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O T T A W A April 17th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1628.

Examination of a Section of Admiralty Cable
(Pattern A.P. 7048) which Failed in Service.

(Copy No. 10.)

Bureau of Mines
Division of Metallic
Minerals.

Ore Dressing
and Metallurgical
Laboratories

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
Mines and Geology Branch

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Origin of Request and Object of Investigation:

On April 1st, 1944, a section of Admiralty cable (Pattern A.P. 7048) which had failed in service (submarine work) was submitted, for examination, by the Inspection Board of United Kingdom and Canada, Ottawa, Ontario. In a covering letter (File No. 4-14-2-2) dated March 30th, 1944, Capt. A. L. MacDonald, Inspector of Electrical Engineering, Signals and Engineering Branch stated that a large number of the strands had broken in tension but that some of the strands of armour further back may have been broken by abrasive or other action, thus causing the whole cable to weaken and break when placed under tension. Capt. MacDonald requested that an examination be made to determine the reason for failure.

Macroscopic Examination:

The section of cable submitted was approximately 3½ feet long by 7/8 inch outside diameter. Figure 1 is a photograph of the broken end of the cable as received. Figure 2 is a photograph of the broken ends of all strands comprising the armoured cable. This photograph shows that all 22 strands in the cable broke in tension. There was no sign of wear or abrasion on the section of cable submitted for examination.

Chemical Analysis:

The chemical analysis of the armour strands submitted is shown below:

		Per cent
Carbon	-	0.11
Manganese	-	0.39
Silicon	-	0.18
Sulphur	-	0.040
Phosphorus	-	0.022

Tensile Tests:

The following results were obtained on a 10-inch gauge length, compared to the requirements of the specification.

Test	Maximum stress, p.s.i.	0.2 per cent proof stress, p.s.i.	Per cent elongation, 10-in. gauge	Reduction in area, per cent
Specification	60,500		12.0	
Test No. 1	71,500	64,750	2.8	64.7
Test No. 2	71,000	64,750	2.9	61.1

The following results were obtained using a gauge length of $4\sqrt{\text{area}}$:

(Continued on next page)

(Tensile Tests, cont'd) -

Test No.	Maximum stress, p.s.i.	0.2 per cent proof stress, p.s.i.	Elongation, per cent $4\sqrt{\text{area}}$ gauge	Reduction in area, per cent
1	75,000	64,750	25.0	64.5
2	76,000	69,375	17.0	62.5
3	73,000	72,500	22.2	63.5
4	75,750	74,250	25.0	61.0
5	75,375	71,875	19.5	63.5

Figure 3 shows the necked ends of the strands pulled in tension. A comparison of this illustration with Figure 2 shows definitely that all the strands in the cable "as received" broke in tension, as they are necked down in an exactly similar manner to the strands pulled in the tension machine.

A section of the wire was bent completely around a cylinder of the same diameter as the wire, and back again. There was no sign of injury to the tested piece other than scaling of the zinc coating.

Microscopic Examination:

A longitudinal section from one of the armour wires was mounted, hand polished, etched in 2 per cent nital, and microscopically examined. The structure revealed was normal for wire of this composition after cold working and subsequent annealing (see Figure 4).

Discussion of Results:

Chemical analysis and microscopic examination showed that the steel used was satisfactory.

The wire withstood the specified bending test satisfactorily.

The tensile tests indicated a satisfactory breaking stress but gave low values for the per cent elongation in a 10-inch gauge length. The specification calls for a minimum of 12 per cent elongation in a 10-inch gauge length. This

(Discussion of Results, cont'd) -

specification is for the wire before galvanizing and fabrication into cable. For this reason the results obtained in tensile tests performed during this examination should not be expected to conform completely to the stated specifications. No specifications were available for the wire after it had been galvanized and fabricated into a cable. From the results obtained it seems likely that the cold working to which the wire was subjected during cable fabrication adversely affected its ductility.

The diameters of the individual strands of armour wire were measured in several places. The maximum diameter obtained was 0.102 inch with most of the readings giving a diameter of 0.101 inch, these values being taken on the galvanized surface. Specifications call for a diameter of 0.104 inch with tolerances agreeing with the C.E.S.A. "Standard General Specification for Galvanized Steel Wire Strand" B12-1939 (± 0.002 inch). The diameters obtained were very slightly lower than the minimum specification.

CONCLUSIONS:

The section of Admiralty cable (Pattern 7048) submitted had broken under tension.

The examination indicated no metallurgical reason for the cable failure.

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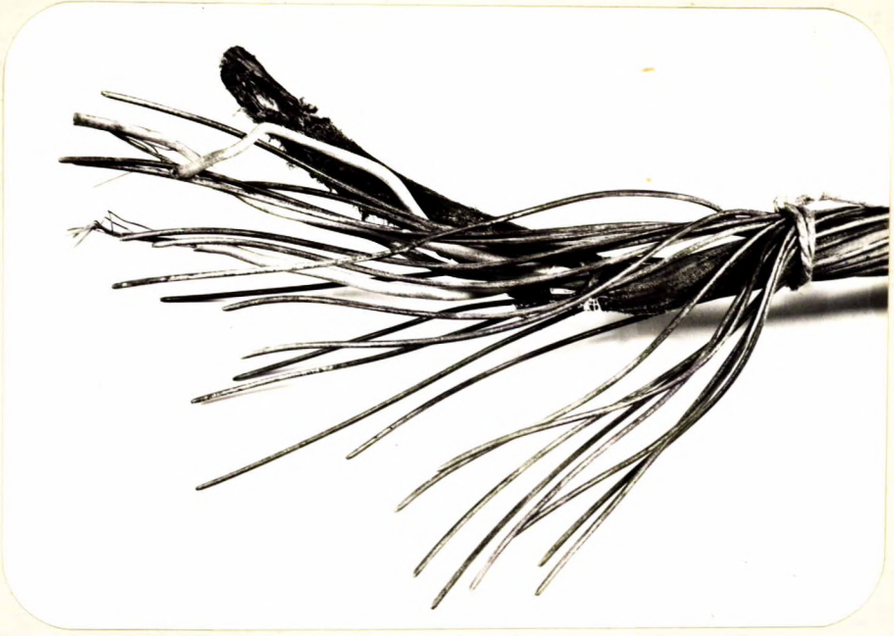
Figure 1.



BROKEN SECTION OF CABLE, AS RECEIVED.

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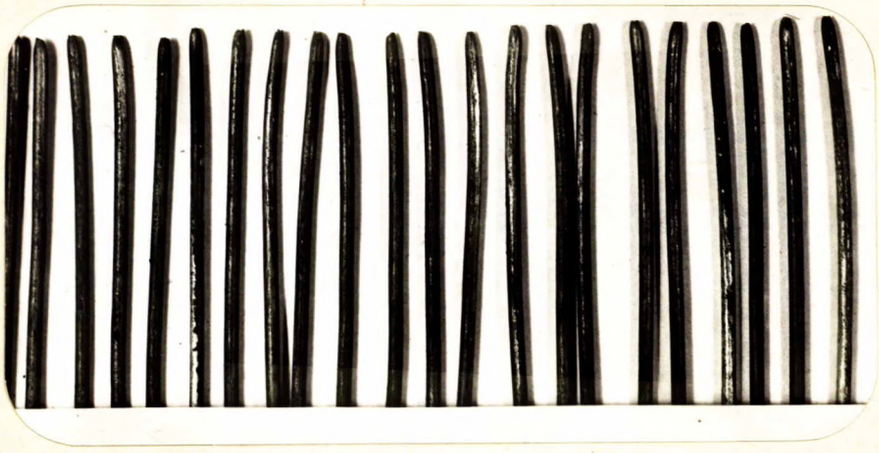
Figure 2.



BROKEN ENDS FROM CABLE, SHOWING
STRANDS WERE BROKEN IN TENSION.

Note necking on all strands.

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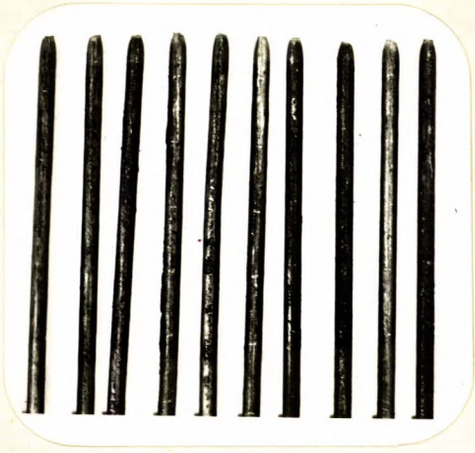
Figure 3.



STRANDS BROKEN IN TENSILE
TESTING MACHINE.

Note necking on all strands.

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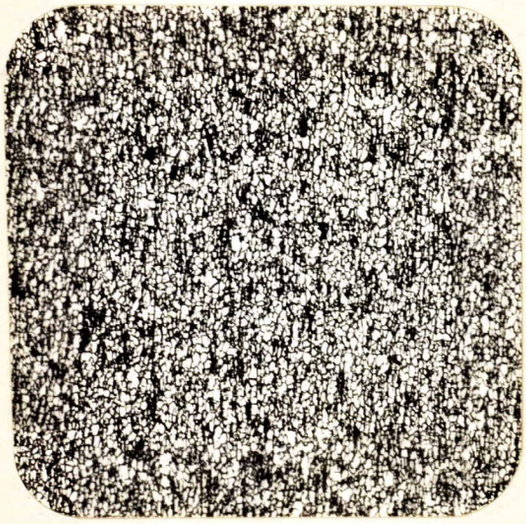
Figure 4.



X100, nital etch.

NORMAL STRUCTURE OF 0.11
PER CENT CARBON WIRE
AFTER COLD WORKING
AND ANNEALING.

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