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U. S. NAVAL PROVING GROUND

DAHLGREN, VA.

NPG-

REPORT NO. 5-43.

EXAMINATION OF JAPANESE EQUIPMENT
37mm ANTI-TANK AMMUNITION
3-INCH A.A. AMMUNITION
75mm HOWITZER AMMUNITION
50mm MORTAR PROJECTILE
50mm MORTAR GRENADE

March 24, 1943.

NAVAL PROVING GROUND
Dahlgren, Virginia

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75mm HOWITZER AMMUNITION

50mm MORTAR PROJECTILE

50mm MORTAR GRENADE

NAVAL PROVING GROUND, DAHLGREN, VIRGINIA
(9) CAPTURED ENEMY EQUIPMENT
REPORT NO. 57

APPROVED:

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CAPTAIN, USN,
INSPECTOR OF ORDNANCE IN CHARGE

CLASSIFICATION (CANCELLED) (~~CHANGED TO~~) Unclassified
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ON 7/1/52 (DATE) B. Brayton (SIGNATURE) (RANK)

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PREFACE

AUTHORIZATION

Specific directives for these investigations were issued in Buord ltr Relb QW19 dated December 30, 1942.

OBJECT

To make a complete physical, chemical and metallurgical examination of the following Japanese equipment:

37mm Anti-tank ammunition.

3-inch A.A. ammunition.

75mm Howitzer ammunition.

50mm Mortar projectile.

50mm Mortar grenade.

I N D E X

I

EXAMINATION OF ONE ROUND OF JAPANESE 37mm ANTI-TANK AMMUNITION

SUMMARY

This projectile was machined from plain carbon steel bar stock, normalized and nose hardened. A complete description of the analysis, hardness and microstructure is presented; the heat treatment used is discussed.

The chemical composition, hardness and microstructure of the fuze components have been investigated and the fuze action is described.

The decoppering foil of this ammunition is found to be a 60-40 tin-lead alloy weighing .039 ounces.

CONTENTS

NPG PHOTO NO. 551 (APL) - Examination of Metals from Enemy Weapons. Report No. 57. Round of Japanese 37 mm. anti-tank ammunition showing component parts. Projectile, base detonating fuze, de-coppering foil and cartridge case.
4 February, 1943.

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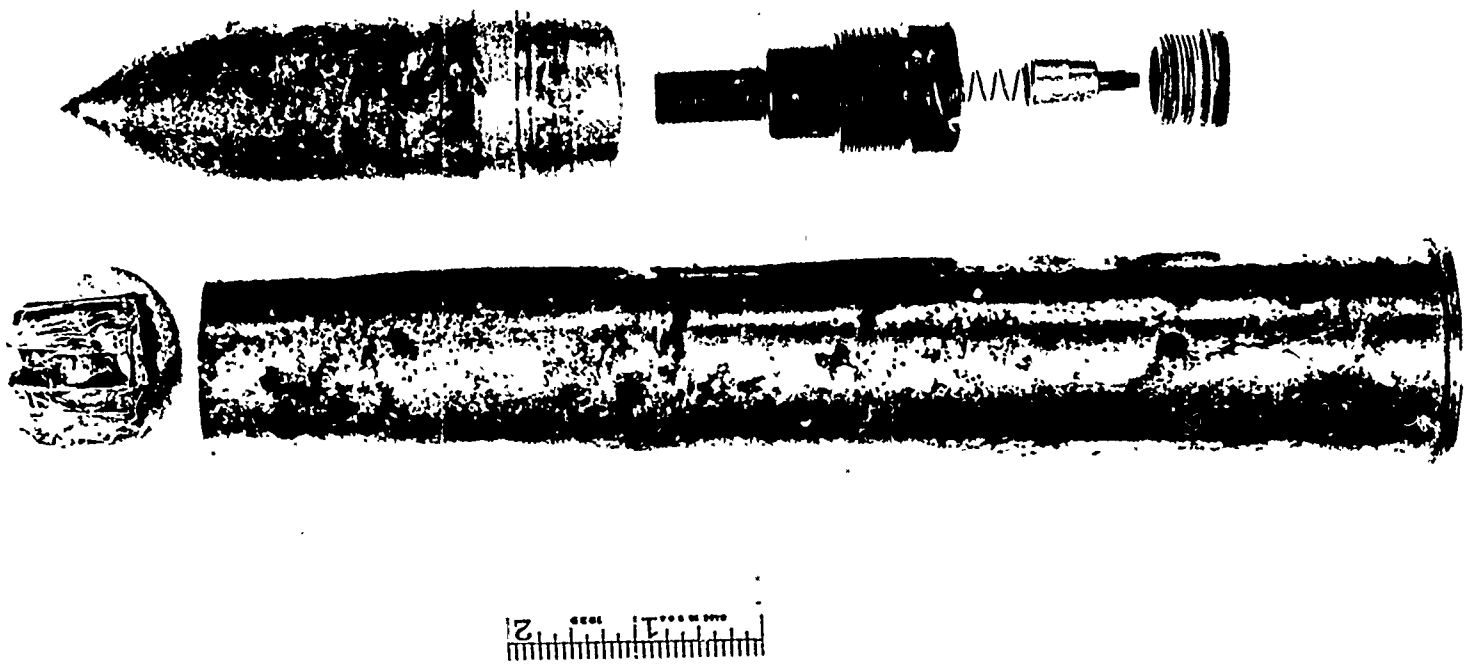

[illegible] No. 865 (APL) - Examination of Metals from Enemy Weapons. Report No. 57. Component parts of Japanese 37 mm. anti-tank projectile. 4 February 1943.

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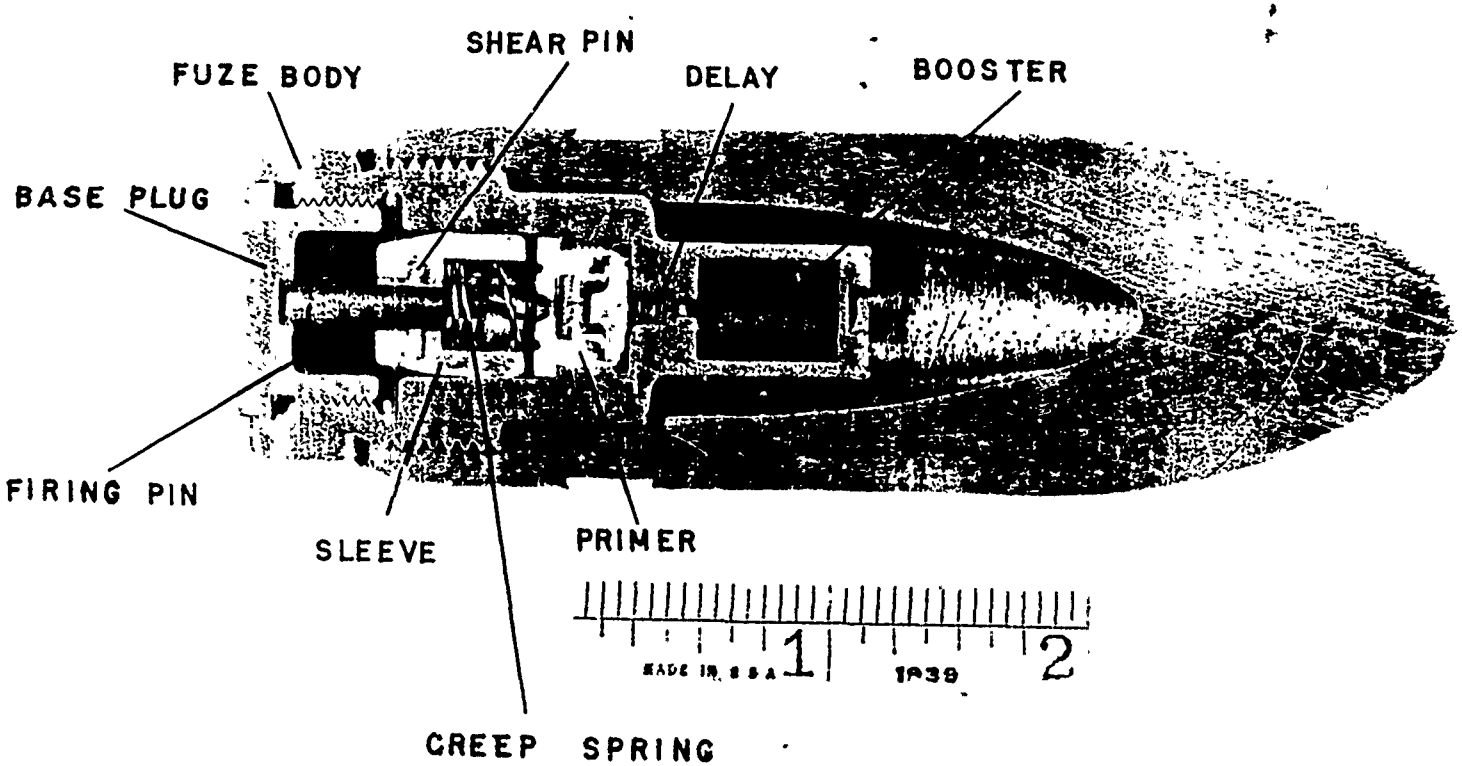
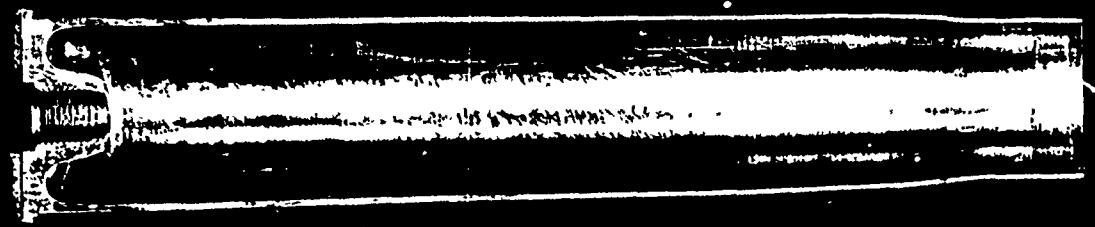


NPG PHOTO NO. 606-A (APL) - Examination of Metals from Enemy Weapons.
Report No. 57[illegible], Cross section Japanese 37mm cartridge case,
4 March, 1943.



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A INTRODUCTION.

A complete round of Japanese 37mm anti-tank ammunition was received by the Naval Proving Ground for physical, chemical and metallurgical examination. The following is a report of this investigation, in accordance with the directives.

B INVESTIGATION.

PHYSICAL.

NPG Photo. No. 551 (APL) shows the component parts of this ammunition; an uncapped 37mm projectile, a base detonating fuze, decoppering foil and a large brass cartridge case. NPG Photo. No. 605 (APL) shows this projectile and fuze in cross section.

The projectile has a very small capacity, only .825 cu. in. for filler; most of the cavity being taken up by the unusually large fuze. This fuze has evidently been adapted from a larger projectile. The fuze action is as follows:

Set back - The brass sleeve flies to the rear, shearing the copper shear pin and wedging firmly on the firing pin taper; firing pin and sleeve now form one unit.

Flight - The firing pin-sleeve unit is restrained from moving forward by the creep spring.

Impact - The firing pin-sleeve unit flies forward and the firing pin strikes the primer, setting off the delay element (short) and subsequently the booster charge.

CHEMICAL ANALYSIS OF JAPANESE 37mm ANTI-TANK AMMUNITION

TABLE A

Component	C	P	S	Mn	Si	Ni	Cr	Mo	Va	Ti	Zr	W	Co	B	Sn	Cu
Projectile Body	.59	.023	.026	.79	.28	.05	NT	T	NT	NT	NT	NT	NT	NT	NT	T
Projectile Base Plug	.35	.042	.028	.98	.28	.08	.07	T	NT	NT	NT	NT	NT	NT	NT	T
Fuze Body	.35	.042	.028	.70	.17	.08	.07	T	NT	NT	NT	NT	NT	NT	NT	T
Firing Pin	-	-	-	.58	.05	.08	.07	NT	NT	NT	NT	NT	NT	NT	T	T

	Cu	Zn	Sn	Pb	Ni	Al	Fe	Ag
Rotating Band	~100				T	T	T	T
Cartridge Case	61.9	38.5	T	.05	NT	.004	.50	T
Sleeve	*	*	T	T	NT	NT	NT	T
Foil	NT	.31	59.5	40.2	NT	NT	NT	NT

T = Trace.
NT = No Trace.
* = Predominant in spectrochemical analysis.

The decoppering foil is held in the cartridge case by means of a cardboard disk, to which it is attached by a substance resembling shellac. This foil weighed 1.065 grams. (039 oz.)

The projectile was painted black and is identified by a yellow band approximately 1/2 inch wide located immediately behind the bourrelet and a white band of the same width immediately in front of the rotating band. The fuze carried the following markings:

[illegible]

The cartridge case is of conventional design, NPG Photo. No. 606 (APL) shows the longitudinal section of this case.

CHEMICAL ANALYSIS.

Chemical analyses of all components are listed in Table A. Steel analyses are spectrochemical excepting carbon phosphorus and sulphur which have been obtained by standard wet chemical methods.

METALLURGICAL EXAMINATION.

This examination entailed a study of the manufacture and heat treatment of the projectile with the resulting distribution of hardness and microstructure. The hardness and microstructure of the fuze were also investigated.

A deep etch of the cross section of the projectile showed that it was machined from bar stock. NPG Photo. No. 610 (APL) shows a lightly etched cross section of this projectile; the nature of the heat treatments are clearly indicated. A study of the microstructure and hardness of the zones delineated by the light etch indicated that:

1. The lightly etched region on the nose surface represents a tempered martensitic structure of high hardness, 62 R.C. (80 Shore).

2. The deeply etched region in the center of the nose and extending to the cavity represents a structure arising from a partial reaction of the austenitized matrix to pearlite and martensite. The hardness varies from 55 R.C. (73 Shore) at the interface of the wholly martensitic region to 25 R.C. (40 Shore at the cavity; at this point the structure is entirely pearlitic.

3. The remainder of the body and base, which show

NPG PHOTO NO. 610 (AFL) - Examination of Enemy Weapons.
Report No. 57. Cross section of Japanese 57 mm. anti-tank projectile; lightly etched to show nature of heat treatments.
Etch: 5 minutes in Picral.
4 February, 1943.

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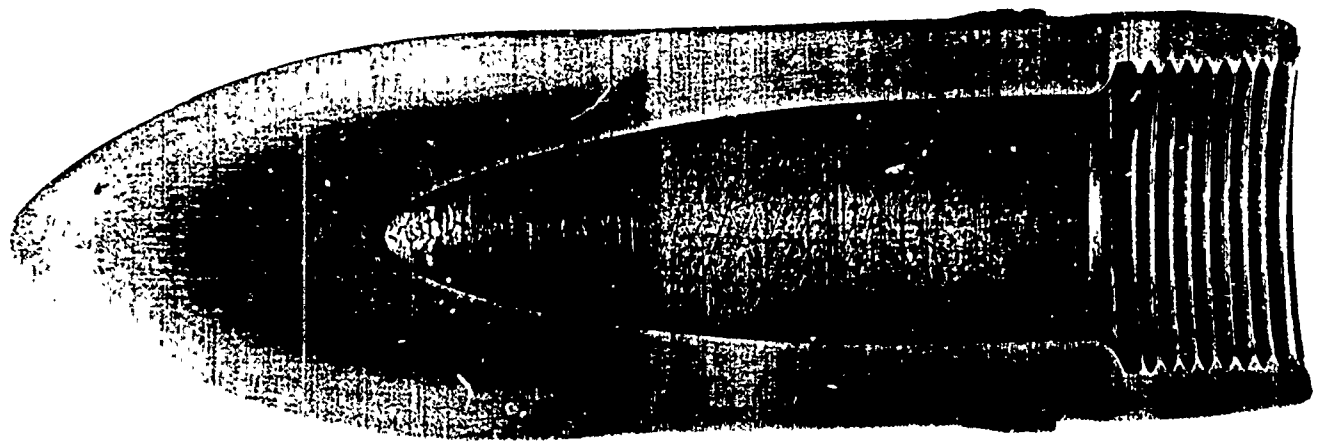

even etching, represents a zone having a uniform hardness of 25 R.C. (40 Shore) and a normalized structure. The interface of this zone and the darkly etched zone shows almost complete spheroidization of this normalized structure. It would appear that the projectiles were heat treated as follows:

(1) Normalized by holding at approximately 1400° F and air cooling.

(2) Nose hardened by dipping 2-1/8 inches of the nose into a lead alloy pot held at approximately 1500° F for a definite time, followed by a timed oil quench.

(3) Tempered at approximately 300° F.

The structure and hardness of the fuze components were found to be as follows:

Fuze Plug	Normalized structure,	90 R_B
Fuze Body	" "	20 R_C
Firing Pin	" "	80 R_B

C DISCUSSION.

On the basis of the distribution of the hardness and microstructure found in this projectile, it is believed that a serious weakness exists at a point immediately behind the bourrelet. (The hardness falls abruptly from 62 R.C. (80Shore) to 25 R.C. (40Shore)) which should cause this projectile to fail at this point on impacts involving appreciable obliquities.

II

EXAMINATION OF ONE ROUND OF JAPANESE 3-INCH A.A. AMMUNITION.

SUMMARY

The projectile of this ammunition was found to have been made from nickel-chrome steel by forging and then normalizing.

This ammunition uses a decopperizing foil of a tin-lead 60-40 alloy, weighing .096 ounces.

Complete chemical and metallurgical analyses for all components are presented.

CONTENTS

TABLE A

CHEMICAL ANALYSIS OF JAPANESE 3-INCH A.A. AMMUNITION

Component	Analysis														
	C	P	S	Mn	Si	Ni	Cr	Mo	Va	Ti	Zr	W	Co	B	Cu
Projectile	.48	.019	.011	.46	.35	.85	.25	T	NT	NT	NT	NT	NT	NT	T
Base Plug	.58	.042	.034	.82	.28	1.50	.48	T	NT	NT	NT	NT	NT	NT	T

	Cu	Zn	Sn	Pb	Al	Ni	Fe	P	Sb
Booster Cup	57.40	40.40	NT	.28	.34	NT	.66	T	-
Fuze	59.90	39.90	NT	.16	.02	NT	.02	T	-
Cartridge Case	70.30	29.90	NT	NT	NT	NT	NT		
Foil	T	.30	61.70	38.10	NT	NT	-	-	NT
Gaskets	Pure copper.								
Rotating Band	Pure Copper.								

T = Trace.

NT = No Trace.

NPG PHOTO NO. 548 (APL) - Examination of Metals from Enemy Weapons. Report No. 57. Japanese 3 inch AA cartridge case. The cardboard disk shown fits into the mouth of the case and serves to hold the decoppering foil.
4 February, 1943.

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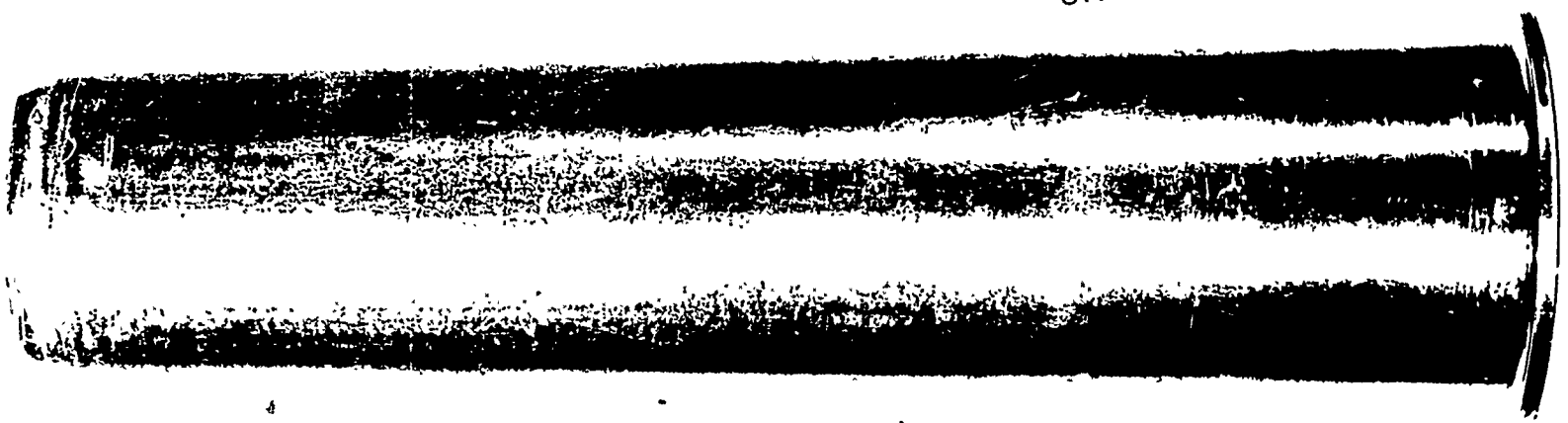
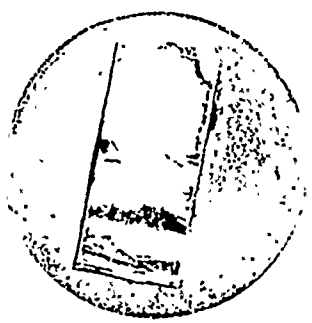
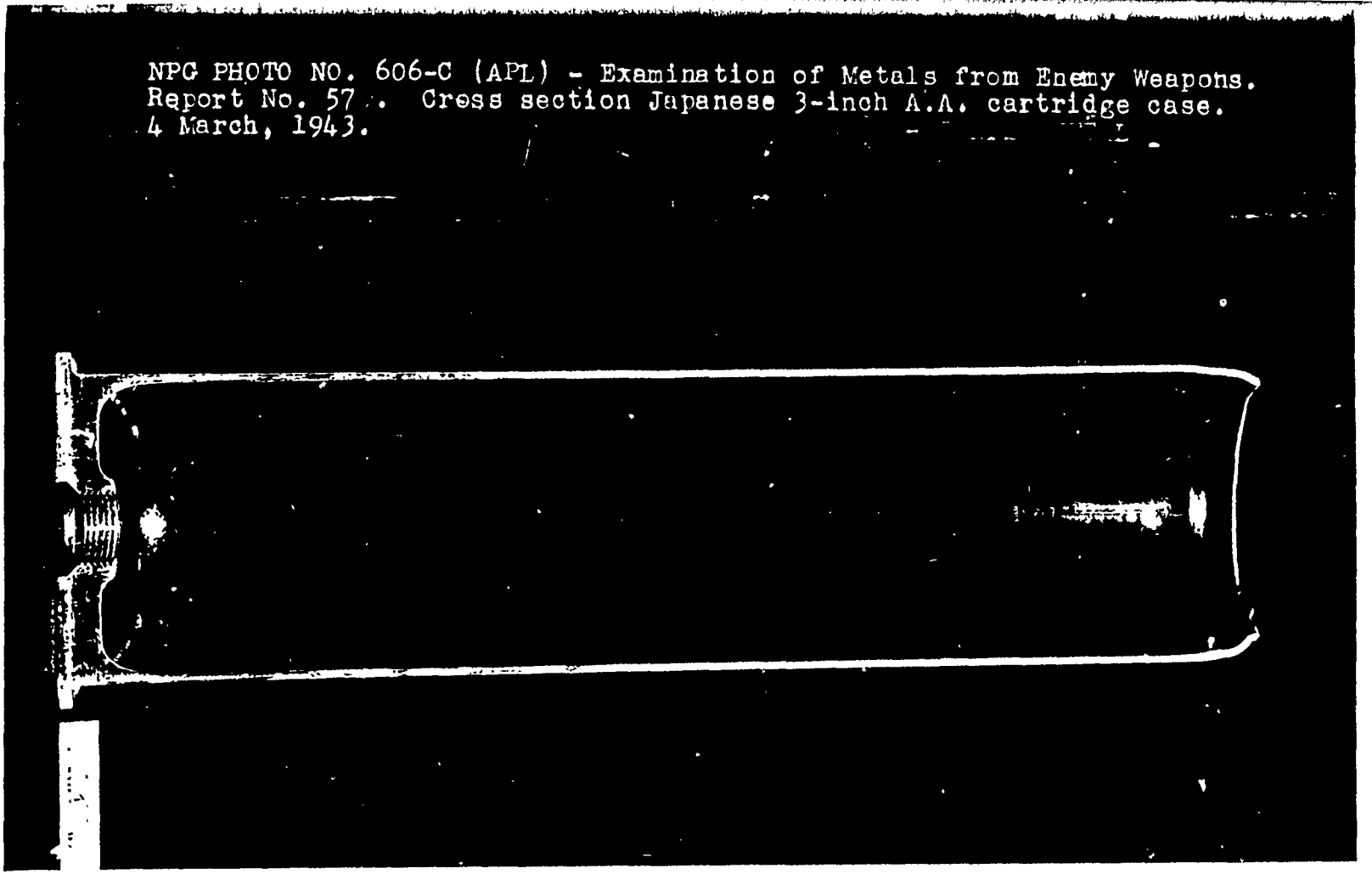




NPG PHOTO NO. 606-C (APL) - Examination of Metals from Enemy Weapons. Report No. 57 . Cross section Japanese 3-inch A.A. cartridge case. 4 March, 1943.



NPG PHOTO NO. 629 (APL) - Examination of Metals from Enemy Weapons.
Report No. 57. Component parts of Japanese 3 inch AA fuze.
4 February, 1943.

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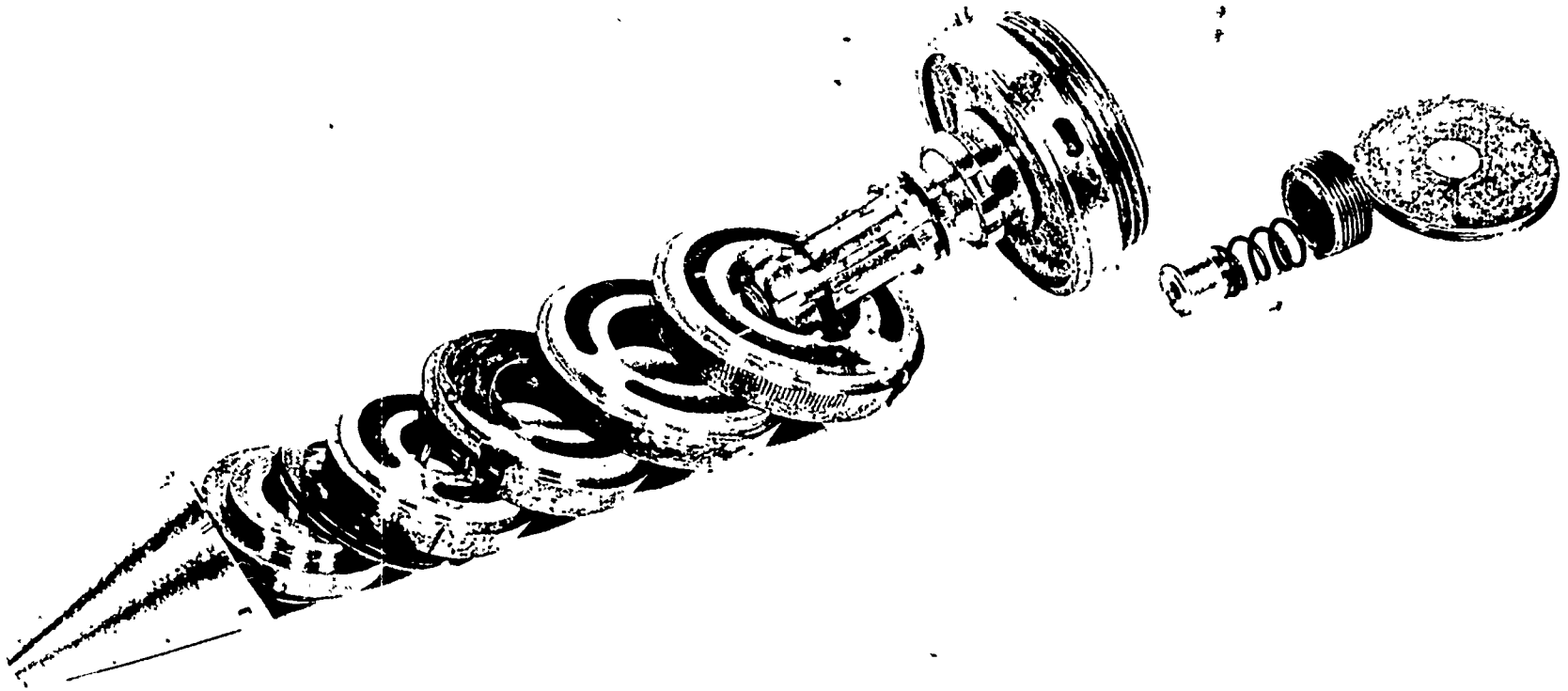

NDG PHOTO N., 251 (A&E) - Examination of Metals from Enemy Weapons.
Report No. 57. Cross section of Japanese 3 inch A.A. Projectile.
Note wood section in base plug to prevent pressure detonation

4 February, 1943.

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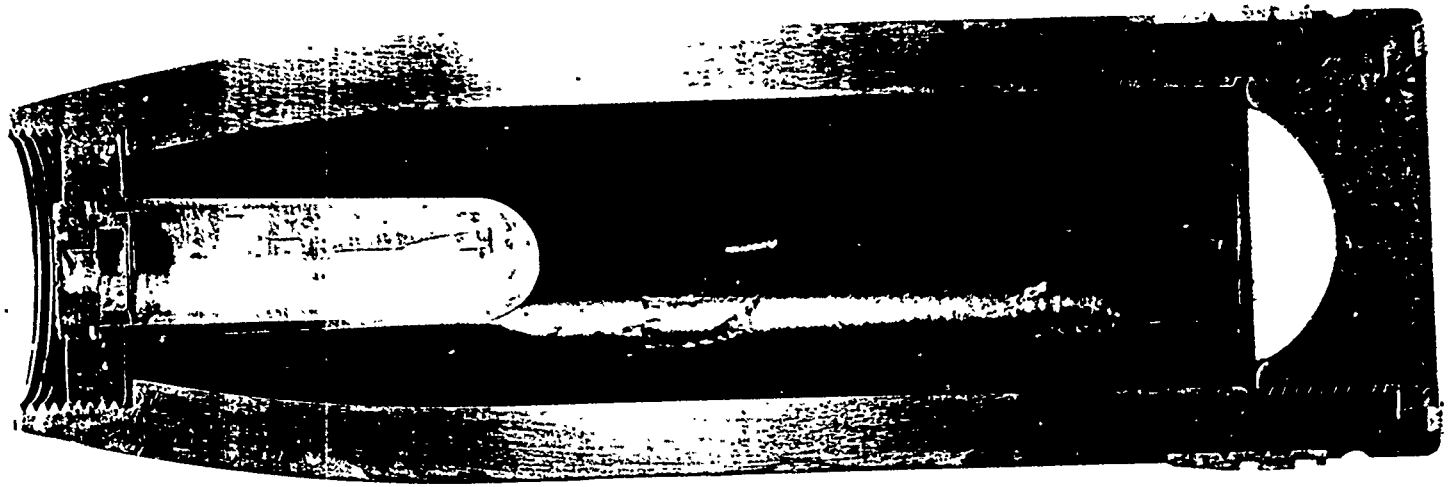

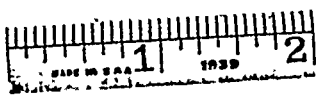

A INTRODUCTION.

One complete round of Japanese 3-inch A.A. ammunition was received by the Naval Proving Ground for a complete physical, chemical and metallurgical examination. The following is a report of this investigation, in accordance with the directives.

B. INVESTIGATION.

PHYSICAL

NPG Photo. No. 548 (APL) shows the cartridge case and decoppering foil, NPG Photo. No. 629 (APL) shows the fuze components, NPG Photo. No. 251 (APL) shows a cross section of the projectile, and NPG Photo. No. 6030 (APL) shows a cross section of the cartridge case.

The projectile body contains a spherical section of wood, which is recessed into a conjugate depression in the base plug. This wood plug serves as a cushion for the filler on set-back.

The decoppering foil was positioned in the cartridge case by means of a cardboard disk to which it was attached by a shellac-like material. The foil weighed 2.717 gms. (.096 oz.).

No color markings were found on this projectile; the following identification was found on the base plug. F S No 3 5

A dark brown varnish was used to coat the cavity of the projectile.

CHEMICAL.

Chemical analyses of all components are listed in Table A. Steel analyses are spectrochemical excepting for the carbon, phosphorus and sulphur, which have been obtained by wet chemical methods.

Non-ferrous analyses are by standard wet chemical procedures.

TABLE B

MICROSTRUCTURE AND HARDNESS OF VARIOUS COMPONENTS OF JAPANESE 3-INCH A.A. AMMUNITION

Component	Microstructure	Hardness
Projectile	Normalized	20 R_C
Base Plug	Normalized	27 R_C
Booster Cup	Cast Muntz Metal	70 R_B

METALLURGICAL.

This examination entailed a study of the hardness, macrostructure and microstructure relating the quality of the ammunition and the probable methods used in its manufacture.

The deep etched macrostructure indicated this steel to be sound and free from segregation of non-metallics; the flow figures were found to be parallel to the contour of the projectile in such a fashion as to indicate that it was formed by a draw forging operation.

The microstructures and hardness of the various components are listed in Table B.

The projectile has been made from a low alloy nickel-chrome steel and air cooled following the forging operation to give a tensile strength of approximately 110,000 psi. The base plug is of approximate SAE 3150 composition. It was made by forging a section cut from a plate and then normalizing to give a tensile strength of 130,000 psi.

The booster cup and detonator assembly were made by die casting Muntz metal and then machining to final size. The inside surface has a thin coating of tin .001 - .002 in thickness.

III

EXAMINATION OF ONE ROUND OF JAPANESE 75mm HOWITZER AMMUNITION

SUMMARY

The projectile of this ammunition was found to have been made from a plain carbon steel of approximately SAE 1065 grade by forging and normalizing.

A complete chemical and metallurgical analysis of all components is presented.

CONTENTS

TABLE A

CHEMICAL ANALYSIS OF JAPANESE 75mm HOWITZER AMMUNITION

Component	Analysis														
	C	S	P	Mn	Si	Ni	Cr	Mo	Va	Ti	Zr	W	Co	B	Cu
Projectile	.53	.025	.041	.67	.22	.10	.07	NT	NT	NT	NT	NT	NT	NT	T
Booster Cup	.30	.060	.026	.30	.20	.07	.08	NT	NT	NT	NT	NT	NT	NT	T
Fuze Adapter	-	-	-	.68	.27	.06	.07	NT	NT	NT	NT	NT	NT	NT	T

	Cu	Zn	Sn	Pb	Al	Ni	Fe
Cartridge Case	70.60	29.50	NT	NT	.002	NT	NT
Rotating Band	Pure copper						

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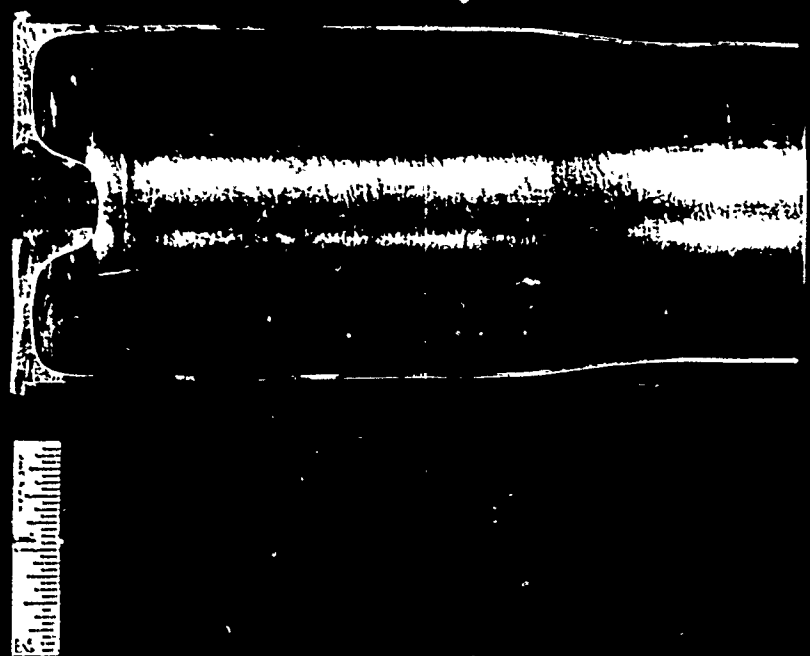
Fig. 3.
NPG PHOTO NO. 606-E (APL) - Examination of Metals from Enemy Weapons.
Report No. 57 . Cross section Japanese 75mm Howitzer cartridge case.
4 March, 1943.



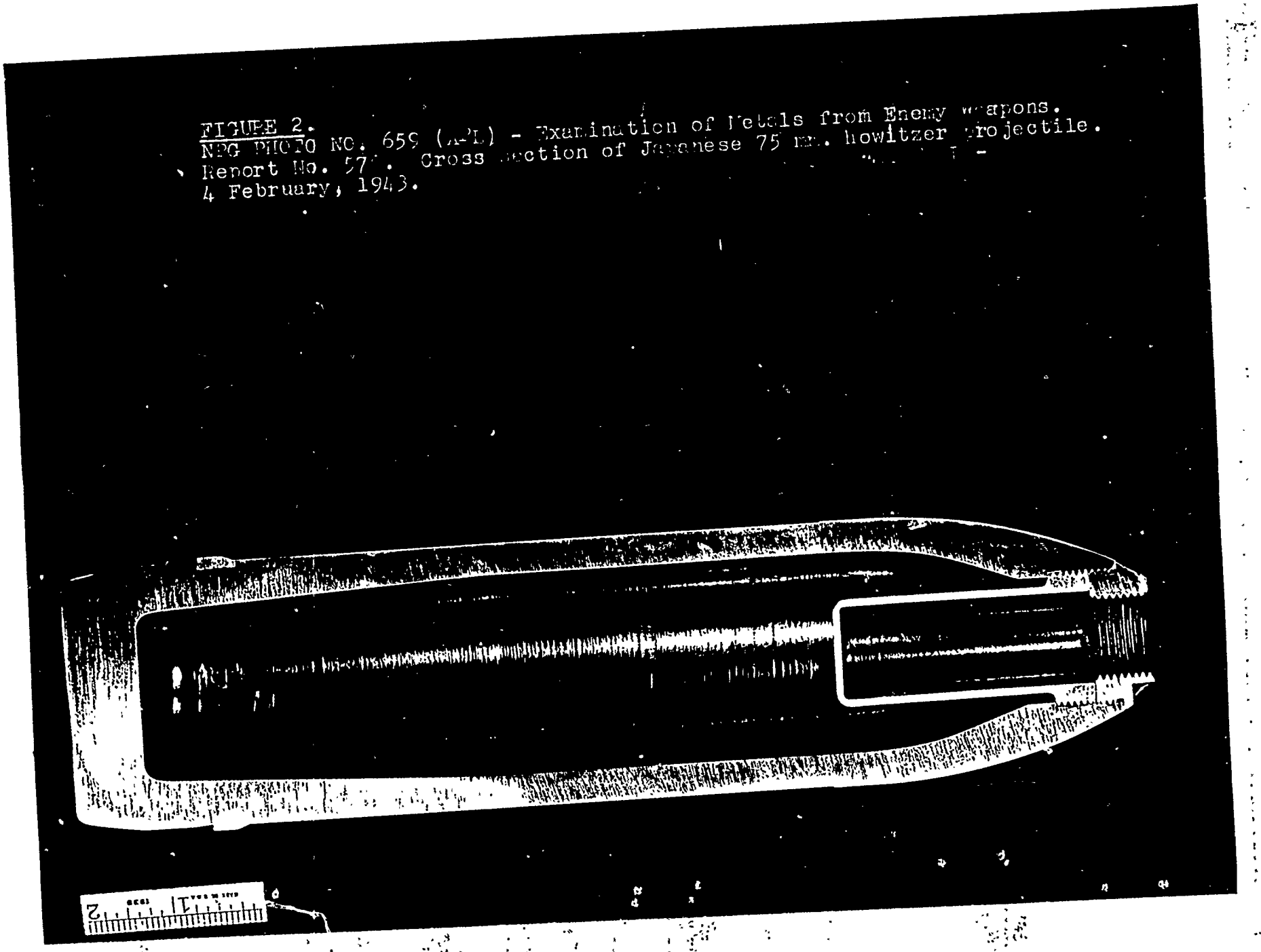


FIGURE 2.
NPG PHOTO NO. 659 (APL) - Examination of Metals from Enemy Weapons.
Report No. 57 . Cross section of Japanese 75 mm. howitzer projectile.
4 February, 1943.

I INTRODUCTION.

One round of Japanese 75mm Howitzer ammunition was received by the Naval Proving Ground for a complete physical, chemical and metallurgical examination. The following is a report of this investigation, in accordance with the directives.

II INVESTIGATION.

PHYSICAL.

The component parts of this ammunition are shown in NPG Photo. No. 547 (APL). NPG Photos. Nos. 659 and 606E (APL) show the cross section of the projectile and cartridge case respectively.

The projectile was painted black and was identified by white bands behind the bourrelet and immediately in front of and behind the rotating band.

A dark brown varnish was used to coat the cavity of the projectile.

CHEMICAL.

Chemical analyses of all components are listed in Table A. Steel analyses are spectrochemical excepting those of carbon, phosphorus and sulphur, which have been obtained by wet chemical methods.

METALLURGICAL.

This examination entailed a study of the hardness, macrostructure and microstructure relating the quality of the ammunition and the probable methods used in its manufacture.

The deep etched macrostructure indicated this steel to be fairly sound and free from segregation of non-metallics; the flow figures were found to follow the contour of the projectile in such a fashion as to indicate that the projectile was formed by piercing and bench drawing a section cut from bar stock.

The projectile was made from a plain carbon steel of approximately SAE 1050 grade and air cooled from forging temperature to give a normalized structure having a tensile strength of approximately 110,000 psi. (90 R_B).

The booster cup was made from steel of approximately SAE 1030 grade by a hot cupping and drawing operation after which it was normalized to give a tensile strength of approximately 65,000 psi. (73 R_B).

IV

EXAMINATION OF A JAPANESE 50mm MORTAR PROJECTILE

SUMMARY

Examination shows this projectile to be of conventional design, with exception of an expansible copper band, which makes use of the propellant gases to affect bore seal in a rifled mortar; the action is explained.

The projectile has been manufactured from plain carbon, normalized bar stock by machining, there is no evidence of forging.

Chemical and metallurgical examinations have been made of all components.

CONTENTS

TABLE A

CHEMICAL ANALYSIS OF JAPANESE 50mm MORTAR PROJECTILES

Component	C	P	S	Mn	Si	Ni	Cr	Mo	Va	Ti	Zr	W	Co	B	Si	Cu
Projectile Body	.38	.033	.030	.68	.17	.05	NT	T	NT	NT	NT	NT	NT	NT	NT	T
Projectile Base	.30	.038	.036	.64	.20	.05	.08	T	NT	NT	NT	NT	NT	NT	NT	T
Discharger Band	.65	.018	.045	.69	.25	.05	.08	T	NT	NT	NT	NT	NT	NT	NT	T

Pure copper.

NT = No Trace.

T = Trace.

NPG PHOTO NO. 545 (APL) - Examination of Metals from Enemy Weapons.
Report No. 57. Japanese 50 mm. mortar projectile.
4 February, 1943.

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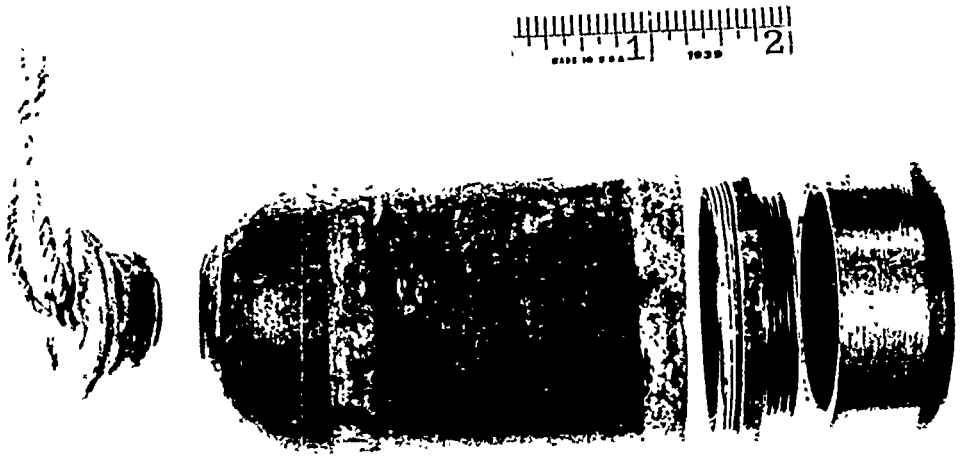

[illegible] G PHOTO NO. 602 ([illegible]) - Examination of Metals from Enemy Weapons.
Report No. 57. Cross section of Japanese 50 [illegible]. mortar projectile.
4 February, 1943.

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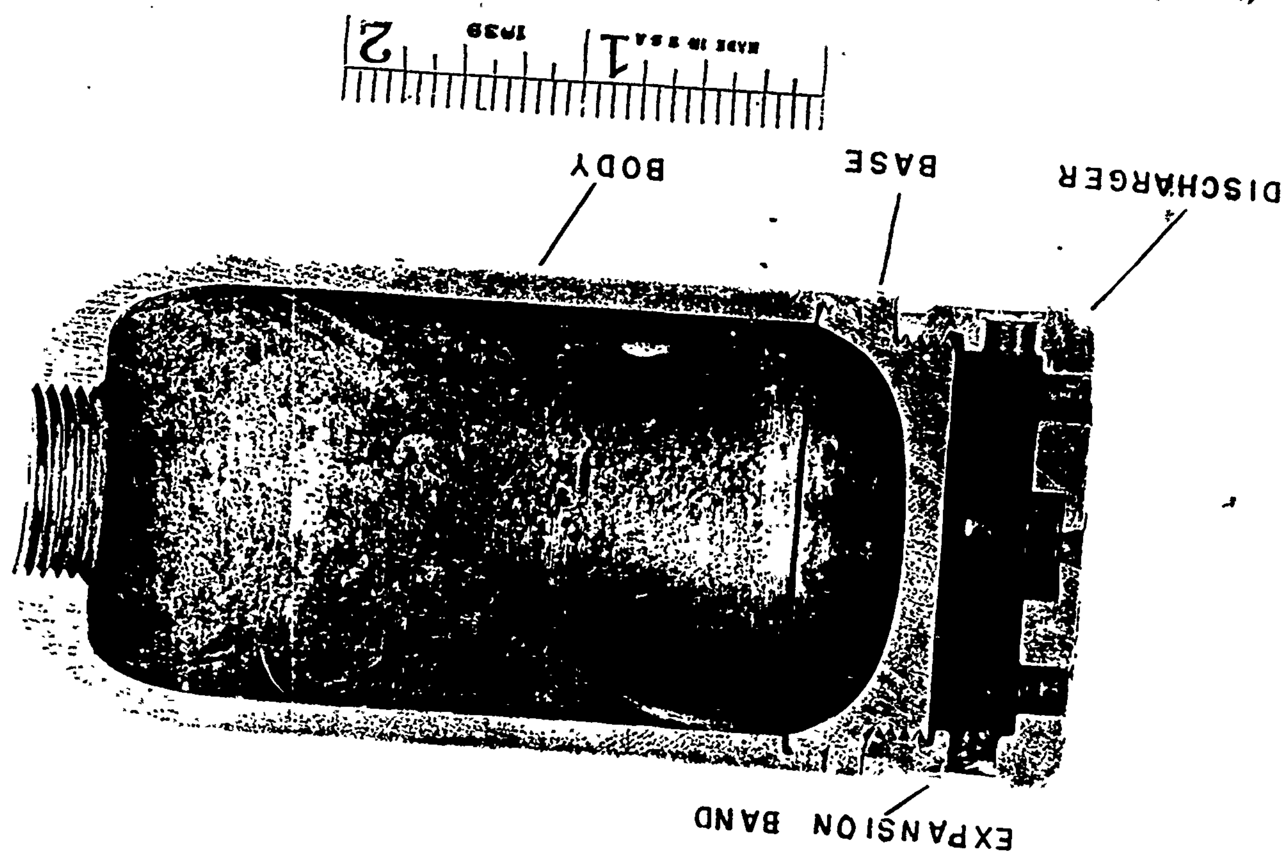


A INTRODUCTION.

One 50mm Japanese mortar projectile was received by the Naval Proving Ground for a complete physical, chemical and metallurgical examination. The following is a report of this investigation, in accordance with the directives.

B INVESTIGATION.

PHYSICAL.

NPG Photo. No. 545 (APL) shows the component parts of this ammunition; the projectile body, base and discharger. A cross sectional view of the projectile is shown in NPG Photo. No. 602 (APL).

The design is that of a conventional mortar projectile with the exception of an attempt to secure increased forcing of the projectile by the use of a copper expansion band, which encircles the discharger. When the propellant charge is set off the resulting gas pressure which is built up in the discharger body, and subsequently against the base of the projectile, also acts to expand the copper band against the rifled bore of the mortar. Small copper pins are inserted between the expansible rotating band and the discharger body to prevent stripping. To prevent possible slapping, the forward part of the projectile has been machined to have a bourrelet.

The projectile was painted black with the exception of the following color markings:

Nose: red band 1/2 inch wide.
Behind bourrelet: yellow band 1/2 inch wide.
Rear section of body forward of copper band: white band 1/2 inch wide.

CHEMICAL.

Chemical analyses of all components are listed in Table A. Steel analysis are spectrochemical excepting carbon, phosphorus and sulphur which have been obtained by standard wet chemical methods.

METALLURGICAL EXAMINATION.

This examination entailed a study of the hardness, macrostructure and microstructure relating to the quality of the projectile and the probable methods which were used in its manufacture.

The deep etched macrostructure of all three projectile components shows only longitudinal flow figures, indicating that these components were made by machining from bar stock.

Such manufacturing procedure indicates a lack of forging shop capacity and the availability of machine shop facilities.

The microstructure indicates that no heat treating was done on any of the components, all show a normalized structure which is probably the air cooled structure of the original bar stock.

The hardness was found to be 85 R.B. for the body and base, and 88 R.B. for the discharger.

V

EXAMINATION OF A JAPANESE 50mm MORTAR GRENADE

SUMMARY

This grenade consists of two parts; a body of pearlitic gray cast iron and a discharger of normalized medium carbon steel.

Chemical and metallurgical examinations have been made of all components.

The action of the grenade is explained.

CONTENTS

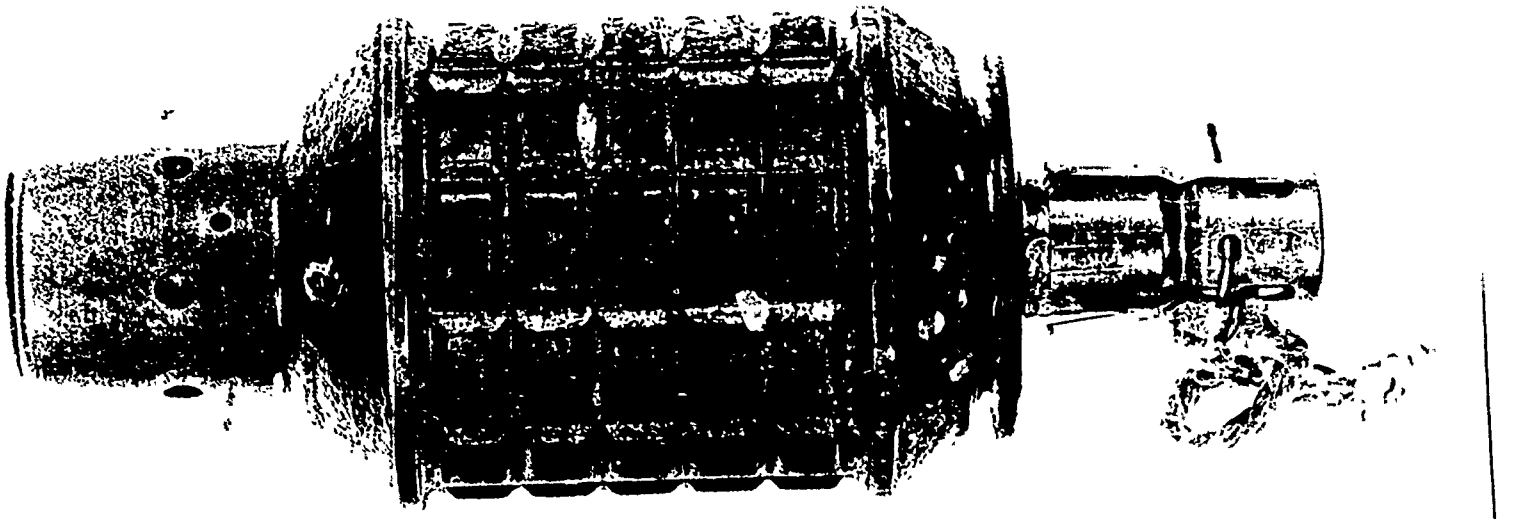
TABLE A

Chemical Analysis of Japanese Mortar Grenade

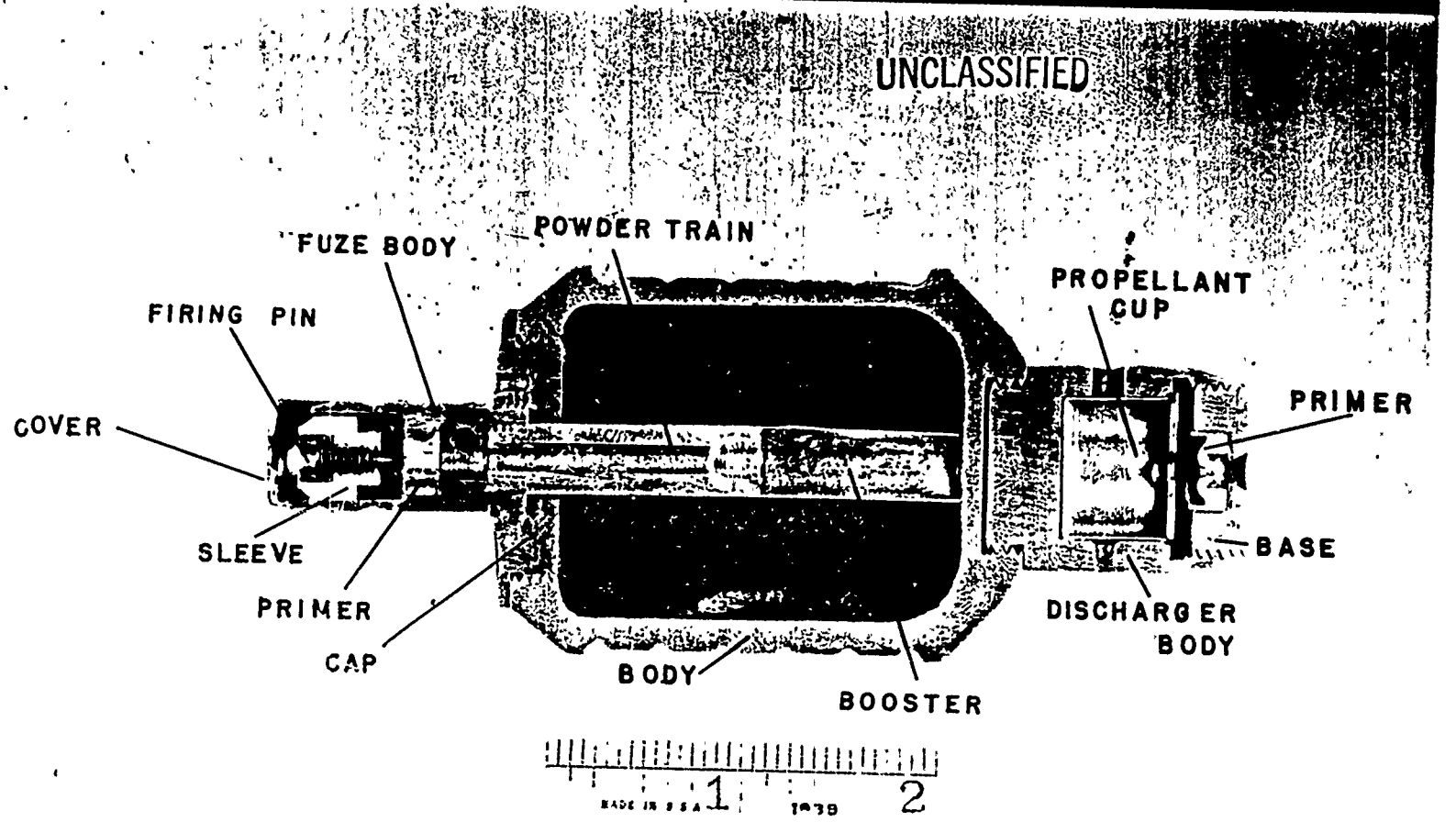
Component	C	P	S	Mn	Si	Cr	Ni	Cu	Mo
Grenade Body	3.69	.218	.055	1.15	2.14	.07	.05	T	T
Grenade Cap	3.73	.136	.154	1.48	2.14	.11	.17	T	T
Discharger Body	2.35	.020	.060	.65	.20	NT	.05	T	T
Discharger Base	-	-	-	.98	.31	.07	.08	T	T
Firing Pin	-	-	-	.68	.31	.08	.07	T	NT
Booster Tubing	Pure copper								
Propellant Cup	Pure copper								
Powder Train	Cu + Zn spectrochemically; no wet analysis made.								
Firing Pin Sleeve	Cu + Zn spectrochemically; no wet analysis made.								
Fuze Body	Cu + Zn spectrochemically; no wet analysis made.								

NPG PHOTO NO. 546 (APL) - Examination of Metals from Enemy Weapons.
Report No. 57D. Japanese 50 mm. mortar grenade.
4 February, 1943.

UNCLASSIFIED



NPG PHOTO NO. 603 (APL) - Examination of Fetals from Enemy Sections.
Report No. 57. Cross section of Japanese Mortar Grenade.
4 February, 1943.



A INTRODUCTION.

One Japanese mortar grenade was received by the Naval Proving Ground for a complete physical, chemical and metallurgical examination. The following is a report of this investigation, in accordance with the directives.

B INVESTIGATION.

PHYSICAL.

NPG Photo. No. 546 (APL) shows the grenade as received; NPG Photo. No. 603 (APL) shows the component parts of this ammunition. The details of assembly are evident.

This ammunition can evidently be used by hand throwing or by mortar projection. In either case the safety fork (shown in NPG Photo. No. 546 (APL)) is first removed, (the fork fits under the sleeve holding the firing pin and thus prevents the firing pin from moving) and then if it is desired to throw the grenade by hand a sharp blow is struck on the fuze cover driving the firing pin into the primer thus setting off the powder delay train. If it is desired to propel the grenade by means of a mortar, the grenade is merely dropped into the mortar and the propellant charge set off in the usual mortar fashion. The resulting set-back causes the firing pin to strike the primer and consequently to set off the powder delay train. The delay train detonates the booster and finally the bursting charge.

This grenade has no markings, it is painted black on the outside and inside surfaces.

CHEMICAL.

Chemical analyses of all components are listed in Table A. Analyses are spectrochemical excepting for carbon, phosphorus and sulphur, which have been obtained by wet chemical methods.

METALLURGICAL.

The body and cap of this grenade are made of pearlitic gray iron having a tensile strength of approximately 40,000 psi. The discharger was machined from bar stock of approximate SAE 1035 grade, it was not heat treated.

Table B lists the microstructure and hardness of the various components.

TABLE B

Microstructure and Hardness of Components of Japanese 50mm Mortar Grenade.

Component	Hardness	Microstructure
Grenade Body	15 R_C	Graphitic plates in a matrix of pearlite.
Grenade Cap	15 R_C	Graphitic plates in a matrix of pearlite.
Discharger Body	73 R_B	Normalized hypoeutectoid steel.
Discharger Base	79 R_B	Normalized hypoeutectoid steel.