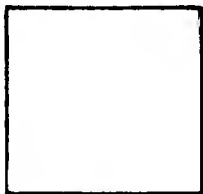


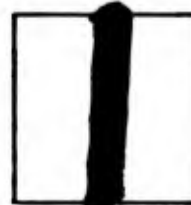
PHOTOGRAPH THIS SHEET

A952867

DTIC ACCESSION NUMBER



LEVEL



INVENTORY

WA - 441/3

DOCUMENT IDENTIFICATION

29 Sep '41

DISTRIBUTION STATEMENT A

Approved for public release;
Distribution Unlimited

DISTRIBUTION STATEMENT

ACCESSION FOR	
NTIS	GRA&I <input checked="" type="checkbox"/>
DTIC	TAB <input type="checkbox"/>
UNANNOUNCED	<input type="checkbox"/>
JUSTIFICATION	
(29 Sep '41)	
BY	
DISTRIBUTION /	
AVAILABILITY CODES	
DIST	AVAIL AND/OR SPECIAL
A/1	

DISTRIBUTION STAMP

Released

DTIC
ELECTE
DEC 1 1983
D

DATE ACCESSIONED

UNANNOUNCED

88 09 22 038

DATE RECEIVED IN DTIC

PHOTOGRAPH THIS SHEET AND RETURN TO DTIC-DDA-2

441/3

AD-A95-2867



Test Lab.
INDEXED

Memorandum Report No. 441/3

INSPECTION

MAGFLUX INSPECTION OF THE
EXTERIOR SURFACE OF GUN TUBES

by
H. H. Lester
Principal Physicist
Carlton H. Hastings
Junior Engineer

SEP 30 1941

SEPTEMBER 30 1941

WATERTOWN ARSENAL
WATERTOWN, MASS.

WATERTOWN ARSENAL

WATERTOWN, MASS.

INTRAOFFICE MEMORANDUM

FOR USE WITHIN THE ARSENAL ONLY

9/26/42

(Date)

FROM: Lt. Col. Cox (Dr. ^{V HKS}Lester) (C. Hastings), Laboratory (Name) (Division)

TO: Colonel Voysey, Building 131, Production (Name) (Division)

SUBJECT: Inspection of Cast Gun Tubes Prior to Cold Work--Suggested Method

- References: a. Watertown Arsenal Memorandum Report No. 441/3, 9/30/41
- b. Navy Dept., Bureau of Ships Correspondence No. L5-1(10)(350)

1. Last year this Laboratory undertook a series of tests performed on 90 mm. and 105 mm. centrifugally cast gun tubes, the purpose of which was to test the applicability of the magnetic powder method of inspecting gun tubes for defects prior to the cold working operation. Results of these tests were reported in reference a. A copy of this report was sent to the Navy Department, Bureau of Ships.

2. At present, visual inspection, with occasional use of the oil and whiting method, is being relied upon for inspection of gun tubes prior to cold working.

3. A recent communication received from the Navy Department, Bureau of Ships indicates that they have tried or are using the magnetic powder method of inspection with success. (See reference b.) A suggestion, intended to expedite production testing of hollow tubes, is attached to their communication.

4. It is suggested that this Arsenal consider the magnetic powder method of inspection to be used in production inspection with the view to the detection of defects which might not otherwise be found until late stages in the manufacture of the gun tube. Defects have been found in certain instances when the tube was nearly finish machined. Earlier detection would result in a great saving of time and money. The present used method of inspection depends upon visual examination by the machine operator who performs the rough machining operation and the inspector. The suggested method will enable a more thorough and dependable inspection to be carried on at a rate that will not slow up production.

C. H. H.

Dr. Lester

9/26/42

Lt. Col. Cox (Dr. Lester) (C. Hastings) Laboratory

Colonel Voysey Building #73, Production

Inspection of Cast Gun Tubes Prior to Cold Work--Suggested Method

- References: a. Watertown Arsenal Memorandum Report No. 441/3, 9/30/41
b. Navy Dept., Bureau of Ships Correspondence No. L5-1(10)(350)

1. Last year this Laboratory undertook a series of tests performed on 90 mm. and 105 mm. centrifugally cast gun tubes, the purpose of which was to test the applicability of the magnetic powder method of inspecting gun tubes for defects prior to the cold working operation. Results of these tests were reported in reference a. A copy of this report was sent to the Navy Department, Bureau of Ships.
2. At present, visual inspection, with occasional use of the oil and whiting method, is being relied upon for inspection of gun tubes prior to cold working.
3. A recent communication received from the Navy Department, Bureau of Ships indicates that they have tried or are using the magnetic powder method of inspection with success. (See reference b.). A suggestion, intended to expedite production testing of hollow tubes, is attached to their communication.
4. It is suggested that this Arsenal consider the magnetic powder method of inspection to be used in production inspection with the view to the detection of defects which might not otherwise be found until late stages in the manufacture of the gun tube. Defects have been found in certain instances when the tube was nearly finish machined. Earlier detection would result in a great saving of time and money. The present used method of inspection depends upon visual examination by the machine operator who performs the rough machining operation and the inspector. The suggested method will enable a more thorough and dependable inspection to be carried on at a rate that will not slow up production.

WAR DEPARTMENT
WATERTOWN ARSENAL
WATERTOWN, MASS.

SPRINGFIELD ARMOY 5-10-42 004

ECM/mtd

INTRAOFFICE MEMORANDUM

FOR USE WITHIN THE ARSENAL ONLY

October 20, 1942

(Date)

FROM: H. C. Mann (Name) Laboratory (Division)

TO: Colonel Cox (Name) Laboratory (Division)

SUBJECT: COMMENTS ATTACHED MEMORANDUM AND REPORT

1. There are certain features in the attached report which need clarification before further consideration of the magniflux method of inspection for production purposes.

2. In the first place the report is not clear in indicating whether in the guns examined those which showed defects in the magniflux test also showed defects under normal visual examination. From the report (inclosure 3) 18 guns were found defective, 13 showed questionable areas and 4 showed cracks. Of these, 9 were sent back for repair, yet there is nothing in the report to indicate on what basis that 9 were accepted and 9 repaired. Furthermore would the 9 sent back be representative of conditions not revealed from visual examination but brought out from the magniflux test. It seems that more significant details should be brought out before going further ^{with} into this report.

3. With regard to paragraph 3 of the memorandum attached, this statement seems rather optimistic since the Navy Department letter does not specifically state that they are "-- using the magnetic powder method of inspection with success".

4. There is no question but that the magnetic powder method for inspection has possibilities which should be further developed for gun tube inspection. However, it is felt that the attached report, as written, is rather weak argument to be presented. If this report compared the visual and magniflux results and showed magniflux to pick up rejectable defects not revealed from visual examination, it would be much more convincing and a more sound basis for further discussion.


H. C. MANN

NO CARBON COPY AND NO RECORD REQUIRED. PEN OR PENCIL MAY BE USED.

N. B. B. 1

ADDRESS BUREAU OF SHIPS, NAVY DEPARTMENT
AND REFER TO No.

L5-1(10) (350)

NAVY DEPARTMENT

ENCLOSURES

BUREAU OF SHIPS

WASHINGTON, D. C.

SEP 19 1941

From: The Chief of the Bureau of Ships
To: Commanding General, Watertown Arsenal,
Watertown, Massachusetts.

SUBJECT: Magnetic Powder Inspection of Large Tubular
Sections - Method of Magnetizing.

Reference:

- (a) Watertown Arsenal Memorandum Report No. 441/3 dated
September 30, 1941.

Enclosure: (hw)

- (A) Copy of sketch - Simplified Method of Threading Cable
Through Pipe.

1. Receipt of a copy of reference (a) is acknowledged.
It is interesting to note that two men perform magnetic powder
inspection of 30 tubes in 8 hours.

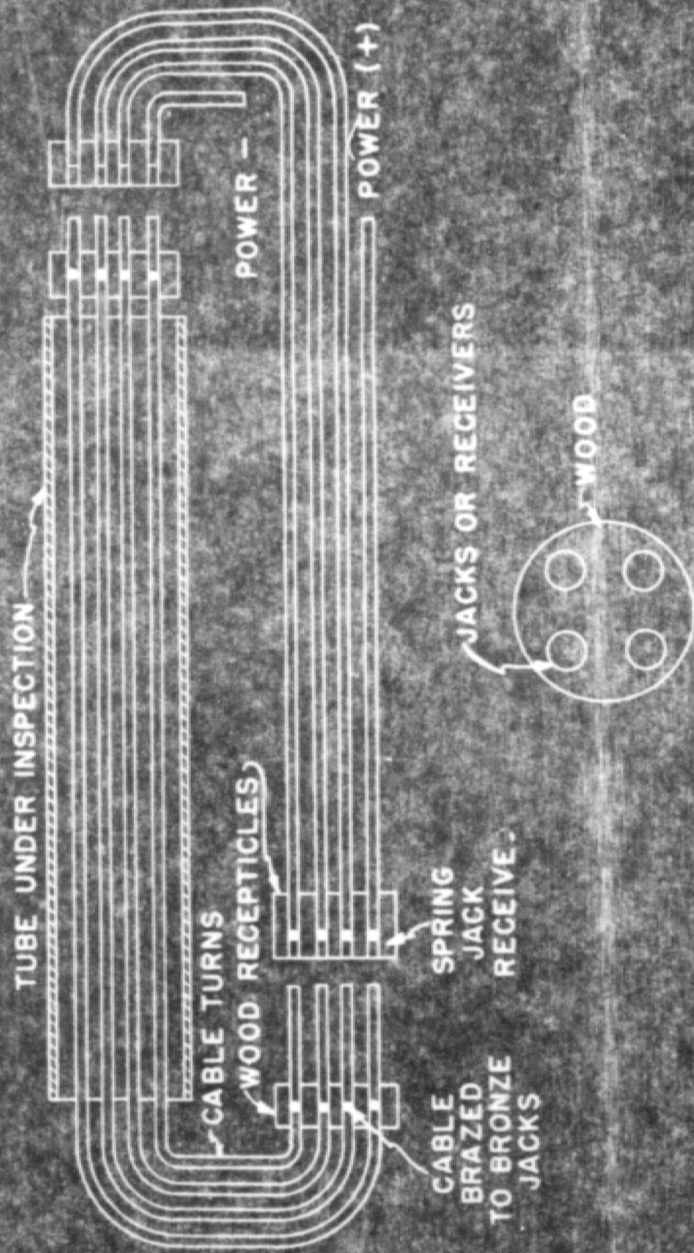
2. The sketch, enclosure (A), which indicates a method
of winding cable through the bore of a tubular section and
which has been found to be a time saver where production is
involved, is forwarded for such use as the arsenal may care
to make of it.

3. If this method is found applicable, precaution
should be taken to key the receivers to insure continuous
flow of current from positive to negative power connections
and to insure good contact pressure in the multiple connectors.

E. J. Forsyth

Enc - Attached

E. J. Forsyth
By Direction



SIMPLIFIED METHOD OF THREADING
CABLE THROUGH PIPE

DISTRIBUTION OF REPORTS

REPORT NO. 441/3

DATE DISTRIBUTED _____

NO. OF COPIES 8

Author - 1 ✓

Lab. File - 1 ✓

Main Office File - 1 ✓

Chief of Ordnance

Springfield Armory

Springfield OD - 8/10/42 - 1

Watervliet Arsenal

Rock Island Arsenal

Frankford Arsenal

Picatinny Arsenal

Aberdeen Proving Ground

Extra Copies - 1

Other establishments
requesting work.

Foundry - 1 ✓

Newhall - 1 ✓

Inspection - 1 ✓

*Mr Lenke - Bureau of Ships - gave to
him in Lab. office - 11/26/41 ✓
1-ORDTX - Control - 7/19/42*

*Local distribution
only*

Memorandum Report No. 441/3
Watertown Arsenal

September 29, 1941

Inspection

Magnaflux Inspection of the Exterior
Surface of Gun Tubes

Object

To determine the applicability of the magnetic powder method to the inspection of gun tubes prior to cold working.

Summary

1. Defects on the exterior surface of gun tubes can be discovered by Magnaflux inspection without injury to the metal. (See inclosures 1 and 4).
2. Present accumulated evidence indicates that the method is reliable, simple and is sensitive enough but not too sensitive for use. (Inclosure 3).
3. Because of the simplicity of the method it is practical to investigate the entire outside area of a gun tube. (Inclosure 3).
4. The method is suited to the routine inspection of production gun tubes. (Inclosures 1 and 3).
5. It is estimated that with one inspection crew of two men and the proper equipment and layout, it would be possible to inspect at the rate of 30 entire 90 m/m gun tubes per 8 hour day including time necessary for reporting results. (Inclosures 1 and 3).

Inclosures

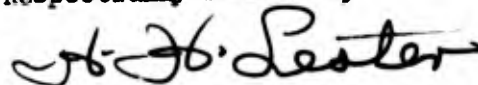
1. Introduction
2. Method of Test
3. Discussion
4. Results

(a) Tabulation

(b) Illustrations:

Figures 1, 2, 3.

Respectfully submitted,



H. H. Lester
Principal Physicist



Carlton H. Hastings
Junior Engineer

APPROVED:

S. B. Ritchie,
Lt. Col., Ordnance Dept., U. S. A.
Director of Laboratory.

Inclosure 1

Introduction

Methods of test are needed for the inspection of gun tubes to be cold worked in order to detect certain surface defects such as cracks or seams and to determine whether or not these have been completely removed by chipping or machining operations. At the present time, defects have been detected by the machinist who rough turns the gun and acid etching has been relied upon to determine when the defect has been removed. The machinist does not always find all the defects and the application of acid is messy and time consuming. The magnetic powder method seems to offer possibility for more dependable original detection and to offer a simpler and more desirable method for determining whether the defect has been completely removed. This study has been carried out in order to test the possibilities of the magnaflux method for the purposes indicated.

In carrying out the method the magnetic flux may be applied in one of two ways, first by producing relative motion between the gun and a solenoid, through which direct current is flowing, the solenoid being wound around the gun. The flux in this case is parallel to the major axis of the gun tube and transverse cracks or seams would be most readily detected. However, few defects are altogether transverse or altogether longitudinal. They

Inclosure 1 (cont.)

have components in both directions. Hence, the solenoid would detect the majority of longitudinal defects as well as all of the serious transverse ones. The second method is to apply the flux by threading a conductor through the bore of the gun tube and applying the direct current through this conductor. In this case the magnetic flux flows transversely to the major axis of the tube and longitudinal defects would be detected most readily. However, transverse defects would be detected for the reasons cited above. When using this method, it is not necessary to cause relative motion between the gun and the cable since the gun can be magnetized throughout its entire length with one position of the cable.

Inclosure 2

Method of Test

Direct current, obtained from two welding generators connected in parallel, was used to produce the desired magnetic field. Conductors of high current carrying capacity were pulled through the bore of the gun, each end of the cable being connected to a generator terminal. It was found that a current of the order of 1500 amperes flowing through the cable set up a circular magnetic field in the gun tube, which was of sufficient strength to allow detection of defects on the surface running in either a longitudinal or a transverse direction with relation to the major axis of the gun. A dry magnetic powder of contrasting color was used to indicate the defects.

Inclosure 3

Discussion

Acid Etch Method

The chief method of inspection used at the present time, the acid etch, is messy and practically confined to small areas on the gun tube where cracks have been discovered during the machining operations. The objection to using acid near machinery is obvious. This objection is overcome but another less serious objection encountered with the magnetic powder method. The powder is often messy and may be tracked around. High pressure lines in the cold work shop may become clogged by the powder if the work is done there. A location for this equipment in the shop other than in the cold work department would overcome this objection. Besides inspecting localized areas where cracks have been discovered during the machining operation, it is practical to inspect by magnaflux the entire exterior surface of the gun tube. Some subsurface defects, lying not more than 1/2" below the surface as well as surface defects may be detected by magnetic inspection. This cannot be accomplished by the acid etch method.

Oil and Whiting Method.

Another method in use employs calcium carbonate in suspension in kerosene. In this method the kerosene penetrating the crack keeps the calcium carbonate moist around the edges of the crack in contrast to the dry white powder remaining on the surface of the surrounding metal.

Inclosure 3. (cont.)

It has the advantage of being less messy than either the acid etch or magnetic powder method. This method may be used on a gun tube while it is in the lathe. It is possible, also, to utilize magnetic testing to determine the presence or extent of a surface defect while the gun is in the lathe. This would be accomplished by means of an electromagnet and a suspension of the magnetic powder in a light oil. The kerosene and calcium carbonate application will not detect cracks that are in internal compression as will the magnetic method. A rough machined surface or even a more irregular surface is adequate for the purpose of the magnetic powder method whereas a reasonably smooth finish is necessary for these other methods.

Magnetic testing is not over-sensitive. Out of 42 gun tubes examined, 24 of them were found to be free from surface defects, only 18 being defective. Of these 18 defective guns, 9 were allowed to go through cold working, the defects not being considered to be of a serious nature, and did not fail. The other 9 tubes were sent to the shop for repair.

Inclosure 11

Gun Tubes Inspected by Magnaflux

<u>Gun #</u>	<u>Gun Size</u>	<u>Results</u>
C-7950	105 m/m Howitzer	Clear
C-6969	" " "	"
C-8251	" " "	2 Cracks and One Questionable Area
C-7091	" " "	Clear
C-7520	" " "	"
C-8060	90 m/m A. A.	"
C-8216	" " "	2 Questionable Areas - Breech and Muzzle
C-8098	" " "	Crack - Breech end.
2-3888-4	" " "	Clear
6572	" " "	"
7262	" " "	"
7304	" " "	"
7594	" " "	"
C-4235	" " "	2 Questionable Areas - Muzzle end.
C-6105	" " "	1 Questionable Area - Muzzle end.
C-6095	" " "	Crack 6" - 14" from muzzle end; 5:00 o'clock. Questionable area 2' - 3 1/2' from muzzle end; 11:00 o'clock.
C-6205	" " "	Questionable area 2' - 3' from muzzle end; all around the tube.
C-6531	" " "	Questionable area 2' from muzzle end; 7:00 o'clock.
C-3510	" " "	Small crack at grinding mark.
C-6654	" " "	Small questionable area 1/4' from muzzle end; 11:00 o'clock.

Inclosure 4, (Cont)

Gun Tubes Inspected by Magnaflux

<u>Gun #</u>	<u>Gun Size</u>	<u>Results</u>
C-6209	90 m/m A. A.	Questionable area 1-1/2' from muzzle end; 2:00 o'clock - 10:00 o'clock.
C-7323	" " "	Clear
C-7162	" " "	Questionable area 6" - 1-1/2' from muzzle end; 9:00 o'clock.
C-8455	" " "	Clear
C-8932	" " "	Clear
C-6506	" " "	Questionable area 6" from muzzle end; 6:00 - 11:00 o'clock.
C-7083	" " "	Clear
C-6931	" " "	Questionable area 1' - 2-1/2' from muzzle end; all around tube.
C-6167	" " "	Clear
C-6007	" " "	Clear
C-6068	" " "	Clear
C-6631	" " "	Crack on muzzle end; 7:00 o'clock. Questionable area 18" - 2-1/2' from muzzle end; 5:00 - 10:00 o'clock.
C-7802	" " "	Clear
C-7162	" " "	Questionable area 6" from muzzle end; 4:00 o'clock.
C-7369	" " "	Clear
C-6708	" " "	Clear
C-6015	" " "	Clear
C-5911	" " "	Clear
C-7326	" " "	Clear

Inclosure 4. (Cont.)

Gun Tubes Inspected by Magnaflux

<u>Gun #</u>	<u>Gun Size</u>	<u>Results</u>
C-6953	90 m/m A. A.	3 Questionable Areas. 14" from muzzle; 4:00 - 11:00 o'clock. 3" " " ; 1:00 - 2:00 o'clock. 5' " " ; 4:00 o'clock.
C-7191	" " "	Questionable area 6" - 2' from muzzle end; all around tube.
C-6226	" " "	Clear



WATERTOWN ARSENAL

QUESTIONABLE AREA, POSSIBLY ASSOCIATED WITH A COLD
SHUT, IN 90 MM GUN TUBE #8216 DETECTED BY MAGANAF-
LUX. JUNE 28, 1941 W.A. 420-93

ILL. 1

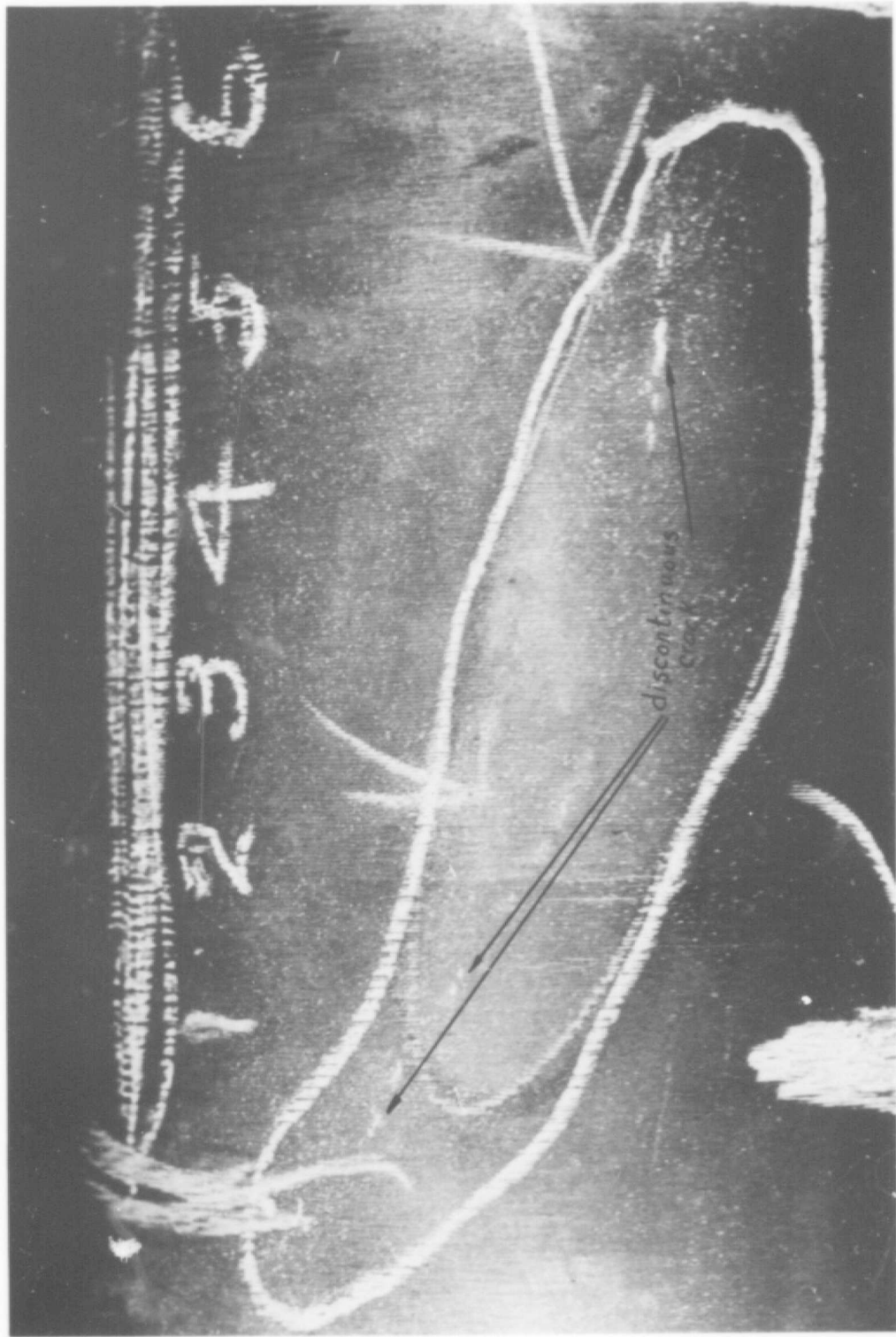


WATERTOWN ARSENAL

CRACKS IN 90 MM GUN TUBE #8098 DETECTED BY MAGNAFLUX
JUNE 28, 1941

W.A. 420-94

ILL. 2



WATERTOWN ARSENAL

CRACK, PARTIALLY REMOVED DURING MACHINING
DETECTED BY MAGNAFLUX ON 90 MM GUN TUBE #6095
JUNE 28, 1941 W.A. 420-120

ILL. 3

N. B. B. 1

**ADDRESS BUREAU OF SHIPS, NAVY DEPARTMENT
AND REFER TO NO.**

L5-1(10) (350)

**NAVY DEPARTMENT
BUREAU OF SHIPS
WASHINGTON, D. C.**

*L. Dr. Beath
Laboratory*

SEP 19 1941

ENCLOSURES

From: The Chief of the Bureau of Ships
To: Commanding General, Watertown Arsenal,
Watertown, Massachusetts.

SUBJECT: Magnetic Powder Inspection of Large Tubular
Sections - Method of Magnetizing.

Reference:

- (a) Watertown Arsenal Memorandum Report No. 441/3 dated
September 30, 1941.

Enclosure: (hw)

- (A) Copy of sketch - Simplified Method of Threading Cable
Through Pipe.

1. Receipt of a copy of reference (a) is acknowledged.
It is interesting to note that two men perform magnetic powder
inspection of 30 tubes in 8 hours.

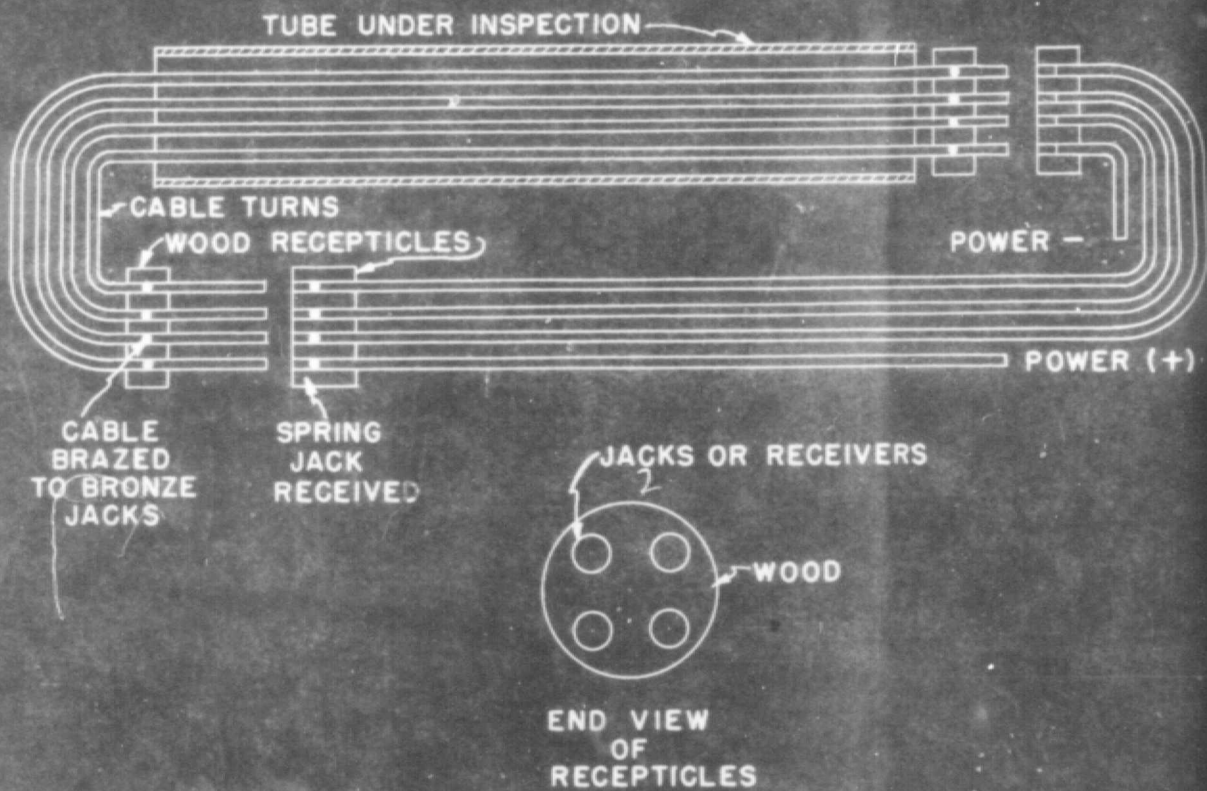
2. The sketch, enclosure (A), which indicates a method
of winding cable through the bore of a tubular section and
which has been found to be a time saver where production is
involved, is forwarded for such use as the arsenal may care
to make of it.

3. If this method is found applicable, precaution
should be taken to key the receivers to insure continuous
flow of current from positive to negative power connections
and to insure good contact pressure in the multiple connectors.

E. G. Fought

1 Enc - Sketch

**E. G. Fought
By Direction**



SIMPLIFIED METHOD OF THREADING
CABLE THROUGH PIPE

WAR DEPARTMENT
 WATERTOWN ARSENAL
 WATERTOWN, MASS.

HCM/mtd

INTRAOFFICE MEMORANDUM

FOR USE WITHIN THE ARSENAL ONLY

October 20, 1942

(Date)

FROM: H. C. Mann (Name), Laboratory (Division)

TO: Colonel Cox (Name), Laboratory (Division)

SUBJECT: COMMENTS ATTACHED MEMORANDUM AND REPORT

1. There are certain features in the attached report which need clarification before further consideration of the magniflux method of inspection for production purposes.

2. In the first place the report is not clear in indicating whether in the guns examined those which showed defects in the magniflux test also showed defects under normal visual examination. From the report (inclosure 3) 18 guns were found defective, 13 showed questionable areas and 4 showed cracks. Of these, 9 were sent back for repair, yet there is nothing in the report to indicate on what basis that 9 were accepted and 9 repaired. Furthermore would the 9 sent back be representative of conditions not revealed from visual examination but brought out from the magniflux test. It seems that more significant details should be brought out before going further ^{with} into this report.

3. With regard to paragraph 3 of the memorandum attached, this statement seems rather optimistic since the Navy Department letter does not specifically state that they are "-- using the magnetic powder method of inspection with success".

4. There is no question but that the magnetic powder method for inspection has possibilities which should be further developed for gun tube inspection. However, it is felt that the attached report, as written, is rather weak argument to be presented. If this report compared the visual and magniflux results and showed magniflux to pick up rejectable defects not revealed from visual examination, it would be much more convincing and a more sound basis for further discussion.


 H. C. MANN

WATERTOWN ARSENAL

WATERTOWN, MASS.

INTRAOFFICE MEMORANDUM

FOR USE WITHIN THE ARSENAL ONLY

9/26/42

(Date)

✓ HKS
 FROM: Lt. Col. Cox (Dr. Lester) (C. Hastings), Laboratory
 (Name) (Division)

TO: Colonel Voysey, Building 131, Production
 (Name) (Division)

SUBJECT: Inspection of Cast Gun Tubes Prior to Cold Work--Suggested Method

References: a. Watertown Arsenal Memorandum Report No. 441/3, 9/30/41

b. Navy Dept., Bureau of Ships Correspondence No. L5-1(10)(350)

1. Last year this Laboratory undertook a series of tests performed on 90 mm. and 105 mm. centrifugally cast gun tubes, the purpose of which was to test the applicability of the magnetic powder method of inspecting gun tubes for defects prior to the cold working operation. Results of these tests were reported in reference a. A copy of this report was sent to the Navy Department, Bureau of Ships.

2. At present, visual inspection, with occasional use of the oil and whiting method, is being relied upon for inspection of gun tubes prior to cold working.

3. A recent communication received from the Navy Department, Bureau of Ships indicates that they have tried or are using the magnetic powder method of inspection with success. (See reference b.) A suggestion, intended to expedite production testing of hollow tubes, is attached to their communication.

4. It is suggested that this Arsenal consider the magnetic powder method of inspection to be used in production inspection with the view to the detection of defects which might not otherwise be found until late stages in the manufacture of the gun tube. Defects have been found in certain instances when the tube was nearly finish machined. Earlier detection would result in a great saving of time and money. The present used method of inspection depends upon visual examination by the machine operator who performs the rough machining operation and the inspector. The suggested method will enable a more thorough and dependable inspection to be carried on at a rate that will not slow up production.

C. H. H.

9/26/42

Lt. Col. Cox (Dr. Lester) (C. Hastings) Laboratory

Colonel Voysey Building #73, Production

Inspection of Cast Gun Tubes Prior to Cold Work--Suggested Method

- References: a. Watertown Arsenal Memorandum Report No. 441/3, 9/30/41
b. Navy Dept., Bureau of Ships Correspondence No. L5-1(10)(350)

1. Last year this Laboratory undertook a series of tests performed on 90 mm. and 105 mm. centrifugally cast gun tubes, the purpose of which was to test the applicability of the magnetic powder method of inspecting gun tubes for defects prior to the cold working operation. Results of these tests were reported in reference a. A copy of this report was sent to the Navy Department, Bureau of Ships.

2. At present, visual inspection, with occasional use of the oil and whiting method, is being relied upon for inspection of gun tubes prior to cold working.

3. A recent communication received from the Navy Department, Bureau of Ships indicates that they have tried or are using the magnetic powder method of inspection with success. (See reference b.) A suggestion, intended to expedite production testing of hollow tubes, is attached to their communication.

4. It is suggested that this Arsenal consider the magnetic powder method of inspection to be used in production inspection with the view to the detection of defects which might not otherwise be found until late stages in the manufacture of the gun tube. Defects have been found in certain instances when the tube was nearly finish machined. Earlier detection would result in a great saving of time and money. The present used method of inspection depends upon visual examination by the machine operator who performs the rough machining operation and the inspector. The suggested method will enable a more thorough and dependable inspection to be carried on at a rate that will not slow up production.