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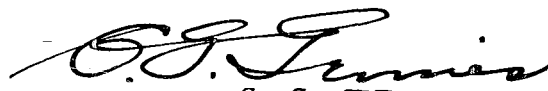
9 February 1946

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From: Chief, Naval Technical Mission to Japan.
To : Chief of Naval Operations.
Subject: Target Report - Japanese Naval Guns.
Reference: (a) "Intelligence Targets Japan" (DNI) of 4 Sept.
1945.

1. Subject report, covering Target O-54(N) of Fascicle O-1 of reference (a), is submitted herewith.

2. The investigation of the target and the report preparation were accomplished by Lt. Comdr. J.R. Lyman, USNR, and Lt. Comdr. R.A. Hay, USNR, assisted by Lt.(jg) R.R. Boggess, USNR, interpreter and translator.


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Captain, USN

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O-54(N)

JAPANESE NAVAL GUNS

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

FASCICLE O-1, TARGET O-54(N)

FEBRUARY 1946

U.S. NAVAL TECHNICAL MISSION TO JAPAN

SUMMARY

ORDNANCE TARGETS

JAPANESE NAVAL GUNS

Manufacturing and design data are given for all Japanese naval guns larger than 40mm which could be considered operational during the war.

In general, Japanese naval guns were of conventional design and construction; a 10cm (3.94 in) /65 caliber gun with a muzzle velocity of 3300 feet/second was ballistically the most advanced. In the last two years of the war, extensive use was made by the Japanese of low-nickel "substitute" steel for gun barrels.

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REFERENCES

Location of Target:

Kure Naval Arsenal, KURE, Hiroshima Prefecture
Kamegakubi Proving Ground, KUREHASHISHIMA, Hiroshima Prefecture.

Japanese Personnel who Assisted in Gathering Documents:

Lt. Comdr. J. ICHINOI, IJN.

Japanese Personnel Interviewed:

Vice Adm. R. SHIBUYA, Chief of Navy Technical Department.
Capt. N. IWASHIMA, Head of Guns & Powder Section, Navy Technical Department.
Capt. KANAZAWA, Guns & Powder Section, Navy Technical Department.
Capt. M. MITSUI, Head of Ordnance Experimental Department, Kure Naval Arsenal.
Capt. (Tech.) TAKEBAYASHI, Head of Steel Manufacturing, Kure Naval Arsenal.
Lt. Comdr. Y. KOZU, ten months Turret Officer of YAMATO: later in Ordnance Experimental Department, Kure Naval Arsenal.
Lt. Comdr. M. TSUKASAKI, from 1943 to 1945 Chief Officer, Gun Shop, Kure Naval Arsenal.
H. KATAOKA, Assistant Engineer, Ordnance Department, Kure Naval Arsenal (a gun designer).
J. MINATO, 20 years a ballistician, Ordnance Experimental Department, Kure Naval Arsenal.
T. OTANI, draftsman and gun designer, Kure Naval Arsenal.
Engineer OHATA, production chief, Steel Manufacturing Department, Kure Naval Arsenal.

Related NavTechJap Reports:

<u>Index No.</u>	<u>Title</u>
0-15	Japanese Steel Manufacturing Methods
0-16	Japanese Heavy Armor
0-21	Japanese Interior Ballistics
0-36	Japanese Light Armor
0-47(N)-2	Japanese Naval Guns and Mounts, Article 2 - AA Machine Guns and Mounts

LIST OF ENCLOSURES

- (A) List of Documents Forwarded Through ATIS to the Washington Document Center.
- (B) "Gun Barrel Manufacture," Compiled by M. TSUKASAKI, former Chief Officer, Gun Shop, Kure Naval Arsenal.

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INTRODUCTION

A study was made of Japanese naval guns for the purposes of obtaining information on the construction and design of the guns used during the war, and of discovering any features that might be used in design of future guns in the United States.

Guns for the Japanese Navy were manufactured in the Naval Arsenals at KURE, Honshu, and MURORAN, Hokkaido. The latter plant was concerned chiefly with routine production, while the design and development work was carried out at KURE and the neighboring Kamegakubi Proving Ground. Investigation, accordingly, was concentrated at KURE.

After interviewing key personnel at TOKYO, KURE and KAMEGAKUBI were visited, and all personnel available there were interrogated. Unfortunately, virtually all written records at KURE were destroyed, either deliberately or by bombing or typhoon. Meanwhile, however, an Ordnance Library containing classified blueprints and documents was discovered at YOKOSUKA, near TOKYO; and the report, written in TOKYO, draws upon the material obtained at KURE and YOKOSUKA, and the interrogation of former naval personnel available at TOKYO.

THE REPORT

PART I - PARTICULARS OF JAPANESE GUNS

The following tables give the principal dimensions and ballistic particulars of the operational guns of the Japanese Navy, as far as they were obtainable. Blueprints of several guns were collected; these are listed in Enclosure (A). It is probable that blueprints of most of the other guns exist in the files of the Yokosuka Ordnance Library, which are being forwarded en masse to the Washington Document Center. Limitations of time and personnel made it impractical to conduct a further search among the large number of blue prints there.

Some explanation of the quantities given in the tables is necessary. Japanese guns are in general designated according to the type of breech mechanism, which is usually numbered for the year of initiation of design. Two systems of year numbering are employed, referring either to the Japanese calendar or to the length of reign of the Emperor. These compare as follows:

A.D.	Japanese Chronology			
1900	MEIJI	33		2560
1912	MEIJI	45	TAISHO 1	2572
1926	TAISHO	15	SHOWA 1	2586
1946	SHOWA	21		2606

If "year" is included in the designation, the reference is to a reign; if not, the Japanese calendar is indicated. Thus, "11th Year Type" means 1922 or 1936; "Type 88" means 1928.

Gun barrels themselves are designated by numerals roughly similar to the old U.S. Navy Mark and Mod. system. The earliest model takes the Roman numeral I; later minor changes are indicated by subscripts such as I₂, I₃; major changes are denoted by higher Roman numerals, II, III, etc.

In Japanese documents the length in calibers is usually written first, followed by the approximate caliber in centimeters; thus 45/40 3d Year Type is the 41cm(16.11in)/45 caliber gun of 1914, and 40/8 is 7.62cm(3in)/40 caliber.

The length in calibers is the length from breech face to muzzle divided by the caliber (diameter across the lands); it is generally expressed in round figures.

The length of rifling if measured from the muzzle to the point where the lands attain full height.

The length of chamber is measured from the breech face to the base of the seated projectile, and the distance of projectile travel is the remaining length from the base of the projectile to the muzzle. Obviously both of these quantities depend on the type of projectile used, as well as the gun barrel itself; for separate ammunition they will also vary as the gun becomes worn. Japanese star gauge sheets (see NavTechJap Document No. ND50-3460) give as the length of chamber the distance from breech face to origin of rifling. These sheets also include a seating distance from the breech end of the barrel to the base of projectile, from which, with the length of the breech block, the other figure for chamber length can be derived.

Chamber volume is computed for a seated projectile. (NavTechJap Document No. ND21-3428 describes the procedure for calculating the volume of a projectile for use in this connection).

Muzzle velocities as given in different Japanese sources may vary somewhat according to whether new gun velocities or mean velocities over the life of a gun are being specified. An attempt has been made to have all velocities given in the tables represent values for new barrels.

LIST OF PRINCIPAL OPERATIONAL JAPANESE NAVAL GUNS

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12cm (4.72 in)/45 cal 11th Year Type	Page 21
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8cm (3 in)/40 cal 11th Year Type	Page 29
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8cm (3 in)/23 cal 5th Year Type	Page 32
8cm (3 in)/23 cal Type 41	Page 33
6cm (2.24 in) YAMANOUCI	Page 34
5cm (1.85 in)/40 cal Subcaliber	Page 35
5cm (1.85 in)/30 cal Short Gun	Page 36

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JAPANESE GUNS

DESIGNATION: Type 94

NOMINAL CALIBER: 40 cm Actual caliber: 46 cm 18.11 in
 LENGTH, CALIBERS: 45 cm Weight with breech mechanism: 165,000 kg 363,000 lb
 Length, breech face to muzzle: cm in Overall: 2130 cm 839.5 in
 Type of construction: Wirewound and radially expanded; muzzle 4 layers, breech 5.
 Type of breech: Screw.

RIFLING:

Number of grooves: 72 Twist: Uniform, 1 in 28 calibers
 Groove depth: 4.6 mm 0.181 in; width: — mm in
 Length of rifling: — cm in
 Bore cross section: 1698 sq.cm 263.19 sq.in

CHAMBER:

Length: — cm in Volume: 480 liters 29,290 cu.in
 Powder container: 6 bags

BALLISTICS:

Muzzle vel. (3200 -lb proj.) 780 m/s 2556 f/s
 Muzzle vel. (3000 -lb proj.) 805 m/s 2640 f/s
 Max. bore pressure: 30-32 kg/sq.mm 19.1-20.4 long tons/sq.in
 Muzzle pressure: — kg/sq.mm long tons/sq.in
 Projectile weight (AP, TP): 1465 kg 3220 lb; 2M/d³: 1.08
 Projectile weight (Comm, I.S.): 1360 kg 3000 lb; 2M/d³: 1.01
 Approximate charge weight: 330 kg 728 lb
 Ignition weight: 2.5 kg 5.5 lb
 Projectile travel: 1759 cm 693 in
 Point of complete combustion: — cal. from muzzle
 Maximum range: 42,050 m 45,960 yards
 Maximum altitude: 11,000 m 13,200 yards
 Approximate life: 200-250 equivalent service rounds

YEAR OF DESIGN: 1939.

SHIPS FITTED WITH: BB YAMATO class.

REMARKS: A 48cm/45 cal(18.9 in) gun was given proving ground tests but was never put into service.

JAPANESE GUNS

DESIGNATION: 3d Year Type

NOMINAL CALIBER: 40 cm Actual caliber: 41 cm 16.14 in
 LENGTH, CALIBERS: 45 cm Weight with breech mechanism: 102,000 kg 225,000 lb
 Length, breech face to muzzle: 1829.4 cm 719 in Overall: 1884 cm 742 in
 Type of construction: Wirewound; 4 layers muzzle and breech.
 Type of breech: Screw; withdraws directly to rear before opening.

RIFLING:

Number of grooves: 84 Twist: Uniform, 1 in 28 calibers
 Groove depth: 4.1 mm 0.1615 in; width: 8.754 mm 0.345 in
 Length of rifling: 1562.9 cm 615 in
 Bore cross section: 1347 sq.cm 208.8 sq.in

CHAMBER:

Length: 232.04 cm 92 in Volume: 467.11 liters 28,500 cu.in
 Powder container: 4 bags.

BALLISTICS:

Muzzle vel. (2260 -lb proj.) 780 m/s 2560 f/s
 Muzzle vel. (2070 -lb proj.) 805 m/s 2640 f/s
 Max. bore pressure: 30.0-30.7 kg/sq.mm 19.0-19.5 long tons/sq.in
 Muzzle pressure: 5.4 kg/sq.mm 3.4 long tons/sq.in
 Projectile weight (AP, TP): 1020 kg 2260 lb; 2M/d³: 1.075
 Projectile weight (Comm, IS): 936 kg 2070 lb; 2M/d³: 0.985
 Approximate charge weight: 219 kg 483 lb
 Ignition weight: 1.0 kg 2.2 lb
 Projectile travel: (Type 91) 1597.4 cm 628 in
 Point of complete combustion: 20 cal. from muzzle
 Maximum range: 38,400 m 42,000 yards
 Maximum altitude: 11,100 m 12,100 yards
 Approximate life: 250 equivalent service rounds

YEAR OF DESIGN: 1918.SHIPS FITTED WITH: BB NAGATO class.

REMARKS: Chamber length and volume are given for Type 91 (boat-tailed) projectiles. With Type 88 projectiles they are 243.19cm (95.6 in.) and 480.30 liters (29,300 cu.in.) respectively. Type 88 projectiles weighed 1000kg (2205 lb; 2M/d³, 1.06).

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JAPANESE GUNS

DESIGNATION: 41 st year Type (VICKERS)

NOMINAL CALIBER: 36 cm Actual caliber: 35.56 cm 14 in
 LENGTH, CALIBERS: 45 cm Weight with breech mechanism: 86,000 kg 190,000 lb
 Length, breech face to muzzle: 1600.2 cm 630 in Overall: 1646.9 cm 640 in
 Type of construction: Wirewound and radially expanded: 4 layers muzzle and breech.
 Type of breech: Screw.

RIFLING:

Number of grooves: 84 Twist: Uniform, 1 in 28 calibers
 Groove depth: 3.048 mm 0.12 in; width: 8.8646 mm 0.349 in
 Length of rifling: 1373.73 cm 541 in
 Bore cross section: 1015 sq.cm 157.33 sq.in

CHAMBER:

Length: 200.67 cm 79 in Volume: 294.9 liters 18,000 cu.in
 Powder container: 4 bags.

BALLISTICS:

Muzzle vel. (1490 -lb proj.)	<u>770</u>	m/s	<u>2525</u>	f/s
Muzzle vel. (1380 -lb proj.)	<u>805</u>	m/s	<u>2640</u>	f/s
Max. bore pressure: <u>30.0-30.2</u>	kg/sq.mm	<u>19.0-19.3</u>	long tons/sq.in	
Muzzle pressure: <u>5.2</u>	kg/sq.mm	<u>3.3</u>	long tons/sq.in	
Projectile weight (AP, TP):	<u>673.5</u>	kg	<u>1490</u>	lb; 2M/d ³ : <u>1.09</u>
Projectile weight (Comm, IS):	<u>625</u>	kg	<u>1380</u>	lb; 2M/d ³ : <u>1.01</u>
Approximate charge weight:	<u>144</u>	kg	<u>318</u>	lb
Ignition weight:	<u>0.90</u>	kg	<u>2.0</u>	lb
Projectile travel: (Type 91)	<u>1399.4</u>	cm	<u>551.5</u>	in
Point of complete combustion:	<u>18</u>	cal. from muzzle		
Maximum range:	<u>35,500</u>	m	<u>38,800</u>	yards
Maximum altitude:	<u>9,750</u>	m	<u>10,670</u>	yards
Approximate life:	<u>250-280</u>	equivalent service rounds		

YEAR OF DESIGN: about 1908.

SHIPS FITTED WITH: BB, ISE class, HARUNA class, FUSO class.

REMARKS: Chamber dimensions as given are for Type II and III barrels and Type 91 (boat-tailed) projectiles. With Type 88 projectiles the length is 209.97cm (82.7 in) and volume 303.16 liters (18,500 cu.in) Type III₂ and III₄ barrels have 0.10cm greater chamber length, same volume, and 3.1cm shorter length of rifling. Type 88 projectiles weighed 635 kg (1400 lb; 2M/d³, 1.02).

JAPANESE GUNS

DESIGNATION: 3d Year Type

NOMINAL CALIBER: 20 cm Actual caliber: 20.32 cm 8 in
 LENGTH, CALIBERS: 50 cm Weight with breech mechanism: 17,800 kg 39,300 lb
 Length, breech face to muzzle: 1000 cm 393.7 in Overall: 1031 cm 408 in
 Type of construction: See remarks.
 Type of breech: Screw.

RIFLING:

Number of grooves: 48 Twist: Uniform, 1 in 27.56 calibers
 Groove depth: 2.28 mm 0.0898 in; width: 8.299 mm 0.327 in
 Length of rifling: 848.09 cm 334 in
 Bore cross section: 332.7 sq.cm 51.569 sq.in

CHAMBER:

Length: 134.825 cm 53.1 in Volume: 68 liters 4150 cu.in
 Powder container: 2 bags.

BALLISTICS:

Muzzle vel. (278 -lb proj.) 840 m/s 2750 f/s
 Muzzle vel. (-lb proj.) --- m/s --- f/s
 Max. bore pressure: 30-31.3 kg/sq.mm 19-19.9 long tons/sq.in
 Muzzle pressure: 6.1 kg/sq.mm 3.9 long tons/sq.in
 Projectile weight (--): 125.85 kg 278 lb; 2M/d³: 1.12
 Projectile weight (): -- kg -- lb; 2M/d³: --
 Approximate charge weight: 33.8 kg 75 lb
 Ignition weight: 0.170 kg 0.375 lb
 Projectile travel: 865.2 cm 340.5 in
 Point of complete combustion: 17 cal. from muzzle
 Maximum range: 28,900 m 31,600 yards
 Maximum altitude: 10,000 m 11,000 yards
 Approximate life: 320-400 equivalent service rounds

YEAR OF DESIGN: 1924SHIPS FITTED WITH: CV AKAGI, CA AOBA class, NACHI class, TAKAO class, TONE, MOGAMI.REMARKS: Early models semi-wire-wound; later, built up with autofrettaged liner; still later, built up with radially expanded renewable liner.

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O-54(N)

JAPANESE GUNS

DESIGNATION: Short gun

NOMINAL CALIBER: 20 cm Actual caliber: 20.32 cm 8 in
 LENGTH, CALIBERS: 12 cm Weight with breech mechanism: 630 kg 1390 lb
 Length, breech face to muzzle: 243.84 cm 95.9 in Overall: 252.0 cm 100 in
 Type of construction: Monobloc.
 Type of breech: Screw.

RIFLING: "Raised"

Number of grooves: 32 Twist: Increasing, 1/30 to 1/13 calibers
 Groove depth: 1.5 mm 0.0453 in; width: 16.61 mm 0.654 in
 Length of rifling: 198.44 cm 78.2 in
 Bore cross section: 332 sq.cm 51.46 sq.in

CHAMBER:

Length: 39.54 cm 16.1 in Volume: 14.6 liters 891 cu.in
 Powder container: Case, semifixed.

BALLISTICS:

Muzzle vel. (-1b proj.) 305 m/s 1000 f/s
 Muzzle vel. (-1b proj.) -- m/s -- f/s
 Max. bore pressure: 6.5-7 kg/sq.mm 4.1-4.5 long tons/sq.in
 Muzzle pressure: -- kg/sq.mm -- long tons/sq.in
 Projectile weight (--) : 47 kg 104 lb; 2M/d³: 0.40
 Projectile weight (--) : -- kg -- lb; 2M/d³: --
 Approximate charge weight: 2 kg 4.4 lb
 Ignition weight: -- kg -- lb
 Projectile travel: 204.3 cm 80.6 in
 Point of complete combustion: -- cal. from muzzle
 Maximum range: 6300 m 6900 yards
 Maximum altitude: 3300 m 3600 yards
 Approximate life: 2000 equivalent service rounds

YEAR OF DESIGN: 1943.SHIPS FITTED WITH: Merchant ships.

REMARKS:

RESTRICTED

O-54(N)

JAPANESE GUNS

DESIGNATION: Short gun

NOMINAL CALIBER: 20 cm Actual caliber: 20.32 cm 8 in
 LENGTH, CALIBERS: 12 cm Weight with breech mechanism: 630 kg 1390 lb
 Length, breech face to muzzle: 243.84 cm 95.9 in Overall: 252.0 cm 100 in
 Type of construction: Monobloc.
 Type of breech: Screw.

RIFLING: "Raised"

Number of grooves: 32 Twist: Increasing, 1/30 to 1/13 calibers
 Groove depth: 1.5 mm 0.0453 in; width: 16.61 mm 0.654 in
 Length of rifling: 198.44 cm 78.2 in
 Bore cross section: 332 sq.cm 51.46 sq.in

CHAMBER:

Length: 39.54 cm 16.1 in Volume: 14.6 liters 891 cu.in
 Powder container: Case, semifixed.

BALLISTICS:

Muzzle vel. (-lb proj.)	<u>305</u>	m/s	<u>1000</u>	f/s	
Muzzle vel. (-lb proj.)	<u>--</u>	m/s	<u>--</u>	f/s	
Max. bore pressure:	<u>6.5-7</u>	kg/sq.mm	<u>4.1-4.5</u>		long tons/sq.in
Muzzle pressure:	<u>--</u>	kg/sq.mm	<u>--</u>		long tons/sq.in
Projectile weight (--)	<u>47</u>	kg	<u>104</u>	lb;	2M/d ³ : <u>0.40</u>
Projectile weight (--)	<u>--</u>	kg	<u>--</u>	lb;	2M/d ³ : <u>--</u>
Approximate charge weight:	<u>2</u>	kg	<u>4.4</u>	lb	
Ignition weight:	<u>--</u>	kg	<u>--</u>	lb	
Projectile travel:	<u>204.3</u>	cm	<u>80.6</u>	in	
Point of complete combustion:	<u>--</u>	cal. from muzzle			
Maximum range:	<u>6300</u>	m	<u>6900</u>	yards	
Maximum altitude:	<u>3300</u>	m	<u>3600</u>	yards	
Approximate life:	<u>2000</u>				equivalent service rounds

YEAR OF DESIGN: 1943.

SHIPS FITTED WITH: Merchant ships.

REMARKS:

JAPANESE GUNS

DESIGNATION: Type 41 (etc.)

NOMINAL CALIBER: 8 cm Actual caliber: 7.62 cm 3 in
 LENGTH, CALIBERS: 40 cm Weight with breech mechanism: 610 kg 1350 lb
 Length, breech face to muzzle: 304.8 cm 120 in Overall: 313.94 cm 127 in
 Type of construction: --
 Type of breech: --

RIFLING:

Number of grooves: 24 Twist: Uniform, 1 in 28 calibers
 Groove depth: 1.0 mm 0.039 in; width: 6.12 mm 0.241 in
 Length of rifling: 261.7 cm 102.8 in
 Bore cross section: sq.cm sq.in

CHAMBER:

Length: 39.45 cm 15.5 in Volume: 2.076 liters 127 cu.in
 Powder container: --

BALLISTICS:

Muzzle vel. (-lb proj.) 680 m/s 2230 f/s
 Muzzle vel. (-lb proj.) m/s f/s
 Max. bore pressure: kg/sq.mm long tons/sq.in
 Muzzle pressure: kg/sq.mm long tons/sq.in
 Projectile weight (): 5.67 kg 12.5 lb; 2M/d³: 0.93
 Projectile weight (): kg lb; 2M/d³:
 Approximate charge weight: kg lb
 Ignition weight: kg lb
 Projectile travel: 265.4 cm 104.7 in
 Point of complete combustion: cal. from muzzle
 Maximum range: m yards
 Maximum altitude: m yards
 Approximate life: equivalent service rounds

YEAR OF DESIGN: about 1905.

SHIPS FITTED WITH: IZUMO, TOKIWA, NISSIN, KASUGA, etc.

REMARKS: Rifing as given is for Type III, IV, VII barrels; Type I and II have 16 grooves, same depth, 9.3mm (0.366 in) wide, with twist 1/30. Type IV barrel has chamber length 39.473cm (15.5 in); same volume, rifling length 262.31cm (103.2 in).

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O-54(N)

JAPANESE GUNS

DESIGNATION: Type 5

NOMINAL CALIBER: 8 cm Actual caliber: 7.62 cm 3 in
 LENGTH, CALIBERS: 40 cm Weight with breech mechanism: kg lb
 Length, breech face to muzzle: cm in Overall: cm in
 Type of construction: Monobloc.
 Type of breech: Sliding.

RIFLING:

Number of grooves: Twist: Uniform, 1 in 28 calibers
 Groove depth: mm in; width: mm in
 Length of rifling: cm in
 Bore cross section: sq.cm sq.in

CHAMBER:

Length: cm in Volume: 2.1 liters 128 cu.in
 Powder container: Case, fixed

BALLISTICS:

Muzzle vel. (-1b proj.) 600 m/s 1965 f/s
 Muzzle vel. (-1b proj.) m/s f/s
 Max. bore pressure: 14 kg/sq.mm 8.9 long tons/sq.in
 Muzzle pressure: kg/sq.mm long tons/sq.in
 Projectile weight (): 5.99 kg 13.2 lb; 2M/d³: 0.98
 Projectile weight (): kg lb; 2M/d³:
 Approximate charge weight: 0.60 kg 1.3 lb
 Ignition weight: Primer 0.02 kg .044 lb
 Projectile travel: cm in
 Point of complete combustion: cal. from muzzle
 Maximum range: m yards
 Maximum altitude: m yards
 Approximate life: equivalent service rounds

YEAR OF DESIGN: about 1945.

SHIPS FITTED WITH:

REMARKS: Designed to be carried by aircraft; still in development stage.

JAPANESE GUNS

DESIGNATION: 3d Year Type

NOMINAL CALIBER: 14 cm Actual caliber: 14 cm 5.51 in
 LENGTH, CALIBERS: 50 cm Weight with breech mechanism: 5700 kg 12,600 lb
 Length, breech face to muzzle: 699.93 cm 285 in Overall: 723.5 cm 276 in
 Type of construction: Wire-wound; 4 layers muzzle and breech (Type II); built up (Type IV)
 Type of breech: Screw.

RIFLING:

Number of grooves: 42 Twist: Uniform, 1 in 28 calibers
 Groove depth: 1.40 mm 0.055 in; width: 6.40 mm 0.252 in
 Length of rifling: 596.84 cm 235 in
 Bore cross section: 158 sq.cm 24.49 sq.in

CHAMBER:

Length: 94.24 cm 37.1 in Volume: 23 liters 1405 cu.in
 Powder container: One bag.

BALLISTICS:

Muzzle vel. (83.8 -lb proj.) 850 m/s 2790 f/s
 Muzzle vel. (-lb proj.) m/s f/s
 Max. bore pressure: 29-29.1 kg/sq.mm 18.4-18.5 long tons/sq.in
 Muzzle pressure: 6.1 kg/sq.mm 3.9 long tons/sq.in
 Projectile weight (Common, Mod 2): 38.0 kg 83.8 lb; 2M/d³: 1-00
 Projectile weight (Anti-sub): 42.0 kg 92.5 lb; 2M/d³: 1-11
 Approximate charge weight: 11 kg 24.3 lb
 Ignition weight: 0.060 kg 0.133 lb
 Projectile travel: 605.8 cm 238.5 in
 Point of complete combustion: 15 cal. from muzzle
 Maximum range: 20,500 m 22,400 yards
 Maximum altitude: -- m -- yards
 Approximate life: 500-600 equivalent service rounds

YEAR OF DESIGN: about 1915.

SHIPS FITTED WITH: CL KATORI class, etc., BB NAGATO class.

REMARKS:

RESTRICTED

O-54(N)

JAPANESE GUNS

DESIGNATION: 11th Year Type

NOMINAL CALIBER: 14 cm Actual caliber: 14 cm 5.51 in
 LENGTH, CALIBERS: 40 cm Weight with breech mechanism: 3900 kg 8580 lb
 Length, breech face to muzzle: 560 cm 221 in Overall: 590 cm 232.5 in
 Type of construction: Types I, I₂ built up; I₃ monobloc; all radially expanded.
 Type of breech: Horizontal sliding.

RIFLING:

Number of grooves: 38 Twist: Uniform, 1 in 28 calibers
 Groove depth: 1.65 mm 0.065 in; width: 7.024 mm 0.285 in
 Length of rifling: 466.8 cm 183.5 in
 Bore cross section: -- sq.cm -- sq.in

CHAMBER:

Length: 83.15 cm 32.8 in Volume: 15 liters 915 cu.in
 Powder container: Case, semi-fixed.

BALLISTICS:

Muzzle vel. (83.8 -lb proj.) 700 m/s 2300 f/s
 Muzzle vel. (-- -lb proj.) -- m/s -- f/s
 Max. bore pressure: 25 kg/sq.mm 16 long tons/sq.in
 Muzzle pressure: 4.8 kg/sq.mm 3.05 long tons/sq.in
 Projectile weight (Common, etc): 38 kg 83.8 lb; 2M/d³: 1.00
 Projectile weight (Anti-sub): 42 kg 92.5 lb; 2M/d³: 1.11
 Approximate charge weight: 16.82 kg 15.1 lb
 Ignition weight: (Primer) 0.020 kg 0.044 lb
 Projectile travel: 476.9 cm 188 in
 Point of complete combustion: 8 cal. from muzzle
 Maximum range: 16,000 m 17,500 yards
 Maximum altitude: surface use only -- m -- yards
 Approximate life: 800-1000 equivalent service rounds

YEAR OF DESIGN: 1925.

SHIPS FITTED WITH: SS, I-1, I-7, I-121 classes.

REMARKS:

JAPANESE GUNS

DESIGNATION: 3d Year Type

NOMINAL CALIBER: 12.7 cm Actual caliber: 12.7 cm 5 in
 LENGTH, CALIBERS: 50 cm Weight with breech mechanism: 4245 kg 9400 lb
 Length, breech face to muzzle: 6265 cm 247 in Overall: 648.3 cm 256 in
 Type of construction: Two tubes, inner autofrettaged (I₂): three tubes (I).
 Type of breech: Screw.

RIFLING:

Number of grooves: 36 Twist: Uniform, 1 in 28 calibers
 Groove depth: 1.52 mm 0.06 in; width: 6.63 mm 0.261 in
 Length of rifling: 535.05 cm 211 in
 Bore cross section: 130 sq.cm 20.15 sq.in

CHAMBER:

Length: 82.25 cm 32.4 in Volume: 16 liters 976.4 cu.in
 Powder container:

BALLISTICS:

Muzzle vel. (50.8 -lb proj.) 910 m/s 2960 f/s
 Muzzle vel. (-- -lb proj.) -- m/s -- f/s
 Max. bore pressure: 28.4 kg/sq.mm 18.0 long tons/sq.in
 Muzzle pressure: 5.7 kg/sq.mm 3.6 long tons/sq.in
 Projectile weight (Common, etc.): 23 kg 50.8 lb; 2M/d³: 0.81
 Projectile weight (Anti-sub): 21 kg 46.4 lb; 2M/d³: 0.74
 Approximate charge weight: 7.7 kg 17 lb
 Ignition weight: 0.050 kg 0.11 lb
 Projectile travel: 544.25 cm 214.6 in
 Point of complete combustion: 14 cal. from muzzle
 Maximum range: 18,400 m 20,100 yards
 Maximum altitude: 11,500 m 12,550 yards
 Approximate life: 550-700 equivalent service rounds

YEAR OF DESIGN: about 1926.

SHIPS FITTED WITH: DD, HATSU HARU class, etc.

REMARKS:

RESTRICTED

O-54(N)

JAPANESE GUNS

DESIGNATION: Type 5

NOMINAL CALIBER: 12.7 cm Actual caliber: 12.7 cm 5 in
 LENGTH, CALIBERS: 50 cm Weight with breech mechanism: 4665 kg 10,300 lb
 Length, breech face to muzzle: _____ cm _____ in Overall: _____ cm _____ in
 Type of construction: Monobloc, autofrettaged (I₃).
 Type of breech: Horizontal sliding.

RIFLING:

Number of grooves: 36 Twist: Uniform, 1 in 28 calibers
 Groove depth: _____ mm _____ in; width: _____ mm _____ in
 Length of rifling: _____ cm _____ in
 Bore cross section: _____ sq.cm _____ sq.in

CHAMBER:

Length: _____ cm _____ in Volume: _____ liters _____ cu.in
 Powder container: Case, fixed
 Weight of assembled round: 48.1 kg. 106 lb.

BALLISTICS:

Muzzle vel. (59.6 -lb proj.)	<u>880</u>	m/s	<u>2880</u>	f/s
Muzzle vel. (-lb proj.)	<u>--</u>	m/s		f/s
Max. bore pressure: <u>26.5-28</u>	kg/sq.mm	<u>16.8-17.8</u>	long tons/sq.in	
Muzzle pressure:	kg/sq.mm		long tons/sq.in	
Projectile weight (): <u>27</u>	kg	<u>59.6</u>	lb;	2M/d ³ : <u>0.95</u>
Projectile weight (): _____	kg		lb;	2M/d ³ : _____
Approximate charge weight: <u>9.8</u>	kg	<u>21.6</u>	lb	
Ignition weight: _____	kg		lb	
Projectile travel: _____	cm		in	
Point of complete combustion: _____	cal.	from muzzle		
Maximum range: <u>22,400</u>	m	<u>24,500</u>	yards	
Maximum altitude: <u>15,200</u>	m	<u>16,600</u>	yards	
Approximate life: <u>--</u>	equivalent service rounds			

YEAR OF DESIGN: about 1944

SHIPS FITTED WITH: None.

REMARKS: Designed to increase range and fragment effectiveness of the 5" AA Gun. Also known as Type 1.

JAPANESE GUNS

DESIGNATION: Types 88 and 89

NOMINAL CALIBER: 12.7 cm Actual caliber: 12.7 cm 5 in
 LENGTH, CALIBERS: 40 cm Weight with breech mechanism: 3100 kg 6850 lb
 Length, breech face to muzzle: 508 cm 200 in Overall: 528.4 cm 208 in
 Type of construction: Monobloc, autofrettaged.
 Type of breech: Horizontal sliding.

RIFLING:

Number of grooves: 36 Twist: Uniform, 1 in 28 calibers
 Groove depth: 1.52 mm 0.06 in; width: 6.63 mm 0.261 in
 Length of rifling: 445.01 cm 175.3 in
 Bore cross section: 130 sq.cm 20.15 sq.in

CHAMBER:

Length: 53.44 cm 21.0 in Volume: 9 liters 549.2 cu.in
 Powder container: Case, fixed
 Weight of assembled round: 35 kg. 77 lb.

BALLISTICS:

Muzzle vel. (50.8 -lb proj.) 725 m/s 2380 f/s
 Muzzle vel. (-lb proj.) -- m/s -- f/s
 Max. bore pressure: 25-25.3 kg/sq.mm 15.9-16.1 long tons/sq.in
 Muzzle pressure: 3.4 kg/sq.mm 2.2 long tons/sq.in
 Projectile weight (Common, etc.): 23 kg 50.8 lb; 2M/d³: 0.81
 Projectile weight (Anti-sub): 21 kg 46.4 lb; 2M/d³: 0.74
 Approximate charge weight: 4 kg 8.8 lb
 Ignition weight: Primer 0.02 kg 0.044 lb
 Projectile travel: 454.6 cm 179 in
 Point of complete combustion: 19 cal. from muzzle
 Maximum range: 14,800 m 16,200 yards
 Maximum altitude: 9,400 m 10,300 yards
 Approximate life: 800-1500 equivalent service rounds

YEAR OF DESIGN: 1930.

SHIPS FITTED WITH: SS, I-5, I-6; BB, NAGATO, YAMATO classes; CV KAGA, SORYU; DD, ASHIGARA class etc.

REMARKS: Barrel length 5096cm (235 in); 5284cm with breech housing.

RESTRICTED

O-54(N)

JAPANESE GUNS

DESIGNATION: 11th Year Type

NOMINAL CALIBER: 12 cm Actual caliber: 12 cm 4.72 in
 LENGTH, CALIBERS: 45 cm Weight with breech mechanism: 2860-3240 kg 6300-7150 lb
 Length, breech face to muzzle: 527 cm 208 in Overall: 555 cm 219 in
 Type of construction: Built up and radially expanded.
 Type of breech: Types J and L horizontal sliding: Type L, screw.

RIFLING:

Number of grooves: 34 Twist: Uniform, 1 in 28 calibers
 Groove depth: 1.45 mm 0.057 in; width: 6.688 mm 0.264 in
 Length of rifling: 447.08 cm 176 in
 Bore cross section: -- sq.cm -- sq.in

CHAMBER:

Length: 72.27 cm 28.5 in Volume: 10.44 liters 637.1 cu.in
 Powder container: Case, semi-fixed

BALLISTICS:

Muzzle vel. (45.0 -lb proj.) 825 m/s 2700 f/s
 Muzzle vel. (-lb proj.) -- m/s -- f/s
 Max. bore pressure: 27-27.5 kg/sq.mm 17.2-17.5 long tons/sq.in
 Muzzle pressure: -- kg/sq.mm -- long tons/sq.in
 Projectile weight (Common, etc.): 20.413 kg 45.0 lb; 2M/d3: 0.86
 Projectile weight (Anti-sub): 16.4 kg 35.8 lb; 2M/d3: 0.69
 Approximate charge weight: 5.27 kg 11.6 lb
 Ignition weight: -- kg -- lb
 Projectile travel: -- cm -- in
 Point of complete combustion: -- cal. from muzzle
 Maximum range: 16,000 m 17,500 yards
 Maximum altitude: -- m -- yards
 Approximate life: 700-1000 equivalent service rounds

YEAR OF DESIGN: about 1927.

SHIPS FITTED WITH: SS, I-53, I-71 classes; TB, OTORI class.

REMARKS:

JAPANESE GUNS

DESIGNATION: 10th Year Type

NOMINAL CALIBER: 12 cm Actual caliber: 12 cm 4.72 in
 LENGTH, CALIBERS: 45 cm Weight with breech mechanism: 2900 kg 6400 lb
 Length, breech face to muzzle: 540 cm 212.5 in Overall: 560.4 cm 221 in
 Type of construction: Monobloc and radially expanded (Type IX5); Types IX, IX2 built up.
 Type of breech: Horizontal sliding.

RIFLING:
 Number of grooves: 34 Twist: Uniform, 1 in 28 calibers
 Groove depth: 1.45 mm 0.057 in; width: 6.688 mm 0.264 in
 Length of rifling: 464.93 cm 188 in
 Bore cross section: 116 sq.cm 17.98 sq.in

CHAMBER:
 Length: 65.6 cm 25.8 in Volume: 10.774 liters 657.5 cu.in
 Powder container: Case, fixed
 Assembled round weight: 34 kg. 75 lb.

BALLISTICS:
 Muzzle vel. (45.0 -lb proj.) 825 m/s 2700 f/s
 Muzzle vel. (-lb proj.) -- m/s -- f/s
 Max. bore pressure: 26.4-26.5 kg/sq.mm 16.8 long tons/sq.in
 Muzzle pressure: 5.3 kg/sq.mm 3.4 long tons/sq.in
 Projectile weight (Common, etc.): 20.4 kg 45.0 lb; 2M/d3: 0.86
 Projectile weight (): 16.4 kg 35.8 lb; 2M/d3: 0.69
 Approximate charge weight: 5.55 kg 12.3 lb
 Ignition weight: Primer 0.02 kg 0.044 lb
 Projectile travel: 474.4 cm 186.6 in
 Point of complete combustion: minus 8 cal. from muzzle i. e. beyond
 Maximum range: (see note) 16,000 m 17,500 yards
 Maximum altitude: 10,000 m 11,000 yards
 Approximate life: 700-1000 equivalent service rounds

YEAR OF DESIGN: 1927SHIPS FITTED WITH: CA TAKAO, CV AKAGI class.

REMARKS: Some barrels were rifled with 36 grooves.
 The range was increased to 20,000 meters (21,900 yds) horizontally and 12,500 meters (13,700 yds) vertically, using 22.5kg (49.7-lb; 2M/d3, 1.05) sharp-nosed projectiles and perforated ("short tubite") powder.

RESTRICTED

O-54(N)

JAPANESE GUNS

DESIGNATION: 3d Year Type

NOMINAL CALIBER: 12 cm Actual caliber: 12 cm 4.72 in
 LENGTH, CALIBERS: 45 cm Weight with breech mechanism: 2616-3200 kg 5780-7070 lb
 Length, breech face to muzzle: 527 cm 207.5 in Overall: 540 cm 212.5 in
 Type of construction: Monobloc with separate breech ring of plain carbon steel.
 Type of breech: Horizontal sliding.

RIFLING:

Number of grooves: 34 Twist: Uniform, 1 in 28 calibers
 Groove depth: 1.45 mm 0.057 in; width: 6.688 mm 0.263 in
 Length of rifling: 447.08 cm 176 in
 Bore cross section: 115 sq.cm 178.25 sq.in

CHAMBER:

Length: 72.27 cm 28.7 in Volume: 10.44 liters 637.1 cu.in
 Powder container: Case, semi-fixed.

BALLISTICS:

Muzzle vel. (	-1b proj.)	<u>780</u>	m/s	<u>2560</u>	f/s
Muzzle vel. (	-1b proj.)	<u>--</u>	m/s	<u>--</u>	f/s
Max. bore pressure:	<u>27</u>	kg/sq.mm	<u>17.2</u>	long tons/sq.in	
Muzzle pressure:	<u>--</u>	kg/sq.mm	<u>--</u>	long tons/sq.in	
Projectile weight (	)	<u>20.413</u>	kg	<u>45.0</u>	lb; 2M/d ³ : <u>0.86</u>
Projectile weight (	)	<u>--</u>	kg	<u>--</u>	lb; 2M/d ³ : <u>--</u>
Approximate charge weight:		<u>--</u>	kg	<u>--</u>	lb
Ignition weight:		<u>--</u>	kg	<u>--</u>	lb
Projectile travel:		<u>454.7</u>	cm	<u>179</u>	in
Point of complete combustion:		<u>--</u>	cal. from muzzle		
Maximum range:		<u>--</u>	m	<u>--</u>	yards
Maximum altitude:		<u>--</u>	m	<u>--</u>	yards
Approximate life:		<u>1000</u>	equivalent service rounds		

YEAR OF DESIGN:

SHIPS FITTED WITH: Old DD.

REMARKS: Rifling as given is for Type VII barrels; Type V has 36 grooves 6.43mm (0.253 in.) wide, 1.02mm (0.04 in) deep. There were also obsolesent 12 cm/40 cal guns used on old destroyers.

JAPANESE GUNS

DESIGNATION: Short Gun

NOMINAL CALIBER: 12 cm Actual caliber: 12 cm 4.72 in
 LENGTH, CALIBERS: 12 cm Weight with breech mechanism: 218 kg 480 lb
 Length, breech face to muzzle: 144 cm 56.7 in Overall: 151 cm 61.0 in
 Type of construction: Monobloc.
 Type of breech: Screw.

RIFLING: "Raised"

Number of grooves: 24 Twist: Increasing 1/30 to 1/13 calibers
 Groove depth: 1.0 mm 0.039 in; width: 11.78 mm 0.468 in
 Length of rifling: 112.7 cm 44.4 in
 Bore cross section: 118 sq.cm 18.29 sq.in

CHAMBER:

Length: 24.0 cm 9.45 in Volume: 3 liters 183.1 cu.in
 Powder container: Case, semi-fixed

BALLISTICS:

Muzzle vel. (-lb proj.) 290 m/s 950 f/s
 Muzzle vel. (-lb proj.) -- m/s -- f/s
 Max. bore pressure: 7 kg/sq.mm 4.5 long tons/sq.in
 Muzzle pressure: -- kg/sq.mm -- long tons/sq.in
 Projectile weight (): 13 kg 28.7 lb; 2M/d³: 0.55
 Projectile weight (): -- kg -- lb; 2M/d³: --
 Approximate charge weight: 0.49 kg 1.08 lb
 Ignition weight: -- kg -- lb
 Projectile travel: 120 cm 47.3 in
 Point of complete combustion: -- cal. from muzzle
 Maximum range: 5300 m 5800 yards
 Maximum altitude: 2400 m 2620 yards
 Approximate life: Undetermined equivalent service rounds

YEAR OF DESIGN: 1941.

SHIPS FITTED WITH: Merchant ships.

REMARKS:

RESTRICTED

O-54(N)

JAPANESE GUNS

DESIGNATION: Type 98

NOMINAL CALIBER: 10 cm Actual caliber: 10 cm 3.94 in
 LENGTH, CALIBERS: 65 cm Weight with breech mechanism: 3053 kg 6740 lb
 Length, breech face to muzzle: 650 cm 256 in Overall: 673 cm 265 in
 Type of construction: Type I lined, Type I2 monobloc; radially expanded.
 Type of breech: Horizontal sliding.

RIFLING:

Number of grooves: 32 Twist: Uniform, 1 in 28 calibers
 Groove depth: 1.25 mm 0.049 in; width: 5.565 mm 0.219 in
 Length of rifling: 563.1 cm 222 in
 Bore cross section: 81 sq.cm 12.56 sq.in

CHAMBER:

Length: 75.0 cm 29.5 in Volume: 10.5 liters 640.7 cu.in
 Powder container: Case, fixed.
 Weight of assembled round: 28 kg. 62 lb.

BALLISTICS:

Muzzle vel. (-lb proj.) 1010 m/s 3300 f/s
 Muzzle vel. (-lb proj.) 1010 m/s 3300 f/s
 Max. bore pressure: 30.5 kg/sq.mm 19.4 long tons/sq.in
 Muzzle pressure: -- kg/sq.mm -- long tons/sq.in
 Projectile weight (): 13 kg 28.7 lb; 2M/d³: 0.94
 Projectile weight (): -- kg -- lb; 2M/d³: --
 Approximate charge weight: 6 kg 13.2 lb
 Ignition weight: -- kg -- lb
 Projectile travel: 575 cm 226.5 in
 Point of complete combustion: -- cal. from muzzle
 Maximum range: 19,500 m 21,320 yards
 Maximum altitude: 13,000 m 14,220 yards
 Approximate life: 350-400 equivalent service rounds

YEAR OF DESIGN: 1940.

SHIPS FITTED WITH: DD, AKITSUSHIMA class; CV.

REMARKS: The favorite gun of the Japanese Naval ordnance personnel interrogated.

JAPANESE GUNS

DESIGNATION: Type 88

NOMINAL CALIBER: 10 cm Actual caliber: 10 cm 3.94 in
 LENGTH, CALIBERS: 50 cm Weight with breech mechanism: 2830 kg 6250 lb
 Length, breech face to muzzle: 500 cm 197 in Overall: 530 cm 209 in
 Type of construction: Monobloc, radially expanded.
 Type of breech: Horizontal sliding.

RIFLING:

Number of grooves: 32 Twist: Uniform, 1 in 28 calibers
 Groove depth: 1.25 mm 0.049 in; width: 5.5646 mm 0.219 in
 Length of rifling: 4.295 cm 169 in
 Bore cross section: -- sq.cm -- sq.in

CHAMBER:

Length: 62.5 cm 24.6 in Volume: 8 liters 488 cu.in
 Powder container: Case, fixed
 Assembled round weight: 24 kg. 53 lb.

BALLISTICS:

Muzzle vel. (-lb proj.) 885 m/s 2900 f/s
 Muzzle vel. (-lb proj.) -- m/s -- f/s
 Max. bore pressure: 28.2 kg/sq.mm 17.9 long tons/sq.in
 Muzzle pressure: 6.3 kg/sq.mm 4.0 long tons/sq.in
 Projectile weight (): 13 kg 28.7 lb; 2M/d³: 0.94
 Projectile weight (): -- kg -- lb; 2M/d³: --
 Approximate charge weight: 4.13 kg 9.12 lb
 Ignition weight: Primer 0.02 kg 0.044 lb
 Projectile travel: 437.5 cm 172.4 in
 Point of complete combustion: minus 5 cal. from muzzle i. e. beyond
 Maximum range: 16,200 m 17,700 yards
 Maximum altitude: 11,200 m 12,250 yards
 Approximate life: 400-700 equivalent service rounds

YEAR OF DESIGN: 1930.

SHIPS FITTED WITH: SS, I-63 class.

REMARKS:

RESTRICTED

O-54(N)

JAPANESE GUNS

DESIGNATION: Type 98 AA Gun

NOMINAL CALIBER: 8 cm Actual caliber: 7.62 cm 3 in
 LENGTH, CALIBERS: 60 cm Weight with breech mechanism: 1320 kg 2910 lb
 Length, breech face to muzzle: 56.65 cm 179.6 in Overall: 477.7 cm 188 in
 Type of construction: Type I lined; Type I2 Monobloc; radially expanded.
 Type of breech: Horizontal sliding.

RIFLING:

Number of grooves: 24 Twist: Uniform, 1 in 28 calibers
 Groove depth: 1.02 mm 0.04 in; width: 6.12 mm 0.241 in
 Length of rifling: 403.65 cm 159 in
 Bore cross section: 47 sq.cm 7.285 sq.in

CHAMBER:

Length: 440 cm 17.3 in Volume: 3.5 liters 213.6 cu.in
 Powder container: Case, fixed
 Assembled round weight: 12 kg. 26.5 lb.

BALLISTICS:

Muzzle vel. (-lb proj.) 900 m/s 2950 f/s
 Muzzle vel. (-lb proj.) m/s f/s
 Max. bore pressure: 28-29 kg/sq.mm 17.8-18.4 long tons/sq.in
 Muzzle pressure: kg/sq.mm long tons/sq.in
 Projectile weight (): 5.99 kg 13.2 lb; 2M/d³: 0.98
 Projectile weight (): kg lb; 2M/d³:
 Approximate charge weight: 3.91 kg 8.65 lb
 Ignition weight: kg lb
 Projectile travel: 412.65 cm 162.3 in
 Point of complete combustion: cal. from muzzle
 Maximum range: 13,500 m 14,750 yards
 Maximum altitude: 8,500 m 9,300 yards
 Approximate life: undetermined equivalent service rounds

YEAR OF DESIGN: 1941.

SHIPS FITTED WITH: CL, AGANO class: CA, IBUKI class.

REMARKS: Ratio of charge weight to projectile weight 0.65.

JAPANESE GUNS

DESIGNATION: 3d Year Type

NOMINAL CALIBER: 8 cm Actual caliber: 7.62 cm 3 in
 LENGTH, CALIBERS: 40 cm Weight with breech mechanism: 600 kg 1323 lb
 Length, breech face to muzzle: cm in Overall: cm in
 Type of construction: Monobloc (Type VIII), autofrettaged; older types built-up.
 Type of breech: Vertical sliding.

RIFLING:
 Number of grooves: 21 Twist: Uniform, 1 in 28 calibers
 Groove depth: 1.02 mm 0.04 in; width: mm in
 Length of rifling: cm in
 Bore cross section: 47 sq.cm 7.285 sq.in

CHAMBER:
 Length: 39.0 cm 15.35 in Volume: 2.1 liters 128.2 cu.in
 Powder container: Case, fixed
 Weight of assembled round: 10 kg. 22 lb.

BALLISTICS:
 Muzzle vel. (-1b proj.) 680 m/s 2230 f/s
 Muzzle vel. (-1b proj.) m/s f/s
 Max. bore pressure: 22.2-23 kg/sq.mm 14.1-14.6 long tons/sq.in
 Muzzle pressure: 4.1 kg/sq.mm 2.6 long tons/sq.in
 Projectile weight () : 5.99 kg 13.2 lb; 2M/d³: 0.98
 Projectile weight () : kg lb; 2M/d³:
 Approximate charge weight: 0.93 kg 2.05 lb
 Ignition weight: Primer 0.02 kg 0.044 lb
 Projectile travel: 265.8 cm 104.6 in
 Point of complete combustion: minus 10 cal. from muzzle i. e. beyond
 Maximum range: 10,800 m 11,800 yards
 Maximum altitude: 7,200 m 7,870 yards
 Approximate life: 1200-2000 equivalent service rounds

YEAR OF DESIGN: about 1915.

SHIPS FITTED WITH: DD HIRA class etc; Type 88 in SS, RO-33 class.

REMARKS: Type 88 similar but with horizontal sliding breech.

RESTRICTED

O-54(N)

JAPANESE GUNS

DESIGNATION: 11th Year Type

NOMINAL CALIBER: 8 cm Actual caliber: 7.62 cm 3 in
 LENGTH, CALIBERS: 40 cm Weight with breech mechanism: 600 kg 1320 lb
 Length, breech face to muzzle: 304.8 cm 120 in Overall: 320.3 cm 126 in
 Type of construction: Solid.
 Type of breech: Horizontal sliding.

RIFLING:

Number of grooves: 24 Twist: Uniform, 1 in 28 calibers
 Groove depth: 1.0 mm 0.039 in; width: 5.905 mm 0.232 in
 Length of rifling: 260.85 cm 105 in
 Bore cross section: -- sq.cm -- sq.in

CHAMBER:

Length: 389.7 cm 15.35 in Volumes: 2.057 liters 125 cu.in
 Powder container: --

BALLISTICS:

Muzzle vel. (-1b proj.) 680 m/s 2230 f/s
 Muzzle vel. (-1b proj.) -- m/s -- f/s
 Max. bore pressure: 23 kg/sq.mm 14.6 long tons/sq.in
 Muzzle pressure: -- kg/sq.mm -- long tons/sq.in
 Projectile weight (--): 5.67 kg 12.5 lb; 2M/d³: 0.93
 Projectile weight (--): -- kg -- lb; 2M/d³: --
 Approximate charge weight: -- kg -- lb
 Ignition weight: -- kg -- lb
 Projectile travel: 265.8 cm 104.6 in
 Point of complete combustion: -- cal. from muzzle
 Maximum range: -- m -- yards
 Maximum altitude: -- m -- yards
 Approximate life: 2000 equivalent service rounds

YEAR OF DESIGN:

SHIPS FITTED WITH: Submarines.

REMARKS: See also the other types of 3"/40 cal gun.

JAPANESE GUNS

DESIGNATION: 3d Year Type

NOMINAL CALIBER: 15.5 cm Actual caliber: 15.5 cm 6.10 in
 LENGTH, CALIBERS: 60 cm Weight with breech mechanism: 12,700 kg 28,000 lb
 Length, breech face to muzzle: 930 cm 367 in Overall: 961.5 cm 378.5 in
 Type of construction: Built up; one layer muzzle, two breech; autofrettaged.
 Type of breech: Screw.

RIFLING:
 Number of grooves: 40 Twist: Uniform, 1 in 28 calibers
 Groove depth: 1.80 mm 0.071 in; width: 7.514 mm 0.296 in
 Length of rifling: 802.5 cm 316 in
 Bore cross section: 194 sq.cm 30.07 sq.in

CHAMBER:
 Length: 112.8 cm 44.4 in Volume: 38 liters 2315 cu.in
 Powder container: One bag

BALLISTICS:
 Muzzle vel. (-- -lb proj.) 950 m/s 3120 f/s
 Muzzle vel. (-- -lb proj.) -- m/s -- f/s
 Max. bore pressure: 33.9-34 kg/sq.mm 21.5-21.6 long tons/sq.in
 Muzzle pressure: 5.9 kg/sq.mm 3.8 long tons/sq.in
 Projectile weight (--): 55.87 kg 123.1 lb; 2M/d³: 1.09
 Projectile weight (--): -- kg -- lb; 2M/d³: --
 Approximate charge weight: 19.5 kg 43.1 lb
 Ignition weight: 0.075 kg 0.166 lb
 Projectile travel: 817.2 cm 322 in
 Point of complete combustion: 29 cal. from muzzle
 Maximum range: 27,400 m 30,000 yards
 Maximum altitude: 12,600 m 13,800 yards
 Approximate life: 250-300 equivalent service rounds

YEAR OF DESIGN: 1933.SHIPS FITTED WITH: BB YAMATO class, CL TONE class, MIKUMA class (originally).REMARKS: Range with common projectile, 26,500 m. (29,000 yds).

RESTRICTED

O-54(N)

JAPANESE GUNS

DESIGNATION: 41st Year Type

NOMINAL CALIBER: 15 cm Actual caliber: 15.24 cm 6 in
 LENGTH, CALIBERS: 50 cm Weight with breech mechanism: 8360 kg 18,450 lb
 Length, breech face to muzzle: 761.99 cm 300 in Overall: 787.56 cm 311 in
 Type of construction: Three tubes, liner radially expanded.
 Type of breech: Screw.

RIFLING:

Number of grooves: 42 Twist: Uniform 1 in 30 calibers
 Groove depth: 1.27 mm 0.050 in; width: 7.62 mm 0.30 in
 Length of rifling: 658.44 cm 259 in
 Bore cross section: 186 sq.cm 28.83 sq.in

CHAMBER:

Length: 94.936 cm 37.4 in Volume: 26.14 liters 1594 cu.in
 Powder container: One bag

BALLISTICS:

Muzzle vel. (-- -lb proj.) 850 m/s 2790 f/s
 Muzzle vel. (-- -lb proj.) m/s f/s
 Max. bore pressure: 28.7-29 kg/sq.mm 18.5-19 long tons/sq.in
 Muzzle pressure: 5.0 kg/sq.mm 3.2 long tons/sq.in
 Projectile weight (--): 45.36 kg 100 lb; 2M/d³: 0.925
 Projectile weight (): kg lb; 2M/d³:
 Approximate charge weight: 12.76 kg 28.2 lb
 Ignition weight: 0.06 kg 0.133 lb
 Projectile travel: 667.05 cm 262.6 in
 Point of complete combustion: 19 cal. from muzzle
 Maximum range: 21,000 m 23,000 yards
 Maximum altitude: 10,000 m 10,940 yards
 Approximate life: 500-600 equivalent service rounds

YEAR OF DESIGN: about 1905.

SHIPS FITTED WITH: CL, AGANO class: BB, FUSO class, HARUNA class.

REMARKS: Type IV barrel is 10.5cm (4.1 in) shorter overall and breech face to muzzle;
 other data same. Older guns of this type were wirewound, made in England. There
 were also obsolescent English 6"/45 and 6"/40 cal. guns.

JAPANESE GUNS

DESIGNATION: Short, 5th Year Type

NOMINAL CALIBER: 8 cm Actual caliber: 7.62 cm 3 in
 LENGTH, CALIBERS: 25(23) cm Weight with breech mechanism: 300 kg 660 lb
 Length, breech face to muzzle: 178.04 cm 70.1 in Overall: -- cm -- in
 Type of construction: Monobloc, rear half radially expanded (Type IX6).
 Type of breech: Horizontal sliding.

RIFLING:

Number of grooves: 24 Twist: Uniform, 1 in 28 calibers
 Groove depth: 1.0 mm 0.04 in; width: -- mm -- in
 Length of rifling: -- cm -- in
 Bore cross section: 47 sq.cm 7.285 sq.in

CHAMBER:

Length: -- cm -- in Volume: 1.155 liters 70.5 cu.in
 Powder container: Case, fixed
 Assembled round weight: 8.5 kg. 18.8 lb.

BALLISTICS:

Muzzle vel. (-lb proj.) 450 m/s 1475 f/s
 Muzzle vel. (-lb proj.) -- m/s -- f/s
 Max. bore pressure: 16.6 kg/sq.mm 10.5 long tons/sq.in
 Muzzle pressure: 3.1 kg/sq.mm 2.0 long tons/sq.in
 Projectile weight (): 5.79 kg 12.7 lb; 2M/d³: 0.94
 Projectile weight (): -- kg -- lb; 2M/d³: --
 Approximate charge weight: 0.4 kg 0.88 lb
 Ignition weight: .02 kg .044 lb
 Projectile travel: 154 cm 60.7 in
 Point of complete combustion: 1 cal. from muzzle
 Maximum range: 7700 m 8400 yards
 Maximum altitude: 4700 m 5100 yards
 Approximate life: 1600 equivalent service rounds

YEAR OF DESIGN: 1930.SHIPS FITTED WITH: ATAMI class, SS, gunboats.REMARKS: Actually 23 cal. but generally designated 25 cal.

RESTRICTED

O-54(N)

JAPANESE GUNS

DESIGNATION: Short Gun, Type 41 etc.

NOMINAL CALIBER: 8 cm Actual caliber: 7.62 cm 3 in
 LENGTH, CALIBERS 25(23) cm Weight with breech mechanism: 316 kg 715 lb
 Length, breech face to muzzle: 178.04 cm 70.1 in Overall: 187.18 cm 73.7 in
 Type of construction: --
 Type of breech: --

RIFLING:

Number of grooves: 24 Twist: Uniform, 1 in 28 calibers
 Groove depth: 1.0 mm 0.04 in; width: 6.12 mm 0.241 in
 Length of rifling: 150.39 cm 59.9 in
 Bore cross section: -- sq.cm sq.in

CHAMBER:

Length: 24 cm 9.45 in Volume: 1.190 liters 72.6 cu.in
 Powder container: --

BALLISTICS:

Muzzle vel. (-lb proj.) 450 m/s 1475 f/s
 Muzzle vel. (-lb proj.) -- m/s f/s
 Max. bore pressure: kg/sq.mm long tons/sq.in
 Muzzle pressure: kg/sq.mm long tons/sq.in
 Projectile weight (): 5.67 kg 12.5 lb; 2M/d³: 0.93
 Projectile weight (): kg lb; 2M/d³:
 Approximate charge weight: kg lb
 Ignition weight: kg lb
 Projectile travel: 154 cm 60.7 in
 Point of complete combustion: cal. from muzzle
 Maximum range: m yards
 Maximum altitude: m yards
 Approximate life: equivalent service rounds

YEAR OF DESIGN:

SHIPS FITTED WITH: Type 41: BB NAGATO class, FUSO class.

REMARKS: Actually 23 cal but generally designated 25 cal. Dimensions as given are for Type VI and VIII barrels. Type I has 16 grooves, 0.6mm (0.024 in) deep; twist 1 in 25.59; chamber length 23.54cm (9.27 in); capacity 1,154 liters (70.5 cu.in). Types I and IV have length, breech face to muzzle, 175.83cm (69.3 in); length of rifling 148.18cm (58.4 in).

JAPANESE GUNS

DESIGNATION: YAMANOUCHI

NOMINAL CALIBER: 6 cm Actual caliber: 5.7 cm 2.24 in
 LENGTH, CALIBERS: -- cm Weight with breech mechanism: -- kg -- lb
 Length, breech face to muzzle: -- cm -- in Overall: -- cm -- in
 Type of construction: --
 Type of breech: --

RIFLING:
 Number of grooves: -- Twist: -- calibers
 Groove depth: -- mm -- in; width: -- mm -- in
 Length of rifling: -- cm -- in
 Bore cross section: -- sq.cm -- sq.in

CHAMBER:
 Length: -- cm -- in Volume: -- liters -- cu.in
 Powder container: --

BALLISTICS:
 Muzzle vel. (-lb proj.) -- m/s -- f/s
 Muzzle vel. (-lb proj.) -- m/s -- f/s
 Max. bore pressure: -- kg/sq.mm -- long tons/sq.in
 Muzzle pressure: -- kg/sq.mm -- long tons/sq.in
 Projectile weight (): -- kg -- lb; 2M/d3: --
 Projectile weight (): 66 kg -- lb; 2M/d3: --
 Approximate charge weight: -- kg -- lb
 Ignition weight: -- cm -- in
 Projectile travel: -- cal. from muzzle
 Point of complete combustion: -- m -- yards
 Maximum range: -- m -- yards
 Maximum altitude: --
 Approximate life: -- equivalent service rounds

YEAR OF DESIGN: --

SHIPS FITTED WITH: CV KAGA, CL ISUZU, gunboats.

REMARKS: Six-powder caliber.

RESTRICTED

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JAPANESE GUNS

DESIGNATION: Subcaliber Gun

NOMINAL CALIBER: 5 cm Actual caliber: 4.7 cm 1.85 in
 LENGTH, CALIBERS: 40 cm Weight with breech mechanism: -- kg -- lb
 Length, breech face to muzzle: 188.1 cm 74 in Overall: 204.8 cm 80.7 in
 Type of construction: --
 Type of breech: --

RIFLING:

Number of grooves: 20 Twist: -- calibers
 Groove depth: 0.40 mm .014 in; width: 5.5 mm 0.217 in
 Length of rifling: 148.2 cm 58.4 in
 Bore cross section: -- sq.cm -- sq.in

CHAMBER:

Length: 34.1 cm 13.4 in Volume: -- liters -- cu.in
 Powder container: --

BALLISTICS:

Muzzle vel. (-1b proj.) -- m/s -- f/s
 Muzzle vel. (-1b proj.) -- m/s -- f/s
 Max. bore pressure: -- kg/sq.mm -- long tons/sq.in
 Muzzle pressure: -- kg/sq.mm -- long tons/sq.in
 Projectile weight (): -- kg -- lb; 2M/d³: --
 Projectile weight (): -- kg -- lb; 2M/d³: --
 Approximate charge weight: -- kg -- lb
 Ignition weight: -- kg -- lb
 Projectile travel: 154 cm 60.6 in
 Point of complete combustion: -- cal. from muzzle
 Maximum range: -- m -- yards
 Maximum altitude: -- m -- yards
 Approximate life: -- equivalent service rounds

YEAR OF DESIGN:

SHIPS FITTED WITH:

REMARKS:

JAPANESE GUNS

DESIGNATION: Short Gun

NOMINAL CALIBER: 5 cm Actual caliber: 4.7 cm 1.95 in
 LENGTH, CALIBERS: 30 cm Weight with breech mechanism: 100 kg 220 lb
 Length, breech face to muzzle: 141 cm 48.3 in Overall: 155.75 cm 61.3 in
 Type of construction: --
 Type of breech: --

RIFLING:

Number of grooves: 20 Twist: 1 in 22.4 or 1 in 35 calibers
 Groove depth: 0.4 mm 0.016 in; width: 5.51 mm 0.217 in
 Length of rifling: 124.03 cm 48.9 in
 Bore cross section: -- sq.cm

CHAMBER:

Length: -- cm in Volume: 0.20 liters 12.2 cu.in
 Powder container: Case, fixed
 Assembled round weight: 1.5 kg. 3.3 lb.

BALLISTICS:

Muzzle vel. (-lb proj.) 455 m/s 1500 f/s
 Muzzle vel. (-lb proj.) 455 m/s 1500 f/s
 Max. bore pressure: 14.6 kg/sq.mm 9.3 long tons/sq.in
 Muzzle pressure: 1.4 kg/sq.mm 0.9 long tons/sq.in
 Projectile weight (): 1.1 kg 2.4 lb; 2M/d³: 0.76
 Projectile weight (): 1.1 kg 2.4 lb; 2M/d³: 0.76
 Approximate charge weight: .067 kg .15 lb
 Ignition weight: Primer 0.007 kg .016 lb
 Projectile travel: 0.007 kg .016 lb
 Point of complete combustion: minus 3 cal. from muzzle i. e. beyond
 Maximum range: minus 3 cal. from muzzle i. e. beyond
 Maximum altitude: minus 3 cal. from muzzle i. e. beyond
 Approximate life: minus 3 cal. from muzzle i. e. beyond
 equivalent service rounds

YEAR OF DESIGN:

SHIPS FITTED WITH:

REMARKS:

PART II - DESIGN AND CONSTRUCTION OF GUNS

In general, Japanese naval guns were of fairly old-fashioned design. Thus, for example, the 46cm (18.11 inch) guns for YAMATO class, designed in 1939, were wire-wound their full length, although they had also a radially-expanded liner. One noteworthy feature of the wire-wound and built-up guns was the use of silicon-steel Belleville springs (called "cunnular rings" by the Japanese) in the joints where the tubes changed diameter. These are shown in the blueprints of the wire-wound guns, and are described in a pamphlet found at YOKOSUKA (NavTechJap Document No. ND50-3421).

Another novel feature of Japanese big guns in which loading was to be accomplished at high angles of elevation was the use of ridges around the compression slope, to aid in gripping the projectile rotating bands and prevent the projectiles from slipping back after seating. This is described in another pamphlet (NavTechJap Document No. ND50-3963).

Ballistically, all but the latest Japanese naval guns were not outstanding. The exceptions are the 10cm (3.94 inch)/65 caliber gun, with a muzzle velocity of 3300 f/s, with projectile of $2M/d^3 = 0.94$; the 8cm (3 inch)/60 cal. gun, with muzzle velocity of 2950 f/s with projectile of $2M/d^3 = 0.98$, and the 15.5cm (6.10 inch)/60 caliber gun, with muzzle velocity of 3120 f/s with projectile of $2M/d^3 = 1.09$. These guns, however, had a relatively short life, a consideration perhaps not so important to the Japanese operating near home waters as it would be to other navies. In fact the gun-life figures for all Japanese guns seem short; possibly the use of cordite as propellant is responsible. No Japanese naval guns of the calibers treated in this report were chromeplated.

A different direction of development was taken in the 12.7cm (5 inch)/50 caliber, Type 5, case gun under development at the end of the war. With this gun the projectile weight was increased from 50.8lb to 59.6lb, with the muzzle velocity only slightly decreased from that of the 1926 vintage 12.7cm (5 inch)/50 caliber big gun, resulting in increased range and fragment effectiveness.

In some cases, powders were poorly matched to the gun. For example, the 12cm (4.72 inch)/45 caliber gun, 10th Year Type, used long solid rods of the same granulation made for the 12.7cm (5 inch)/50 caliber and 14cm (5.5 inch)/40 caliber guns. When the 12cm propellant type was changed to single-perforated short grains ("short tubite" to the Japanese), it was found possible to increase the projectile weight without increasing muzzle velocity or maximum bore pressure, and the maximum range of the gun was thereby increased from 17,500 to 21,900 yards.

The pamphlets relating to guns and gun construction are listed in Enclosure (A) and have been forwarded separately to the Washington Document Center. Enclosure (B), prepared by M. TSUKASAKI, formerly a lieutenant-commander, IJN, and in charge of the gun shops at KURE Naval Arsenal, describes the manufacturing processes for the three principal types of Japanese naval guns, namely wire-wound, built-up and monobloc.

PART III - SUBSTITUTE STEEL FOR GUNS

A. HISTORY AND JAPANESE EVALUATION

The project of developing a substitute steel for gun barrels was initiated because of the shortage of nickel in Japan during World War II. Similar projects aimed at reducing the nickel content of armor plate and projectiles were part of an overall program, similar to that of the U.S. steel manufacturers (war emergency steels) in reducing the alloy content or use. However, in the

Japanese program, nickel was the most critical element and its reduction was sometimes accomplished at the expense of having to increase or add other alloying elements. In the case of the gun barrel "substitute" steel, the nickel content was reduced to a minimum of 1.5 % for experimental purposes and to 1.7 % for production, but in the case of armor it was eliminated completely in some types except for residual quantities. Other than accomplishing the objective, no advantages were claimed for the "substitute" steel over the standard type formerly used. A minor disadvantage was a small decrease in machineability.

B. USE

The largest caliber gun to be made from "substitute" steel was a single experimental model of 20cm size. In mass production, the case of this steel was limited to medium caliber guns of the following sizes and types and was used almost exclusively after about July 1943.

40/12.7cm	Types 88 and 89 - monobloc construction
45/12cm	10th and 11th Year Type - monobloc and built up construction
45/12cm	1940 design AA land gun (no name) - monobloc construction
25(23 actual)/8cm	Short, Type 41 - construction unknown
60/8cm	Type 98 AA - monobloc construction

C. CHEMICAL COMPOSITION AND MECHANICAL PROPERTIES

1. Composition of "Substitute" Steel

a. Type "Mark 68" (Japanese designation) for Monobloc Guns and the Inner Tube of Built-Up Guns

C	Si	Mn	P	S	Ni	Cr	Cu	Mo
0.3	0.25	0.5	0.035	0.035	1.7	1.2	0.2	0.3

b. Type "Mark G7" for the Outer Tube of Built-Up Guns

C	Si	Mn	P	S	Ni	Cr	Cu	Mo
0.3	0.25	0.5	0.035	0.035	1.7	1.2	0.2	--

2. Composition of Standard Steel for Comparison

a. Type "Mark GI" for the Inner Tube of Built-Up Guns

C	Si	Mn	P	S	Ni	Cr	Cu	Mo
0.3	0.35	0.5	0.035	0.035	3.5	0.7	0.2	--

b. Type "Mark GO" for the Outer Tube of Built-Up Guns

C	Si	Mn	P	S	Ni	Cr	Cu	Mo
0.35	0.25	0.5	0.035	0.035	1.5	0.03	0.2	--

3. Mechanical Properties

Yield strength	47 kg/mm ² (66,800 psi)
Ultimate strength	66 to 82 kg/mm ² (93,800 to 116,300 psi)
Elongation	16%
Reduction of area	25%
Impact value (Izod)	20 ft-lb
Hardness - minimum	200 BHN
maximum	not specified

The location of test specimens is shown in the following sketch:

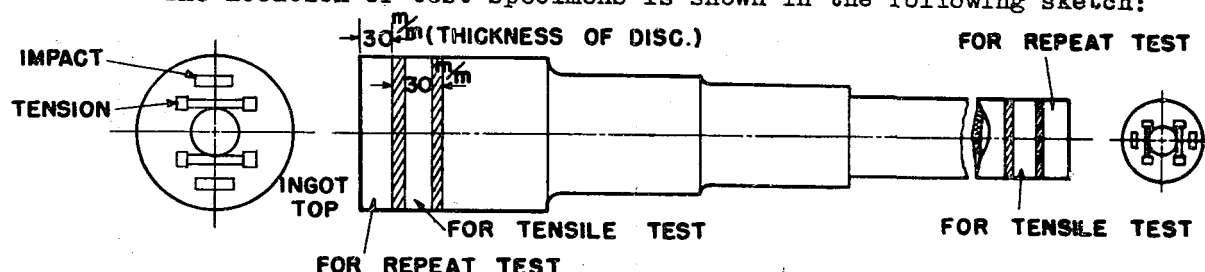


Figure 1

LOCATION OF TEST SPECIMENS

D. MANUFACTURING PROCEDURE AND DATA FOR THE 45/12cm 1940 DESIGN OF AA LAND GUN (NO NAME) MADE FROM "SUBSTITUTE" STEEL

1. Ingot Production

- Type of furnace - acid open hearth of approximately 50 metric tons (55 short tons) capacity.
- Type of ingot - inverted cone type with octagonal cross section. The weight of the ingot was 12 metric tons (13.2 short tons). The size and shape are shown in the following sketch:

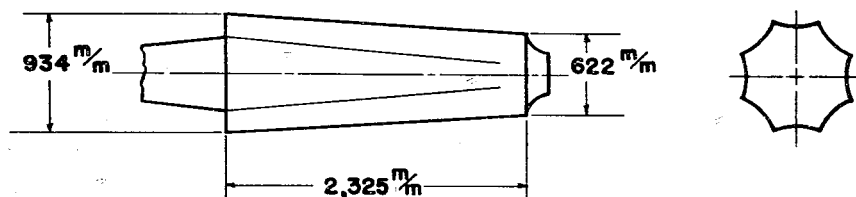


Figure 2

INGOT

2. Forging Operations

- First heating - The ingot was stripped from the mold approximately four hours after pouring and then put into a heating furnace employing producer gas as the fuel. After increasing the temperature during a six hour period to a value of 1250°C (2282°F), the temperature was held for four hours.
- First forging - The ingot was roughly forged to produce an approximately circular cross section. Using a 2000 metric ton (2200 short ton) press, 30% (by weight) from the top end and 5% from the bottom end was cut off. The temperature at the end of the operation was approximately 800°C (1472°F).

c. Second heating - Same as the first except only four hours were required to reach 1250°C (2282°F) and the rough forging was held at this temperature for only two hours.

d. Second forging - The shape was changed to the following:

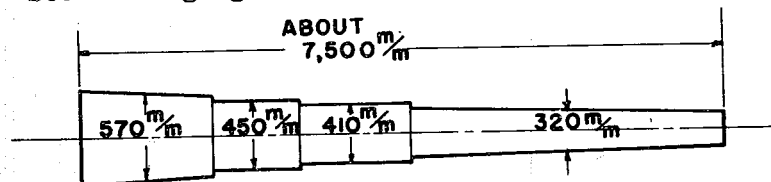


Figure 3
SECOND FORGING

3. Annealing

Immediately after forging, the gun barrel was put into an annealing furnace and heated to 800°C (1472°F). The barrel was held at this temperature for 10 hours, after which it was allowed to cool to 300°C (572°F) during a 30 hour period.

4. Rough Machining

The barrel was shaped to the following size on a turning lathe, and then bored, resulting in a weight of about four metric tons (4.4 short tons) at the end of the operation:

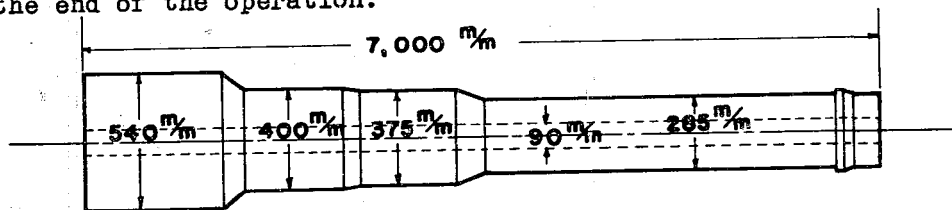


Figure 4
FINAL DIMENSIONS OF BARREL

5. Heat Treatment

a. Hardening - Using a car-type furnace and coal as the fuel, the barrel was gradually heated to 850°C (1562°F) and held there for $2\frac{1}{2}$ hours. It was then quenched in oil (rape seed) until the temperature had been lowered to 100°C (212°F). The oil temperature at the start of the quenching was 45°C (113°F).

b. Tempering - The tempering operating and equipment was similar to the above except that the temperature to which the barrel was heated was about 625°C (1157°F) and the length of time it was held at this temperature was about $4\frac{1}{2}$ hours.

6. Smooth Machining

The usual machining operations followed, as described in Enclosure (B).

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ENCLOSURE (A)

LIST OF DOCUMENTS FORWARDED THROUGH ATIS TO THE WASHINGTON DOCUMENT CENTER

<u>NavTechJap No.</u>	<u>ATIS No.</u>	<u>Subject</u>
<u>Guns in general:</u>		
ND50-3478	4368	MS pamphlet on guns, 3" to 18", Oct. 1945.
ND50-3404	4256	Powder and ammunition components used for various guns. Dec. 1934.
ND50-3479	4570	Sheet of gun and ammunition data. March 1942
ND50-3480	4571	MS sheet of ballistic data on guns. Dec. 1945.
ND50-3481	4572	MS sheet of gun data. Dec. 1945.
<u>Blueprints, etc:</u>		
ND50-3460	4252	Blank star gauge sheets, 5cm to 36cm; recent.
ND50-3418	4269	Blueprints of 12cm gun, 13th Year Type.
ND50-3420	4271	Blueprints of 12.7cm/40 cal. gun, Type 88.
ND50-3419	4270	Blueprints of 12.7cm/40 cal. gun, 3rd Year Type.
ND50-3400	4366	Blueprint of 12.7cm/50 cal. gun, 3rd Year Type.
ND50-3421	4272	Blueprints of 14cm/50 cal. gun, 3rd Year Type.
ND50-3417	4268	Blueprints of 40cm/45 cal. gun, 3rd Year Type.
ND21-3428	3830	Measuring area and center of gravity of projectiles.
<u>Gun Construction (Forging, etc.):</u>		
ND50-3455	4247	Manufacture of thick gun sections by pierce-forging. 1938.
ND21-3415	4236	Forging of breech ring. (Forging to close tolerances to reduce machining) 1942.
ND21-3405	4233	Improvements in barrel construction. 1934.
<u>Defects:</u>		
ND50-3467	4355	Tests to determine causes of longitudinal cracks in MURORAN nickel chrome steel gun barrels. 1933.
ND503408	4258	Investigation of defects in 12cm gun barrel surfaces in KAGO. 1934.
<u>Strength Calculations:</u>		
ND50-3477	4363	Research on strength of gun barrels. 1931.
ND50-2475	4361	Strength calculations in guns with separate liners. 1931.
ND50-3442	4222	Research on strength on gun barrels. 1937.
<u>Radial Expansion and Autofrettage:</u>		
ND50-3406	4259	Experiments with autofrettage hydraulic compression. 1928.
ND50-3458	4250	Physical experiments on autofrettaged barrels. 1929.
ND50-3444	4221	Basic research on autofrettage (technique of measuring pressures involved). 1929.
ND50-3451	4286	Report on autofrettage. 1929.

ENCLOSURE (A), continued

ND50-3452	4287	Basic research on autofrettaged guns. 1929.
ND50-3450	4285	Radial expansion of 20cm gun barrel. 1921.
ND50-3453	4245	Radial expansion tests in gun barrels. 1934.

Wire:

ND50-3454-	4246	Heat treatment and tensile strength of gun wire. 1935.
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Rifling:

ND50-3401	4253	Experimental rifling cutting. 1933.
ND50-3465	4292	Procedure for rifling a tapered barrel. 1937.

Projectile Seating:

ND50-3963	4294	Investigation of preventing projectiles from slipping down in the chamber. 1929.
ND50-3448	4283	Erosion of 20cm barrels and the force necessary to seat projectiles. 1933.
ND21-3405	4233	20cm projectile ejector (for removing projectiles stuck in loading drill). 1943.

Gas Checks and Obturators:

ND50-3975	4367	Experiments on gas checks for various kinds of guns below 20cm.
ND50-3410	4262	Methods of manufacturing obturators. 1935.

Breech Mechanisms, etc.:

ND50-3471	4359	Investigation of breech plugs (proper pitch of threads, etc., for screw-type breeches). 1931.
ND50-3409	4261	Experiments on breech stop (to reduce galling of the part). 1934.
ND50-3411	4263	Experiments on 3rd Year Type 12cm gun firing pin. 1934.
ND50-3407	4260	Research on breech screw lubricants. 1935.
ND50-3412	4353	Technical report on primer lock and pistol firing pin. 1937.
ND50-3972	4297	Modification of breech stopper of 12.7cm/50 cal. gun, 3rd Year Type. 1937.
ND50-3469	4357	Experiments on motive force of 36cm firing device ejectors. 1937.

Submarine guns:

ND50-3464	4291	Anti-rust springs for submarine guns. 1937.
ND21-3407	4234	Modification of submarine guns (elimination of case sticking from corrosion). 1942.

Miscellaneous:

ND50-3971	4296	Design and operation of 12.7cm twin AA gun type 89 (part 3). (Chiefly details of case design). 1932.
ND50-3463	4290	Air blast ejector tests (air flow through a gun barrel). 1936.
ND50-3466	4293	Measure of bending of 20cm/50 cal. guns (3rd Year Type) due to heating by sun. 1936.

ENCLOSURE (B)

GUN BARREL MANUFACTURE
(Compiled by M. TSUKASAKI, former Chief
Officer, Gun Shop, Kure Naval Arsenal.)

1. Gun Elements

- a. Forged gun elements are bored and turned.
- b. Roughly bored and turned gun elements are then quenched and tempered. The data on the heat-treatments are as follows:

Quenching temperature 850°C (1560°F)
Tempering temperature 550° to 650°C (1020°-1200°F)
Quenching oil Colza oil

- c. The heat-treated gun elements are two to three times heavier than the finished gun barrel.

- d. Two tensile test pieces and two shock test pieces are taken from each end of gun elements and physically tested by naval inspectors.
Specification of Physical Tests:

	Materials	
	G ₀	G ₁
Elastic limit, kg/mm ² (psi)	over 33.07 (47,000)	over 47.25 (67,000)
Tensile strength, kg/mm (psi)	53.55-69.29 (76,000-98,000)	70.87-86.62 (100,000-123,000)
Elongation	over 17%	over 16%
Contraction	over 30%	over 30%
Shock value, Izod, ft/lb	over 15	over 20

- e. For gun elements to be autofrettaged, three more tensile test pieces are taken at 150mm inside the ends of gun elements. These tensile test pieces are called Elastic Test Pieces, and the specifications of these tests are 10% less than those in paragraph 1d. Data obtained from the test, i.e., elastic limit and b-coefficient, are considered as authentic for autofrettage practice.

- f. Upon approval of naval inspectors, the gun elements are stamped with serial number and "Good" mark.

2. Monobloc Guns (Example: 45 Caliber 12cm (47in) AA Gun)

- a. Autofrettage tube

- (1) Boring - Gun elements are bored to a diameter of 10mm (0.4in) less than that of the finished gun barrel.
- (2) Turning.
- (3) Chambering.

ENCLOSURE (B), continued

b. Autofrettage

- (1) Autofrettage of rear part of autofrettage tube - Autofrettage pressure is determined as follows:

$$P_a = 52.5 \times Fe / 50 \text{ kg/mm}^2 = 1.05 Fe$$

Where Fe: Elastic limit of the respective gun elements obtained from the elastic tests.

- (2) Autofrettage of forepart of autofrettage tube - Autofrettage pressure is determined as follows:

$$P_a = 42 \times Fe / 50 \text{ kg/mm}^2 = 0.84 Fe$$

c. Soaking

Radial expanded autofrettage tubes are then soaked at 300°C (570°F)

d. Machining to finish gun barrel

- (1) Rough turning

Cutting speed 40 m/min (130 ft/min)
 Cutting depth 10mm to 15mm (0.4 to 0.6 in)
 Cutting feed 1mm to 1½mm (.04 to .06 in)

- (2) Rough boring

Cutting speed 20 m/min (65 ft/min)
 Cutting depth 4mm (0.16 in)
 Cutting feed 0.8mm (.03 in)

- (3) Fine boring - Four cutters are used in tandem

- (4) Chambering

- (5) Rifling - Four cutters engrave twelve grooves simultaneously

Cutting speed 10 m/min (33 ft/min)
 Cutting depth 0.01 to 0.05mm (.0004 to .002 in)

- (6) Fine turning

Cutting speed 60 m/min (200 ft/min)
 Cutting depth 2 to 4mm (.08 to .16 in)
 Cutting feed 0.8mm (.03 in)

- e. Coupling with breech ring

- f. Assembling with breech mechanism and firing lock

- g. Inspection

- h. Proof firing

3. Built-up Guns (Example: 50 Caliber 12.7cm (51n) Gun)

a. 2A tube

- (1) Boring - Gun element is fine bored with tolerance of + 0.08mm to 0.00mm (+ .003 to .000 in).

ENCLOSURE (B), continued

b. 1A tube

- (1) Rough boring - Gun element is bored leaving the diameter 10mm (0.4 in) less than that of finished gun barrel.
- (2) Fine turning - The tube is then turned off to have the diameter required with tolerance of $\pm 0.05\text{mm}$ (.002 in). The outer diameters of 1A tube are determined to be bigger by the shrinkage amount, i.e., 0.1 to 0.25%, than the respective measured inner diameters of 2A tube.

c. Building-up

- (1) 2A tube is heated up to 800°F in furnace.
- (2) 1A tube is erected upright in shrinking pit. Heated 2A tube is then put on 1A tube, and cooled by water jet from the breech end to muzzle. It depends only upon the decision of the Chief Officer of the Gun Shop whether the cooling water inside 1A tube is applied or not.

d. Fine boring.

e. Chambering.

f. Rifling. Four cutters are used, cutting eight grooves simultaneously.

g. Fine turning.

h. Coupling with breech ring.

i. Housing breech box.

j. Planing up keys.

k. Assembling with breech mechanism and firing lock.

l. Inspection.

m. Proof firing.

4. Wire Wound Guns (Example: 50 Caliber 20cm (8 in) Gun)

a. 2A tube.

- (1) Rough boring - Gun element is bored leaving the inner diameter ca. 10mm (0.4 in) less than scheduled.
- (2) Fine turning.

b. 4A tube.

- (1) Fine boring.

c. Wire winding on 2A tube - Gun wire is wound on 2A tube with tension of 55kg/mm² (79,000 psi). Dimensions of gun wire are as follows:

Width 6.35mm (0.25 in)
 Thickness 1.524mm (0.060 in)
 Tensile strength over 102.37kg/mm² (178,000 psi)

d. Building up 4A tube on wire wound 2A tube with shrinkage - Heating temperature of 4A tube is 800°F. Shrinkages between 4A and wire wound 2A tube are 0.1 to 0.25%.

e. 4AW2A tube.

- (1) Fine boring - Rear part of the tube is bored cylindrically, and forepart in taper with tolerance of 0.08 to 0.00mm (.003 to .000 in)

- (2) Fine turning.
- f. 1A tube.
 - (1) Boring and chambering - The tube is bored and chambered as described under autofrettage.
 - (2) Fine turning - The tube is turned to have the diameters the same as the measured inner diameters of 4AW2A with tolerance of 0.05mm (.002 in)
- g. Inserting 1A in 4AW2A - 4AW2A is erected upright, muzzle at bottom, in the shrinking pit, and then 1A is inserted slowly into 4AW2A. To secure 1A tube in scheduled position, an iron block weighing five tons dropped from a height of 500mm to 100mm (4 to 20 in) is used.
- h. Hydraulic pressure test. On the 4AW2A1A tube is applied hydraulic pressure, ca. 5kg/mm² (7000 psi) to ensure contact between 4AW2A and 1A.
- i. 4AW2A1A tube
 - (1) Fine boring.
 - (2) Chambering.
 - (3) Rifling.
- j. Coupling with Breech Ring.
- k. Housing Breech Box.
- l. Assembling with Breech Mechanism and Firing Lock.
- m. Inspection.
- n. Proof-Firing.