FILE COPY

O T T A W A April 13, 1946.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2030.

Metallurgical Examination of Trailer Spring Suspension U-Bolts and Broken Leaf Springs from Tractor Rear Towing Attachment.

(Copy No. 1.)

Bureau of Mines
Division of Metallic
Minerals

Physical Metallurgy
Research Laboratories

CANADA

DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

O T T A W A April 13, 1946.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2030.

Metallurgical Examination of Trailer Spring Suspension U-bolts and Broken Leaf Springs from Tractor Rear Towing Attachment.

==========

Source of Material and Object of Investigation:

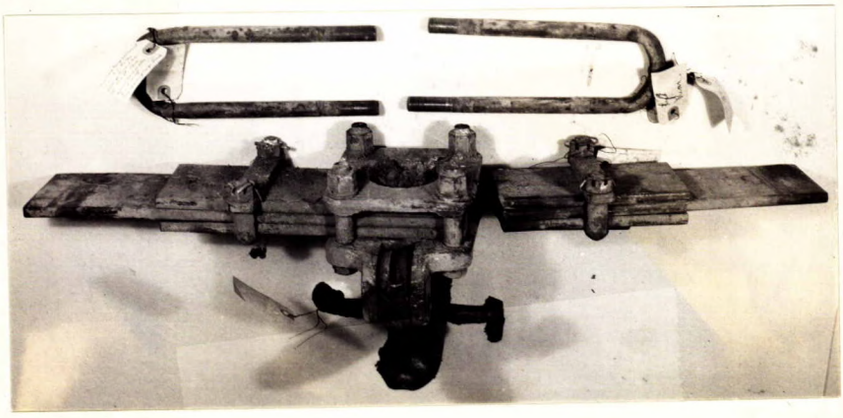
On March 28, 1946, Mr. L. H. Wolff, for Director General, Army Engineering Design Branch, Department of Reconstruction and Supply, Ottawa, Ontario, submitted for examination two spring U-bolts from a trailer spring suspension and two broken sections of D.N.D. rear towing attachment.

In the covering request letter (dated March 28, 1946, File No. 73-1-17/73-T-105), it was stated that during mileage tests numerous spring failures occurred which necessitated removing the U-bolts and reinstalling the latter when a new spring assembly was installed. Failure of the spring clips in service was also reported. A full metallurgical examination of the component parts was requested in order to determine, if possible, the cause of these failures.

Macro Examination:

Figure 1 is a photograph showing the U-bolts and the rear towing attachment in the "as received" condition.

Figure 1.



U-BOLTS AND SPRING ASSEMBLY.

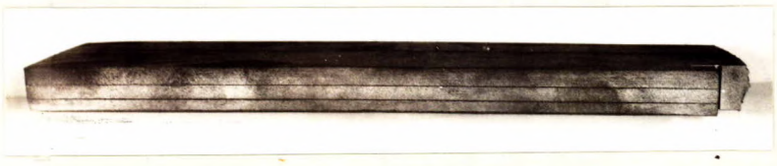
(Approximately 1/8 actual size).

-

Magnaflux Examination:

Cracks were observed, on the edge of the top spring leaf, on a section removed for microscopic examination. After sandblasting, the spring assembly was magnafluxed and then examined for cracks. One crack was noted in the centre and three cracks at the edge of the top leaf. The cracks are shown in Figures 2, 3 and 4. No cracks were observed in the other two leaves.

Figure 2.



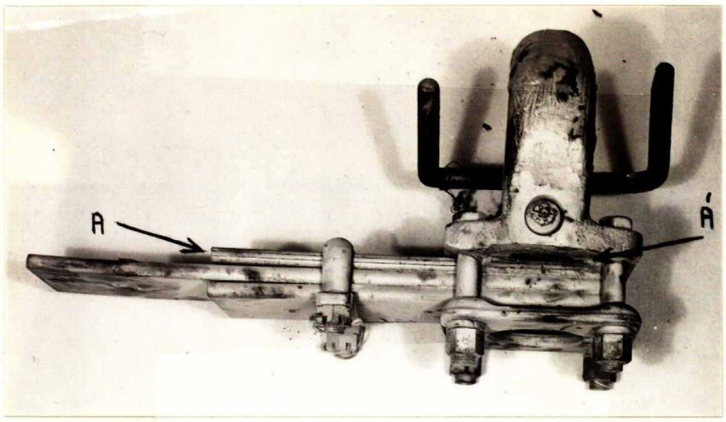
SHOWING THREE CRACKS AT EDGE OF SPRING LEAF.

(Approximately to size).

-

(Magnaflux Examination, cont'd) -

Figure 3.

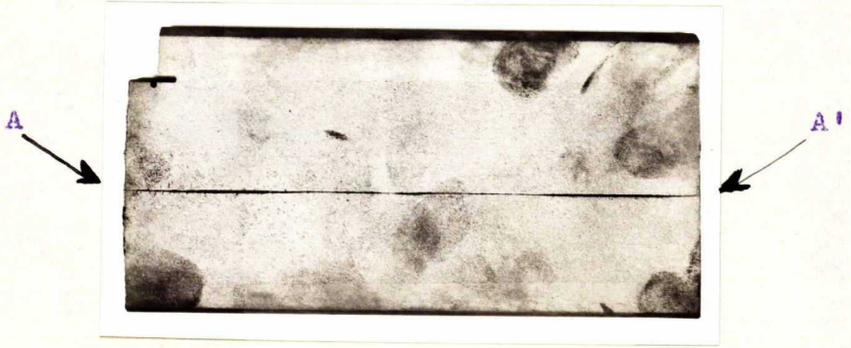


SHOWING CRACKS IN TOP LEAF AT A, A'.

(Approximately 1/9 actual size).

-

Figure 4.

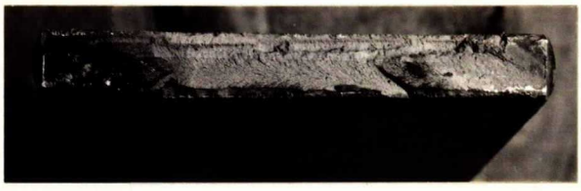


SHOWING CRACK IN CENTRE OF LEAF AT A, A'.

(Approximately full size).

-

Figure 5.



SHOWING FRACTURE OF TOP LEAF.

(Approximately 7/8 size).

—

Chemical Analysis:

	SPRING LEAF		SPRING CLIP	
	Specified, SAE 9260	Found	Specified, SAE 1020	Found
Carbon, per cent	0.55-0.65	0.62	0.18-0.23	0.27
Manganese, "	0.70-0.90	0.84	0.30-0.50[Φ]	0.79
Silicon, "	1.80-2.20	2.07	0.15-0.30	0.13
Phosphorus, "	0.040 max.	0.020	0.040 max.	0.018
Sulphur, "	0.040 max.	0.010	0.050 max.	0.016

[Φ] X1020, Mn = 0.70-1.00 per cent.

	U-BOLT	
	SAE 3125	Found
Carbon, per cent	0.20-0.30	0.24
Manganese, "	0.60-0.80	0.63
Silicon, "	0.20-0.35	0.27
Phosphorus, "	0.04 max.	0.006
Sulphur, "	0.04 max.	0.014
Nickel, "	1.10-1.40	1.39
Chromium, "	0.55-0.75	0.54
Molybdenum "	Nil	0.07

Mechanical Properties:

Hardness Tests -

The hardness of the three spring leaves, the U-bolts and the spring clips was determined by the Brinell method, using a 3,000-kilogram load. The following values were obtained:

	Brinell Hardness
Spring Leaves[Φ] -	388
U-Bolt -	136
Clip -	110

[Φ] Specified, 353-414.

Tensile Tests -

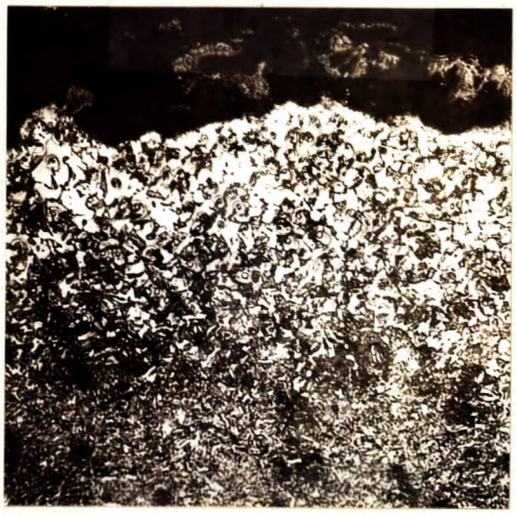
A tensile test bar machined from one of the U-bolts had the following tensile properties:

Ultimate stress, p.s.i. - -	88,800
Yield " " - -	54,800
Reduction in area, per cent -	68.0
Elongation, per cent in 2 inches -	35.0
Brinell hardness - - -	136

Microscopic Examination:

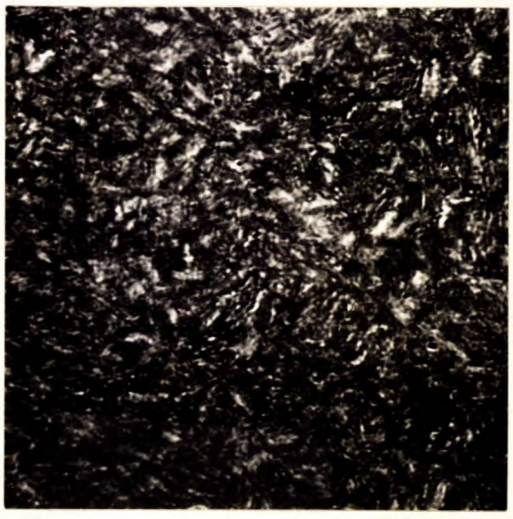
Samples were cut from the three broken steel springs, mounted in bakelite, polished, and examined in the unetched condition under the microscope. The steels were fairly dirty. Three cracks were noted on the edge of the top leaf. However, no cracks were noted in the other two leaves. The steels were then etched in 4 per cent picric acid solution in alcohol and re-examined. The etched structures are shown in Figures 6, 7 and 8.

Figure 6.



X100, etched in 4 per cent picric acid.

Figure 7.



X1000, etched in 4 per cent picric acid.

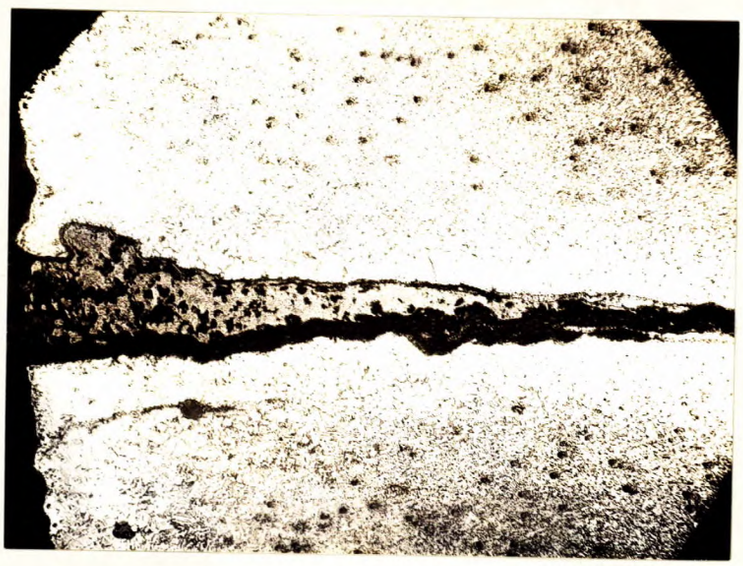
MICROSTRUCTURE OF BROKEN LEAF SPRINGS.

The microstructure of all three leaves is normal for that of SAE 9260 steel quenched and tempered, i.e., tempered martensite. However, in Figures 6 and 8 it will be observed that the steel is decarburized on the edge and also in the area surrounding the crack.

(Continued on next page)

(Microscopic Examination, cont'd) -

Figure 8.



X200, etched in 4 per cent
picric acid.

SHOWING CRACK AND DECARBURIZED AREA.

-

Discussion of Results:

The compositions of the three component parts examined were within the limits specified. The macroscopic examination revealed a number of cracks in the top broken leaf. No fractures were noted in any of the other component parts. The fractures are typical of a fatigue failure. The decarburized surface and the cracks in the steel would both definitely lower the fatigue strength of the steel. The presence of a decarburized layer along the crack would indicate that these cracks were present prior to heat treatment and most probably originated in the forming operation.

From the results of this investigation, it is concluded that the spring leaves failed in fatigue. The low mechanical properties of the SAE 3125 steel U-bolt may account for its stretching in service. No defects were observed in the spring clips submitted except a crack in the weld metal

(Discussion of Results, cont'd) -

between the clip and the bottom leaf. The welding of SAE 1020 steel to SAE 9260 is not considered good practice.

Recommendations:

(1) The leaves should be heat treated in a protective atmosphere in order to prevent decarburization.

(2) Shot peening of the leaves will increase their fatigue strength and is recommended.

(3) The strength of the suspension U-bolt should be increased. Heat treating to a higher hardness is recommended.

(4) Welding of the spring clip to the leaf is not shown on the D.N.D. drawing No. C1017, and should not be permitted.

oooooooooooo
oooooooo
oo

NBB:LB.