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R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1757.

Examination of Broken Snowmobile Track Adjusting Assembly.

(Copy No. 10 .)

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Description of Material and Object of Investigation:

On November 29th, 1944, one broken Snowmobile Track Adjusting Assembly (see Figure 1) was submitted, for examination, by Mr. H. J. Stevenson, Assistant Director General, Army Engineering Design Branch, Department of Munitions and Supply, Ottawa, under Requisition No. 678 (A.E.D.B. Lot No. 571, Report No. 107, Section "D", Test No. 23). The covering letter, dated November 29th, 1944, contained the following information:

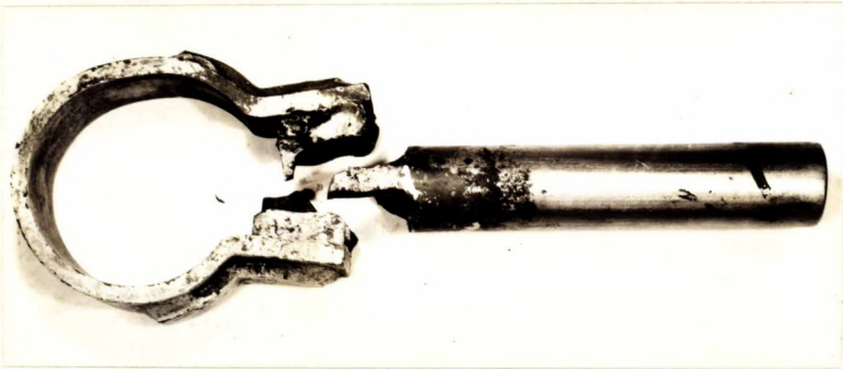
> "Material presently specified for the tubular part is SAE 1020. Assemblies are failing at very low mileages; the one submitted failed at approximately 35-45 miles."

A request was made to determine the cause of

(Description of Material and Object of Investigation, cont'd) -

failure of the steel tubing portion of the assembly.

Figure 1.



GENERAL VIEW OF TRACK ADJUSTING ASSEMBLY, SHOWING LOCATION OF BREAK IN TUBING.

(Approximately 1/3 normal size).

Macro-Examination:

Visual examination revealed that failure of the tubing had occurred in areas near the weld.

A photograph of the fractured tubing is shown in Figure 2. The appearance of the fracture is that of a typical fatigue failure.

Figure 2.

BRITTLE FATIGUE FRACTURE.

(Approximately normal size).

Chemical Analysis:

A sample was cut from the tubing and analysed. The results are given in Table I.

TABLE I.

		Per Cent
Carbon	-	0.81
Silicon	-	0.47
Manganese	-	0.23
Chromium	-	4.45
Tungsten	-	4.81
Molybdenum	-	2.40
Nickel	-	Nil.
Vanadium	-	0.64

Hardness Test:

Hardness tests, using the Vickers machine, were made on the tubing material at two areas, one immediately adjacent to the break and the other away from the break. The extreme hardness of the former is caused by the heat from the welding operation. The comparatively low reading obtained from the latter is typical of the steel in the "as received" condition. The results are given in Table II.

TABLE II.

	Vickers (30-kg. load)	Rockwell 'C' Hardness
Zone adjacent to break (Heat-affected zone) -	776	60
Zone away from break (Unaffected zone) -	231	22

Microscopic Examination:

Sections of the tubing were cut adjacent to and remote from the fracture.

Figure 3 is a photomicrograph, taken at X1000 magnification, showing the normal spheroidized structure of

(Microscopic Examination, cont'd) -

the tubing remote from the zone affected by the heat of welding.

Figure 4 shows the microstructure, at magnification X750, of the heat-affected zone of the tubing near the break. The structure consists of carbides in a background of martensite marked by austenite grain boundaries. Such a structure is very hard and brittle, approximately 60 Rockwell 'C'.

Figure 5 is a photomicrograph, at X750 magnification, of a section adjacent to the weld. The microstructure consists of eutectic at the grain boundaries and a background of martensite. This structure is very hard and extremely brittle and was caused by the melting of the steel during the welding operation.

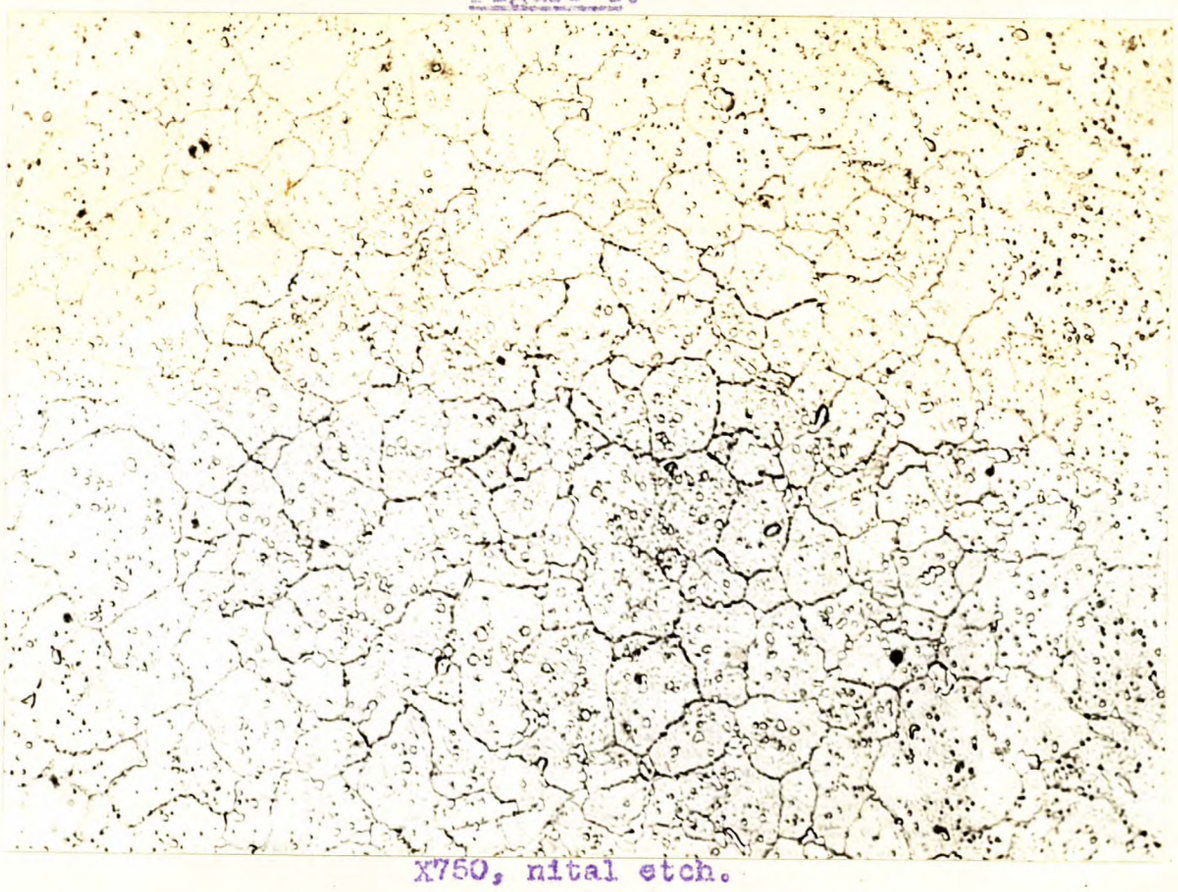
Figure 3.

X1000, nital etch.

NORMAL STRUCTURE OF STEEL TUBING
AWAY FROM WELD.

Carbide spheres in a background of ferrite.

Figure 4.



X750, nital etch.

HARDENED STRUCTURE NEAR WELD.

Carbides in a background of martensite.

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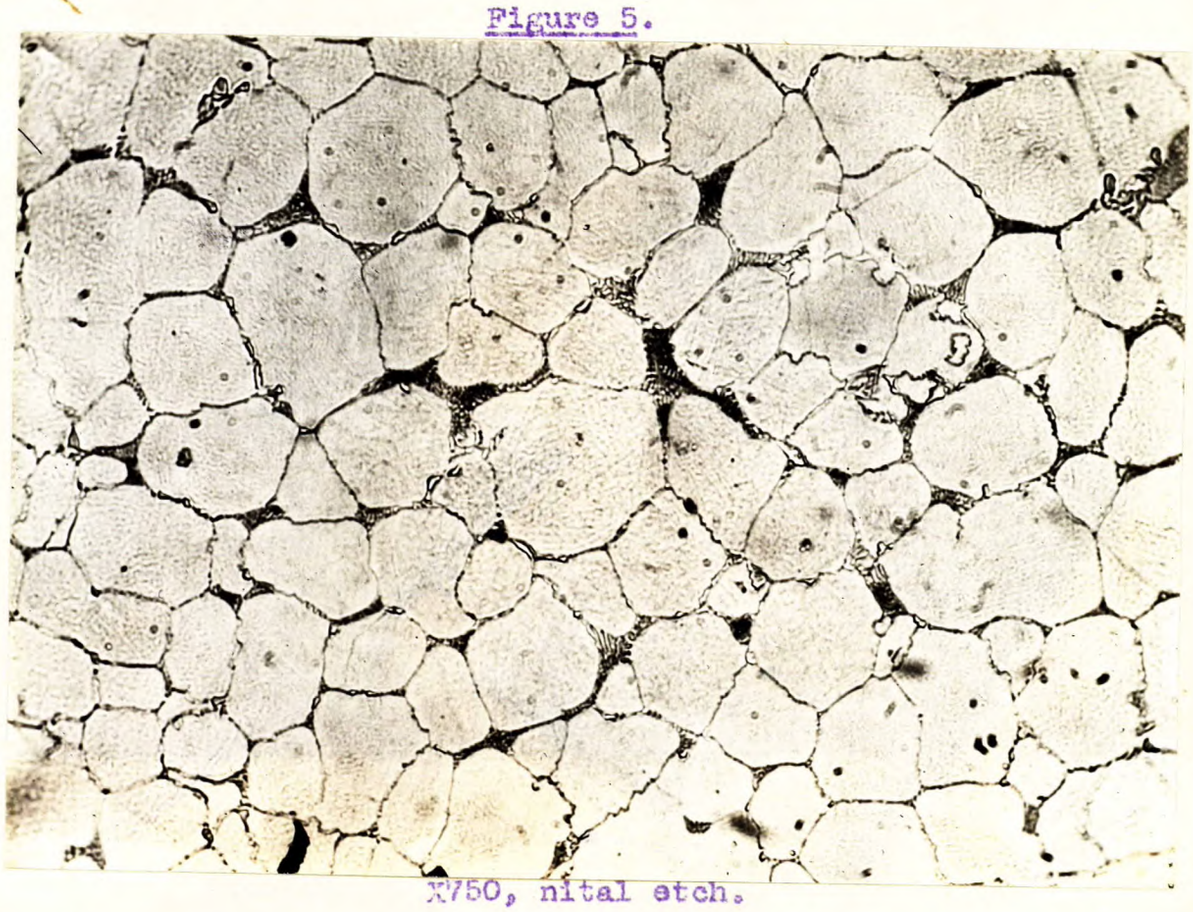
Figure 5.



X750, nital etch.

HARD, BRITTLE STRUCTURE ADJACENT TO WELD, SHOWING EUTECTIC IN A BACKGROUND OF MARTENSITE, CAUSED BY ACTUAL MELTING OF THE STEEL.

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Discussion:

According to the specifications in Dwg. C-38036, the tubing for this part should be SAE 1020 steel. The results of the chemical analysis showed that the tubing examined was made of a material which in no way resembles a plain carbon steel. As a matter of fact, the steel was found to be a tool steel containing, in addition to high carbon, the alloying elements chromium, tungsten, molybdenum and vanadium. This type of steel, on being subjected to a temperature high enough to melt it, as in welding, becomes a very hard (60 Rockwell 'C') and extremely brittle product (see Figure 5) which is totally incapable of withstanding any shock. Hence, it is not surprising that the part failed after very limited service.

The photomicrographs substantiate the results of the chemical analysis. The steel is actually a highly alloyed tool steel.

CONCLUSIONS:

1. The steel tubing which failed in service was made of a tool steel containing the alloying elements tungsten, chromium, molybdenum and vanadium.

2. Since the steel specified was SAE 1020, it must be concluded that the wrong steel was employed due to an error in the selection of the materials.

3. Failure of the tubing resulted from the employment of a steel entirely unsuited for the purpose intended.

Recommendation:

It is strongly recommended that a rigid system of inspection be installed, in order to prevent the use of faulty materials in the field.

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