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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

UNCLASSIFIED

REPORT NO. 7-45

AD-B/C 007

EXAMINATION OF ITALIAN PROJECTILES

47mm A.P. PROJECTILE
47mm H.E. PROJECTILE
105mm H.E. PROJECTILE
120mm COMMON PROJECTILE
149mm H.E. PROJECTILE
6" H.E. PROJECTILE
6" COMMON PROJECTILE

ANTEPRIMA RIDOTTA
PAGINE MANCANTI
TALPO.IT
TALPO.IT
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INDEXED
DESCRIPTIVE

APPROVED:

K. M. MCLAREN
CAPTAIN, U. S. N.
ACTING COMMANDING OFFICER

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AUTHORIZATION

Specific directives for these investigations were issued in BuOrd ltr. EF 74(Re3) dated 23 December 1944 and BuOrd ltr. EF 74(Re3) dated 26 February 1945.

OBJECT

To make a complete physical, chemical and metallurgical examination of the following Italian projectiles.

47mm A.P. Projectile
47mm H.E. Projectile
105mm H.E. Projectile
120mm Common Projectile
149mm H.E. Projectile
6" H.E. Projectile
6" Common Projectile

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SECTION

ANTEPRIMA RIDOTTA
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I

EXAMINATION OF ONE ITALIAN 47mm. A.P. PROJECTILE CEE NO. 3662

SUMMARY

This projectile was made from nickel, chromium, silicon steel. It was forged and machined, then heated uniformly and quenched and drawn. The base was drawn in a separate operation to a low hardness.- A hardness survey of the entire projectile was made.

The chemical analyses and microstructure of all the projectile components are given.

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LIST OF FIGURES

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Figure 1

NPG Photo No. 2270 (APL)
As received and disassembled view of Italian 47mm A.P. round. CEE No. 3662.
15 May 1945

[redacted]

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Figure 2

MARKINGS ON ITALIAN 47mm AP PROJECTILE AND CASE

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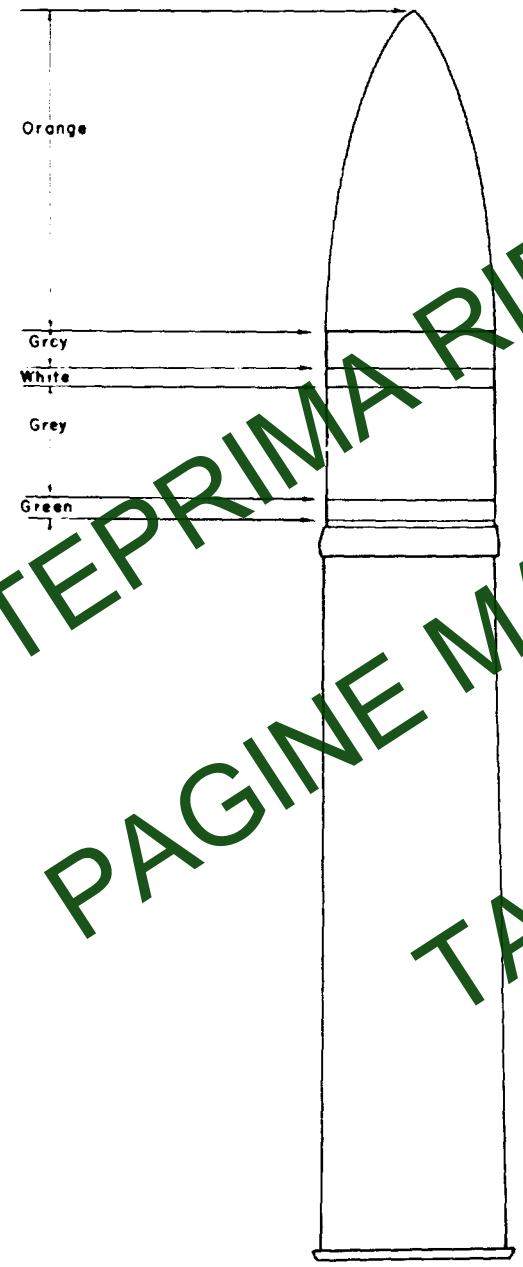
CEE 3662

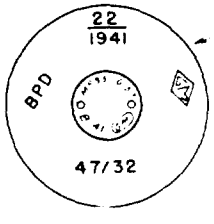


Stenciled
T-P
DOG. 39

Stamped
P-T

Indistinct Stenciling

Cor[illegible]da 47 P. Poiv.
P.C. 30, 75x8[illegible]110x140 Dr. 173
4[illegible]9008-'941'
[illegible]REZ. D'ARTIGL.-PIACENZA
NOVEMBRE 9'41



All Markings Stamped

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NPG Photo No 2548 (APL)
May 15, 1945

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I. INTRODUCTION

One Italian 47mm A.P. round was received at the Naval Proving Ground for complete physical, chemical and metallurgical examination. The following is a report of this investigation in accordance with the directives.

II. EXAMINATION

PHYSICAL

The complete round, as received and disassembled is shown in Figure 1. The projectile is provided with a windshield which is crimped to the nose and with a base plug carrying a base detonating fuze and tracer. The markings found on the round are reproduced in Figure 2. These markings show that the case was manufactured in 1941 but give no indication as to the date of manufacture of the projectile. Colors used to identify the projectile and its loading are also shown in Figure 2.

CHEMICAL

Chemical analyses of the projectile components are given in the following table. Steel analyses are spectrochemical excepting carbon, phosphorus and sulphur which have been obtained by standard wet chemical methods.

	C	Mn	P	S	Si	Ni	Cr	Mo	Cu	Al
Windshield	.07	.35	.007	.031	NTr	<.08	NTr	.02	Tr	Tr
Body	.50	.53	.027	.022	1.23	.62	.80	.02	.18	NTr
Base Plug	.36	.62	.015	.014	.29	<.08	NTr	<.005	Tr	NTr

	Cu	Zn	Sn	Fe	P
Band	99.78	.035	.035	.120	.024

Tr = Trace NTr = No Trace

The windshield has been fabricated from a low carbon rimmed steel of the type commonly used for the manufacture of thin sheet to be used for deep drawing. A nickel, chromium, silicon steel has been used for the body of the projectile and the base plug is manufactured from a medium carbon steel similar to SAE 1035. The rotating band is copper but is rather impure as compared to American standards for this material.

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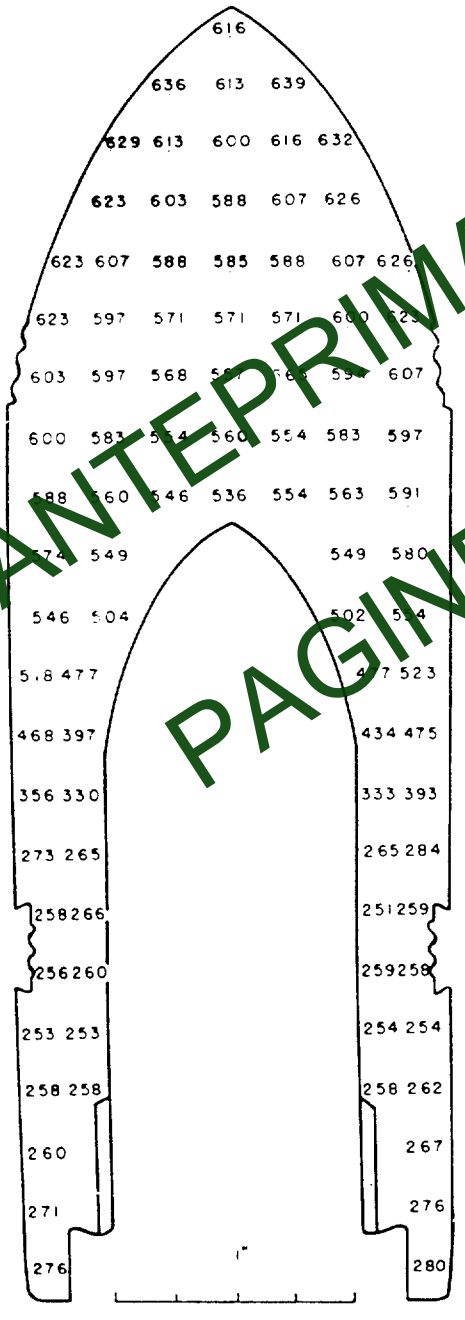
Figure 3

HARDNESS DISTRIBUTION AND MACROSECTION OF ITALIAN 47mm AP PROJECTILE

Hardness Values: Vickers Pyramid (50 Kg.)
Etch: Ammonium Persulphate

CEE 3662



NPG Photo No. 2546 (APL)
May 15, 1945

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Figure 4

MICROSTRUCTURES OF
ITALIAN 47mm AP PROJECTILE

PROJECTILE NOSE Martensite with Bainite Needles

Hardness - 610 VPN
Magnification - 1000X
Etch - Picral Nital
M489

PROJECTILE BASE Tempered Martensite

Hardness - 260 VPN
Magnification - 1000X
Etch - Picral Nital
M490

NPG Photo No. 2649 (APL)
15 June 1945

[redacted]

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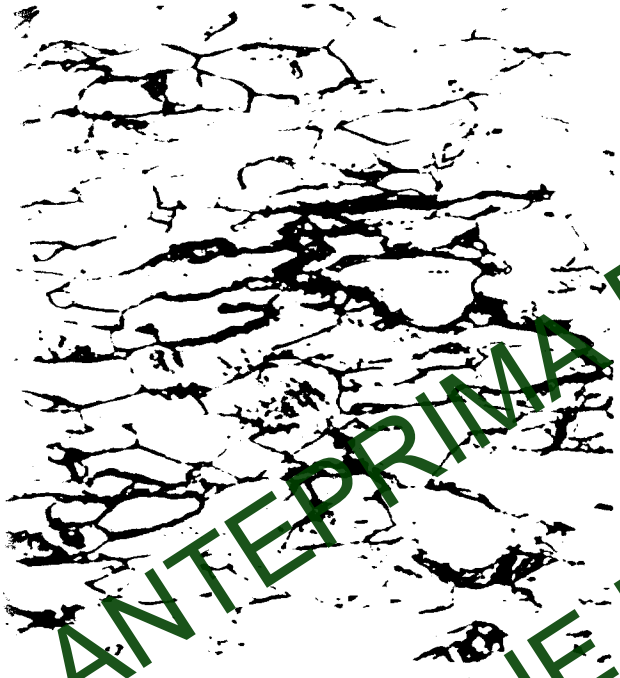
Figure 5

MICROSTRUCTURES OF
ITALIAN 47mm AP PROJECTILE



WINDSHIELD Ferrite

Hardness - 79 Rb
Magnification - 250X
Etch - Nital
M492

BASE PLUG Pearlite and Ferrite

Hardness - 85 Rb
Magnification - 250X
Etch - Picral
M491

NPG Photo No. 2650 (AFL)
15 June 1945

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METALLURGICAL

The projectile body was split longitudinally with an abrasive cut-off wheel and a hardness survey made of the entire cross-section. Figure 3 shows the hardness distribution and macro-etch section of the body. A maximum hardness of approximately 630 VPN (56Rc) has been obtained on the nose of the projectile. The hardness drops off slowly from the nose to a point about a quarter of an inch above the band score where it drops off rapidly to approximately 260 VPN (25Rc) which hardness is maintained throughout the base. The flow lines shown in the macro-etch section indicate that the projectile was forged and machined.

The microstructure of the nose and base of the projectile are shown in Figure 4. Both structures were produced by a normal quench and temper operation, the nose consisting of martensite and bainite and the base, tempered martensite. The microstructures of the other components of the projectile are shown in Figure 5. The windshield is seen to consist of ferrite with perhaps a slight trace of pearlite, while the base plug has a normalized structure of pearlite and ferrite. The hardness of these two components was found to be as follows:

Windshield - - - -	79 Rb
Base Plug - - - -	85 Rb

III. DISCUSSION

The maximum nose hardness of this 47mm projectile is somewhat lower than the nose hardness of American projectiles of this caliber. The American 37mm and 40mm AP projectiles generally have a nose hardness of from 700 to 750 VPN (60 to 62 Rc), as compared to approximately 630 VPN (56Rc) for the subject projectile.

An examination of the photomicrographs and etch section of this projectile indicate that it was probably heat treated in the following manner.

(a) Heated uniformly to above its critical temperature and quenched

(b) Drawn at a temperature to produce a hardness of approximately 630 VPN (56Rc)

(c) Base drawn in lead at a temperature between 1100 and 1200° F.

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II

EXAMINATION OF ONE ITALIAN 47mm H.E. PROJECTILE CEE NO. 3662

SUMMARY

The projectile body was machined from a sulphur bearing plain carbon steel. It was given a single normalizing heat treatment, and has a uniform hardness of approximately 93 R_B.

The chemical composition and microstructure of the projectile are given.

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LIST OF FIGURES

Figure 1

NFG Photo No. 1350 (APL).
As received and disassembled view of Italian 47mm H.E. round. CER No. 3662.
15 May 1945

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Figure 2

MARKINGS ON ITALIAN 47mm HE PROJECTILE

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NPG Photo No 2443 (APL)
May 15, 1945

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Figure 3

NPG PHOTO NO. 2594 (APL)
Deep etched section of Italian 47mm H.E. projectile.
CEE No. 3662.
15 May 1945

[redacted]

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NPG Photo No. 2651 (APL)

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Figure 4

MICROSTRUCTURE OF THE BODY OF ITALIAN 47mm HE PROJECTILE

Fine Pearlite and Ferrite

Hardness - 92 Rb Magnification 250X

Etch - Picral M493

15 June 1945

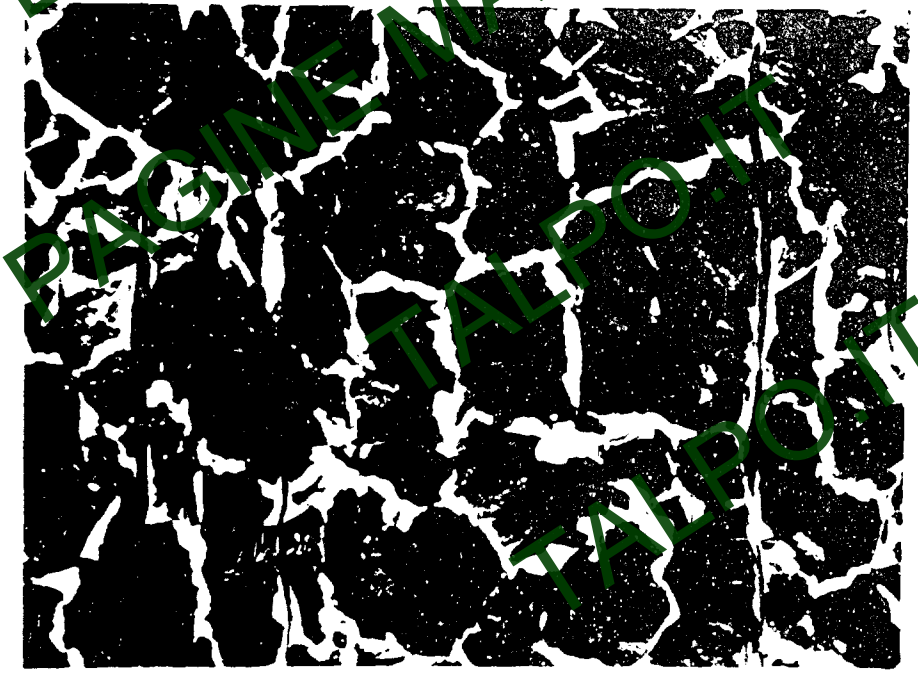

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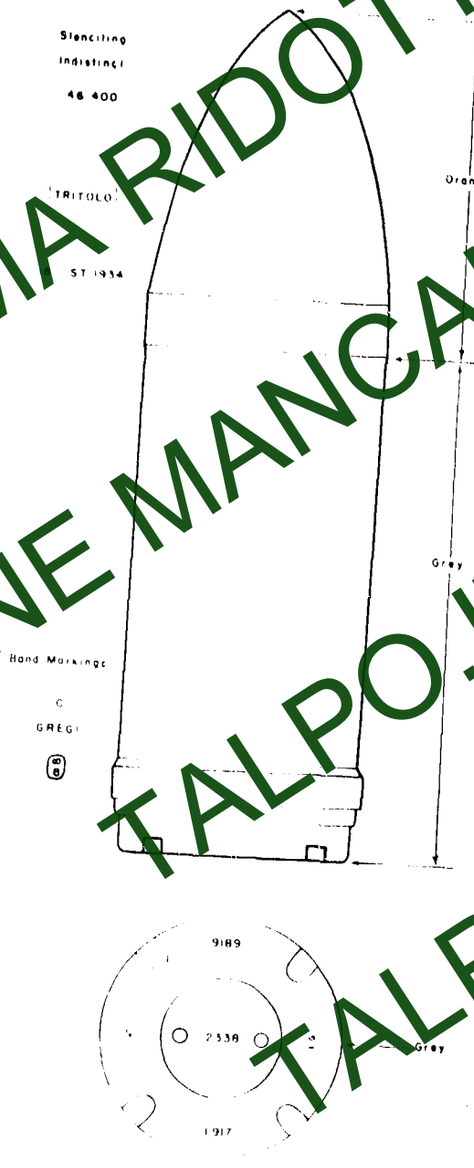
Figure 2

MARKINGS ON ITALIAN 6" COMMON PROJECTILE

GEE 3438



Markings on Body of Projectile are Stenciled
Band and Base Markings are Stamped

NPG Photo No. 2560 (APL)
May 15, 1945

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Figure 3

NPG PHOTO NO. 2557 (APL)
Bottom View and Deep Etched Section of Base Plug from Italian 6" Common Projectile, CEE No. 3438.
15 May 1945 -[redacted]

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Figure 4

NPG PHOTO NO. 2562 (APL)
Deep Etched Section of Body of Italian 6" Common Projectile, CEE No. 3438.
15 May 1945

[redacted]

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Table A

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CHEMICAL ANALYSES OF ITALIAN 6" COMMON PROJECTILE COMPONENTS

	C	P	S	Si	Mn	N	Cr	Cu
Body	.33	.034	.046	.21	.89	<.08	<.08	.12
Base Plug	.55	.032	.051	.26	.92	<.08	<.08	.09

	Cu	Sn	Fe
Rotating Band	99.91	.023	.007
Sealing Ring	99.95	.03	.02

	Pb	Sn	Trace
Lead Sealing Ring	99.90	.068	Cu, Ag
Lead Sealing Disk	99.96	.034	Sb,Bi,Ag

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I. INTRODUCTION

One Italian 6" Common projectile was examined and two of the same type were tested ballistically. The following is a report of the examination and of the ballistic tests in accordance with the directives. Although the directive lists this projectile as an AP, upon examination it was evident that it was a common projectile and this designation is therefore used.

II. EXAMINATION

PHYSICAL

This projectile is shown as received and disassembled in Figure 1. The projectile has no hood or windshield. The base plug is unique in that its outer edge forms the contour of the base end of the projectile. The base plug is threaded to take a base detonating fuze which in turn is protected from the propellant gases by a small disk screwed into the base plug behind the fuze. A wooden plug shaped to fit the forward end of the cavity and a felt-like pad are provided to act as a cushion for the explosive filler.

A single rotating band 1-1/4" from the base was securely attached by the conventional means.

All stenciled and stamped markings are indicated in Figure 2 which also indicates the painting. The stenciling was indistinct.

CHEMICAL

The chemical analyses of the important metallic components are given in Table A. The analyses for steels were determined spectro-chemically except for the elements carbon, phosphorus, and sulfur, which were determined by the usual wet chemical methods.

The projectile body and base plug analyses are similar to those of SAE 1035 and SAE X 1055 analyses respectively. The copper in the rotating bands is of a purity comparable to that of American rotating bands. The sealing ring is also made of high purity copper.

The etch patterns of the base plug and of the body are shown in Figure 3 and 4 respectively. Both of these pieces show flow lines resulting from forging.

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