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O T T A W A September 1st, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1705.

Examination of T.50 Steel Tubing.

(Copy No. 10.)

Bureau of Mines
Division of Metallic Minerals
Physical Metallurgy
Research Laboratories

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
Mines and Geology Branch

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Origin of Material and Object of Investigation:

On August 22nd, 1944, two samples of T.50 steel tubing, showing surface defects, were submitted by A/C A. L. Johnson, for Chief of Air Staff, Department of National Defence for Air, Ottawa.

The covering letter, dated August 21st, 1944, File No. 938NIV-5-5(AMAE DAI), requested that one sample be subjected to a flattening test and the other be examined to determine the nature of the defect.

Chemical Analysis:

		Specified - Per Cent -	Found
Carbon	-	0.50 max.	0.45
Manganese	-	1.75 "	1.48
Silicon	-	0.30 "	0.28
Phosphorus	-	0.05	0.023
Sulphur	-	0.05	0.042

Mechanical Tests:

Two microtensile specimens were machined from one of the tubes and tested in the Hounsfield tensometer. The following results were obtained:

		SPECIFIED (Specification No. 2-T-50)	FOUND Test No. 1	FOUND Test No. 2
Ultimate stress, p.s.i.	-	112,000	130,000	132,000
Yield stress, p.s.i.	-	100,800◆	110,000	112,000
Elongation, per cent in 1 inch	-		19.0	20.0
Reduction in area, per cent	-		53.0	55.0

◆ 0.2 per cent proof stress.

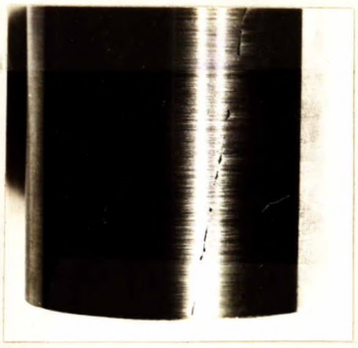
Flattening Test:

The tubing was found to meet the requirements of the flattening test. However, when the tubing was flattened to slightly less than the specified diameter it cracked along the line of the defect (see Figures 1, 2 and 3).

(Continued on next page)

(Flattening Test, cont'd) -

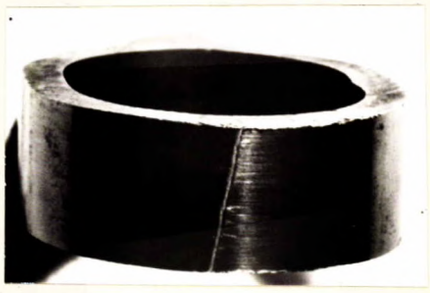
Figure 1.



SHOWING DEFECT IN TUBING AS RECEIVED.

(Approximately $\frac{3}{4}$ size).

Figure 2.



SHOWING CRACK IN BEND SPECIMEN ALONG THE LINE OF DEFECT.

(Approximately to size).

Figure 3.

SHOWING CRACK ON END OF OVERSTRESSED BEND SPECIMEN.

(Approximately $2\frac{1}{2}$ times actual size).

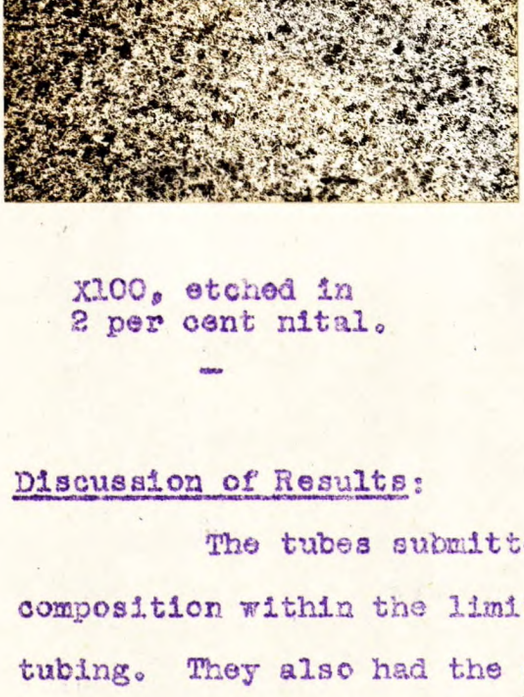
Microscopic Examination:

A cross-section of the steel tube, cutting across the defect, was given a metallographic polish and examined under the microscope in the unetched condition. The steel appeared to be fairly clean and no slag or inclusions could be observed in the surface defect of the tubing. The steel

(Microscopic Examination, cont'd) -

was then etched in a solution of 2 per cent nitric acid in alcohol and re-examined. The nital-etched structure of the steel, shown in Figures 4 and 5 (photomicrographs at X100 and X1000 magnification respectively), consists of fine pearlite, the iron-iron carbide constituent, and ferrite (shown as light material in the photomicrographs), the iron content. No decarburization was noted along the surface of the tubing. The defect in the tube can be observed in Figure 4.

Figure 4.



X100, etched in
2 per cent nital.

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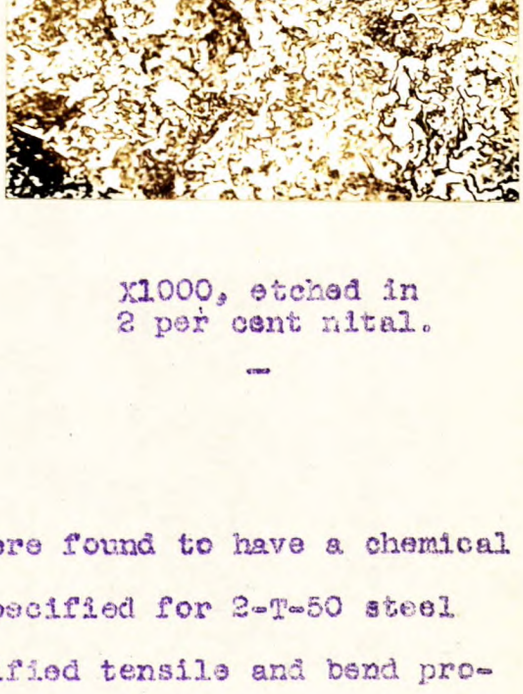
Figure 5.



X1000, etched in
2 per cent nital.

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Discussion of Results:

The tubes submitted were found to have a chemical composition within the limits specified for 2-T-50 steel tubing. They also had the specified tensile and bend properties. The bend test, however, showed that there was a tendency towards stress concentration along the line of the defect (see Figure 2). The microstructure indicated that the tubes had received a normalizing-and-draw heat treatment. Although this conforms to the specification, a more homogeneous

(Discussion of Results, cont'd) -

structure could be obtained by the quench-and-draw heat treatment also allowed by the specification.

Section 4(b) of the specification for 2-T-50 steel tubes states that any tube may be rejected at any time for faults in manufacture, notwithstanding that it has been passed previously on chemical composition and mechanical tests. The surface defect is definitely a fault in manufacture.

Conclusion:

The results of this investigation would indicate that the surface defect in the tube was caused by faulty tube manufacture and did not originate in the raw material. If the defect cannot be removed prior to assembly, these tubes and any tubes with similar defects should be rejected.

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