O T T A W A March 30th, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1195.

Examination of Snowmobile Bogie Wheel Suspension Assembly.

(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

O T T A W A March 30th, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1195.

Examination of Snowmobile Bogie Wheel Suspension Assembly.

Origin of Request:

On March 19th, 1942, Mr. R. J. Kerr, for the Director of Automotive Design, Army Engineering Design Branch, Department of Munitions and Supply, Ottawa, Ontario, submitted for examination a broken snowmobile bogie wheel assembly (shown in Figure 1). This was accompanied by Mr. Kerr's letter of March 18th, file No. 73-V-16, requesting that the cause of this failure be determined.

Macro-Examination:

As is evident from Figure 1, this assembly consists of a short tubular member, approximately $2\frac{3}{4}$ inches in diameter, to which are welded two lengths of axle and a bracket. One of these axles has broken off at the weld.

Chemical Analysis:

Samples for chemical analysis were obtained from both the axle and the tubular member. The results are given in Table I.

Table I. - Chemical Analysis.

	Axle, (Per cent)	Tubular member, (Per cent)
Carbon -	0.41	0.26
Silicon -	0.18	0.05
Manganese -	0.79	0.46
Sulphur -	0.033	0.032
Phosphorus -	0.013	0.017

Microscopic Examination:

A section of the welded joint was prepared for microscopic examination.

Figure 2 is a photomicrograph at 100 diameters showing the structure of the axle steel where it has not been affected by the heat of welding.

Figure 3 is a photomicrograph at 100 diameters showing the structure of the axle steel adjacent to the weld.

Discussion of Results:

An examination of the two photomicrographs, Figures 2 and 3, will clearly show that the structure of the axle steel has been greatly coarsened by the heat of welding. This is to be expected. This transformation in structure will be reflected in increased brittleness of the metal. An idea of how much this change in structure can effect the brittleness

(Discussion of Results, cont'd) -

of the steel can be obtained from a study of the paper, "The Use of the Charpy Test as a Method of Evaluating Toughness Adjacent to Welds,"* by Walter H. Bruckner. The following table is an excerpt from Table III of this report:

Excerpt from Table III. - Impact and Hardness Determinations in Weld Quench Tests on Rolled Steels.

Item	Chemical Analysis Percent			Impact		
	C	Si	Mn	As Received Material (Average of two tests), ft.lbs.	Weld Quench Samples (Average of three tests), ft.lbs.	Percentage of Original Impact after Weld Quench Treatment
1.	0.17	0.17	0.41	16	18	112
2.	0.25	0.20	0.43	16	15	94
3.	0.35	0.23	0.68	19	13	68
4.	0.44	0.24	0.65	10	2½	25

These data also clearly represent the effect of carbon content on the sensitivity of the steel to embrittlement from welding.

Conclusion:

The axle on the snowmobile bogie wheel assembly failed because of the recrystallization and grain growth caused by the heat of welding.

---

* Published in "Symposium on Impact Testing" presented at the Forty-First Annual Meeting of the American Society for Testing Materials, Atlantic City, N.J., June 28, 1938. Reprint from the copyrighted proceedings of the A.S.T.M., Philadelphia, Pa., Vol. 38, Part II, 1938, pp. 71-97.

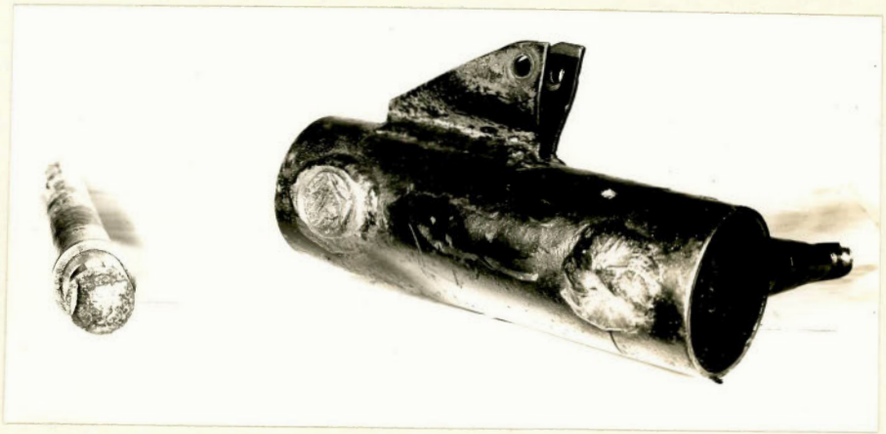
Recommendations:

This condition can be rectified by normalizing the complete assembly after welding, at a temperature of from 1550° F. to 1600° F. It is not recommended that a lower carbon steel be considered unless physical properties can be sacrificed. If the physical properties of S.A.E. 1025 steel are satisfactory for this application, normalizing after welding can be eliminated. However, should physical properties higher than those attainable with S.A.E. 1025 steel be required, and should normalizing after welding not be considered practical, S.A.E. X4130 steel can be used for the axle.

oooooooooooo
ooooooo
o

HVK:GHB.

Figure 1.



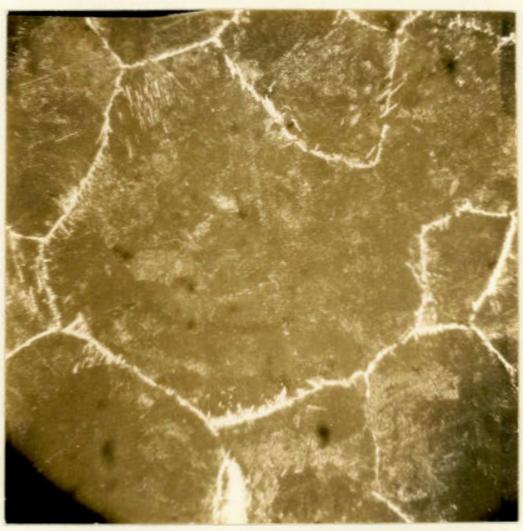
PHOTOGRAPH, 1/3 ACTUAL SIZE, OF
BROKEN SNOWMOBILE BOGIE WHEEL SUSPENSION ASSEMBLY.

Figure 2.

X100, nital etch.

STRUCTURE OF AXLE STEEL NOT
ALTERED BY WELDING HEAT.

Figure 3.



X100, nital etch.

STRUCTURE OF AXLE STEEL AT
WELD, SHOWING COARSE GRAINS.

HVK:GHB.

Our File No: S-2.

Your File:

552 Booth Street,
Ottawa, Ontario,
April 11, 1942.

To: Mr. H. J. Stevenson,
Director of Automotive Design,
Army Engineering Design Branch,
Department of Munition and Supply,
Ottawa.

cc 1, 2, 3.

Identification:

Investigation No. 1195 - Examination of Snowmobile Bogie Wheel Suspension Assembly.

No. of Copies:

3 copies, Nos. 1, 2, and 3.

From: C. S. Parsons, Chief,
Division of Metallic Minerals,
Bureau of Mines.

This work was carried out under the agreement between this department and the various Defence Services, etc., whereby funds have been made available from the War Appropriation.

cc.

R. J. Kerr,
Dept. Munitions and Supply.

JG

Our File No: S-2.

Your File:

552 Booth Street,
Ottawa, Ontario,
April 11, 1942.

To: Mr. R. J. Kerr,
Army Engineering Design Branch,
Department of Munition and Supply,
Ottawa, Canada.

Identification:

Investigation No. 1195 - Examination of Snowmobile Bogie Wheel Suspension Assembly.

No. of Copies:

one copy - No. 4.

From: C. S. Parsons, Chief,
Division of Metallic Minerals,
Bureau of Mines.

This work was carried out under the agreement between this department and the various Defence Services, etc., whereby funds have been made available from the War Appropriation.

cc.

Mr. H. J. Stevenson,
Dept. Munitions and Supply.

JG

O T T A W A, April 11, 1942.

Memorandum

To: The Chief,
Bureau of Mines.

From: C. S. Parsons,
Chief of Division.

Re: Investigation No. 1195 - Examination of Snowmobile Bogie Wheel Suspension Assembly.

I submit herewith Investigation No. 1195, compiled by the staff of the Ore Dressing and Metallurgical Laboratories, Metallic Minerals Division, Bureau of Mines.

Application for this work was made by:-

Mr. R. J. Kerr, Army Engineering Design Branch, Department of Munitions and Supply, Ottawa, Ontario, in his letter of March 18, 1942.

Copies of this investigation ~~should be~~, have been, sent out as follows:-

3 copies 1. Mr. H. J. Stevenson, Dept. Munitions and Supply.

1 copy 2. Mr. R. J. Kerr, Dept. Munitions and Supply.

3.

4.

5.

6.

Respectfully submitted.

JG

C. S. Parsons,
Chief of Division.

WHEN REPLYING
REFER TO FILE 73-V-16

DEPARTMENT OF MUNITIONS AND SUPPLY
OTTAWA, CANADA

March 18th, 1942.

Mr.C.S.Parsons,
Chief of Division of Metallic Minerals,
Bureau of Mines,
552 Booth St.
Ottawa, Ontario.

Dear Sir:

We are sending to your attention, for an analysis, a snowmobile bogie wheel suspension assembly.

When talking to your Mr.Brown, he asked that we advise you the kind of metal used in the shaft. This we find we cannot do. In checking with the manufacturer, he informs us he does not know himself. We do know that he purchases Used axle shafts which he machines down. These may have been out of any one of three manufacturer's products, and may be one of several alloys used.

We are of the opinion that, because of the crude methods used in fabricating this suspension unit, the welding operation has crystalized the shaft and led to its rapid breakdown.

We would like to have your findings on this failure at your earliest possible convenience, and would appreciate it if you would address them to Mr.H.J.Stevenson, Director of Automotive Design, Army Engineering Design Branch, Bldg.#4.

Yours very truly,

(R.J.Kerr),
for Director of Automotive Design,
Army Engineering Design Branch.

RJK/S
c.c.Mr.H.J.Stevenson.