Plate
6. Primer Holder
7. Interlocking Pawl Seat
8. Interlocking Arming Delay Pawls
9. Interlocking Pawl Pin
10. Interlocking Pawl Spring
11. Delay
12. Primer Holder
13. Delay Holder
14. Delay Holder Plug
15. Gaine

Projectiles Used With

8cm Gun, Type 1 AP Shell

Explosive Components

No. 1 Primer - 3 Component Explosive Charge
Black Powder
Relay - Black Powder Column ..... .08 gm
Delay - Fine Black Powder
No. 2 Primer - Lead Azide ..... .1 gm
Tetryl ..... .1 gm
Aux. Booster - Tetryl ..... 1.0 gm
Gaine - Shimose ..... 7.2 gm ± 3%

This fuze was designated Type 13 DPF Mk V. The Type 13 DPF Mk V fuze (Figure 7) was an improvement on the previous fuze and the Japanese naval authorities were determined to use it for other major caliber projectiles. When this was done, an air gap was left between the small booster and the main filling of the projectile, which was designed to take a Mk IV fuze. This gap was filled by a wooden cap which was secured to the fuze. Fuzes used in this manner were called Type 13 DPF Mk V, with cap (Figure 8).

During World War II, complaints were received from several officers that the base delay fuze in use, and even the instantaneous base fuze in use, were not effective against lightly armored ships or merchant ships. The fuzes that were in use during the war were the instantaneous and the Mk IV Type; the Mk II and Mk III type of short delay fuze had gone out of favor as it had been discovered that the delay became inaccurate after storage.

The Navy Technical Department developed two ideas. The first was a delay percussion fuze, giving a delay of .03 seconds and this fuze was called Type 13 DPF Mk 1 Modification 2. The delay was obtained by having two layers of black powder; one layer was fine grain powder and the other pulverized powder. The length of delay depended upon the ratio of thickness of the two layers. This fuze did not get into service (see Figure 3). The other idea they developed was a double action fuze in which it was intended to release a safety device after the first impact on armor or water. After this the striker would function on a second impact on a partition plate of a compartment or with the side of a ship after passing through the water. This idea was not developed sufficiently for them to obtain success in the case of a fuze passing through the water but they obtained some degree of success in their experiment against two parallel steel plates.

The Type 1 DPF fuze (see Figure 9) is designed for Type 1 8cm AP projectiles. It is attached to the inside of the projectile head and acts in the same manner as an ordinary base fuze. Its delay time was 0.1 seconds. This delay was decided upon in order to fit both the case when the projectile struck a submarine directly, or when it passed first through the water. The explosive train is the same as for Type 13 DPF Mk V (see Figure 7).

Base fuze bodies were made of Vanadium Chrome steel with a breaking strength of approximately 75 kg/mm^2 and the striker was made of stainless steel. It was a three-sided pyramid shape with a sharp point. In some of the base fuzes, a lead disc was inserted in the rear of the striker to cushion the shock of discharge. This was quite successful, but was discontinued to simplify manufacture.

All fuzes were supplied to ships, separately from the shell, wrapped in waxed paper. This meant that the shell had to be fuzed on board. In the case of base fuzed shells the adaptor had to be unscrewed; a dummy fuze had to be unscrewed from the front of the adaptor; the live fuze screwed into the front face of the adaptor; and the adaptor then rescrewed into the shell.

Part III - TIME MECHANICAL FUZES

After World War I, the Japanese Navy used Krupp's designs for time mechanical fuzes. All the necessary plans were destroyed, however, in the earthquake; after this they used a clockwork mechanism which they admit is practically of Rheinmetal design, but claim that the remainder of the time mechanical fuze is of their own design. The time mechanical fuze was one of the few fuzes which was made and assembled by a private firm (Hattori Clock Company). The more common practice was for all fuze components to be assembled at Naval Arsenals.

From samples seen and from answers to interrogations, it appears that the essentials, (the clockwork mechanism and the associated hand, striker, safety lever, and brake) were of standard design while the different types vary chiefly as regards shape, weight, and details of the hammer, centrifugal block and

explosive trains.

* * * * *

Notes On Manufacture

Materials

Body: Brass, tensile strength: 40 kg/mm^2
Striker: Stainless steel.
Mechanism plates: Free cutting brass (copper, zinc and lead) nickel plated.
Clockwork train: Brass (except in case of fuze for high velocity where super duralumin was used).

Specification Requirements

1. Load Tests:

Spring	Original Length	Compressed to	Load
Starter Spring	11mm	8.4mm	1.0 - 1.4 kg
Striker Spring	14mm	9.5mm	3.8 - 4.5 kg
Hammer Spring	10mm	7.5mm	3 - 4 kg
Phospher Bronze	Height of Corrugations		
Tensioning Washer	1.7mm	1.2mm	1.2 - 1.8 kg at a radius of 80mm

Load test on wheels to test caulking of wheels to arbors

Wheel No. 2 - Must support more than 60 kg
Wheel No. 3 - Must support more than 22 kg
Escape Wheel - Must support more than 12 kg

2. Shear test on shoulder of striker

A shear test of 160 kg is applied to the cut away part of the striker (the notch into which the safety lever fits).

Safety of Fuze in Bore of Gun

A leaf spring secured to the clockwork mechanism plates presses against the inside of the time setting ring, and when the time setting ring is turned to certain positions the spring engages in a notch cut vertically on the inside of the setting ring. The position and length of the leaf spring are so arranged that the fuze cannot be set to a lower time setting than 0.8 seconds (equivalent to a shell travel of approximately 720 meters in the case of medium guns, or to a lower setting than 2.0 seconds in the case of fuzes for battleship main armament guns).

Accuracy of Fuze

The centrifugal block is tested in manufacture to spin out at 10,000 RPM.

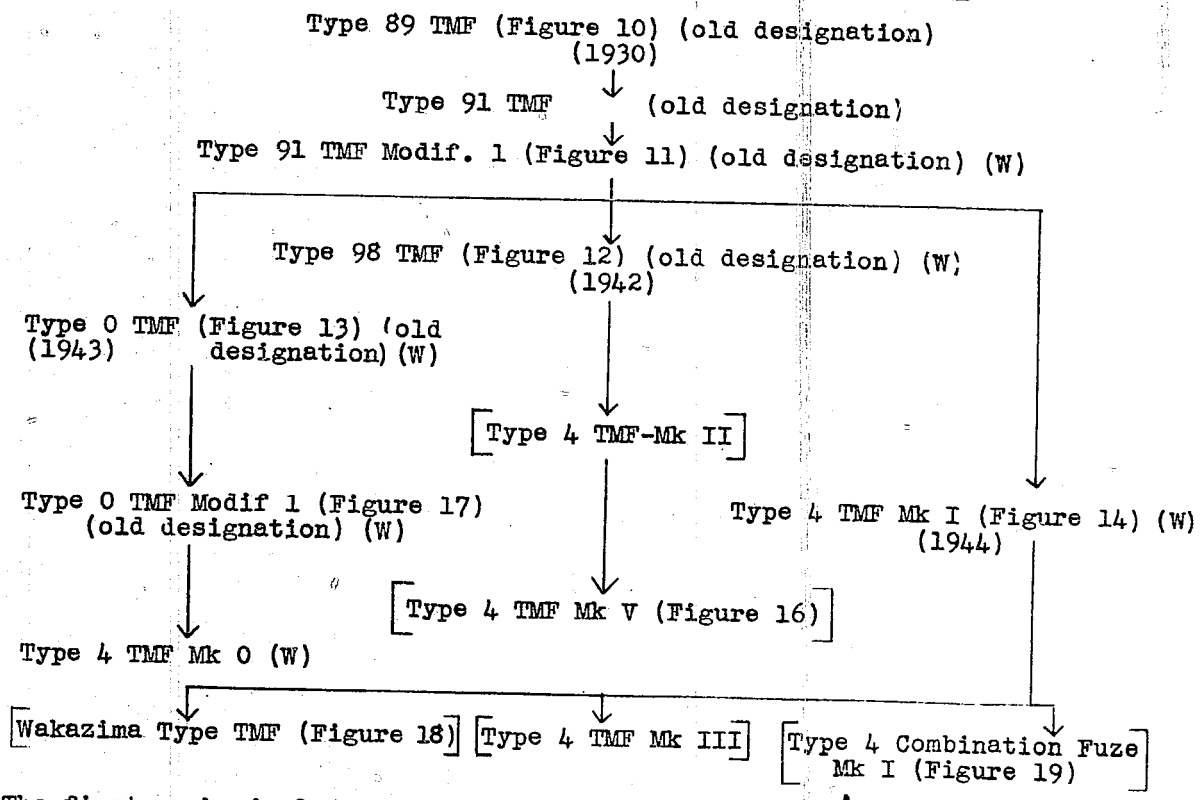
The accuracy of the fuze is tested by running it at the time setting for 20 seconds. Specification requirement is that it should be accurate to plus or minus 0.5 seconds (this does not appear to be a sufficiently accurate standard for an anti-aircraft fuze).

One fuze in 200 is subjected to a drop test before the accuracy test. For this drop test, the fuze is screwed into a 10 kg plug which is dropped 10 feet 5 inches onto a four ton steel block. (This test was arrived at empirically by comparing the results on copper pressure gauges subjected to this test and to firing, from a gun, inside a hollow fuze).

The development of time mechanical fuzes is shown in the following brief chart. Fuzes enclosed in a square bracket were those which did not leave the experimental stage. Fuzes used during World War II have a W after their name.

* * * * *

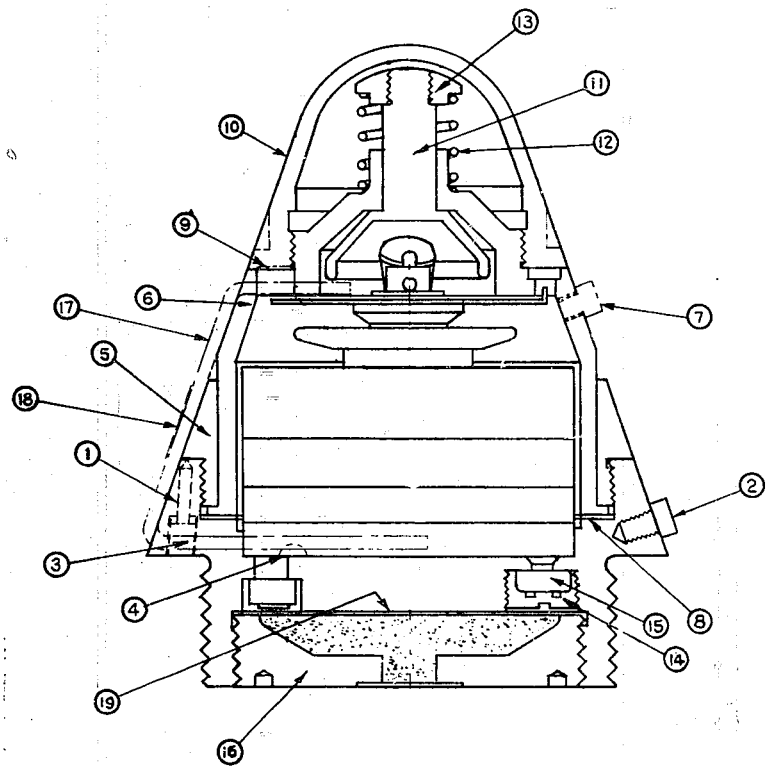
Chart of Development of Time Mechanical Fuzes



The first mechanical fuze developed by the Japanese Navy, with the assistance of the Hattori Clock Company, was the Type 89 MTF (Figure 10). As a result of experiments with Type 89 MTF, modifications were made to it, chiefly to increase the strength of the striker and the accuracy of the clock. The result was the Type 91 MTF. It was then decided that it was necessary to guard against explosions in the bore and since the Japanese technical officers did not consider the mechanical clamping of the firing needle sufficiently reliable, they introduced a 0.4 second delay of black powder in the bottom of the fuze (Figure 11). This fuze was called Type 91 MTF Modif. 1 and became the standard MTF for a long time. (A good description of the Type 91 fuze is given in MEIU #4 report "Japanese Projectiles and Fuzes" dated 19 January 1945). The accuracy

Type 89 Mechanical Time Fuze

Figure 10



Date Adopted: July 1930

Total Weight: 570 gm

Time Setting: 0-55 sec

1. Body
2. Setting Screw
3. Set Screw
4. Locating Pin
5. Lock Ring
6. Setting Cylinder
7. Setting Screw
8. Spring
9. Paper Covering
10. Nose Cap
11. Starting Pin
12. Starting Pin Spring
13. Starting Pin Nut
14. Primer Holder
15. Primer
16. Magazine
17. Safety Pin
18. Instruction Paper
19. Paper

Guns Used With

50 Caliber Type 3rd yr Mk 2 20cm
50 Caliber Type 3rd yr 20cm
50 Caliber Type 3rd yr 12.7cm
40 Caliber Type 88 & 89 12.7cm AA
45 Caliber Type 10th yr 12cm
50 Caliber Type 88 10cm AA

Projectiles Used With

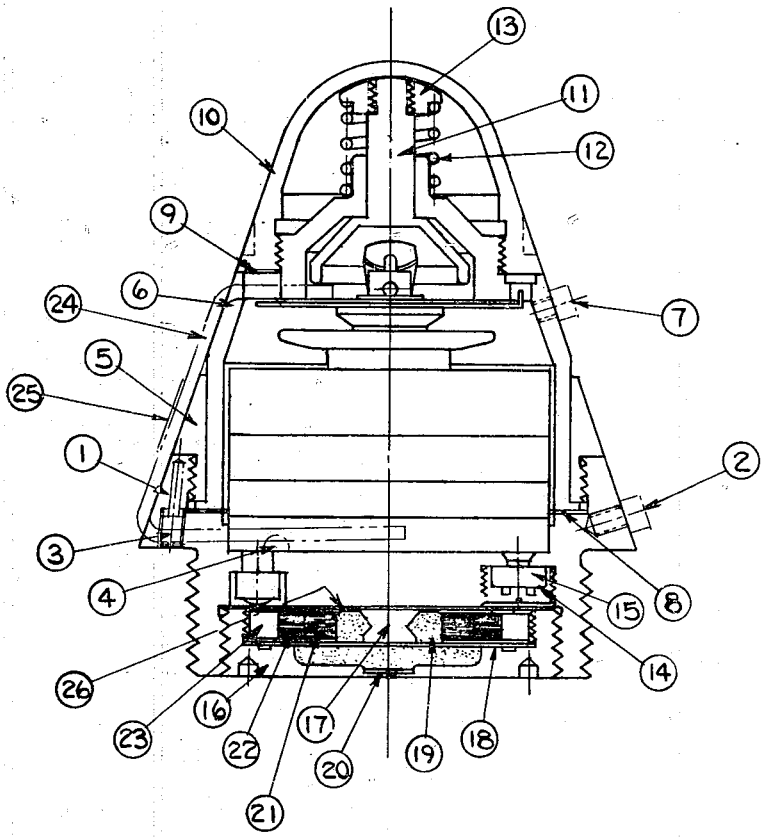
Mk 2 20cm Gun, Time Practice Shell
50 Caliber 20cm Gun, Time Practice Shell
50 Caliber 12.7cm Gun, Time Practice Shell
40 Caliber 12.7cm Gun, Time Practice Shell
12.7cm Gun, AA Time Practice Shell
10cm Gun, AA Time Practice Shell

Explosive Components

Primer - 3 Component Explosive Charge ..... 0.06 gm
Magazine - Black Powder ..... 3.0 gm

Type 91 Modification 1 Mechanical Time Fuze

Figure ..



Date Adopted: Jan. 1932

Total Weight: 577 gm

Time Setting: 0-55 sec

1. Body
2. Setting Screw
3. Set Screw
4. Locating Pin
5. Lock Ring
6. Setting Cylinder
7. Setting Screw
8. Spring
9. Paper Covering
10. Nose Cap
11. Starting Shaft
12. Starting Shaft Spring
13. Starting Shaft Nut
14. Primer Holder
15. Primer
16. Magazine
17. Delay Disc
18. Paper
19. Paper
20. Tin Foil
21. Delay
22. Relay
23. Delay Holder
24. Safety Pin
25. Instruction Paper
26. Paper

Guns Used With

50 Caliber Type 3rd yr Mk 2 20cm
50 Caliber Type 3rd yr 20cm
50 Caliber Type 3rd yr 12.7cm
50 Caliber Type 88 & 89 12.7cm AA
45 Caliber Type 10th yr 12cm AA
50 Caliber Type 88 10cm AA

Projectiles Used With

Mk 2 20cm Gun, Type 91 HE Shell
Mk 2 20cm Gun, Type 91 Time Practice Shell
50 Caliber 20cm Gun, HE Shell
50 Caliber 20cm Gun, Time Practice Shell
50 Caliber 12.7cm Gun, HE Shell
50 Caliber 12.7cm Gun, Time Practice Shell
50 Caliber 12.7cm Gun, Illuminating Shell
40 Caliber 12.7cm Gun, Time Practice Shell
12cm AA Gun, HE Shell
12cm AA Gun, Time Practice Shell
10cm AA Gun, HE Shell
10cm AA Gun, Time Practice Shell

Explosive Components

Primer - 3 Component Explosive Charge
Magazine - Black Powder

Bore Safety Delay Time - 0.4 seconds $\left[\begin{matrix}+.3 \text{ sec} \\ -.25 \text{ sec}\end{matrix}\right]$

actually obtained in firing trials gave a mean error of about plus or minus 0.15 seconds, but the manufacturing specifications only call for an accuracy of plus or minus 0.5 seconds.

The Type 98 MTF (Figure 12) was designed for use with the Type 98 High Velocity 65 caliber gun. It was subject to greater acceleration and rotation, so the clockwork mechanism was strengthened by using super duralumin instead of brass for the gear wheels, and the weight of components that functioned due to inertia was decreased. The Type 0 MTF (Figure 13) was designed for use in major caliber guns. In this case the weight of the components that functioned due to inertia was increased. In the case of both of these fuzes, a special safety flash gate was incorporated in the bottom of the fuze in place of the delay fitting. This, among other things, improved the accuracy of the fuze, which had formerly been affected by variations in the delay times. The external shape of Type 0 MTF was not changed, but the Type 98 MTF had a more pointed ballistic cap.

It became desirable to simplify the manufacture of the MTF during the war and it was intended to improve the safety of the fuzes in the bore. At the same time, the new designation for fuzes came into effect. The Type 91 MTF Modif. 1 (Figure 11) was modified to the Type 4 MTF Mk I (Figure 14) and the Type 98 MTF (Figure 12) was modified to the Type 4 Mk II. The safety pins were abolished. The safety flash gate at the bottom of the fuze was replaced by a simple magazine of black powder. A gaine, given the title of Type 4 gaine, incorporating a safety shutter, was designed after the Japanese had recovered a British gaine. This was the first time they had used a safety shutter between the detonator and the main explosive (they claimed that they suffered such bitter disappointments and troubles in experimenting with this gaine that it would be unjust to accuse them of copying the British gaine).

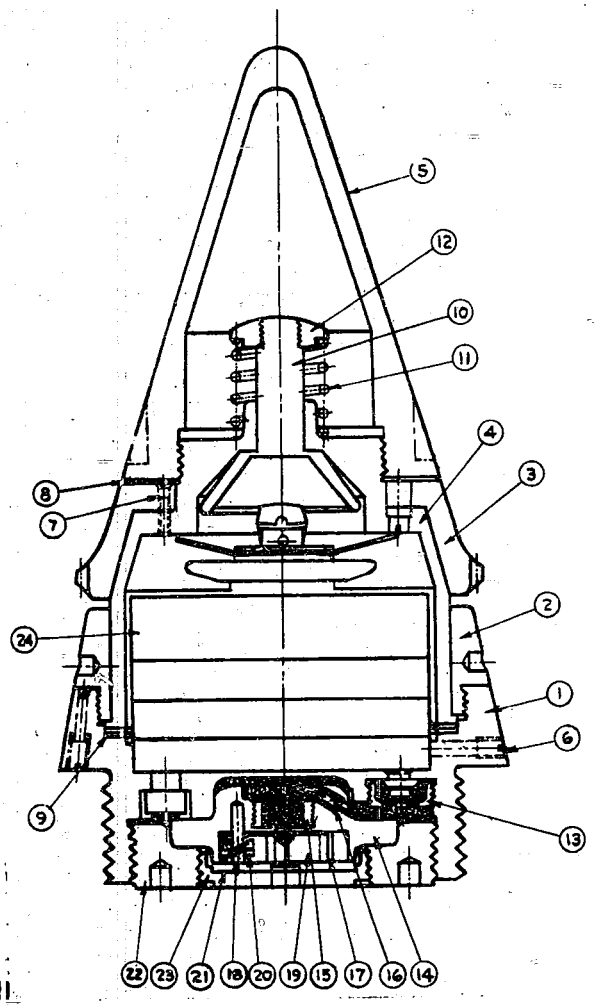
When the Type I 12.7cm gun (afterwards called the Type 5 gun) and the Type 5 10cm gun were designed, a Type 4 MTF Mk III and a Type 4 MTF Mk V (Figure 16) were designed with a front vertical angle of 23.5°. The chief difference between these two fuzes was that the latter had a smooth white metal setting ring which would have been gripped by the teeth of the fuze setter. (Note: Figure 16 is not quite correct as the safety flash gate should not be shown at the bottom of this fuze. A plain magazine should be shown instead).

The use by the Allied Forces of radar, particularly for night firing, led the Japanese naval authorities to the conclusion that it would be necessary to improve their illuminating projectiles to assist them in fighting at longer ranges at night. This was to be a temporary measure, for use during the period when their radar was comparatively ineffective. For this purpose, they designed the larger caliber illuminating projectiles for use in main armament guns, and decided that Type 0 MTF Modif. 1 (Figure 17) would be used with these shells, this fuze having a possible time setting of 100 seconds. To achieve this they slowed down the rate of the clockwork pallet simply by altering the pallet weights.

The Japanese Navy Technical Department was now confronted with what they described as "The Sphinx in their Pyrotechnical Circle". This was the fact that a very large proportion of the fuzes fired from larger caliber guns with illuminating projectiles (and also with incendiary projectiles) were blinds. After lengthy investigation, they concluded that the trouble could be traced to the comparatively large precession of these dynamically unstable major caliber projectiles around their trajectories, and that this, at times, counteracted the centrifugal force acting on the centrifugal block. As a result, the centrifugal block tended to close on the striker and at times prevented the striker from moving onto the detonator. The Type 0 MTF Modif. 1 was further modified by removing the centrifugal block, and this new type fuze was called Type IV MTF Mk 0. Both these fuzes had a safety shutter at the bottom of the fuze, as they were designed for use not only with HE projectiles but also with special projectiles such as illuminating and incendiary projectiles, in which

Type 98 Mechanical Time Fuze

Figure 12



Date Adopted: June 1942

Total Weight: 717 gm

Time Setting: 0-45 seconds

1. Body
2. Lock Ring
3. Gear Ring
4. Setting Cylinder
5. Nose Cap
6. Plug
7. Gear Ring Keying Screw
8. Fiber Washer
9. Spring
10. Starting Pin (HAMMER)
11. Starting Pin
12. Starting Pin Nut
13. No. 1 Primer
14. Shutter Holder
15. No. 2 Primer
16. Copper Plate
17. Shutter Stop Pin
18. Shutter Axis
19. Centrifugal Shutter
20. Shutter Spring
21. Spacer
22. Base Plate
23. Spacer Retaining Plug
24. Clock Work

Guns Used With

Type 98 10cm AA
Type 98 8cm AA

Projectiles Used With

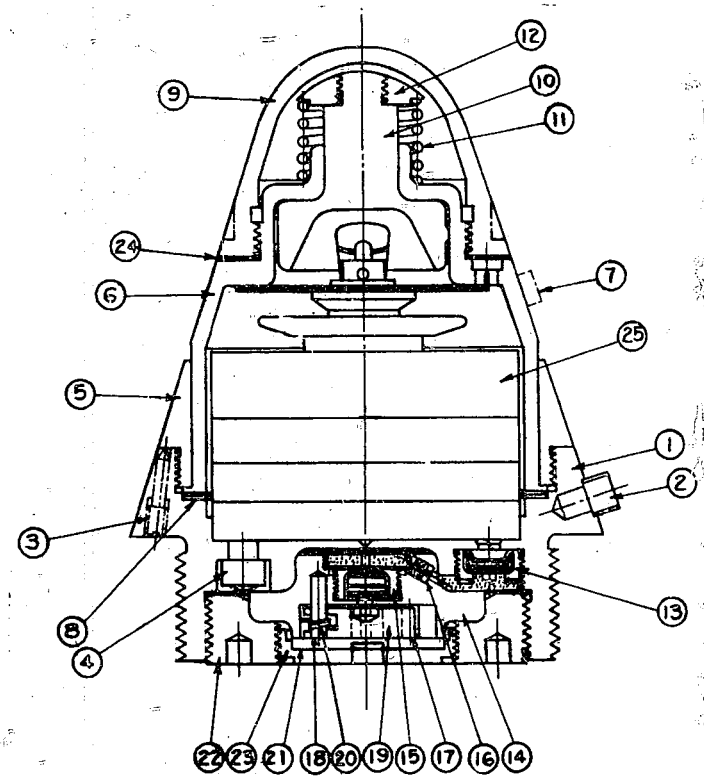
Type 98 10cm AA Gun, Test HE Shells
Type 98 8cm AA Gun, Test HE Shells

Explosive Components

No. 1 Primer - 3 Component Explosive Charge ..... 0.06 gm
Relay - Black Powder
No. 2 Primer - 3 Component Explosive Charge ..... 0.07 gm

Type 0 Mechanical Time Fuze

Figure 13



Date Adopted: Feb. 1943

Total Weight: 307 gm

Time Setting: 0-55 seconds

1. Body
2. Setting Screw
3. Set Screw
4. Locating
5. Lock Ring
6. Setting Cylinder
7. Setting Screw
8. Spring
9. Nose Cap
10. Starting Pin (HAMMER)
11. Starting Pin Spring
12. Starting Pin
13. No. 1 Primer
14. Centrifugal Shutter Holder
15. No. 2 Primer
16. Copper Disc
17. Shutter Stop Pin
18. Shutter Axis
19. Centrifugal Shutter
20. Shutter Spring
21. Spacer
22. Base Plug
23. Spacer Retaining Plug
24. Fiber Washer
25. Clock Work

Guns Used With

Various Guns of 20cm and above

Projectiles Used With

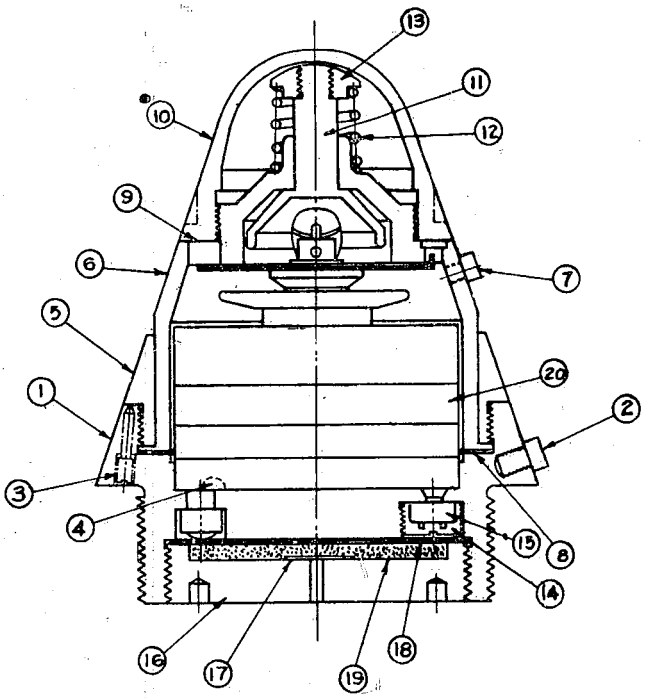
Mk 2 20cm Gun, Illuminating Shell "B"
Type 0 HE Shells for guns of 20cm and above.
Type 3 HE Shells for guns of 20cm and above.

Explosive Components

No. 1 Primer - 3 Component Explosive Charge ..... 0.06 gm
Relay - Fine Black Powder
No. 2 Primer - 3 Component Explosive Charge ..... 0.07 gm

Old Designation - Type 4
Type 4 Model 1 Mechanical Time Fuze

Figure 14



Total Weight: 585.5 gm

Time Setting: 0-55 seconds

1. Body
2. Setting Screw
3. Set Screw
4. Locating Pin
5. Lock Ring
6. Setting Cylinder
7. Setting Screw
8. Spring
9. Key Hole
10. Nose Cap
11. Starting Shaft
12. Starting Shaft Spring
13. Starting Shaft Nut
14. Primer Holder
15. Primer
16. Base Plug
17. Tin Foil
18. Paper
19. Magazine
20. Clock Work

Guns Used With

50 Caliber Type 3rd yr Mk2 20cm
50 Caliber Type 3rd yr 20cm
50 Caliber Type 3rd yr 12.7cm
40 Caliber Type 88 12.7cm AA
40 Caliber Type 89 12.7cm AA
45 Caliber Type 10th yr 12cm AA
50 Caliber Type 88 10cm AA

Projectiles Used With

Mk 2 20cm Gun, Type 91 HE Shell
Mk 2 20cm Gun, Type 91 Time Practice Shell
50 Caliber 20cm Gun, HE Shell
50 Caliber 20cm Gun, Time Practice Shell
50 Caliber 12.7cm Gun, HE Shell
50 Caliber 12.7cm Gun, Time Practice Shell
50 Caliber 12.7cm Gun, Star Shell
40 Caliber 12.7cm Gun, Time Practice Shell
12cm Dual Purpose Gun, HE Shell
12cm Dual Purpose Gun, Time Practice Shell
10cm Dual Purpose Gun, HE Shell
10cm Dual Purpose Gun, Time Practice Shell

Explosive Components

Primer - 3 Component Explosive Charge .... .06 gm
Magazine - Fine Black Powder

"Type 4" Gaine (Used With Fuzes Not Considered Bore Safe)

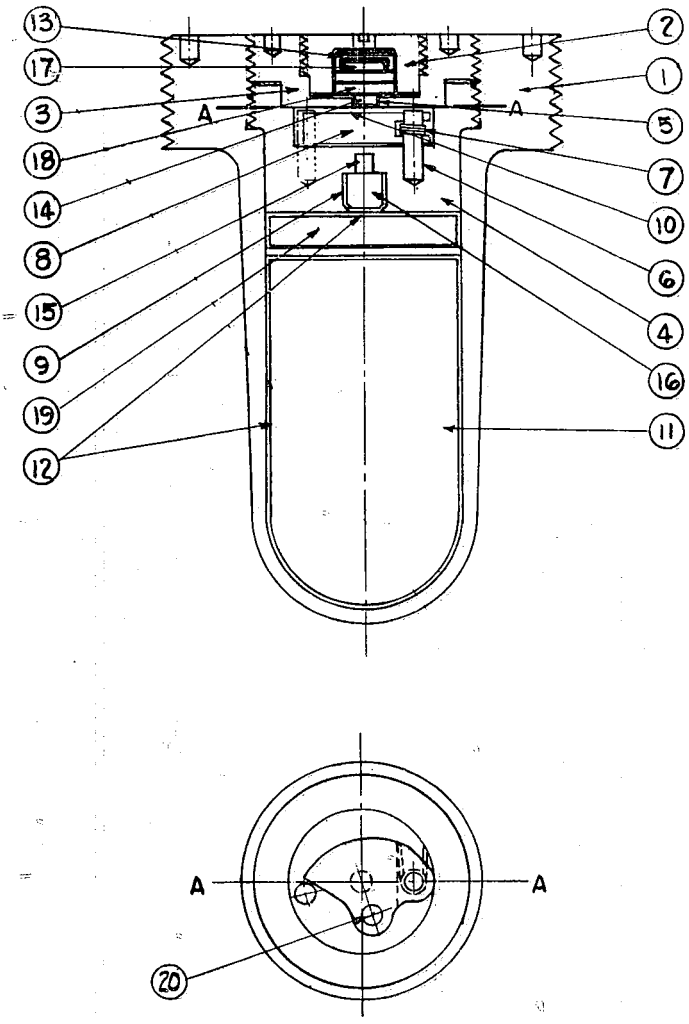


Figure 15

Total Weight: 273 gm

1. Body
2. Primer Holder
3. Closing Plug
4. Shutter Holder
5. Copper Plate
6. Shutter Axis
7. Shutter Spring
8. Shutter
9. Copper Cup
10. Paper
11. Shimose
12. Paper Liner
13. Primer
14. No. 1 Relay
15. No. 3 Relay
16. No. 4 Relay
17. Lead Azide
18. Tetryl
19. Shimose
20. No. 2 Relay

Guns and Projectiles Used With

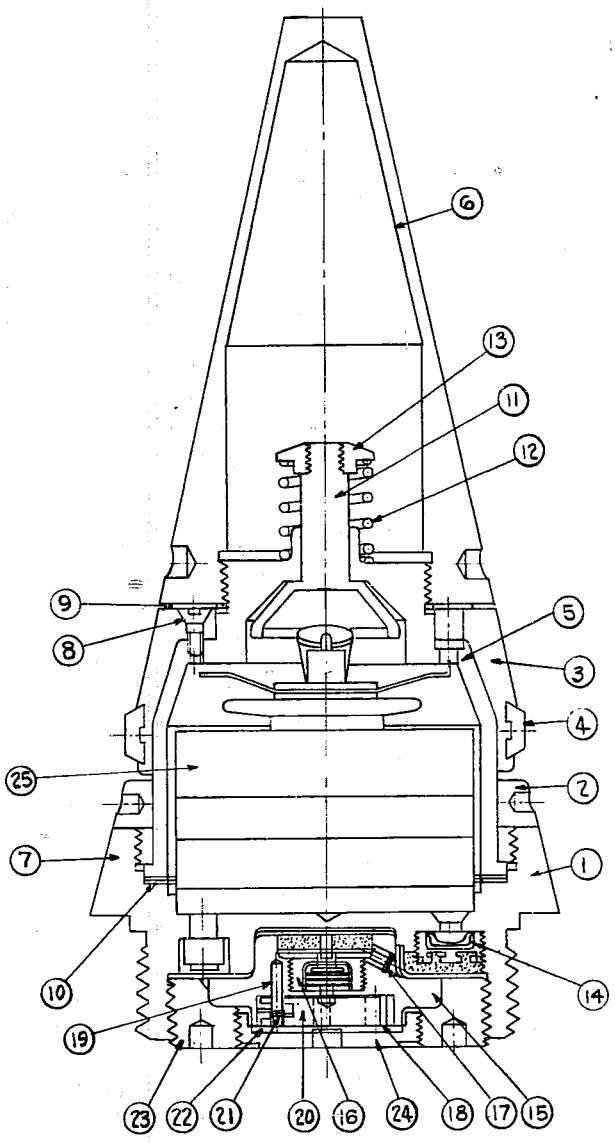
Type 91 Modification 1

Explosive Components

Primer - Lead Azide / Tetryl
No. 1 Relay - Tetryl
No. 2 Relay - Tetryl
No. 3 Relay - Tetryl
No. 4 Relay - Tetryl
Gaine - Shimose

Old Designation - Type 1
Type 4 Model 5 Mechanical Time Fuze

Figure 16



Time Setting: 0-45 seconds

1. Body
2. Lock Ring
3. Gear Ring Cylinder
4. Gear Ring
5. Setting Cylinder
6. Nose Cap
7. Set Screw
8. Set Screw
9. Fiber Washer
10. Tension Spring
11. Starting Pin (HAMMER)
12. Starting Pin Spring
13. Starting Pin Nut
14. No. 1 Primer
15. Shutter Holder
16. No. 2 Primer
17. Metal Washer
18. Shutter Stop Pin
19. Shutter Axis
20. Shutter
21. Shutter Spring
22. Shutter Seat
23. Base Plug
24. Shutter Retaining Plug
25. Time Clock

Guns Used With

Type 1 12. cm Dual Purpose Gun

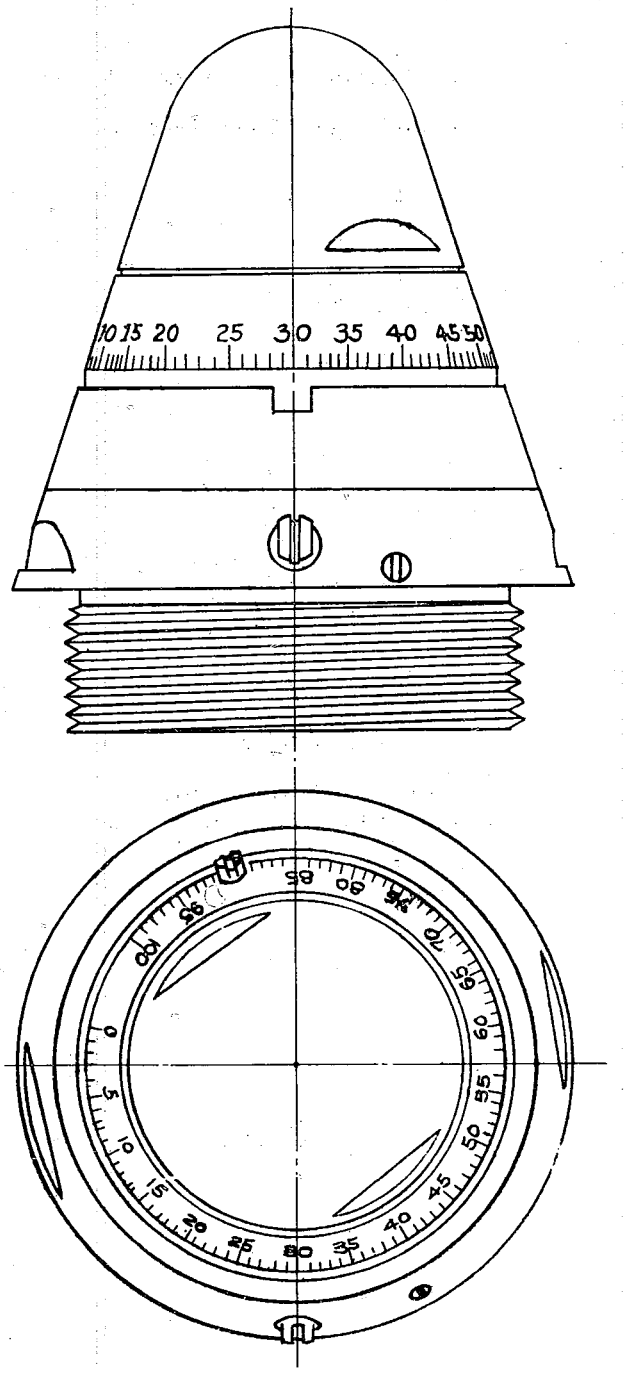
Projectiles Used With

Type 1 12.7cm Gun, HE Shell

Explosive Components

No. 1 Primer - 3 Component Explosive Charge ..... 0.06 gm
Relay - Black Powder
No. 2 Primer - 3 Component Explosive Charge ..... 0.02 gm

Old Designation - Type 0 Modification 1
Type 4 Modification 1 Mechanical Time Fuze



Total Weight: 607 gm

Time Setting: 0-100 seconds

This fuze is the same as the Type 0 Mechanical Time Fuze, except for the increased weight of the pallet and the increase in the time setting scale to 100 seconds.

Projectiles Used With

Mk 2 20cm Gun, Star Shell -13 (OTSU)

Type 0 HE Shell for all guns 20cm and above.

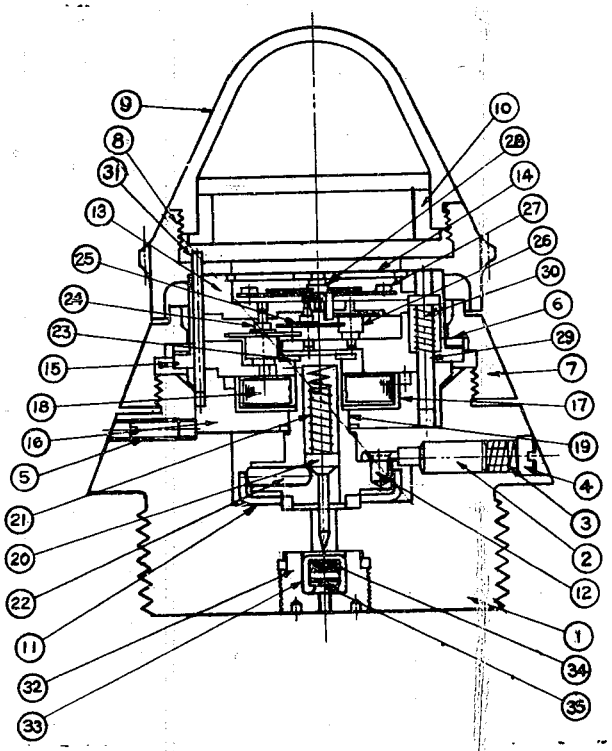
Type 3 HE Shell for all guns 20cm and above

Guns Used With

All types of 20cm and above.

Type WAKAZIMA or Type W Mechanical Time Fuze (Experimental Only)

Figure 18



Total Weight: 599.3 gm

Time Setting: 0-35 seconds

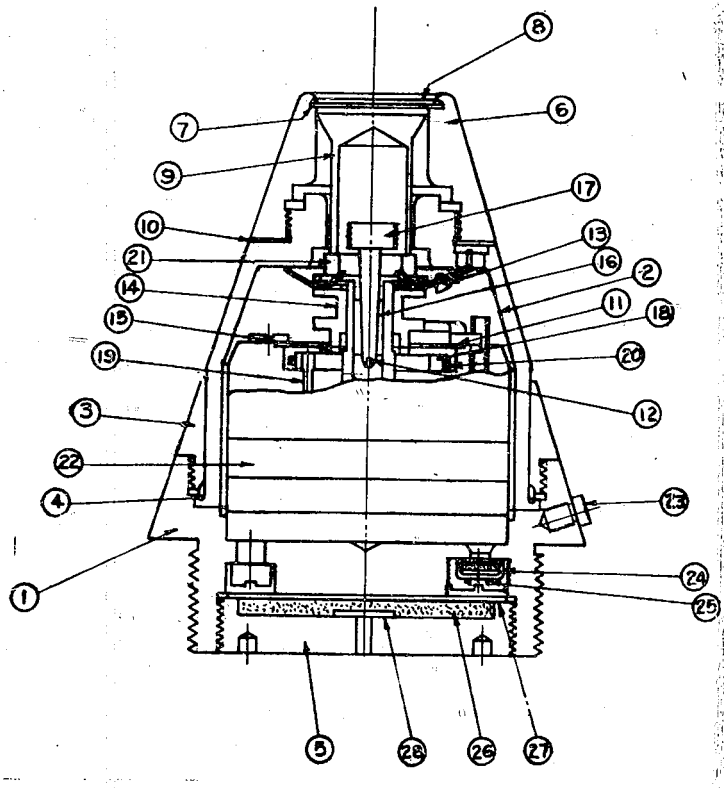
1. Body
2. Detent
3. Detent Spring
4. Detent Plug
5. Set Screw
6. Gasket
7. Lock Ring
8. Gear Ring
9. Nose Cap
10. Set Back Cylinder
11. Cam Retaining Cup
12. Screw
13. Top Plate
14. Top Clock Work Securing Plate
15. Middle Plate
16. Lower Plate
17. Main Spring Housing
18. Main Spring
19. Central Shaft
20. Firing Pin
21. Firing Pin Spring
22. Cam
23. Through 28 Clock Work
29. Set Back Starting Pin
30. Set Back Pin Spring
31. Keying Pin
32. Primer Holder
33. Primer
34. Brass Plate
35. Copper Plate

Explosive Components

Primer - { 3 Component Explosive Charge .... 0.06 gm
Black Powder ..... 0.06 gm

Old Designation - Type 4 Model 2
Type 4 Combination Mechanical Time Fuze

Figure 19



Total Weight: 609 gm

Time Setting: 0-55 sec

1. Body
2. Setting Cylinder
3. Lock Ring
4. Keep Spring
5. Base Plug
6. Nose Cap
7. Copper Disc
8. Securing Ring
9. Coupling Extension
10. Fiber Washer
11. Clock Work Cover
12. Coupling Stop Pin
13. Range Setting Piece
14. Range Setting Piece
15. Central Shaft
16. Coupling
17. Coupling Head
18. Centrifugal Starting Blocks
19. Starting Block Axis
20. Starting Block
21. Collar
22. Clock Work
23. Setting Screw
24. Primer
25. Primer Holder
26. Magazine
27. Paper
28. Tin Foil

Guns Used With

50 Caliber Type 3rd yr 20cm
50 Caliber Type 3rd yr Mk 2 20cm
50 Caliber Type 3rd yr 12.7cm
40 Caliber Type 88 12.7cm Dual Purpose
40 Caliber Type 89 12.7cm Dual Purpose
45 Caliber Type 10th yr 12cm Dual Purpose
50 Caliber Type 88 10cm Dual Purpose

Projectiles Used With

Mk 2 20cm Gun, Type 91 HE Shell
Mk 2 20cm Gun, Type 91 Practice Shell
50 Cal. 20cm Gun, HE Shell
50 Cal. 20cm Gun, Time Practice Shell
50 Cal. 12.7cm Gun, HE Shell
50 Cal. 12.7cm Gun, Time Practice Shell
50 Cal. 12.7cm Gun, Star Shell
40 Cal. 12.7cm Gun, Time Practice Shell
12cm Dual Purpose Gun, HE Shell
12cm Dual Purpose Gun, Time Practice Shell
10cm Dual Purpose Gun, HE Shell
10cm Dual Purpose Gun, Time Practice Shell

Explosive Components

Primer - 3 Component Explosive Charge ..... 0.06 gm
Magazine - Fine Grain Black Powder ..... -

case the Type 4 gaine was not used. In practice, this shutter did not cause blinds in a similar manner to the centrifugal block and this can be attributed to the better dynamical stability of the shutter in its open position under the influence of centrifugal force.

The Japanese technical officers were quite satisfied with the Type 4 MTF Mk I as a clock fuze, but as the war progressed, they were continually forced to consider simplifying the fuze mechanism, in order to assist production. At the same time they were considering designing a clock fuze that would give an accuracy which would not be affected by the rotational speed of the fuze. For this purpose they intended to set the pallet of the clockwork on the axial line instead of the radial. This project was abandoned due to the opposition of the more elderly and more conservative fuze designers. Some degree of simplification was achieved in the design of the Wakazima Type MTF (Figure 18) in which the firing needle was placed on the axial line of the fuze instead of to one side. Experiments along these lines were stopped by the pressure of other work.

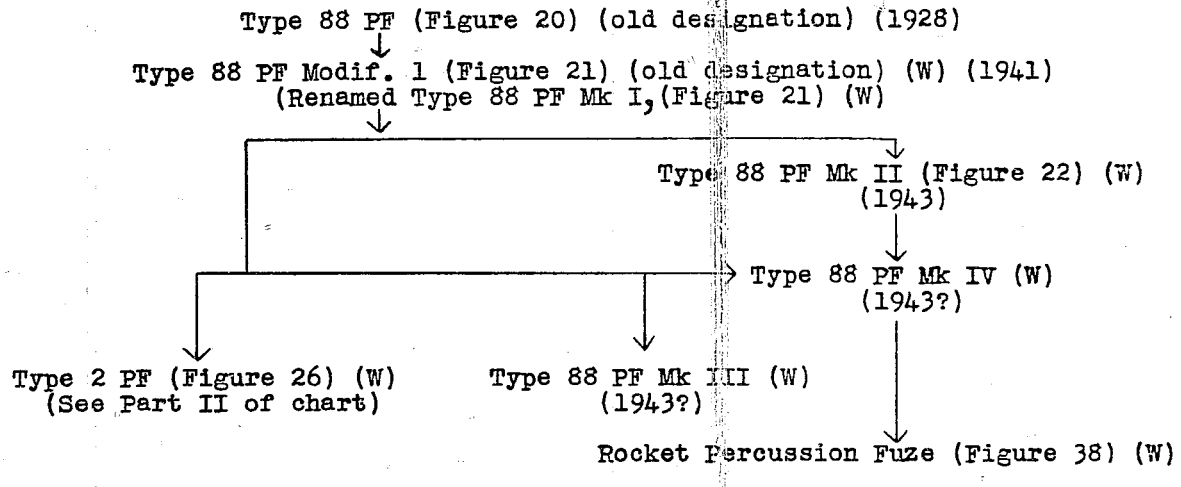
On some occasions, several destroyers fired anti-aircraft projectiles, fuzed with MTF mechanism time fuzes, against enemy ships, and it was found that they functioned as percussion fuzes (probably due to the shoulder of the striker fracturing). Experiments were carried out and it was found that all mechanical time fuzes would function as percussion fuzes against steel plates as thin as 6mm. They could, therefore, be used in emergencies against warships. (Note: This was one of the reasons why the delay feature was removed in the case of Type 91 MTF Modif. 1 and replaced by an instantaneous magazine).

When the Japanese naval authorities decided that B-29s were not seriously damaged by splinters, the technical officers were asked to design a combination fuze which would function on the thin duralumin plates of aircraft. Type 4 combination fuze Mk I (Figure 19) was designed for this purpose by Mr. T. YAMAMOTO, working under Technical Lieut. NISHIDA at Kure Arsenal and was developed by the engineers of the Hattori Clock Company. In this design, the percussion action is obtained by the inertia hammer (or starting pin) forcing the hand down through the clock mechanism top plate (part of which is thin) thereby releasing the safety lever which can then move into a circular groove in the top part of the hand. This in turn releases the striker. In experiments, this fuze functioned at striking angles between 0 and 65° against 0.5mm duralumin plates when the striking velocity was 300 meters per second or more. The interval between striking and explosion of the detonator was less than one thousandth of a second. This fuze did not get into production and, to date, none of the fuzes have been discovered except one badly damaged sample, which appears to have been fired.

Part IV - NOSE PERCUSSION FUZES

In the Japanese Navy nose percussion fuzes divide into two distinct series. The more interesting series was developed from Type 88 and the other series from the 5th Year percussion fuze. A brief chart of the first series is given below as Part I of a chart of development of percussion nose fuzes. Fuzes with a W after their name are those which were in use during World War II. Where known, the date of adoption into service is shown below the fuze.

Chart of Development of Percussion Nose Fuzes (Part I)



The Technical officers carried out many experiments with the Type 88 fuze to determine its characteristics against armor of varying thicknesses, at varying striking velocities and at different striking angles. To their surprise they found that, although a fuze would function on plates of a certain thickness at a certain velocity and striking angle, increasing the thickness of the plate caused the fuze to fail. This was, of course, due to the fact that a thin plate would buckle sufficiently to cause the final resistance of the plate to the fuze to be exerted along the axial line of the fuze. If, however, the plate was too thick or the striking velocity was too high, the plate did not have time to buckle and the head of the fuze was crushed sideways onto the striker. They pursued these experiments for a long time and arrived at the conclusions which are shown in diagram form in Figure 20A. Their final conclusions can be summarized as follows:

1. Against plates thicker than 6 or 7mm, the Type 88 fuze can function at any striking angle down to very nearly 80°. Against plate thickness of about 15mm, the effective striking angle is very much more limited.

2. The higher the striking velocity, the smaller the range of striking angle at which the Type 88 fuze would be effective.

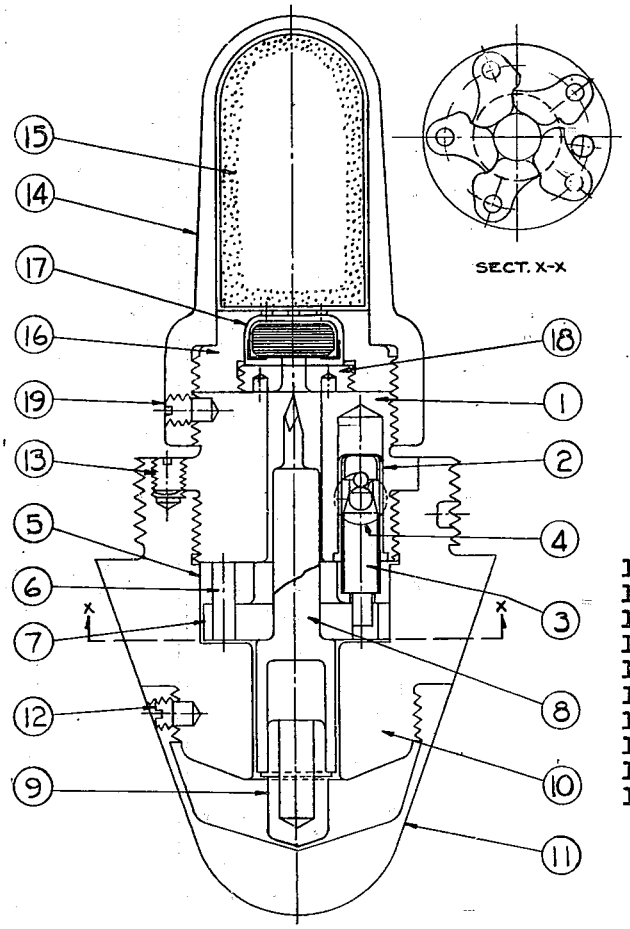
3. The damaging effect of HE projectiles is greatest at striking angles between 30 and 50°.

4. With HE projectiles of medium caliber, steel plate thicker than 25mm will only be damaged if the striking angle comes within the effective region as shown on the diagram.

In Figure 20, the safety device of the striker head is shown in Item 9. If the cap of the fuze (Item 11) is accidentally crushed, the small rim on the safety head of the striker will be sheared off. Therefore the external force will be taken up by the cap and the fuze body without a sufficient amount being transferred through the safety head and the body of the striker to shear the five centrifugal safety shutters.

Type 88 Instantaneous Nose Fuze

Figure 20



Date Adopted: 1928

Total Wt: 970 gm ± 1.5%

1. Base Plug
2. Set Back Pin Spring
3. Set Back Pin
4. Detent
5. Pawl Seat Ring
6. Pawl Axis
7. Interlocking Arming Delay Pawls
8. Firing Pin
9. Firing Pin Safety Plug
10. Body
11. Nose Cap
12. Set Screw
13. Set Screw
14. Gaine
15. Shimose
16. Primer Holder
17. Primer
18. Primer Cap
19. Set Screw

Guns Used With

50 Caliber Type 88 10cm AA
45 Caliber Type 10th yr 12cm AA
40 Caliber Type 88 & 89 12.7cm AA
50 Caliber Type 3rd yr 12.7cm

Explosive Components

Primer - Mercury Fulminate ... 1.4 gm
Gaine - Shimose ..... 16.5 gm

Projectiles Used With

10cm AA Gun, HE Shell
12cm AA Gun, HE Shell
40 Caliber 12.7cm AA Gun, HE Shell
50 Caliber 12.7cm Gun, HE Shell

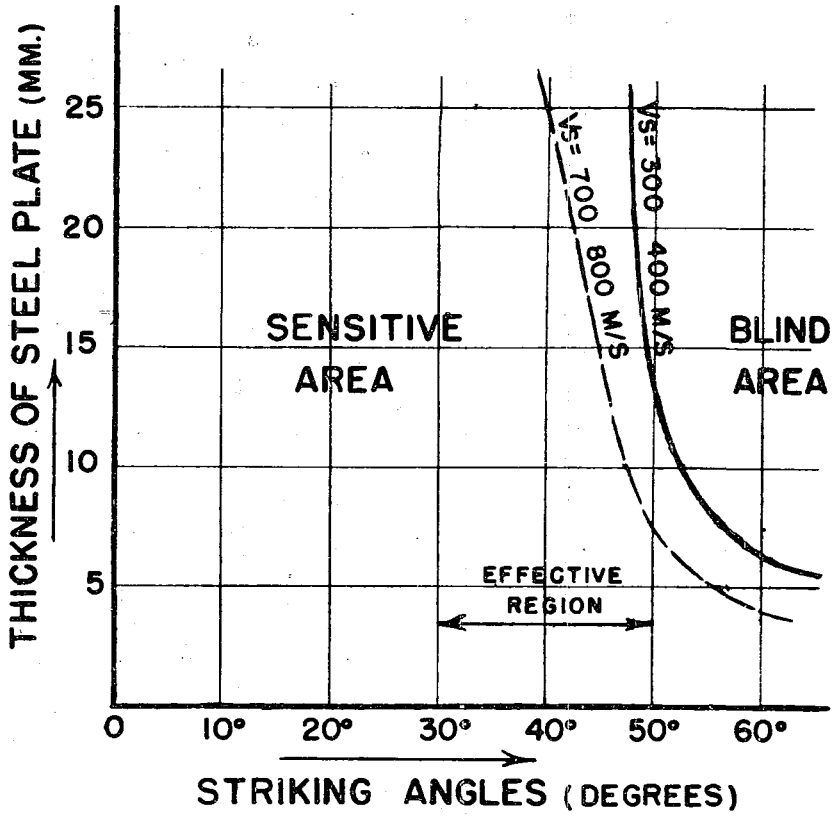


Figure 20A
CHARACTERISTICS OF TYPE 88 - PF

The Type 5th Year percussion fuze is not of much interest except as an example of over-complication. The development of this fuze is shown in Part II of the chart of development of percussion nose fuzes.

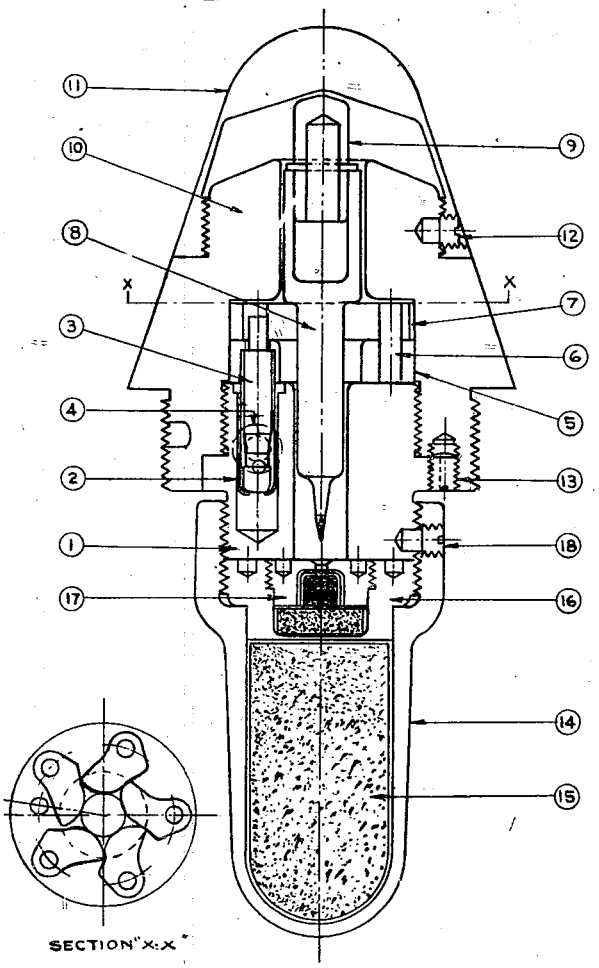
In the case of the Type 88 fuze, it also became necessary to simplify production and the Type 88 PF Modif. 1 was altered to the Type 88 PF Mk II (Figure 22). As many parts of the fuze as possible were altered from brass to steel. The detent plunger was abolished and its function was performed by a spring circlet around the five centrifugal shutters. At the same time, the Type 88 Modif. 1 (Figure 21) had its title altered to Type 88 PF Mk I, in accordance with the new method of designating fuzes, and this title was used to name fuzes in stock which were of the old design.

As the Type 88 PF Mk I was not sensitive enough for use against enemy positions on land, another fuze was designed incorporating both the percussion principle of the machine gun fuze shown in Figure 38 and the safety head feature mentioned above. The Type 88 PF Mk II (Figure 22) was modified in this manner and called the Type 88 PF Mk IV. The Type 88 PF Modif. 1 (Figure 21), modified in this manner was named Type 88 PF Mk III. The former was used for medium caliber guns and the latter for major caliber guns.

The rocket percussion fuze (Figure 38) which is in some ways a primitive design of Type 88 PF Mk IV, is described in a later section.

Type 88 Modification 1 Instantaneous Nose Fuze

Figure 21



Date Adopted: Dec. 1941

Total Wt: 979 gm ± 1.5%

1. Base Plug
2. Set Back Pin Spring
3. Set Back Pin
4. Detent
5. Interlocking Pawl Seat Ring
6. Interlocking Pawl Axis
7. Interlocking Arming Delay Pawls
8. Firing Pin
9. Firing Pin Safety Cap
10. Body
11. Nose Cap
12. Set Screw
13. Set Screw
14. Gaine
15. Shimose
16. Aux. Booster
17. Primer
18. Set Screw

Guns Used With

50 Caliber Type 88 10cm AA
45 Caliber Type 10th yr 12cm AA
40 Caliber Type 88 & 89 12.7cm AA
50 Caliber Type 3rd yr 12.7cm

Explosive Components

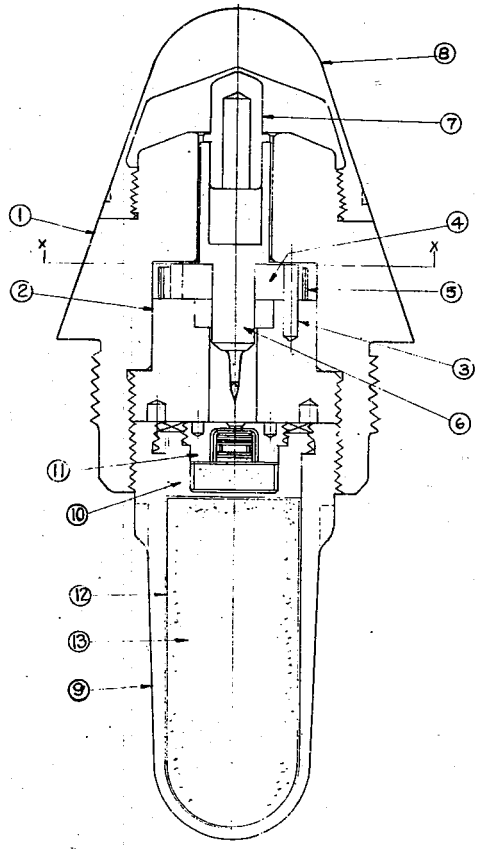
Primer - 3 Component Explosive Charge	
.....	0.1 gm
Lead Azide	0.1 gm
Tetryl	0.1 gm
Aux. Booster - Tetryl	1.0 gm
Gaine - Shimose	20.0 gm

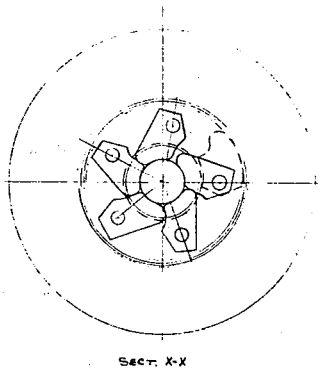
Projectiles Used With

Same projectiles as Type 91 Mechanical Time Fuze
12cm Gun, Mk 4 HE Shell
50 Caliber 12.7cm Gun, HE Shell

Type 88 Modification 2 Instantaneous Nose Fuze

Figure 22





Date Adopted: Feb. 1943

Total Wt: 912 gm

1. Body
2. Interlocking Pawl Seat Ring
3. Interlocking Pawl Axis
4. Interlocking Arming Delay Pawls
5. Interlocking Pawl Spring
6. Firing Pin
7. Firing Pin Safety Cap
8. Nose Cap
9. Gaine
10. Aux. Booster
11. Primer
12. Paper Liner
13. Shimose

Guns Used With

50 Caliber Type 88 10cm AA
45 Caliber Type 10th yr 12cm AA
40 Caliber Type 88 & 89 12.7cm AA
50 Caliber Type 3rd yr 12.7cm
45 Caliber Type 3rd yr 12cm
Type 98 10cmAA
Type 98 8cmAA
Also other small caliber guns

Explosive Components

Primer - 2 Component Explosive Charge	0.1 gm
Lead Azide	0.1 gm
Tetryl	0.1 gm
Aux. Booster - Tetryl	1.0 gm
Gaine - Shimose	27.0 gm

Projectiles Used With

Type 0 HE Shells for small caliber guns
50 Caliber 12.7cm Gun, HE Shell
40 Caliber 12.7cm AA Gun, HE Shell
12 cm AA Gun, HE Shell
12 cm Gun, Mk 4 HE Shell
Type 98 10 cm AA Gun, HE Shell
10 cm AA Gun, HE Shell
Type 98 8 cm AA Gun, HE Shell

Chart of Development of Percussion Nose Fuzes (Part II)

5th Year PF (old designation)
(1916) (Figure 23 is nearly correct)

5th Year PF Modif. 1 (1932) (Figure 23)
5th Year PF Modif. 2 (1936) (Figure 24)
5th Year PF Modif. 3 (1941) (Figure 25)

These fuzes influenced the design of Type 2 Percussion Fuze (Figure 26) which was simplified and reduced the use of copper in favor of steel. (See Part I of Chart.)

The 5th Year PF was modified to produce slightly simpler designs in the form of the 5th Year PF Modif. 1, 2 and 3 (Figures 23, 24 and 25).

During the war, further simplification in design with substitution of steel for brass was carried out, leading to the production of Type 2 PF (Figure 26). This fuze is, in its design, largely influenced by the Type 88 PF Mk II design and was being introduced in place of the Type 5 Year fuze.

Part V - SPECIAL FUZES

The anti-submarine DAPF Mk I (Figure 27) is a most elaborate collection of components taken from other fuzes and was apparently designed in a hurry, due to the urging of senior authorities. Many difficulties were experienced with this fuze. The first problem to overcome was the very great power of the hydrodynamic pressure exerted on the fuze. After lengthy trials, this was overcome by the comparatively simple pressure cap shown in Items 40 and 41 of Figure 27. The other difficulty was due to the use of non-gaseous powders for the time train. At first, the Japanese technicians experimented with powders such as a mixture of barium peroxide and sulphur. In the case of this powder, they found that it became liquid on burning and that centrifugal force moved the burning powder about in its fluid state, causing either irregular burning or complete extinction. Finally, a powder consisting of a mixture of barium peroxide, lead chromate and combustible matter was used with success. (This powder did not become fluid during the period of combustion).

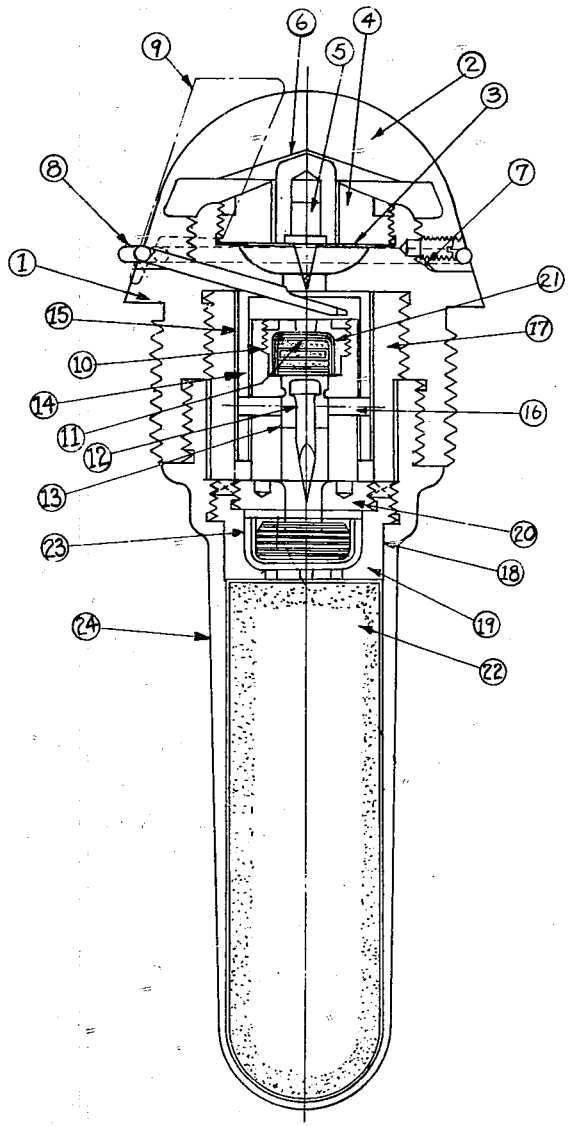
More time was given to the designing of anti-submarine delay percussion fuze Mk II (Figure 28). The improvement in non-gaseous powder enabled reasonable accuracy to be obtained in the burning of the powder pillar under all conditions of deceleration through the water.

The first fuze used for rifle grenades was the 10th Year hand grenade fuze (Figure 29). This started burning when fired and functioned after seven seconds. It was not a successful weapon and a percussion fuze was required to replace it. A percussion fuze called Rifle Grenade Fuze (Figure 30) was designed with a simple shear pin as its safety feature. The safety factor was preserved at about ten by reducing the mass of the needle. This fuze was later modified to RGF Mk I (Figure 31) and again to RGF Mk II (Figure 32) in order to simplify manufacture. RGF Mk II was sometimes called by the name Type 3 Small PF Mk I.

The Japanese Navy Technical Department was asked to develop a small rifle grenade fuze having a definite safety device which would be removed after a certain length of time. This problem was solved by having a hollow cylinder of smokeless powder preventing movement of the striker. This powder was ignited at the moment of firing through a delay which contained the same chemicals as anti-submarine DAPF Mk I. The maximum compressive strain of the powder pillar was about two tons and it was safe when dropped ten meters onto the earth. The powder was the same as that of the machine gun fuze.

Type 5th Year Modification 1 Instantaneous Nose Fuze

Figure 23



Date Adopted: June 1932

Total Wt: 463 gm ±1.5%

1. Body
2. Nose Cap
3. Shear Washer
4. Washer Retainer
5. Primary Firing Pin
6. Firing Pin Cylinder
7. Set Screw
8. Safety Pin
9. Instruction Tag
10. No. 1 Primer
11. Copper Plate
12. Secondary Firing Pin
13. Firing Pin Sleeve
14. Firing Pin Cylinder
15. Secondary Firing Pin Assembly
16. Shear Wire
17. See No. 15
18. Gaine
19. No. 2 Primer
20. Primer Cap
21. Paper Cap
22. Shimose
23. Asbestos Cap
24. Paper Covering

Guns Used With

40 Caliber Type 11th yr 14cm
45 Caliber Type 3rd yr 12cm
45 Caliber Type 11th yr 12cm
40 Caliber Type 11th yr 8cm
40 Caliber Type 3rd yr 8cm AA

Explosive Components

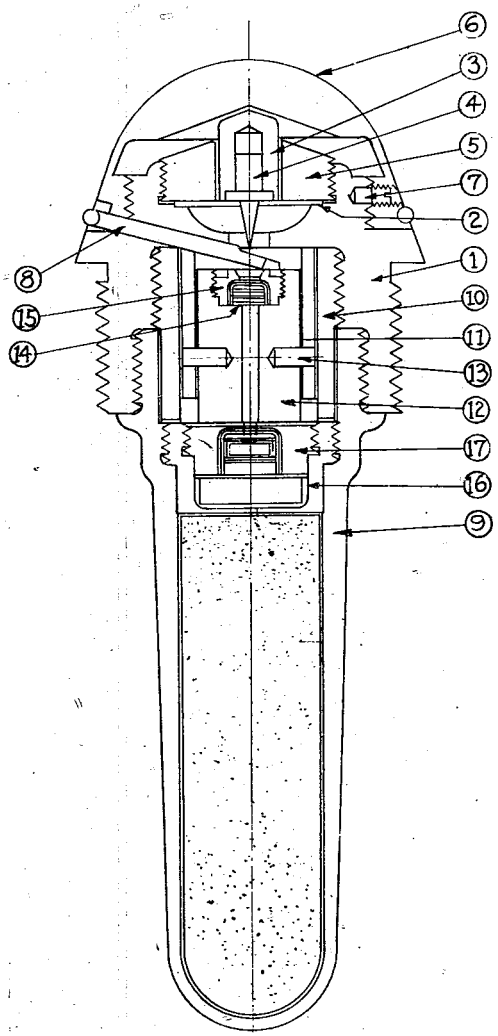
No. 1 Primer - 3 Component Explosive Charge .... .10 gm
Lead Azide ..... 0.05 gm
Tetryl ... 0.10 gm
No. 2 Primer - Mercury Fulminate ..... 1.40 gm
Gaine - Shimose ..... 20.0 gm

Projectiles Used With

40 Caliber 14cm Gun, HE Shells
12cm Gun, Mk 3 HE Shells
12cm Gun, Mk 3 Mod 1 HF Shell
8cm Gun, Mk 3 HE Shell

Type 5th Year Modification 2 Instantaneous Nose Fuze

Figure 24



Date Adopted: June 1936

1. Body
2. Firing Pin Shear Washer
3. Firing Pin Cylinder
4. Firing Pin
5. Shear Washer Retainer
6. Nose Cap
7. Set Screw
8. Safety Pin
9. Gaine
10. Retaining Cylinder
11. Safety Sleeve
12. No. 1 Primer Holder
13. Shear Wire
14. Copper Plate
15. No. 1 Primer
16. Aux. Booster
17. No. 2 Primer

Guns Used With

40 Caliber Type 11th yr 14cm
45 Caliber Type 3rd yr 12cm
45 Caliber Type 11th yr 12cm
40 Caliber Type 11th yr 8cm
40 Caliber Type 3rd yr 8cm AA

Explosive Components

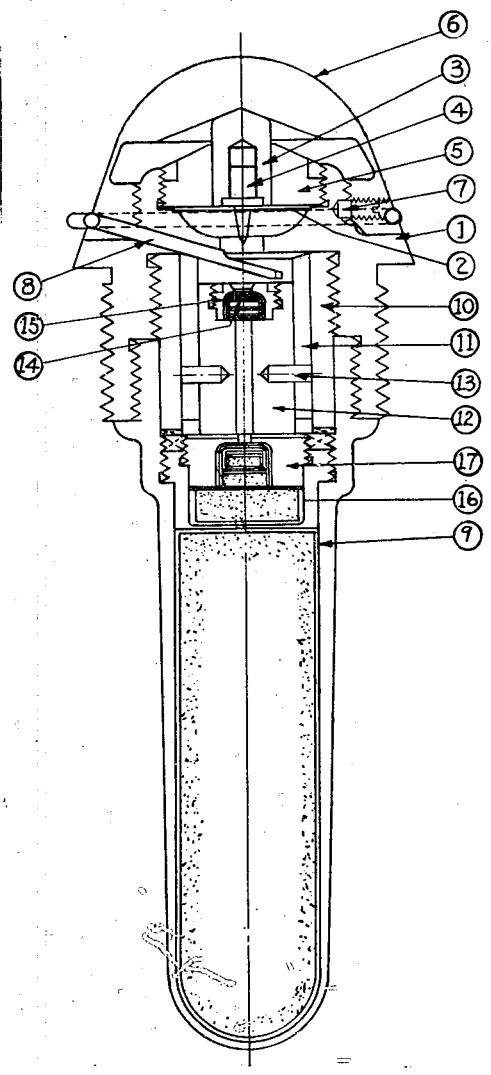
No. 1 Primer - 3 Component Explosive Charge ..... 0.06 gm
No. 2 Primer - Lead Azide ..... 0.10 gm
Aux. Booster - Tetryl .... -
Tetryl .... 1.0 gm
Gaine - Shimose ..... 21.0 gm ± 3%

Projectiles Used With

40 Caliber 14cm Gun, HE Shell
12cm Gun, Mk 3 HE Shell
12cm Gun, Mk 3 Mod. 1 HE Shell
8cm Gun, Mk 3 HE Shell

Type 5th Year Modification 3 Instantaneous Nose Fuze

Figure 25



Date Adopted: December 1941

1. Body
2. Shear Washer
3. Firing Pin Cylinder
4. Firing Pin
5. Shear Washer Retainer
6. Nose Cap
7. Set Screw
8. Safety Pin
9. Booster
10. Retaining Cylinder
11. Safety Sleeve
12. Primer Holder
13. Shear Wire
14. Copper Plate
15. No. 1 Primer
16. Aux. Booster
17. No. 2 Primer

Guns Used With

40 Caliber Type 11th yr 14cm
45 Caliber Type 3rd yr 12cm
45 Caliber Type 11th yr 12cm
40 Caliber Type 11th yr 8cm
40 Caliber Type 3rd yr 8cm AA

Explosive Components

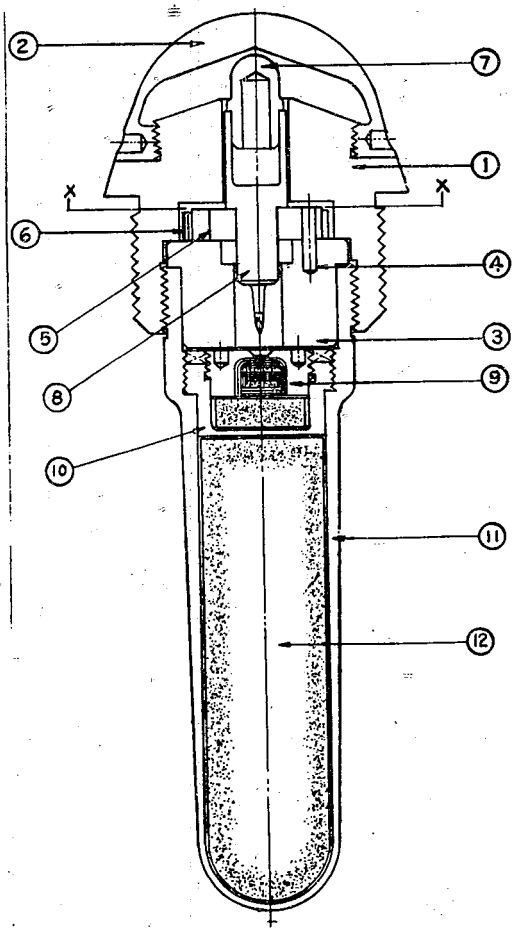
No. 1 Primer - 3 Component Explosive Charge .... 0.06 gm
Lead Azide ..... 0.10 gm
No 2. Primer - Tetryl ... -
Aux. Booster - Tetryl ... 1.0 gm
Gaine - Shimose ..... 20.0 gm

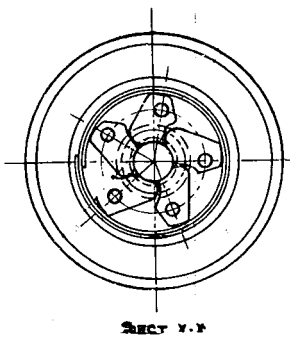
Projectiles Used With

40 Caliber 14cm Gun, HE Shell and Mod 1
12cm Gun, Mk 3 HE Shell
12cm Gun, Mk 3 Mod. 1 HE Shell
8cm Gun, Mk 3 HE Shell & Mod.1
12cm and 8cm Guns, Mk 1 and 2 Mod 1 and 2 HE Shell

Type 2 Instantaneous Nose Fuze

Figure 26





Date Adopted: Feb. 1943

Total Wt: 430 gm

1. Body
2. Nose Cap
3. Interlocking Pawl Seat Ring
4. Interlocking Pawl Axis
5. Interlocking Arming Delay Pawls
6. Interlocking Pawl Spring
7. Firing Pin Safety Cap
8. Firing Pin
9. Primer
10. Aux. Booster
11. Gaine
12. Shimose

Guns Used With

40 Caliber Type 11th yr 14cm
45 Caliber Type 3rd yr 12cm
45 Caliber Type 11th yr 12cm
40 Caliber Type 11th yr 8cm

Explosive Components

Primer - 2 Component Explosive Charge ..... 0.1 gm
Lead Azide ..... 0.1 gm
Tetryl ..... 0.1 gm
Aux. Booster - Tetryl ... 1.0 gm
Gaine - Shimose ..... 25.0 gm

Projectiles Used With

40 Caliber 14cm Gun, HE Shell and Mod 1
12cm Gun, Mk 3 HE Shell
12cm Gun, Mk 3 Mod 1 HE Shell
8cm Gun, Mk 3 HE Shell and Mod 1
12cm Gun, Mk 1 and 2 Mod 2 HE Shell
8cm Gun, Mk 1 and 2 Mod 2 HE Shell

Anti-Submarine Double Action Fuze

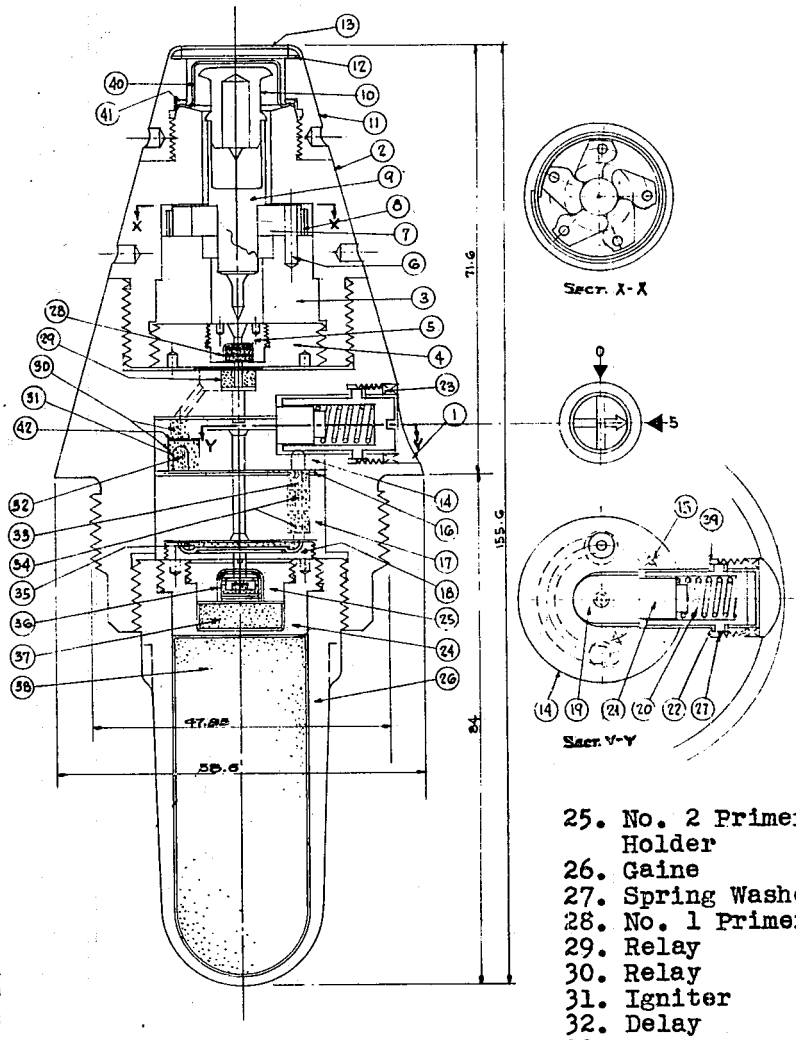


Figure 27

Total Wt: 1108 gm

1. Lower Body
2. Jpper Body
3. Striker Guide
4. Base Plug
5. Primer Holder
6. Pawl Axis
7. Interlocking Arming Delay Pawls
8. Spring
9. Striker
10. Striker Safety Extension
11. Nose Cap
12. Copper Disc
13. Securing Ring
14. Delay Holder
15. Stop Pin
16. Gasket
17. Relay Holder
18. Primer Relay Cover
19. Shutter
20. Spring
21. Spring Seat
22. Guide Screw
23. Screw Lock Nut
24. Auxiliary Booster
25. No. 2 Primer Holder
26. Gaine
27. Spring Washer
28. No. 1 Primer
29. Relay
30. Relay
31. Igniter
32. Delay
33. Non Gaseous Powder
34. Ignition Charge
35. Black Powder
36. No. 2 Primer
37. Tetryl
38. Shimose
39. Fiber Washer
40. Water Proof Cap
41. Gasket
42. Partition Plate

Guns Used With

12cm Short Cannon
20cm Short Cannon

Explosive Components

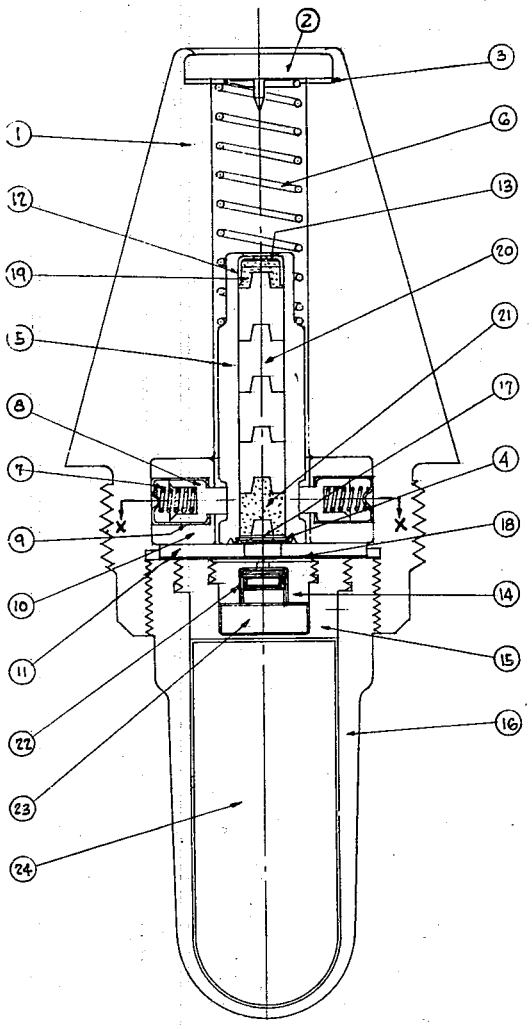
No. 1 Primer -	3 Component Explosive Charge	0.04 gm
	Black Powder	0.14 gm
No. 2 Primer -	Lead Azide	0.1 gm
	Tetryl	0.1 gm
Aux. Booster -	Tetryl	1.0 gm
Gaine -	Shimose	27.0 gm

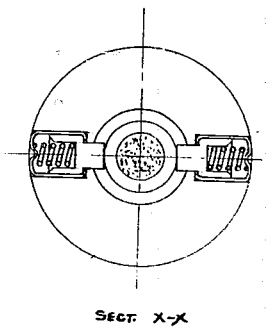
Projectiles Used With

12cm Mk 1 HE Shell
20cm Mk 2 HE Shell

Anti-Submarine Short Delay Fuze Model 2

Figure 28





Total Wt: 1063 gm

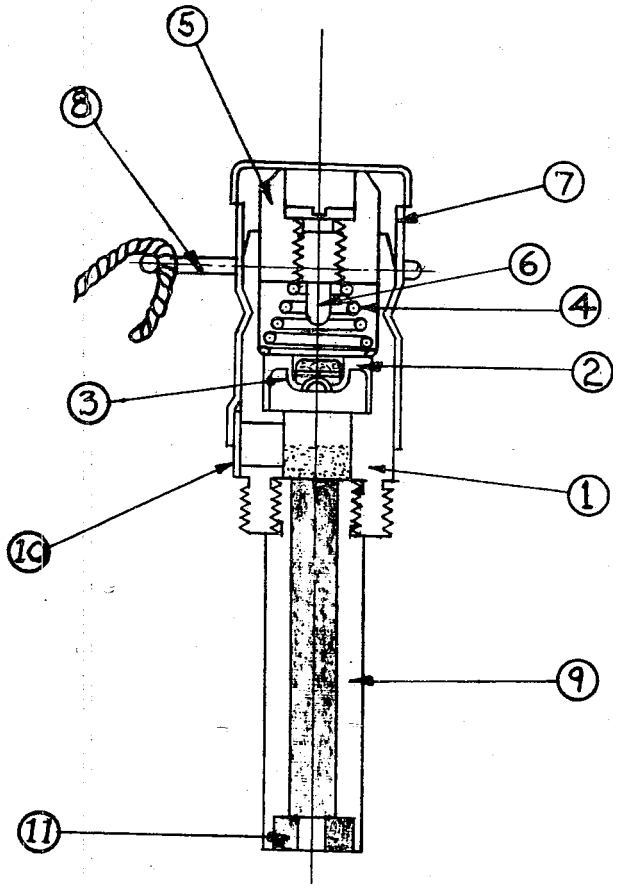
1. Body
2. Fixed Striker
3. Fiber Washer
4. Steel Washer
5. Movable Primer Holder
6. Anti-Creep Spring
7. Detent Spring
8. Centrifugal Detent
9. Detent Housing
10. Detent Holder
11. Fiber Washer
12. Primer Cap
13. Copper Foil
14. Primer Holder
15. Auxiliary Booster
16. Gaine
17. Paper Seat
18. Tin Foil
19. No. 1 Primer
20. Delay Train
21. Ignition Charge
22. No. 2 Primer
23. Tetryl
24. Shimose

Explosive Components

No. 1 Primer -	3 Component Explosive Charge	0.05 gm
Delay Train -	Delay Powder	5.6 gm
	Ignition Charge	0.9 gm
No. 2 Primer -	Lead Azide	0.1 gm
	Tetryl	-
Aux. Booster -	Tetryl	-
Gaine	Shimose	27.0 gm

Type 10th Year Tracer Hand Grenade Fuze

Figure 29



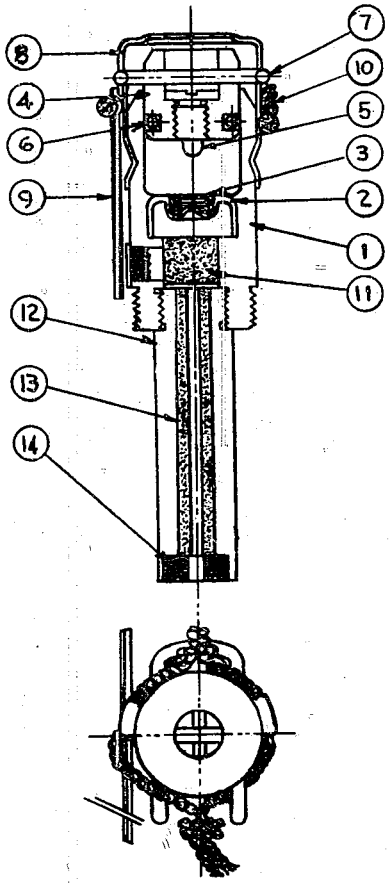
1. Body
2. Primer Holder
3. Primer
4. Firing Pin Spring
5. Firing Pin Body
6. Firing Pin
7. Fuze Cap
8. Safety Pin
9. Delay Train
10. Stop Plate
11. Detonator

Explosive Components

Primer -	Mercury Fulminate	6	0.007 gm
	Potassium Chlorate	6	
	Iron Sulfide	4	
Delay Train -	Granular Black Powder		-
	Fine Powder		0.03 gm
Detonator			-

Percussion Fuze For Rifle Grenade

Figure 30



1. Body
2. Primer Holder
3. Primer
4. Firing Pin Head
5. Firing Pin
6. Safety Fork
7. Open Circuit Pin
8. Nose Cap
9. Instruction Tag
10. Safety Fork Pull Card
11. Black Powder
12. Powder Train
13. Black Powder
14. Relay

Rifles used with: Type 38
Type 99

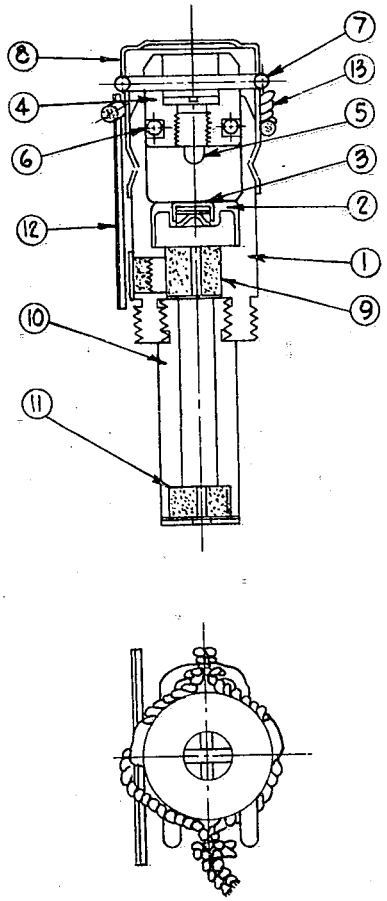
Rifle Grenade used with: Model 1

Explosive Components

Primer - 3 Component Explosive Charge ..... 0.007 gm
Powder Train - Black Powder
Relay - Black Powder

Percussion Fuze For Rifle Grenade Type RGF Mk I

Figure 31



1. Body
2. Primer Holder
3. Primer
4. Firing Pin Head
5. Firing Pin
6. Safety Fork
7. "Open Circuit" Pin
8. Nose Cap
9. Upper Powder Column
10. Flash Tube
11. Lower Powder Column
12. Instruction Tag
13. Safety Fork Pull Card

Rifles used with: Type 38
Type 99

Rifle Grenade used with: Model 3

Explosive Components

Primer - 3 Component Explosive Charge ..... 0.002 gm
Upper Column - Black Powder
Lower Column - Black Powder

Type 3 Small Percussion Fuze Mk I or Rifle Grenade Fuze Model II

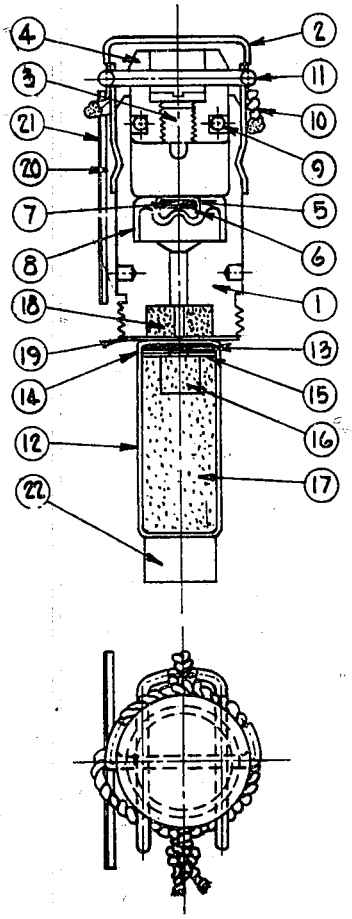


Figure 32

Total Wt: 35.8 gm

1. Body
2. Nose Cap
3. Firing Pin
4. Firing Pin Head
5. Copper Cup
6. Tin Plate
7. Primer
8. Primer Holder
9. Safety Fork
10. Safety Fork Pull Card
11. "Open Circuit" Pin
12. Gaine
13. Copper Plate
14. Cloth Washer
15. Tin Plate
16. Detonator
17. Tetryl
18. Relay
19. Paper
20. Instruction Tag
21. Paper
22. Felt Pad

Rifles used with: Type 38
Type 99

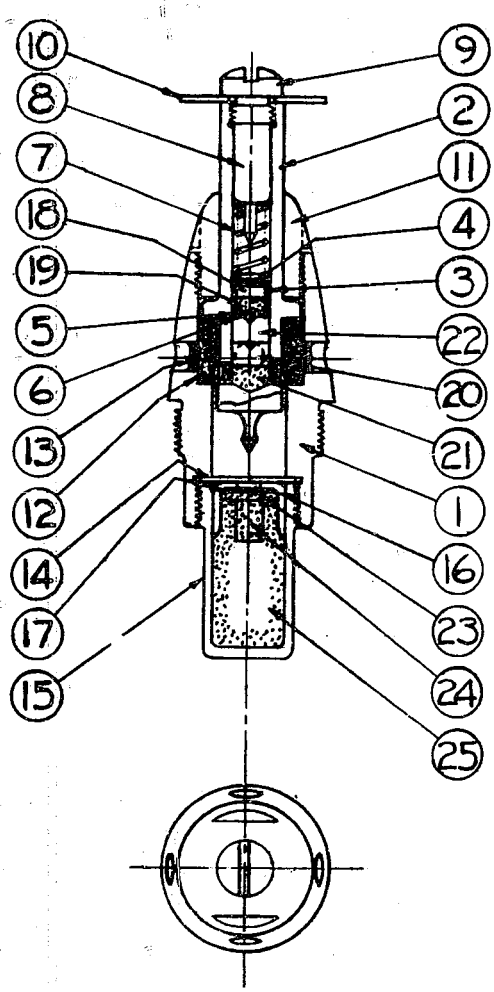
Rifle Grenade used with: Model 3 Modification 1

Explosive Components

Primer - 3 Component Explosive Charge
Relay - Black Powder
Detonator - Lead Azide ..... 3.2 gm
Gaine - Tetryl ..... 1.4 gm

Type 3 Small Percussion Fuze Mk II
Type 3 Model 2 Rifle Grenade Fuze

Figure 33



Total Wt: 35.8 gm

1. Body
2. Impact Striker
3. Copper Cup
4. Copper Plate
5. Paper
6. Copper Disc
7. Setback Spring
8. Setback Firing Pin
9. Striker Screw
10. Washer
11. Nose Cap
12. Supporting Powder
13. Tin Foil
14. Copper Disc
15. Gaine
16. Impact Primer
17. Tin Plate
18. Setback Primer
19. Black Powder
20. Delay Pellet
21. Black Powder
22. Ignition Powder
23. 3 Component Explosive Charge
24. Lead Azide
25. Tetryl (Granular)

Rifles used with: Type 38
Type 99

Rifle Grenade used with: Model 3 Modification 2

Type 3 8cm trench mortar was intended for the use of naval brigades and also to be mounted on light ships for repelling diving aircraft. For this purpose, a small combination time and percussion fuze was designed. This was called the Type 3 mortar combination fuze. (Figure 34). For this purpose, a mechanism similar to that in the Type 3 small percussion fuze Mk II (Figure 33) was combined with a time powder ring of non-gaseous powder which had to be easily ignited by the flame of smokeless powder. For this, a powder of type similar to barium peroxide and sulphur was satisfactory. The fact that it became fluid in the state of combustion did not cause any trouble owing to the absence of centrifugal force. All parts of this fuze were shaped as simply as possible.

Part VI - POWDER TIME FUZES

The Type 89 anti-aircraft fuze (Figure 35) was the same as the Japanese Army type fuze. It had four rings of powder and entailed several other complicated features. The object of the naval technicians was to develop a more simple fuze in which the powder train would not be affected by changing atmospheric pressure or by the rotation of the fuze. They also wished to develop a substitute for black powder, as its hygroscopic nature is a serious defect in the tropics. This led to the development of Type 3 combination powder and percussion fuze, and development of these fuzes closely followed the results of experiments with non-gaseous powders. The different models, Mk I, Mk III and Mk IV of the Type 3 combination powder time and percussion fuze were designed for various projectiles corresponding to the projectiles for which the Type 4 MTF Mk I, the Type 4 MTF Mk III or the Type 89 anti-aircraft fuzes were used. Enclosure (A) includes a chart showing the development of powder trains.

Part VII - ROCKET FUZES

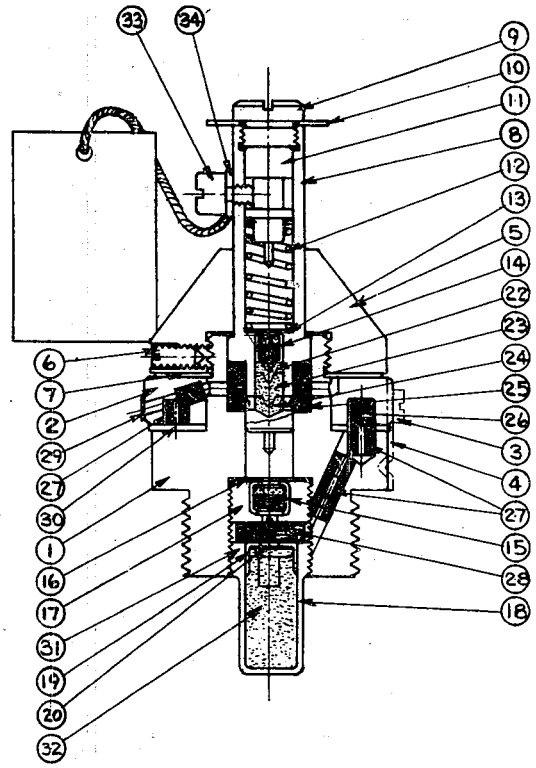
When rockets appeared suddenly in service in the Japanese Navy, ignorance of the ballistic characteristics of rockets misled the technical officers into design of the rocket percussion fuze (Figure 38). They were, however, soon convinced by the incidence of failures that the safety device consisting of five centrifugal shutters was not suitable. They therefore designed the Type 93 DAPF (Figure 39), embodying the Schneider patent which had been in use in the Japanese Army for many years. The chief problem was to make the duralumin striker heads of the correct hardness so that they would maintain their shape and shear the copper pin as necessary. Investigation into this problem led to the design of Type 5 instantaneous percussion fuze Mk I and a smaller fuze Type 5 instantaneous percussion fuze Mk II. The detonators were the same as those for Type 88 PF Mk II. The striker head of the Type IPF Mk II was made to protrude so that, on striking, it would work before the shock of impact on the fuze body had an opportunity to excite the second detonator into a low order explosion. This was particularly necessary, as the fuze was designed for use with rocket hollow charge projectiles.

The Type 5 combination powder time and percussion rocket fuze Mk I (Figure 40) was influenced in design by the Type 5 instantaneous percussion fuze Mk I and the Type 3 combination powder time and percussion fuze Mk I. The Type 5 combination powder time and percussion fuze Mk II (Figure 40A) was influenced in its design by the Type 5 instantaneous percussion fuze Mk II and the Type 2 mortar combination fuze. In these fuzes a double ended detonator was held in a central position in a radial tube. When the setback force of acceleration ceased, two centrifugal bolts actuated by centrifugal force released the detonator. The detonator then moved by centrifugal force to impact against either of two strikers, one set at each end of the radial tube. To overcome the effect of the comparatively large precession of rockets while being certain of the centrifugal bolts opening at a low speed of rotation, and still securing handling safety, it was necessary to design large centrifugal bolts with strong springs.

Type 3 Instantaneous - Short Delay 8cm Mortar Fuze

Figure 34

Total Wt: 210 gm



1. Body
2. Powder Ring
3. Set Screw
4. Scale
5. Nose Cap
6. Set Screw
7. Fiber Washer
8. Impact Striker
9. Striker Screw
10. Tin Washer
11. Setback Striker
12. Setback Spring
13. Tin Washer
14. No.1 Primer
15. No. 2 Primer
16. Copper Disc
17. Primer Holder
18. Gaine
19. Brass Cup
20. Tin Foil
21. Fiber Cover (not indicated on sketch)
22. Ignition Powder
23. Delay
24. Booster Charge
25. Supporting Powder
26. Delay Train
27. Powder Column
28. Black Powder
29. Tin Foil
30. Cloth Washer
31. Washer
32. Tetryl
33. Safety Screw
34. Rubber Seat

Use: Type 3 8cm Mortar HE Shell C

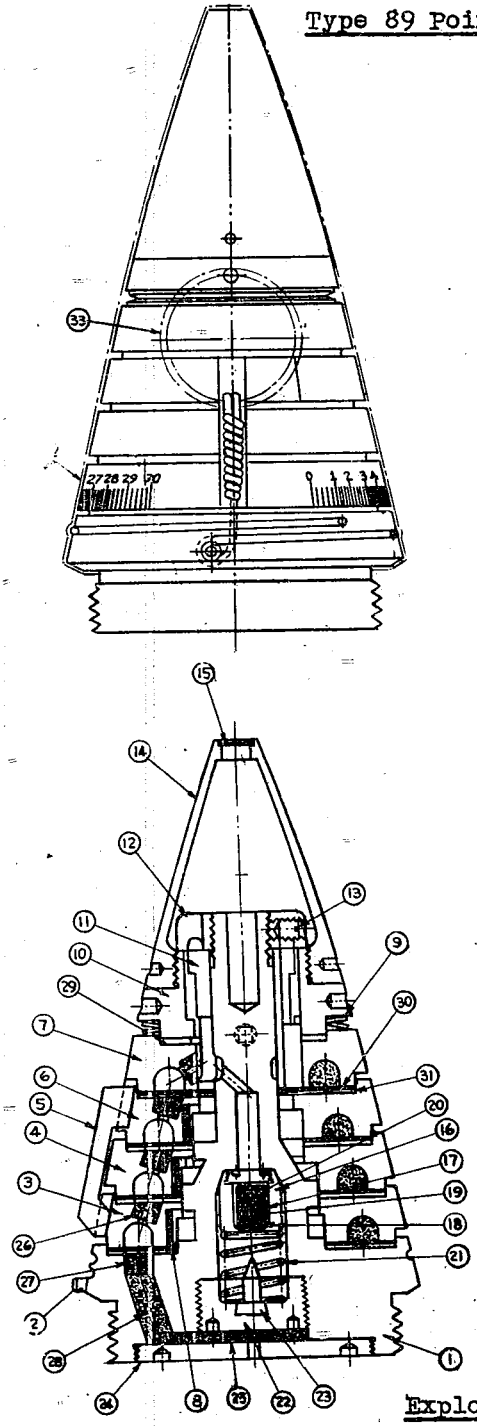
Explosive Components

No. 1 Primer - 3 Component Explosive Charge
Black Powder

No. 2 Primer -	3 Component Explosive Charge	0.06 gm
	Black Powder	0.05 gm
Gaine -	3 Component Explosive Charge	0.06 gm
	Lead Azide	0.09 gm
	Tetryl	0.82 gm

Type 89 Pointed AA Powder Time Fuze

Figure 35



Date Adopted: June 1937

Total Wt: 670 gm

Time Setting: 0-30 second

1. Body
2. Wire Securing Pin
3. No. 4 Powder Ring
4. No. 3 Powder Ring
5. Yoke
6. No. 2 Powder Ring
7. No. 1 Powder Ring
8. Air Vent
9. Tension Spring
10. Pressure Ring
11. Grooved Collar
12. Holding Nut
13. Set Screw
14. Nose Cap
15. Copper Disc
16. Primer Holder
17. Primer Cup
18. Primer
19. Tin Plate
20. Black Powder
21. Setback Spring
22. Striker Seat
23. Striker
24. Base Plate
25. Tin Plate
26. Lead Out
27. Lead Out
28. Black Powder Train
29. Felt Washer
30. Paper Ring
31. Paper Ring
32. Aluminum Cap
33. Cap Retaining Wire

Guns Used With

40 Caliber Type 3rd yr 8cm AA

Projectiles Used With

8cm Gun, Mk 3 Mod 1 HE Shell

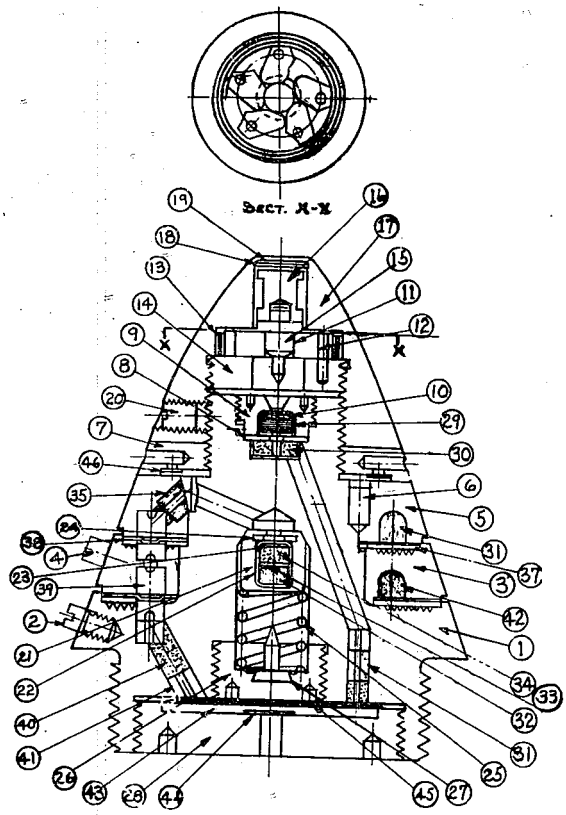
Explosive Components

Primer - 3 Component Explosive Charge ...	0.05 gm
(No.20) Black Powder	0.15 gm
Delay Train - Mk 3 Delay Powder	-
Base Train - Black Powder	0.60 gm

Old Designation - Type 3 Model 2
Type 3 Mk 1 Combination Powder Time Fuze

Figure 36

Total Weight: 739.6 gm
Time Setting: 0-35 sec



1. Body
2. Setting Lug
3. Movable Ring
4. Setting Lug
5. Stationary Ring
6. Key
7. Pressure Ring
8. Brass Disc
9. Import Primer Holder
10. Copper Plate
11. Interlocking Arming Delay Pawls
12. Pawl Axis
13. Spring
14. Pawl Seat Ring
15. Pawl Seat Ring
16. Striker Extension
17. Nose Cap
18. Copper Disc
19. Securing Ring
20. Set Screw
21. Delay Primer Holder
22. Copper Cup
23. Copper Plate
24. Brass Disc
25. Setback Spring
26. Firing Pin Holder
27. Fixed Firing Pin
28. Base Plug
29. Impact Primer
30. Relay
31. Lower Relay
32. Primer Mix
33. Tin Foil
34. Fine Black Powder
35. Delay Relay
36. Fixed Delay Train
37. Cloth Ring
38. Tin Foil
39. Relay
40. Delay Relay
41. Igniter
42. Movable Delay Train
43. Magazine
44. Tin Foil
45. Tin Foil
46. Anti-Flash Tin Foil

Explosive Components

Same as Type 3 Model 4
Combination Powder Time Fuze

Guns Used With

50 Caliber Type 3rd yr 20cm
50 Caliber Type 3rd yr Mk 2 20cm
50 Caliber Type 3rd yr 12.7cm
40 Caliber Type 88 12.7cm Dual Purpose
40 Caliber Type 89 12.7cm Dual Purpose
45 Caliber Type 10th yr 12cm
50 Caliber Type 88 10cm Dual Purpose

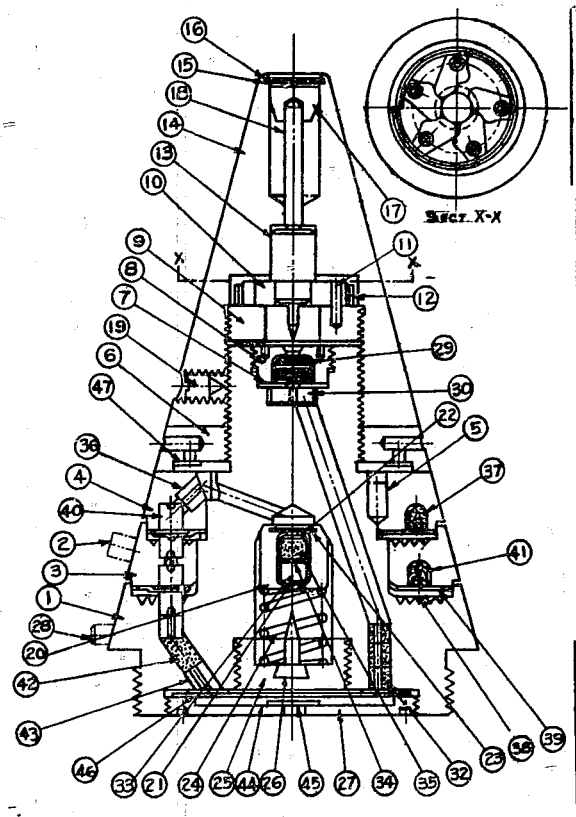
Projectiles Used With

Mk 2 20cm Gun, Type 91 HE Shell
Mk 2 20cm Gun, Type 91 Time Practice Shell
50 Caliber 20cm Gun, HE Shell
50 Cal. 20cm Gun, Time Practice Shell
50 Cal. 12.7cm Gun, HE Shell
50 Cal. 12.7cm Gun, Time Practice Shell
50 Cal. 12.7cm Gun, Star Shell
40 Cal. 12.7cm Gun, Time Practice Shell
12cm Dual Purpose Gun, HE Shell
12cm Dual Purpose Gun, Time Practice Shell
10cm Dual Purpose Gun, HE Shell
10cm Dual Purpose Gun, Time Practice Shell

Old Designation - Type 3 Model 1
Type 3 Mk 4 Combination Powder Time Fuze

Figure 37

Total Weight: 710 gm
Time Setting: 0-35 sec



1. Body
2. Setting Lug
3. Movable Powder Ring
4. Stationary Powder Ring
5. Key
6. Pressure Ring
7. Copper Disc
8. Instant Primer Holder
9. Pawl Seat Ring
10. Interlocking Arming Delay Pawls
11. Pawl Axis
12. Spring
13. Impact Striker
14. Nose Cap
15. Cover Disc
16. Securing Ring
17. Striker Head
18. Striker Extension
19. Set Screw
20. Delay Primer Holder
21. Copper Cup
22. Copper Plate
23. Brass Disc
24. Setback Spring
25. Fixed Firing Pin Holder
26. Fixed Firing Pin
27. Base Plug
28. Fixed Setting Lug
29. Instantaneous Primer
30. Relay
31. -
32. Second Instantaneous Relay
33. Primer Mix
34. Tin Foil
35. Black Powder
36. Delay Relay
37. Delay Train
38. Cloth Ring
39. Tin Foil
40. Relay
41. Delay Train
42. Relay
43. Igniter
44. Magazine
45. Tin Foil
46. Tin Foil
47. Anti-Flash Tin Foil

Guns Used With

40 Caliber Type 3rd yr 8cm Dual Purpose
Type 88 7cm Field AA
50 Caliber Type Vicars 15cm
50 Caliber Type 41 15cm
50 Caliber Type 3rd yr 14cm
15 Caliber Type 3rd yr 12.7cm

Powder Train

Red Lead	10
Silicon	20
Lead Chromate	60
Copper Sulphate	10

Mixed Powder

Red Lead	88%
Silicon	12%

Projectiles Used With

8cm Gun Mk 3 Mod 1 HE Shell
Type 90 Pointed AA Shell
50 Caliber 15cm Gun, Smoke Shell Mod 1
50 Caliber 12.7cm Gun, Smoke Shell

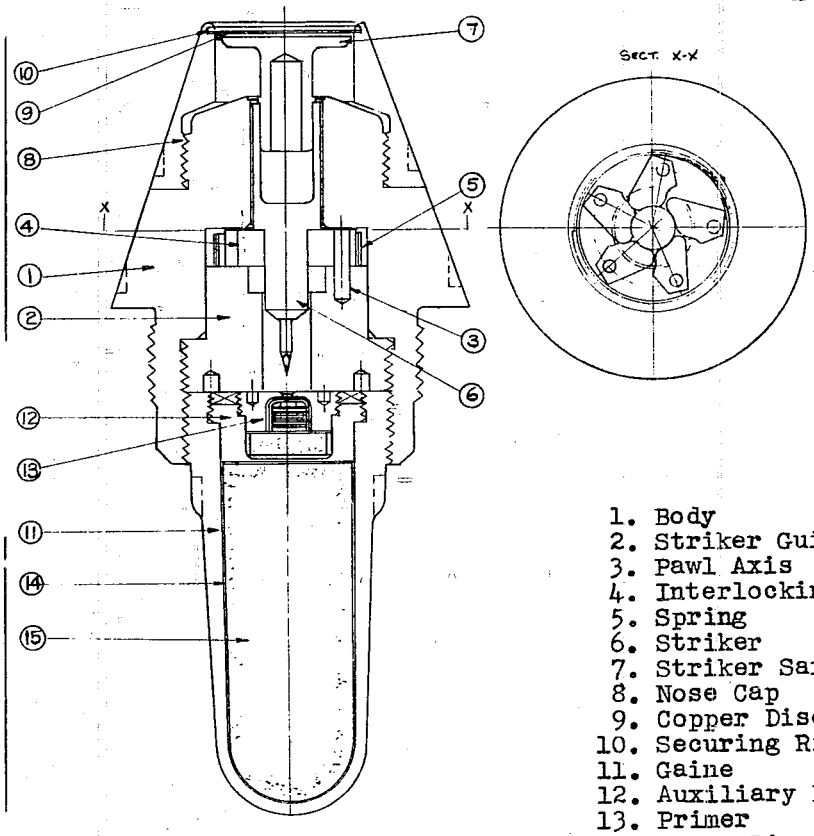
Explosive Components

Impact Primer - 3 Component Explosive Charge; Black Powder
Relay - Fine Black Powder
Delay Primer - 3 Component Explosive Charge ... 0.1 gm; Black Powder .. 0.09 gm

Powder Ring -	Train	Non-gaseous Powder
	Relay	Mixed Powder
	Igniter	Granulated Mixed Powder
Delay -	Primer Relay	Fine Mixed Powder
	Relay	Mixed Powder
Magazine - Mixed Powder		

Rocket Percussion Fuze
20cm Instantaneous Rocket Fuze

Figure 38



Total Weight: 895 gm

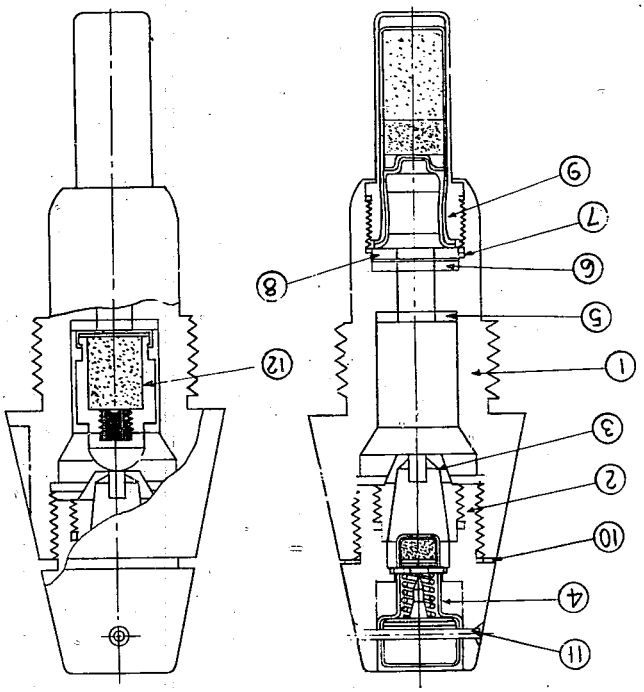
1. Body
2. Striker Guide
3. Pawl Axis
4. Interlocking Arming Delay Pawls
5. Spring
6. Striker
7. Striker Safety Extension
8. Nose Cap
9. Copper Disc
10. Securing Ring
11. Gaine
12. Auxiliary Booster
13. Primer
14. Paper Liner
15. Shimose

Explosive Components

Primer -	2 Component Explosive Charge	0.1 gm
	Lead Azide	0.1 gm
	Tetryl	0.1 gm
Aux. Booster -	Tetryl	1.0 gm
Gaine -	Shimose	27.0 gm

Type 93 Instantaneous or Short Delay Nose Fuze

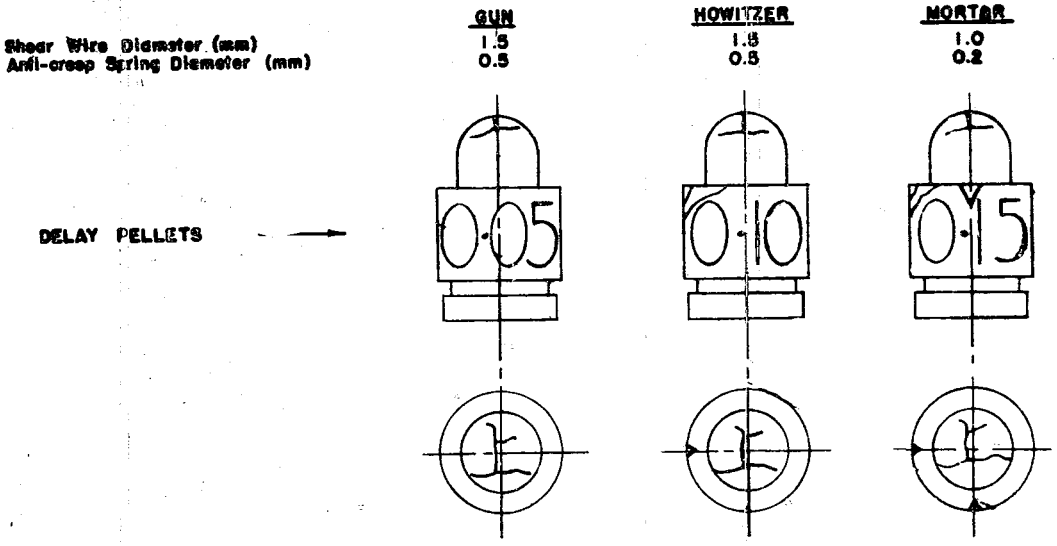
Figure 39



Similar Fuzes Developed:

(Large) Type 5 1 PF Mk I
(Small) Type 5 - 1 PF Mk II

1. Body
2. Nose Assembly Retainer
3. Delay Pellet Holder
4. Firing Pin Assembly
5. Delay Pellet Seat
6. Copper Washer
7. Copper Plate
8. Copper Washer
9. Gaine
10. Paper
11. Shear Wire
12. Delay Pellet



Explosive Components

Primer - Mercury Fuliminate 2 Potassium Chlorates 5 Antimony Trisulfate 5	0.15 gm
Delay Pellet - Fine Grain Delay Powder ...	0.50 gm
Gaine - Mercury Fulminate	0.80 gm
Myoa Powder	1.10 gm

Part VIII - MACHINE GUN FUZES

25mm MGF Mk I (Figure 41) was copied from a foreign fuze. In an endeavor to simplify production, the 25mm MGF Mk IV (Figure 42) was designed. This fuze frequently gave prematures in the bore. This was for some time accepted as a necessary result of simplifying production. When, however, a 25mm naval gun fuze exploded after being dropped about 20cm, investigations were carried out and a sensitive compound, cuprous azide, was found to be present. This led to general alteration in the design of fuzes, in which everything made of copper or brass was either plated or replaced by other metals. The black powder pellet above the lead azide was found to be partly the cause of the chemical action, due to its hygroscopic character. The fuzes modified to obviate these points were 25mm MGF Mk I Modif. 1 (Figure 43) and 25mm MGF Mk I Modif. 2 (Figure 44).

The 6cm and 5cm gun had many old type projectiles without fuzes. A fuze for HE projectiles for these guns was designed, utilizing some ideas taken from the 25mm MGF Mk I. This fuze was known as the 5cm gun fuze (Figure 45). The 25mm MGF Mk V was designed without a striker, after long experiments with the 25mm MGF Mk IV. It is believed that this did not go into production.

The 25mm MGF Mk IV is a copy of the Mauser fuze.

Part IX - ARMY TYPE FUZES

The Type 92 "for reduced charge" fuze (Figure 46) was used instead of the 5th Year percussion fuze when a reduced charge of propellant was used for indirect fire, as the latter fuze was not certain in its action when fired with a smaller acceleration than normal. No other Army type fuzes were used during World War II by the Navy except when naval brigades were armed with Army weapons.

Part X - TIME TUBES

The Japanese Navy used the term "Time Tube" to define a type of fuze in which a time powder train was directly initiated by the propellant. Below are some of their uses.

Short trench mortars (Short Trench Mortar Time Tube Mk I and Mk II - Figure 47) were intended to be used on board ship if all guns should be damaged and projectiles should still be available. The intention was to load the projectiles nose down into the barrels with a time tube in place of the fuze. When fired, the propellant flash ignited the time tube and after an interval of time, the time tube ignited the explosive through a gaine. Mk I and Mk II were interchangeable with Type 88 nose fuze, with all mechanical time fuzes, with Type 5 Year percussion fuze and with Type 2 percussion fuze. The delay powder was the same as that used for machine gun tracers. Type 4 time tube Mk 1 was developed as a temporary expedient to be used with the 45cm rocket after the rocket percussion fuze (Figure 38) had proved unsatisfactory and before the Type 5 instantaneous percussion fuze Mk I (Figure 39) had been designed. It was to be used with an auxiliary initiator and had a delay of non-gaseous powder similar to Type 3 time fuze.

Type 4 time tube Mk II (Figure 46) was developed for the 12cm anti-aircraft rocket. It is similar to the Mk I but smaller. The Japanese Navy experienced several accidents due to the rocket motor propellant bursting the motor and at the same time initiating explosion of the rocket projectile while still on the launcher. To prevent this, they placed a thin tinfoil disc of 0.5mm thickness on the outside of the time tube powder. This was sufficient to blanket the brief flash caused by the propellant bursting the motor but did not prevent the propellant from igniting the time tube powder under normal burning conditions.

Experiments were carried out attempting to use non-gaseous powder for the time tube but this was not successful as the lack of any form of residue or gas

Type 5 Model 1 Combination Powder Time Rocket Fuze

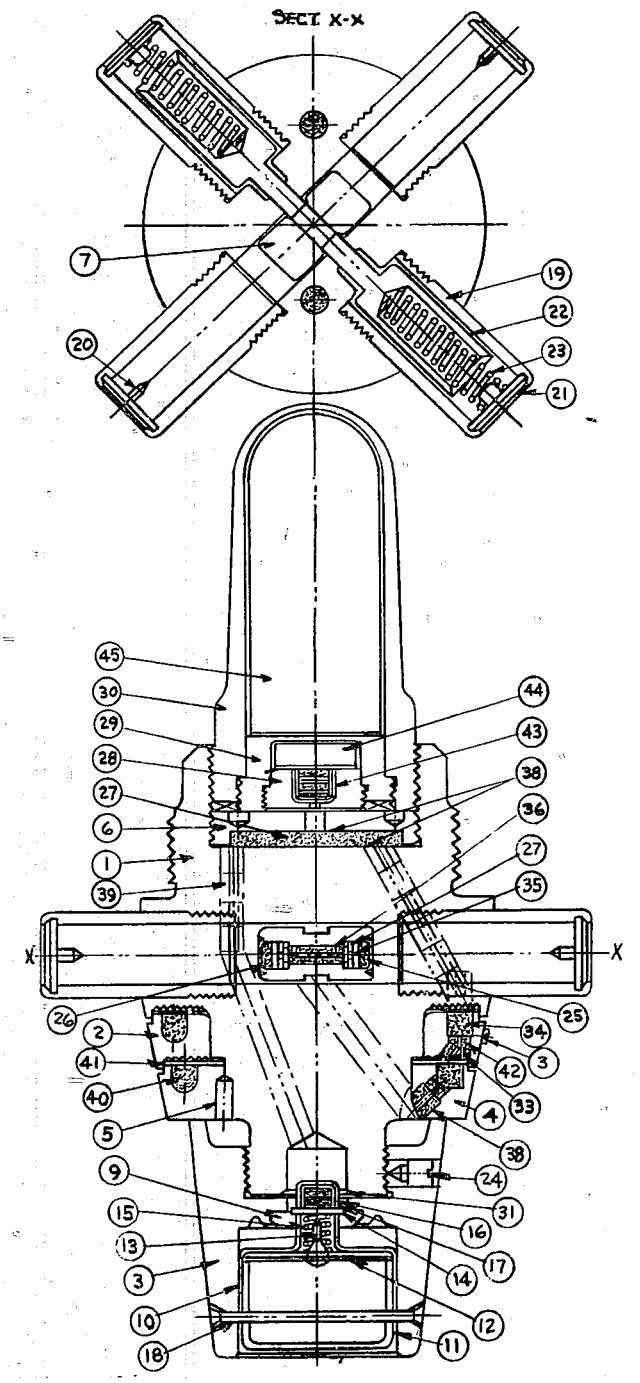


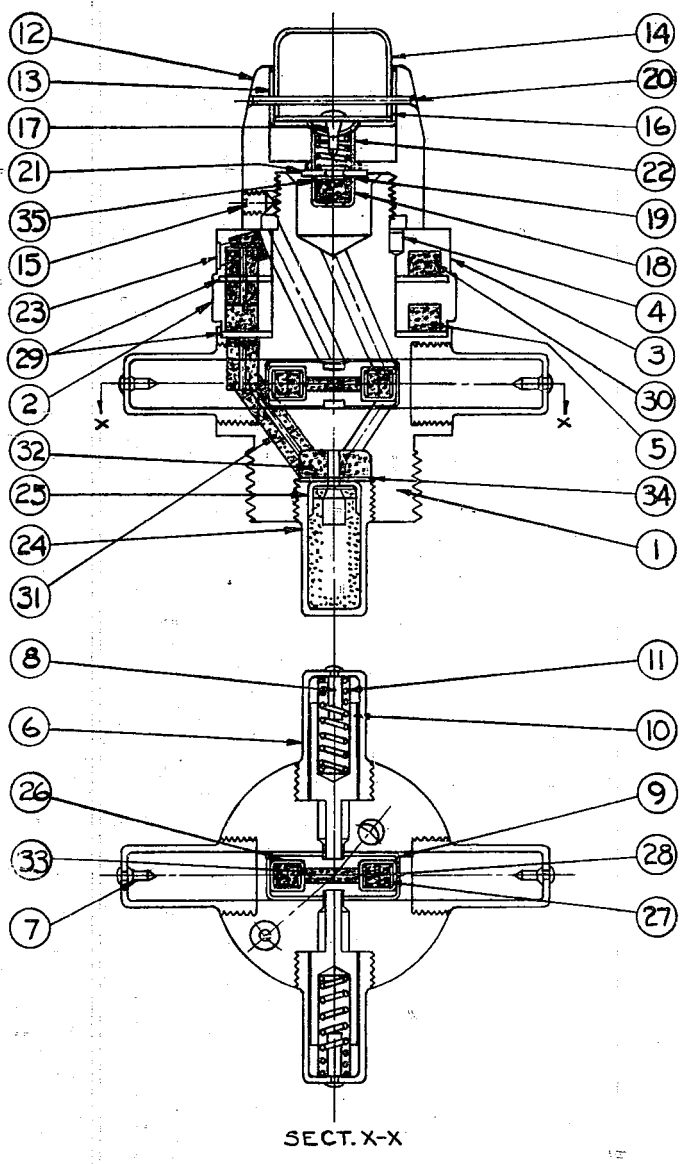
Figure 40

1. Body
2. Powder Ring
3. Setting Screw
4. Powder Ring
5. Key
6. Base Plate
7. Movable Primer Holder
8. Nose Cap
9. Spring Seat
10. Safety Cup
11. Striker Cap
12. Striker Head
13. Impact Striker
14. Spring Seat
15. Primer Spring
16. Impact Primer
17. Tin Foil
18. Shear Wire
19. Detent Holder
20. Delay Striker
21. Spring Seat
22. Centrifugal Detent
23. Detent Spring
24. Set Screw
25. Centrifugal Primer
26. Brass Plate
27. Copper Plate
28. Detonator Holder
29. Auxiliary Booster Holder
30. Caine
31. Washer
32. Powder Column
33. Ring
34. Lead In
35. Relay
36. Relay
37. Magazine
38. Tin Foil
39. Powder Column
40. Lead In
41. Tin Foil
42. Detonator
44. Auxiliary Booster
45. Shimose

Use: Spin Stabilized Rockets

Type 5 Model 2 Combination Powder Time Rocket Fuze

Figure 40A



1. Body
2. Powder Ring
3. Powder Ring
4. Key
5. Powder Train
6. Detent Cup
7. Fixed Firing Pin
8. Spring Seat
9. Delay Primer
10. Centrifugal Detent
11. Detent Spring
12. Nose Cap
13. Striker Seat
14. Striker Cap
15. Set Screw
16. Striker Head
17. Impact Striker
18. Primer Cup
19. Tin Foil
20. Shear Wire
21. Spring Seat
22. Striker Spring
23. Tin Foil
24. Gaine
25. Detonator
26. Movable Primer
27. Copper Plate
28. Brass Plate
29. Cloth Washer
30. Powder Train
31. Powder Column
32. Lead In
33. Relay
34. Copper Disc
35. Impact Primer

Use: Spin Stabilized Rockets

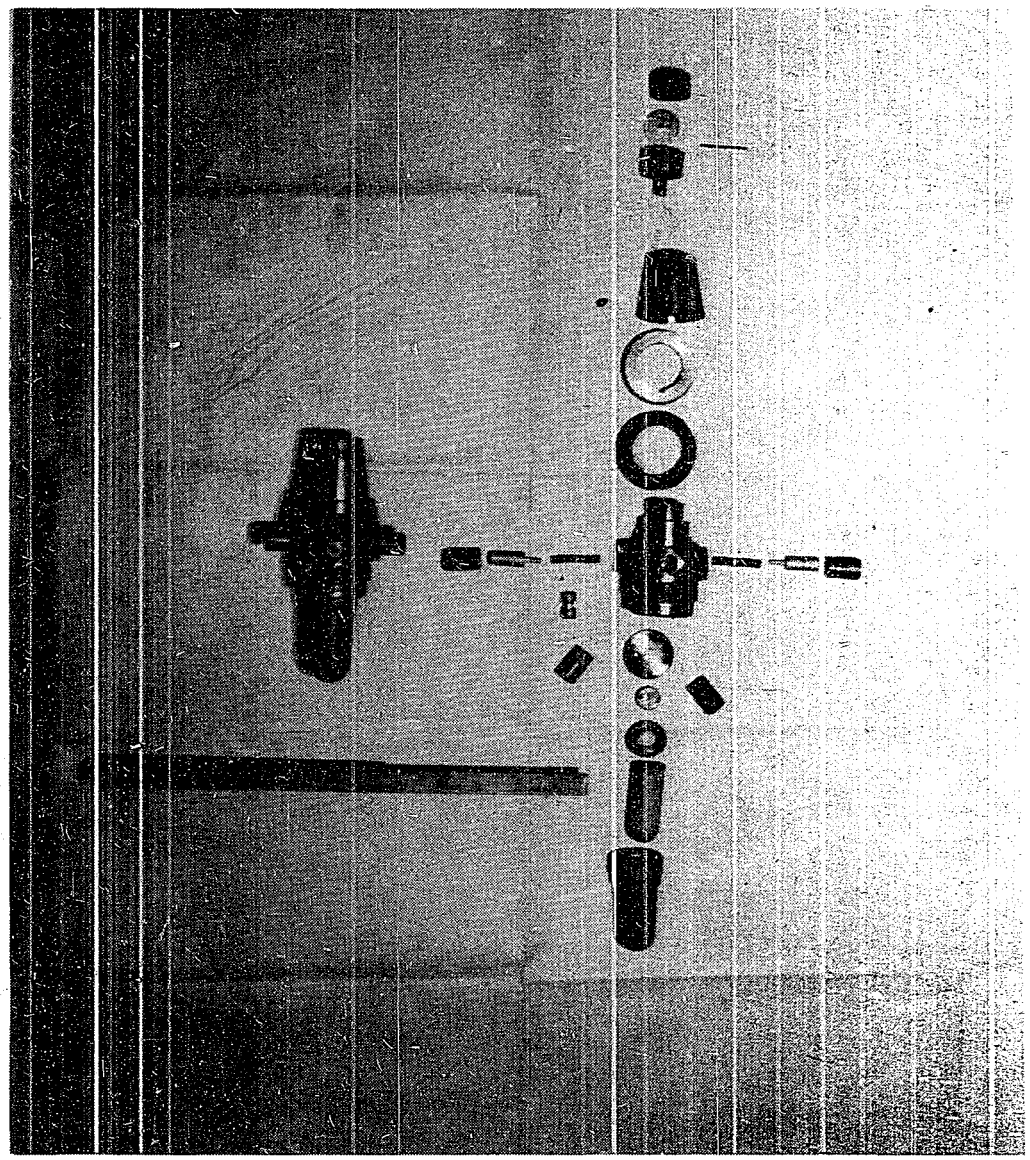
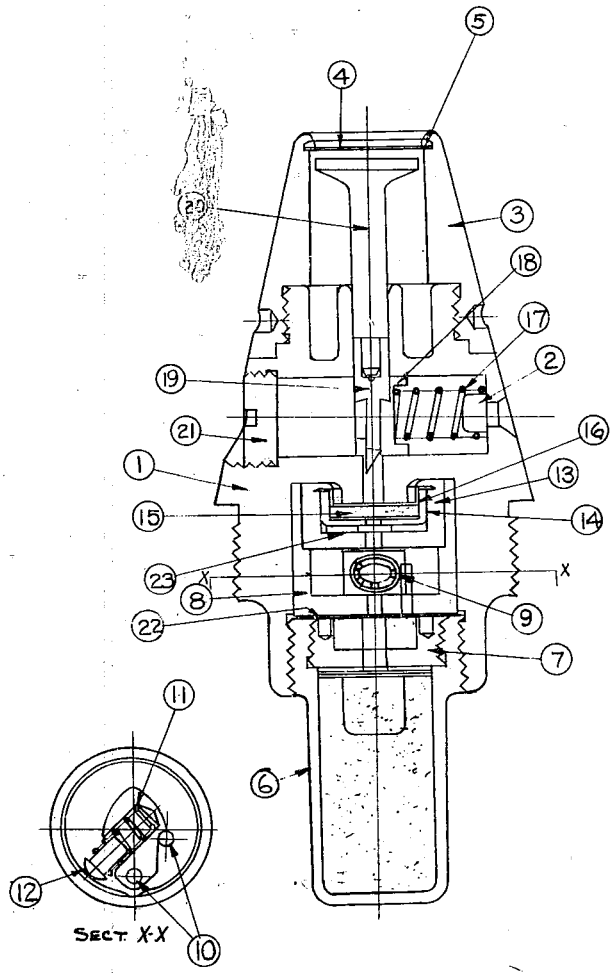


Figure 40B

TYPE 5 MODEL 1 COMBINATION POWDER TIME ROCKET FUZE

25mm Machine Gun Fuze Mk I

Figure 41



Date Adopted: June 1937

Total Weight: 43 gm

1. Body
2. Detent Spring Seat
3. Nose Cap
4. Copper Plate
5. Securing Ring
6. Gaine
7. Auxiliary Detonator
8. Shutter Holder
9. Shutter
10. Shutter Stop Pin and Axis
11. Shutter Spring
12. Shutter Spring Seat
13. Detonator Holder
14. Detonator
15. Tin Plate
16. Copper Plate
17. Detent Spring
18. Detent
19. Striker
20. Striker Extension
21. Detent Plug
22. Collodium Paper
23. Felt Washer

Guns Used With

All 25mm guns

Projectiles Used With

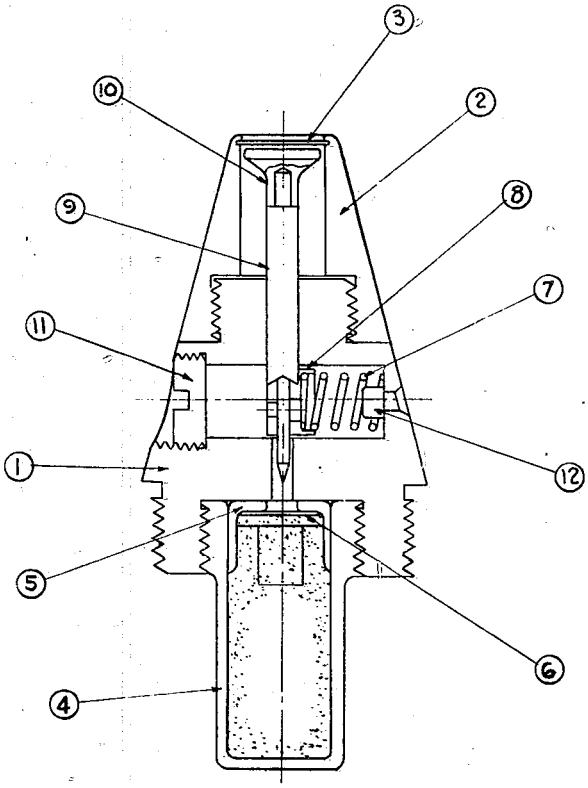
25mm HE Shells

Explosive Components

Detonator - 3 Component Explosive Charge	0.06 gm
Relay - Black Powder	-
Aux. Detonator - Lead Azide	0.16 gm
Gaine - Tetryl	0.70 gm

25mm Machine Gun Fuze (Instantaneous)

Figure 42



1. Body
2. Nose Cap
3. Copper Disc
4. Gaine
5. Detonator
6. Tin Plate
7. Detent Spring
8. Detent
9. Striker
10. Striker Head
11. Detent Plug
12. Detent Spring Seat

Guns Used With

All 25mm guns

Projectiles Used With

25mm HE Shells

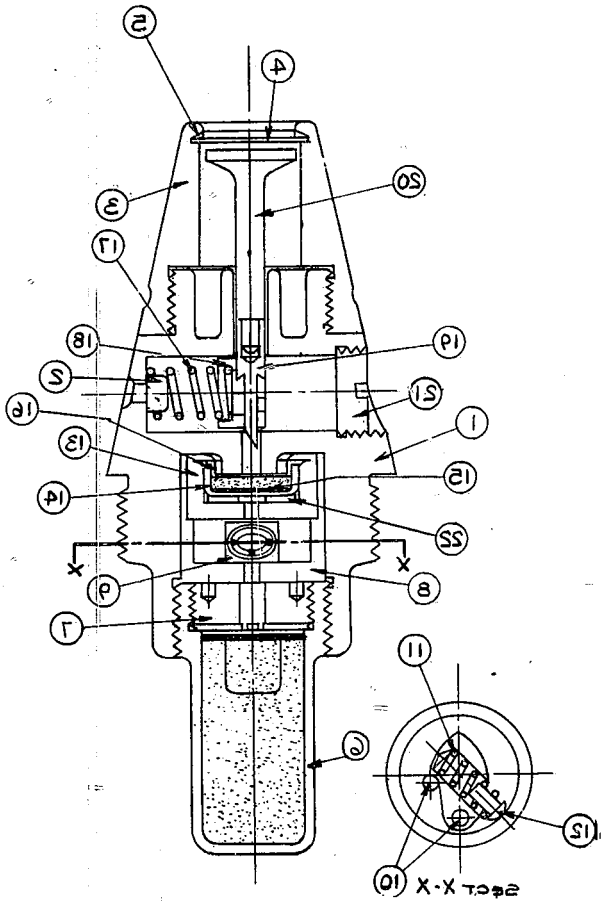
Explosive Components

Detonator - 3 Component Explosive Charge	0.06 gm
Initiator - Lead Azide	0.82 gm
Gaine - Tetryl	0.09 gm

Mk I Modification 1 25mm Machine Gun Fuze

Figure 43

Total Weight: 43 gm



1. Body
2. Spring Seat
3. Nose Cap
4. Copper Disc
5. Securing Ring
6. Gaine
7. Plug
8. Shutter Housing
9. Shutter
10. Shutter Stop Pin and Axis
11. Spring
12. Spring Seat
13. Detonator
14. Copper Cup
15. Tin Plate
16. Copper Dish
17. Detent Spring
18. Detent
19. Striker
20. Striker Extension
21. Detent Plug
22. Washer

Guns Used With

25mm Machine gun
40mm Machine gun

Projectiles Used With

25mm Machine Gun HE Shell
25mm Machine Gun HE Tracer Shell
40mm Machine Gun HE Shell Mod 1

Explosive Components

Primer - 3 Component Explosive Charge ..... 0.06 gm
Detonator - Lead Azide ..... 0.16 gm
Gaine - Tetryl ..... 0.70 gm

Mk 1 Modification 2 Instantaneous 25mm Machine Gun Fuze

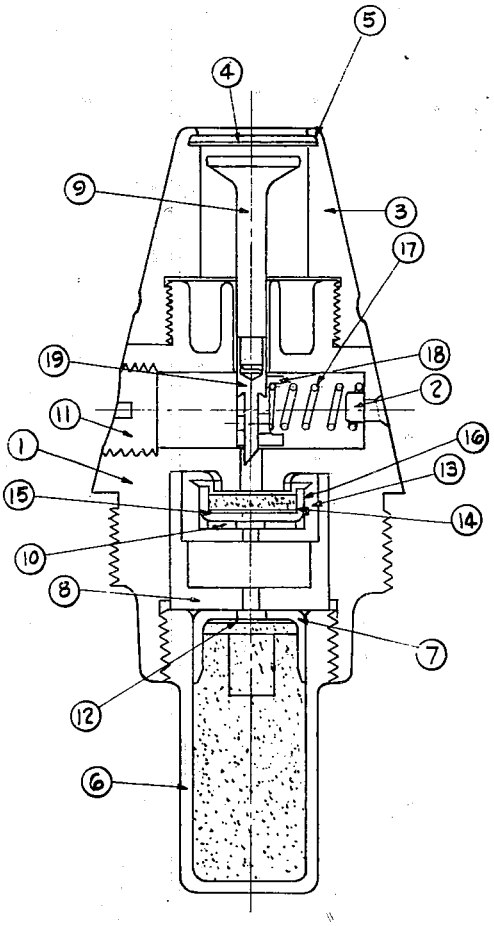


Figure 44

Total Weight: 42 gm

1. Body
2. Spring Seat
3. Nose Cap
4. Copper Disc
5. Securing Ring
6. Gaine
7. Detonator Cup
8. Shutter Housing
9. Striker Extension
10. Gasket
11. Detent Plug
12. Tin Plate
13. Primer
14. Copper Cup
15. Tin Partition
16. Copper Dish
17. Detent Spring
18. Detent
19. Striker

Guns Used With

25mm Machine gun
40mm Machine gun

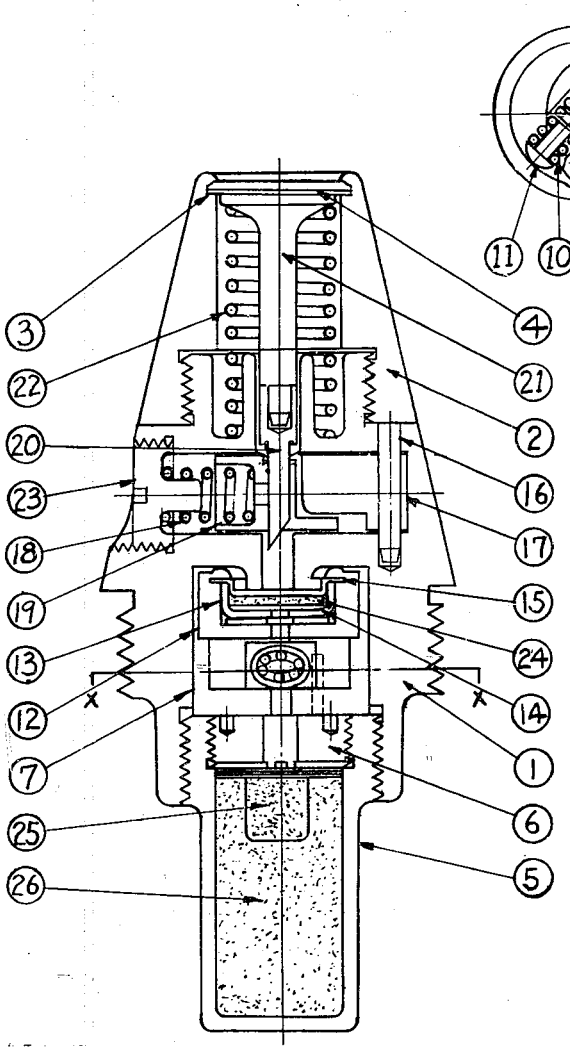
Projectiles Used With

25mm Machine gun HE Shell
25mm Machine gun HE Tracer Shell
40mm Machine gun HE Shell Mod 1

Explosive Components

Primer - 3 Component Explosive Charge	0.06 gm
Detonator - Lead Azide	0.16 gm
Gaine - 3 Component Explosive Charge	0.06 gm
Lead Azide	0.09 gm
Tetryl	0.82 gm

5cm and 6cm Instantaneous Nose Fuze



1. Body
2. Nose Cap
3. Copper Disc
4. Securing Ring
5. Gaine
6. Detonator Retaining Plug
7. Shutter Housing
8. Shutter
9. Shutter Stop Pin and Axis
10. Spring
11. Spring Seat
12. Primer Holder
13. Copper Cup
14. Tin Plate
15. Copper Dish
16. Keying Pin
17. Guide Block
18. Detent Spring
19. Centrifugal Detent
20. Striker
21. Striker Extension
22. Striker Spring
23. Detent Plug
24. Primer
25. Detonator
26. Tetryl

Guns Used With	Projectiles Used With
6cm Cannon	6cm Cannon HE Shell
5cm Cannon	5cm Cannon HE Shell

Explosive Components

Primer - 3 Component Explosive Charge	0.06 gm
Detonator - Lead Azide	0.16 gm
Gaine - Tetryl	0.70 gm

Type 92 Instantaneous Nose Fuze (Special Small Booster)

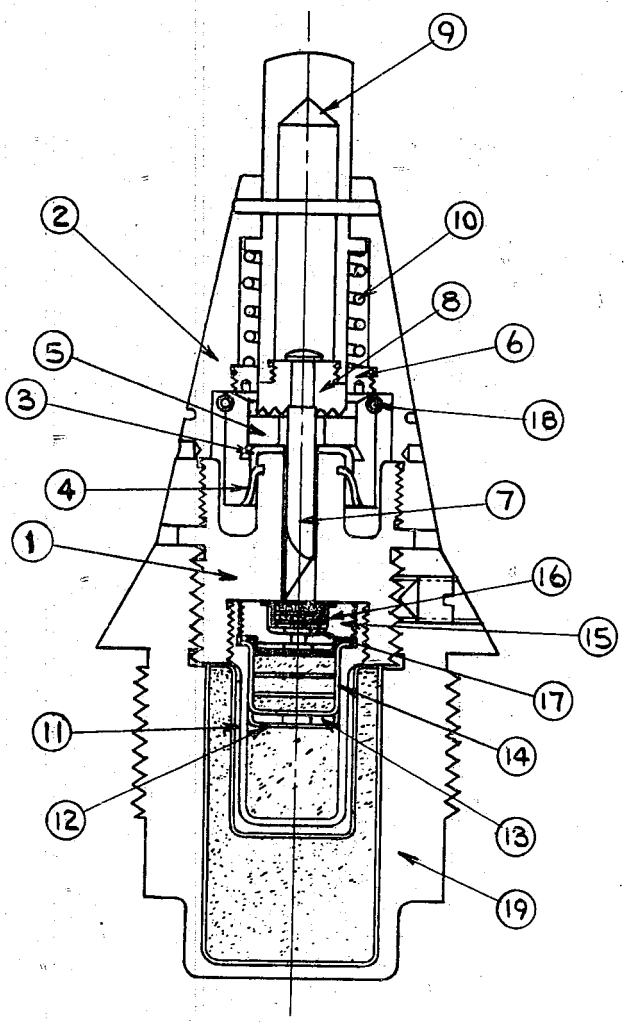


Figure 46

Total Weight: 420 gm

1. Striker Guide
2. Upper Body
3. Stirrup Spring
4. Ferrule
5. Centrifugal Blocks
6. Retaining Collar
7. Striker
8. Striker Head
9. Striker Cap
10. Creep Spring
11. Aux. Booster
12. Separator
13. Felt Washer
14. Copper Detonator Cup
15. Primer Holder
16. Primer
17. Felt Washer
18. Safety Fork
19. Lower Body

Guns Used With

45 Caliber Type 41 15cm
45 Caliber Type "Armstrong" 15cm
50 Caliber Type 3rd yr 14cm
45 Caliber Type 3rd yr 12cm
40 Caliber Type "Armstrong" 12cm
40 Caliber Type 41 12cm
40 Caliber Type 3rd yr 8cm AA
40 Caliber Type "Armstrong" Mk 1 8cm
40 Caliber Type 41 8cm

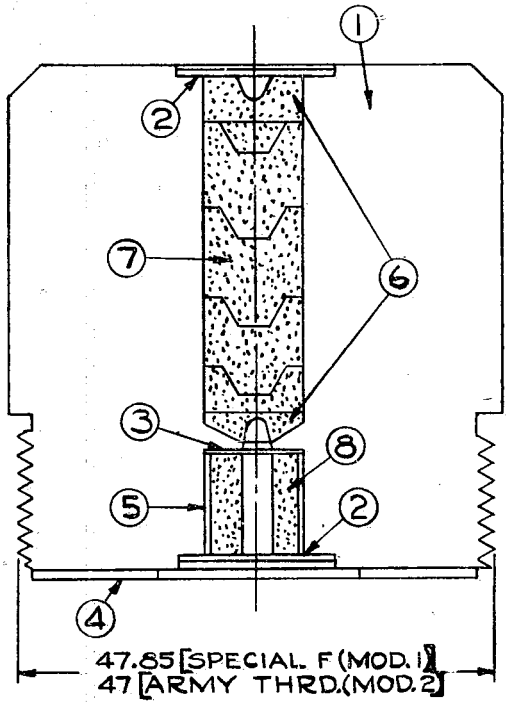
Explosive Components

Primer - 3 Component Explosive Charge ..... 0.06 gm
Detonator - Mercury Fulminate .. 1.0 gm
Aux. Booster - Myoa Powder ..... 1.2 gm
Gaine - Tetryl ..... 10.5 gm ± 5 gm

Projectiles Used With

15cm Gun, Mk2 Mod 2 HE Shell
14cm 50 Caliber Gun, HE Shell
12cm Gun, Mk3 HE Shell
12cm Gun, Mk2 HE Shell Mod 1 & 2
12cm Gun, Mk1 HE Shell Mod 1
8cm Gun, Mk3 HE Shell
8cm Gun, Mk2 HE Shell Mod 1 & 2
8cm Gun, Mk1 HE Shell Mod 1 & 2

Model 1 and 2 Short Trench Mortar Time Tube
Also Type 4 Time Tube Mk I and Mk II



Total Weight: Model 1 674 gm
Model 2 680 gm

1. Body
2. Tin Foil
3. Celluloid Disc
4. Felt Washer
5. Paper
6. Ignition Powder
7. Delay Powder
8. Booster Charge

Mortars Used With

Model 1 - Short 15cm
Short 12.7cm
Short 12cm

Model 2 - Short 8cm

Shells Used With

Model 1 - 15cm Gun, Type 0, HE Shell
40 Caliber 12.7cm AA Gun, HE Shell
40 Caliber 12.7cm AA Gun, HE Shell Mod 4
12cm Gun, Mk 4 HE Shell
12cm Gun, Mk 4 Mod 4 HE Shell
12cm AA Gun, HE Shell
12cm AA Gun, HE Shell, Mod 4
Model 2 - 8cm Gun, Mk 3 Mod 1 HE Shell
8cm Gun, Mk 3 Mod 4 HE Shell

Explosive Components

Ignition Powder - Yellow Ignition Powder .. 1.5 gm
Delay Powder - Yellow Illuminating Powder .. 5.3 gm
Booster - Black Powder ..... 1.2 gm

meant that the final flame was liable to flash back instead of forward to the next explosive in the train.

Part XI - BASIC RESEARCH IN PROGRESS

When the war ended, the Navy Technical Department was still pursuing the following studies:

1. Study of the dynamical foundation of detonation.

2. Investigation of the characteristics of rapid deformation or destruction of metal.

3. To define quantitatively what they described as "shock" and to find the relation between the stability of detonators and shock.

4. To define the characteristics of any pyrotechnic powder by quantitive methods.

5. To investigate the characteristics of different flames as ignitors.

Part XII - TESTS FOR ACCEPTANCE

All ammunition was accepted into service after examination by authorized inspectors who were officers in charge of the Inspection Sections belonging to each Naval Arsenal. The inspection officer in charge was under the chief of the Ammunition Department in the Arsenal, but his judgment was supported by the Navy Technical Department in TYOKYO and he made his reports directly to that office. In practice it was difficult for him to oppose the opinions of the Chief Officer of the Ammunition Department under whom he actually worked.

Acceptance depended upon gauging of components, testing of loaded components for sensitivity, and stability. Safety accuracies and functioning tests of the complete store were then carried out.

For example, one detonator in each lot of 800 had to pass a sensitivity test by firing when a striker of 42 grams was dropped from 15cm on it.

In the following paragraphs are given some examples of specification proof requirements.

1. Base Fuzes

Kind of Test	Gun	Shell	Charge	Target
Safety	14cm/ 50 cal	Flat Nose	Strong	Sand wall (pick up and inspect)
In Bore	14/50	HE	Strong	6mm steel plate near muzzle
Function	40/50	HE	Service Dimi- nished	12mm steel plate shot at angle 40° (for 31-IPF-I, two 8mm steel plates).

Requirements:

For test of safety, fuze must not function.
For test of function, blinds should be below 25%.

Sample: One of each 200 fuzes of same lot.

2. Mechanical Time Fuzes

Kind of Test	Gun	Shell	Charge	Remarks
Safety in Bore	—	—	—	Drop fuze attached to an iron block from 2 m height. Should not be damaged.
Safety in Bore	8cm/40 AA	Time Practice	Service	Should be safe
Accuracy	8cm/40 AA	T.P.	Weak	Maximum acceleration in bore corresponds to that of actual gun.
Accuracy	8cm/40 AA	T.P.	Diminished	Rotating speed corresponds to that of actual guns

Requirements:

For test of safety, fuze must not function.
Blinds should be less than 25%.
For test of accuracy, mean value should be within ± 1.5 sec from expected value, and mean error within ± 0.5 sec of mean value.

Sample: One from each 400 fuzes of same lot.

N.B. For 4-MTF-0 (or 4-MTF-II), a 12.7cm/40 cal AA gun (or Type 98 8cm gun is used so as to satisfy the same purpose in accuracy testing. For 4-MTF-0 no blinds are permitted.

3. Nose Fuzes

Kind of Test	Gun	Shell	Target
Safety in Bore	14cm/50	F.N.	Sand wall (pick up and inspect)
Safety in Bore	12.7cm/50	H.E.	6mm steel plate having a hole in center so as not to impact with fuze; placed near muzzle.
Function	12.7cm/50	H.E.	4mm steel plate, angle of 40° (for 88-PF-III and IV, shoot at hill or water surface)

Requirements: The same as base fuzes.

Sample: One from each 400 of the same lot.

N.B. For 2-PF, 12cm/45 gun with F.N. shell is used and 8cm/40 gun with H.E. shell.

4. Special Fuzes

Example: Anti-SUB-DAPF-I

Kind of Test	Gun	Shell	Charge	Target
Safety in Bore	14cm/50	F.N.	Strong	Sand wall (pick up and inspect)
Function	Short 12cm	H.E.	Service	Sea surface at various ranges
			Diminished	4mm steel plate; angle of 40°

Requirements:

Blinds should be less than 25%.
Delay time in the water should be 5 ± 1 sec.

Sample: One from each 400 fuzes of same lot.

5. The tests quoted above were obtained from interrogation of Lieut. NISHIDA, employed at KURE in design and proof of fuzes.

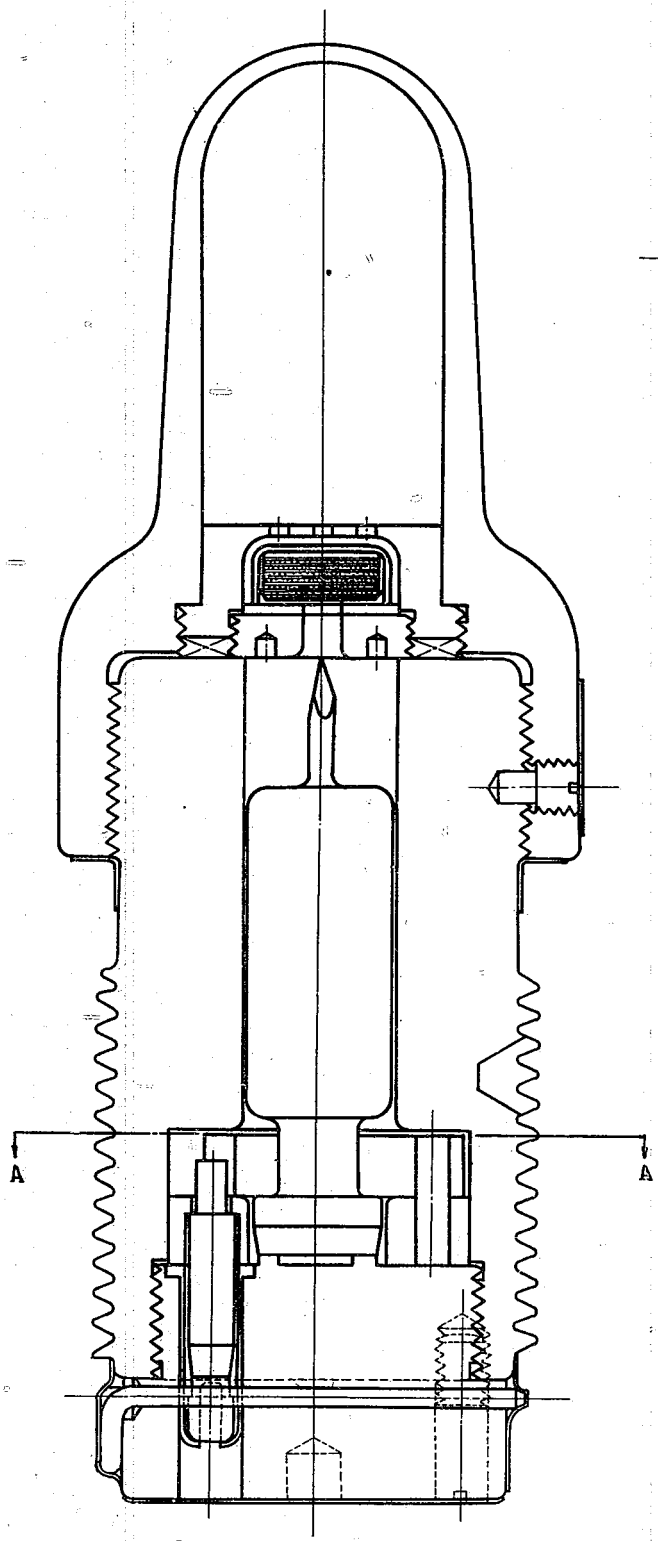
It will be noted that one of the tests was to ensure that fuzes had not armed by the time the projectile left the muzzle of the gun. It is understood that normally in base fuzes the progressively opening centrifugal shutters (five in number) did not start to move by the time the projectile touched a plate placed at the muzzle of the gun. When (for experiment) the plate was placed one meter from the gun, it was usually found that the first centrifugal shutter had opened but not the second.

ENCLOSURE (A)

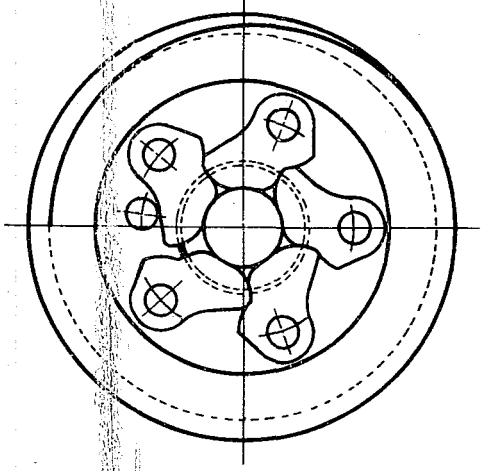
TABLE OF TRAIN POWDERS
Kure Navy Yard – November 1945

Series	No.	Name	Composition (%)	Where Developed	When Developed	Combustion Speed ** (In straight groove)	Firing Result as Fuzes	Property for Preservation	Use	Remarks
Gaseous / Black Powder	1	Mk 3	KNO_3 75 * C 14.5(31%) S 10 Selac 0.5	Army (regular)	Over 15 years ago	10mm/sec – 760mm Hg 5mm/sec – 300mm Hg		Not good at high temperature and humidity.	Type 89 AA Sharp Shaped Fuse	Experimentally manufactured in the 2nd Naval Powder Arsenal.
	2	Mk 4	KNO_3 55 C 15(75%) S 30	Army (regular)	1943-10	3.3mm/sec – 760mm Hg 2.9mm/sec – 300mm Hg		"	Type 2 Combination Fuse	Experimentally manufactured in the 2nd Naval Powder Arsenal.
	3	Ka-70	KNO_3 65 C 15(73%) S 20	Army (experimental)	1943-10					
	4	Ken-Ki	NH_4ClO_4 60 $KClO_4$ 20 C 20(31%)	Army (experimental)	1943-10	4.3mm/sec				
	5	—	Bakelite powder in place of carbon	Army (experimental)	1943-10		Dispersion is large, extinguishing on trajectory in 10 of test.		Abandoned	
	6	—	Black powder added with Stearine ○ Palnitine Selac Boiax Charcoal displaced by brown charcoal	Army (experimental)	About 10 years ago	About half that of black powder	Dispersion is large		Abandoned	
	7	—	B.P. (pulver) 73 Chlor gun 27 $(C_{10}H_{13}Cl_7)_m$	Navy (Tech. Res.)	1944-4	2~3mm/sec Effect of pressure is little		Slightly unsatisfactory	Abandoned	Ignition is slightly difficult compared with B.P.
	8	—	B.P. (pulver) 71 Chlor gun 11 Salicilic acid 18	Navy (Tech. Res.)	1944-4	Nearly the same as No. 7		Slightly unsatisfactory but durable for 8 days in 50°C, 80%.	Abandoned	Reaction products: K_2CO_3, KCl, KCNS, K_2SO_4, CO, CO_2
Barium Oxide	9	—	BaO_2 96 S 4	Navy (Tech. Res.)	1943-10	5.26mm/sec – 760mm Hg 5.09mm/sec – 200mm Hg		In 2 months, its combustion speed suddenly decreased as much as to be unable to be ignited.	Abandoned	One cover with Chlor gun is a little better, but could not be used.
	10	—	BaO_2 85 Se 15	Navy (Tech. Res.)	1943-10	4.36mm/sec – 760mm Hg 3.70mm/sec – 200mm Hg		Not good against humidity	Abandoned	One cover with Chlor gun is a little better, but could not be used.
	11	—	BaO_2 84.5 Se 15 Al 0.5	Navy (Tech. Res.)	1943-10			Not good against humidity	Abandoned	One cover with Chlor gun is a little better, but could not be used.
	12	—	BaO_2 84.5 Se 15 Selac 0.5	Navy(Air Tech. Arsenal)	1944-4			Good at 40°, 80% as long as 70 days	Abandoned	
	13	W13	BaO_2 $PbCrO_4$ Combustible Material	Navy (KURE)	1944-4			Good at 40°, 80% as long as 70 days	Anti-Submarine Fuze Model I	
Non-Gaseous / Lead Oxide	14	—	Pb_3O_4 50 / Fe Si 50 } 50~40 $PbCrO_4$ 50~60	Navy (Tech. Res.)	1944-4	3~4mm/sec	30.8 ± 0.1 sec (By 40/8 HA gun, in Type 89 AA fuze, 4 rds)			As for Pb Oxide series Army also studied but unsuccessfully, especially in view of dispersion.
	15	P4	Pb_3O_4 10 Si 20 $PbCrO_4$ 60 CuP(P 15%) 10 covered by gum	Navy (KURE)	1944-4		36.40 ± 0.12 (40/8 HA) 35.05 ± 0.26 (40/12.7 HA) (In Type 3 Combination fuse 10 rds)	Good at 40°, 80% as long as 70 days	Type 3 Combination Fuze	Successful.
	16	—	Pb_3O_4 70 / Fe Si 30 } 73 Sb_2O_3 27	Navy (Tech. Res.)	1944-4	5.3mm/sec	85 sec at normal temp. 80 sec at -18°C.		(Rapid sinking) Depth Charge Fuze (120mm x 5)	As without rotation, no $PbCrO_4$ was used. Ignitor # { Pb_3O_4 70 / Fe Si 15 / $KClO_3$ 5 } 30 gm
	17	—	Pb_3O_4 80 / Fe Si 20 } 40~50 Fe_3O_4 60~50	Navy (2nd Powder Arsenal)	1944-4	4~5mm/sec			Studied for depth charge fuse(5-65 sec) and 5 time reactible sound charge.	For ignitor, added some nitrocellulose solution.
	18	—	Pb_3O_4 22 Fe Si 35 CuO 22 Fe_3O_4 21			36.1 ± 0.4mm/sec – 760mm Hg 37.6 ± 0.5mm/sec – 400mm Hg (RPM = 15000 (Fuze set at 30 in division				
	19	General	Oxidizer: PbO_2, Pb_3O_4 — Reducer (Oxidized material): S, Si — Controller of Combustion: CuO, CuP_2 — Ignitor (As these series are difficult to be ignited)							
			For Example: 1. PbO_2 – Fe Si – CuO 2. Pb_3O_4 – Fe Si – CuO – Fe_3O_4 3. PbO_2 – S – $PbSO_4$ 4. Pb_3O_4 – Fe Si – CuP_2							
			For Example: 1. Si 16.6, Pb_3O_4 83.4, Gun-cotton 2 — 2. $KClO_4$ 45, Pb_3O_4 28, Al 20, Si 7 — 3. do. 50, 24, 20, 6							
Iron Oxide	20	—	Fe_2O_3 instead of Pb_3O_4	Navy (Tech. Res.)	1944-4					Not so good as compared with Pb_3O_4 series, but the material available is abundant and harmless for workers.

* Degree of Carbonization
** In atmospheric pressure, if not mentioned
\# 15% solution of Chlor gun 6cc added



SECTION AA



ENCLOSURE (B)

TYPE 13 MARK I FUZE

ENCLOSURE (C)

LIST OF JAPANESE DOCUMENTS FORWARDED TO WDC VIA ATIS

NavTechJap Document No.	Description	ATIS No.
ND50-3870	Experiments of Type 88 small instantaneous fuze.	4047
ND50-3871	Report on results of test of Type 91 time fuze reserve.	4048
ND50-3873	Results of surveillance tests of Type 91 time fuze.	4050
ND50-3874	Results on time fuze used for 5cm field gun loaded with high explosive.	4051
ND50-3875	Experimental investigation on "KUPUREN"	4052
ND50-3876	Tests on impacted ammunition components.	4053
ND50-3877	Experimental report on fuze used for high chamber pressure guns.	4054
ND50-3878	Type 91 time fuze revolutions.	4055
ND50-3879	Experimental report on fuze chamber for gas tightness.	4056
ND50-3880	Experimental report on fuze used for anti-loading firing.	4057
ND50-3881	Experimental report on safety setting of fuze firing pin release.	4058
ND50-3882	Experimental report on Vickers Type 40mm MG time fuze.	4059
ND50-3883	Report on storage tests of Type 91 time fuze.	4060
ND50-3884	Report on Vickers Type 40mm MG time fuze (Model "D" fuze).	4061
ND50-3885	Experiments on Vickers 40mm MG time fuze.	4062
ND50-3886	Efficiency of Type 89 and Type 91 time fuzes and their rate of fire.	4063
ND50-3867	Storage of Type 91 time fuze.	4044
ND50-3868	Reports on storage test of Type 91 time fuze.	4045
ND50-3869	Experiments on reasons for duds in Type 91 clock fuze, Modification 1.	4046
ND50-3900	1 blueprint Type 5th year instantaneous nose fuze.	4174
ND50-3901	1 blueprint Model 2 anti-submarine fuze.	4175
ND50-3902	2 blueprints 13mm machine gun fuze.	4176
ND50-3903	2 blueprints Type 91 mechanical time fuze.	4177
ND50-3904	4 blueprints - detail of 40mm time fuze.	4178

ENCLOSURE (C), continued

NavTechJap Document No.	Description	ATIS No.
ND50-3905	8 blueprints of components of Type 13 base fuze.	4179
ND50-3906	24 blueprints of components of Type 98 mechanical time fuze.	4180
ND50-3907	Investigation of sensitivity of primers and detonators at low temperatures.	4181
ND50-3908	Lead rhodanide.	4182
ND50-3909	Tough copper alloys containing no nickel.	4183
ND50-3910	Barium peroxide.	4184
ND50-3911	Research on formation of nitride copper by combining lead azide with copper and metals containing copper.	4185
ND50-3912	Assays of nitrous lead.	4186
ND50-3913	Nitro copper.	4187
ND50-3914	Experimental incendiary powder for Type 93 15cm mortar.	4188
ND50-3915	Powder charge for Rheinmetal 15cm gun.	4189
ND50-3916	Operation of leading 30 second time delay fuze.	4190
ND50-3917	Type 91 clockwork fuze.	4191
ND50-3918	Loading the Type 92 special reduced fuze.	4192
ND50-3919	Tests in Type 94 fuze.	4193
ND50-3920	Tests on detonators.	4194
ND50-3921	Imported mechanical fuzes.	4195
ND50-3922	Tests of time fuze.	4196
ND50-3923	Data on Type 91 Mk 1 Mod. 1 time fuze.	4197
ND50-3924	Type 91 Mod. 1 time fuze.	4198
ND50-3925	Type 91 clockwork fuze.	4199
ND50-3926	Tests of Type 91 time fuze storage.	4200
ND50-3927	Erosion of metals contacting mercury fulminate, picric acid, and black powder.	4213

ENCLOSURE (D)

LIST OF EQUIPMENT SHIPPED TO THE ORDNANCE INVESTIGATION LABORATORY, INDIANHEAD, MARYLAND

NavTechJap Equipment No.	Item
JE21-4070	E-1(a) Fuzes for Parachute Missile
JE10-4004	3rd Year Type Projectile Fuzes
JE10-4006	5th Year Type Projectile Fuzes
JE10-4113	5th Year Type Mod 1 Combination Projectile Fuzes
JE21-4390	9th Year Type Fuzes
JE10-4066	10th Year Type AA Projectile Fuzes
JE50-3326	13th Year Type Model 4 Fuzes
JE50-3319	13th Year Type Mk 4 Fuzes
JE10-4005	Type 44 Projectile Fuzes
JE10-4010	Type 88 Fuzes
JE3-323	Type 88 Fuzes
JE2-66	Type 88 Fuzes
JE2-117	Type 88 Fuzes
JE2-118	Type 88 Fuzes
JE21-4069	Type 88 Fuzes
JE21-4076	Type 88 Fuzes
JE21-4057	Type 88 Mk 2 (Temporary Designation) Firing Mechanism
JE50-3317	Type 88 Model 4 Projectile Fuzes
JE21-4072	Type 88 Model 4 Projectile Fuzes
JE10-4014	Type 89 AA Projectile Fuzes
JE10-4053	Type 89 Time Fuzes
JE21-4117	Type 89 Time Fuzes
JE50-3321	Type 89 Time Fuzes
JE10-4011	Type 91 Projectile Fuzes
JE50-3318	Type 91 Projectile Fuzes
JE21-4074	Type 91 Mod. 1 Mechanical Time Fuzes
JE10-4052	Type 92 Fuzes

ENCLOSURE (D), continued

NavTechJap Equipment No.	Item
JE3-324	Type 93 Fuzes
JE21-4068	Type 93 Mortar Fuzes
JE21-3327	Type 96 Fuzes
JE21-4073	Type 98 Mod 1 Mechanical Time Fuzes
JE21-4053	Type 99 Nose Fuze
JE21-4056	Type 99 Special Firing Mechanisms Model 1
JE3-325	Type 0 Projectile Time Fuzes
JE2-129	Type 0 Projectile Time Fuzes
JE10-4112	Type 0 Projectile Time Fuzes
JE10-4072	Type 1 Projectile Fuzes
JE50-3320	Type 1 Fuzes (25mm)
JE21-4037(1-5)	Type 1 Special Long Delay Nose Fuzes
JE10-4114	Type 2 Projectile Nose Fuzes
JE21-4044(1-2)	Type 2 Projectile Nose Fuzes
JE10-4111	Model 2 Anti-Submarine Projectile Fuzes
JE21-4038(1-7)	Type 3 Electric Firing Mechanisms
JE21-4001(1)	Vacuum Tubes PLSOV, UY6301x3764A for Use with Type 3 Influence Fuze
JE21-4045(1)	Type 3 Model 2 Nose Time Fuzes
JE21-4046(2)	Time 3 Model 2 Nose Time Fuzes
JE10-4001(1-50)	Photoelectric Fuzes (Type 3?)
JE10-4159(1)	Accessories For JEL0-4001(1-50)
JE50-3325	Mk IV (Temporary Designation) Mechanical Time Fuzes
JE50-3933	Type 4 Combination Percussion Mechanical Time Fuze
JE50-3932	Type 4 Mk 0 Navy Mechanical Time Fuze
JE10-4008	Type 5 Mod 2 Fuzes
JE10-4007	Type 13 Mk I Mod 1 Fuzes
JE10-4069	Type 13 No. 2 Projectile Fuzes

ENCLOSURE (D), continued

NavTechJap Equipment No.	Item
JE10-4070	Type 13 No. 3 Projectile Fuzes
JE10-4071	Type 13 No. 4 Projectile Fuzes
JE21-4071	Type 13 Mk III Projectile Fuzes
JE21-4412	Type 18 (Experimental) Aerial Burst Fuzes
JE21-4384	"RO" - 3 Fuzes
JE21-4394	"RO" - 3 Fuzes
JE21-4393	"K)" - 4 Mk I Shell Fuzes
JE50-3931	Portion of Army Experimental Radio Fuze Receiver
JE10-4003	40mm Time Fuzes
JE21-4067(1-9)	50mm Powder Fuzes
JE21-4049	15cm Mortar Fuzes
JE10-4130	15cm Mortar Fuzes
JE21-4414	Transverse Pocket Fuzes
JE21-4392	Experimental Type Small Model Fuzes
JE21-4374	Short Delay Tail Fuzes
JE21-4398	Experimental Model, Two Second Delay Fuzes
JE10-4054-4065	Assorted Projectile Fuzes
JE21-4333	Assorted Projectile Fuzes
JE10-4134	Rocket Fuzes
JE10-4009	Anti-Submarine Fuzes
JE21-4389	Assorted Mortar Fuzes
JE21-4411	Assorted Mortar Fuzes
JE21-4113	Assorted Fuzes