OTTAWA December 23rd, 1940.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 939.

Report on Failure of Leaf Spring
on Military Vehicle.

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BUREAU OF MINES
DIVISION OF METALLIC MINERALS

ORE DRESSING AND
METALLURGICAL LABORATORIES

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

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Origin of Problem and Nature of Investigation:

On December 19th, 1940, Mr. H. H. Scotland, Inspector of Materials, c/o Inspector General, Joint Inspection Board of the United Kingdom and Canada, 58 Lyon Street, Ottawa, Ontario, requested a report on the failure of a leaf spring. A broken part of the spring was submitted for examination.

Appearance of Spring:

The spring submitted was made of flat steel strip 2 inches wide by ¼ inch thick. The original spring was over 26 inches long. Failure consisted of a transverse fracture near the centre of the spring.

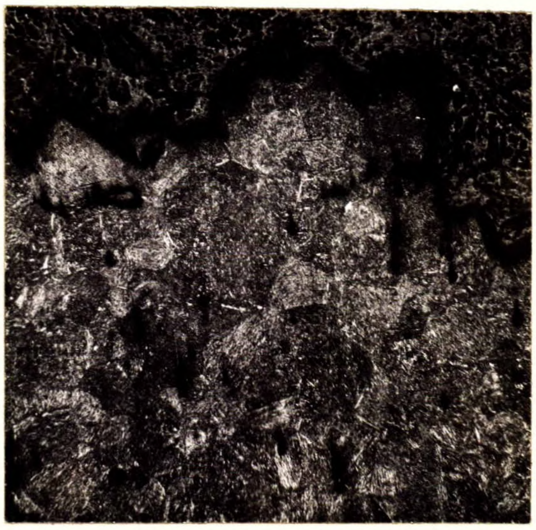
Microstructure:

Dirt inclusions in the steel are shown in Figure 1. Metal structure is shown at 100X in Figure 2. Note that the irregular indentations at the fractured surface are of approximately the same size as the grains in the steel.

Figure 1.

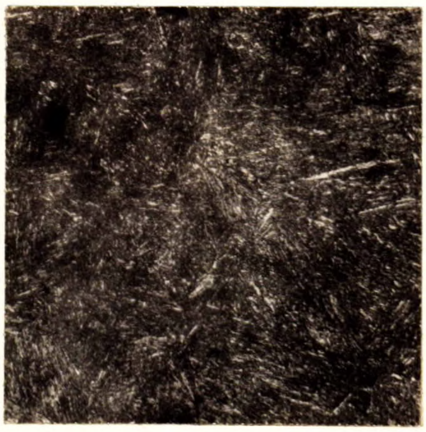
100X, unetched.
Dirt inclusions.

Figure 2.



100X, nital etch.
At edge of fracture.

Figure 3.



1000X, nital etch.
Tempered martensite and ferrite.

Figure 3 shows the nature of the metal structure.

(Continued on next page)

(Microstructure, cont'd) -

It is tempered martensite with ferrite included.

Slight decarburization was noted at the surface of the sample examined.

Hardness:

Vickers hardness number - 480.

Chemical Analysis:

Carbon	-	0.50	per cent
Manganese	-	0.87	"
Silicon	-	0.24	"
Sulphur	-	0.023	"
Phosphorus	-	0.018	"
Chromium	-	0.88	"
Nickel	-	Nil.	
Molybdenum	-	Nil.	
Vanadium	-	Nil.	

Discussion:

The alternating stresses produced in this spring during its life were great enough to cause its failure. In order to prevent the recurrence of this type of failure, those responsible for producing the spring must either -

(A) Subject steel to more carefully controlled heat treatment, or

(B) Choose a better grade of steel, or

(C) Design a heavier spring.

(A) HEAT TREATMENT:

Springs are made of a high strength steel. The desired structure is tempered martensite. The presence of free ferrite either in the martensite or in a decarburized skin will weaken the spring. Free ferrite has been allowed

(Continued on next page)

(Discussion, cont'd) -

to form in the heat treatment of this spring. (See Figure 3).

It is recommended that,

(1) Quench should be drastic enough to form martensite with no traces of free ferrite; and

(2) Heat treating should be done in a protective atmosphere so that there is no decarburization, i.e., no free ferrite produced at the surface.

(B) CHEMICAL ANALYSIS:

The higher the alloy content of a steel the less likelihood there is of forming free ferrite when quenching. It is recommended, therefore, that the analysis of the steel for this spring be changed to specify:

		Per cent
Carbon	-	0.45-0.55
Silicon	-	....
Manganese	-	0.7-0.9
Sulphur	-	0.04 max.
Phosphorus	-	0.04 max.
Chromium	-	1.00-1.20
Vanadium	-	0.15 min.

Conclusion:

Following out suggestions (A) and (B) will result in a spring much superior to the sample submitted for examination.

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