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O T T A W A December 19th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1763.

Metallurgical Examination of Broken Snowmobile Track Adjusting Assembly.

(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:

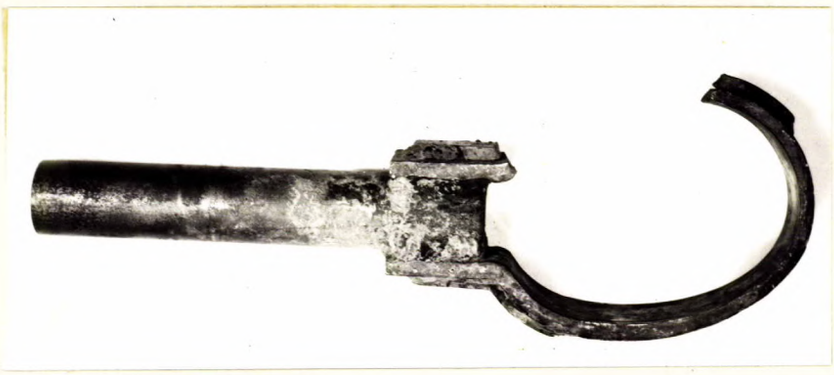
On December 12th, 1944, one fractured Snowmobile Track Adjusting Assembly (Drawing C-38036)(see Figure 1) was submitted by the Division of Metallurgy, Army Engineering Design Branch, Department of Munitions and Supply, Ottawa, Ontario, under Requisition No. 682, A.E.D.B. Lot No. 575, Report No. 107, Section "D", Test No. 26.

The covering letter, dated December 12th, 1944, requested that the cause of failure be determined.

(Continued on next page)

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

Figure 1.



GENERAL VIEW OF BROKEN SNOWMOBILE ADJUSTING ASSEMBLY.

(Approximately 1/3 normal size).

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Visual Examination:

Visual examination showed that the fracture had occurred at one of the elbows (where a severe forming operation had been carried out), through both the ring and the reinforcing plate.

Further visual examination revealed a smooth, brittle fracture of the ring and definite indications of fatigue failure (see Figure 2). The fracture of the reinforcing plate was rather "woody" or "fibrous" in appearance; the reason for this was later determined by the microscopic examination.

Figure 2.

PHOTOGRAPH SHOWING SMOOTH, BRITTLE FATIGUE FRACTURE OF RING (BOTTOM) AND FIBROUS FRACTURE OF REINFORCING PLATE (TOP).

(Approximately 1½ times full size).

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Chemical Analysis:

Samples taken from the three components comprising the assembly, namely, tubing, reinforcing plate, and ring, were then subjected to chemical analysis. The results are given in Table I.

TABLE I.

	Tubing	Ring	Reinforcing Plate
		- Per Cent -	
Carbon -	0.21	0.24	0.26
Manganese -	0.28	0.50	0.59
Silicon -	0.05	0.05	0.05
Sulphur -	0.025	0.039	0.040
Phosphorus -	0.005	0.008	0.008

The specifications in Drawing C-38036 require SAE 1020 steel for these components.

Microscopic Examination:

Figure 3 is a photomicrograph, at X100 magnification, showing the microstructure of the tubing. This structure is typical of SAE 1020 steel.

Figure 4, taken at X100 magnification, shows the microstructure of the ring at the break. Note smooth contour of fracture and absence of distortion, indicating a brittle fracture.

Figure 5, also taken at X100 magnification, shows the fractured edge of the reinforcing plate. Note the banded structure of the steel, which is responsible for the "woody" or "fibrous" appearance of the fracture.

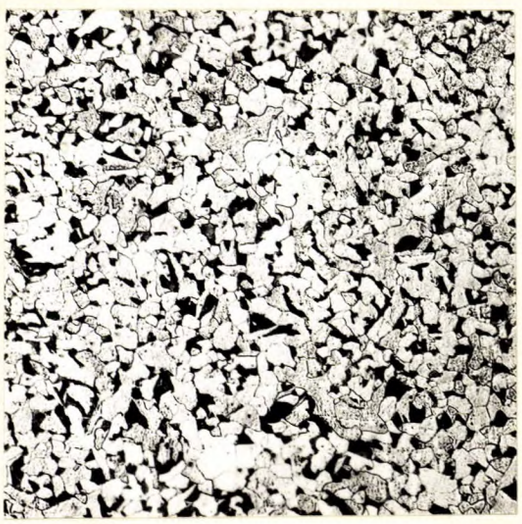
Figure 6, taken at X40 magnification, is a photomicrograph showing the fractured edge of the reinforcing plate, at the surface. Note the heat-affected zone caused by welding splatter.

Figure 7, shows another weld splatter on the surface of the reinforcing plate. The magnification is approximately X45.

(Continued on next page)

(Microscopic Examination, cont'd) -

Figure 3.



X100, nital etch.

MICROSTRUCTURE
OF TUBING.

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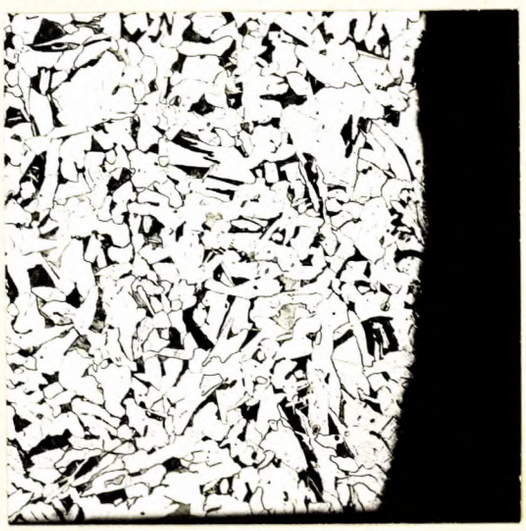
Figure 4.



X100, nital etch.

FRACTURED EDGE
OF RING.

Note lack of distortion, indicating brittle fracture.

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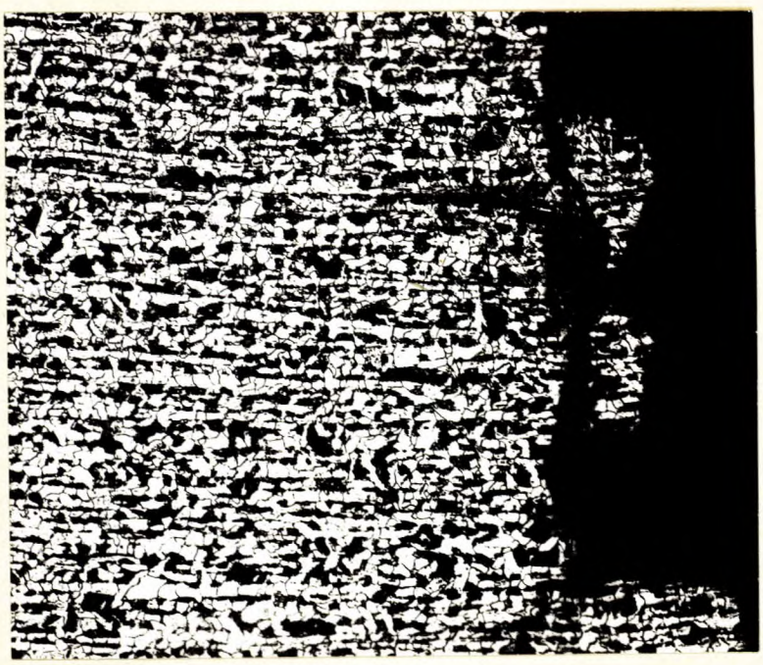
Figure 5.



X100, nital etch.

FRACTURED EDGE OF REINFORCING PLATE.

Note banded structure.

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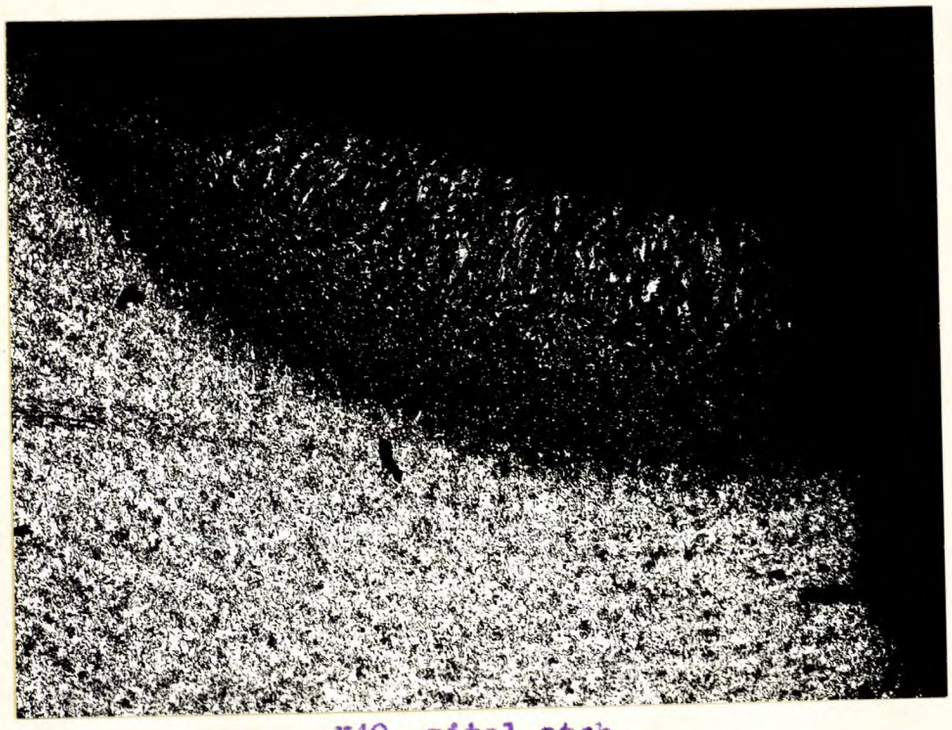
(Microscopic Examination, cont'd) -

Figure 6.



X40, nital etch.

FRACTURED EDGE OF REINFORCING PLATE, AT SURFACE.

Note hard, heat-affected area caused by weld splatter.

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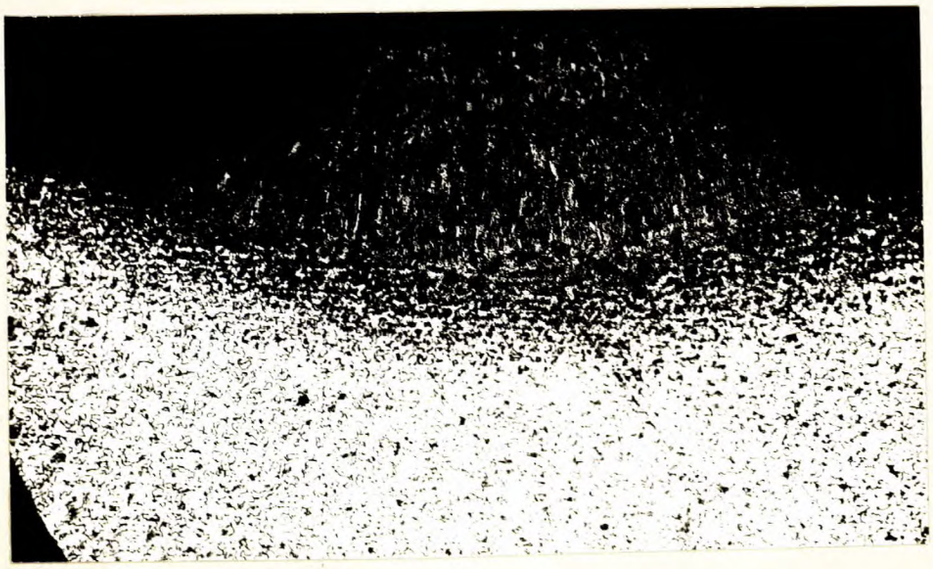
Figure 7.



X45, nital etch.

WELD SPLATTER ON SURFACE OF REINFORCING PLATE.

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Hardness Test:

Hardness readings were taken with the Vickers machine on the reinforcing plate, both on areas away from the heat-affected zone and in the heat-affected zone caused by the weld splatter. The results are given in Table II.

TABLE II.

	Vickers (20-kg. load)	Rockwell 'C' (Converted)
Unaffected zone -	(150	-
	(164	3
Heat-affected zone -	(343	35
	(387	40

Discussion:

The results of the chemical analyses indicate that the components comprising the assembly very nearly approach SAE 1020 steel as required by the specifications.

Visual and microscopic examinations both contribute strong evidence in support of the opinion that the ring failed in fatigue.

The hardness tests taken on the reinforcing plate, in the areas affected by the weld splatter, show that these areas are extremely hard (as high as 40 Rockwell 'C'). In view of the fact that the fracture in the reinforcing plate occurred through one of these areas (see Figure 6), it is quite possible that the initial crack in the reinforcing plate occurred in this area. When the plate had broken completely through, the additional load suddenly applied to the ring caused a rapid, brittle fracture of the latter component.

Another factor which may have contributed to the failure of the ring is the rather abrupt change of contour at the elbow of the ring, causing a notch effect which

(Discussion, cont'd) -

invariably acts as an area of high stress concentration.

All of these factors would contribute to the failure of the assembly under conditions of severe tension for protracted periods of time. This opinion is supported by verbal information obtained from Mr. N. J. Stevenson, of the Army Engineering Design Branch, who indicated that failure had occurred after lengthy service in field testing.

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CONCLUSIONS:

1. The steels from which the components of the assembly have been made are satisfactory.

2. Failure of the ring most likely occurred as a result of fatigue.

3. The initial crack in the reinforcing plate may have been initiated at a hardened, heat-affected point on the surface, caused by a weld splatter.

4. The fracture of the reinforcing plate resulted in the sudden application of an additional load on the ring, causing the brittle fracture of the latter.

5. Fracture of the ring at the elbow occurred at this location because of the sharp change of contour, resulting in an area of high stress concentration.

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Recommendations:

1. It is recommended that the parts of the assembly be painted with anti-splatter compound before welding.

2. The ring should be so formed as to avoid the sharp notch effect at the elbow.

3. The temperature of the ring during the formation of the elbow should be high enough to prevent the setting up of high stresses in this area.

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