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O T T A W A June 1st, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1656.

Metallurgical Examination of a Universal Carrier Track Pin Which Failed After 600 Miles of Field Trial.

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Abstract

A Universal Carrier track pin which failed after 600 miles field test was found to have low core hardness. This, combined with the possibility of excessive stressing (such as in a badly warped link), would account for early failure.

Origin of Material and Object of Investigation:

On April 7th, 1944, the Detroit office of the Inspection Board of United Kingdom and Canada submitted one Universal Carrier track pin identified as "Canadian Sub-Order No. 56492, supplied by Campbell, Wyant and Cannon Foundry Co."

In an accompanying letter (File No. 56492), it was reported that the pin broke after 600 miles of field test. A metallurgical examination was requested, to determine the cause of failure.

Chemical Analysis:

	AS FOUND	S.A.E. 3115 SPECIFICATION*
	- Per cent -	
Carbon -	0.20	0.13-0.18
Manganese -	0.48	0.40-0.60
Phosphorus -	0.014	0.040 max.
Sulphur -	0.032	0.050 "
Nickel -	1.36	1.10-1.40
Chromium -	0.032	0.25-0.45

* Suggested purchasing specification.

Hardness:

Surface hardness - 75-76 Rockwell 'A'.
Core hardness - 18-19 Rockwell 'C'.

Case depth:

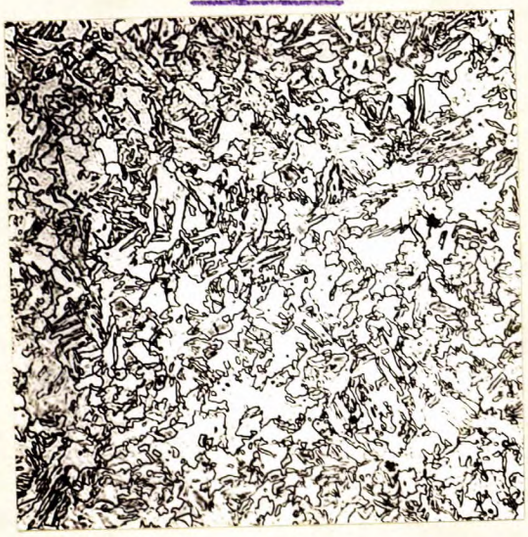
The case depth was measured with a Brinell microscope on a polished specimen etched with 2 per cent nital. It was found to be 0.012 inch.

Microscopic Examination:

Microscopic examination of a transverse specimen showed a core structure of ferrite and low-carbon martensite (see Figure 1, a photomicrograph at X500 magnification).

The microstructure of the case is shown in Figure 2 (a photomicrograph at X250). It is composed of fine martensite.

Figure 1.



X500, etched in 2 per cent nital.

CORE STRUCTURE.

Ferrite and low-carbon martensite.

Figure 2.

X250, etched in 2 per cent nital.

CASE STRUCTURE.

Fine martensite.

Discussion:

The carbon content of the pin (0.20 per cent) is above the maximum of the suggested purchasing specification. Otherwise, the chemical composition is satisfactory.

The case depth (0.012 inch) is in agreement with Specification O.A. 214. The case hardness (75 Rockwell 'A') is below the specified 80 Rockwell 'A' minimum, but since the pin has been in service for 600 miles this is no indication of the original surface hardness. Microscopic examination showed the usual case microstructure of fine martensite.

The core hardness (18-19 Rockwell 'C') is below the 24 to 32 Rockwell 'C' range specified by O.A. 214. The microstructure of the core, ferrite and low-carbon martensite, indicates that this low core hardness is the result of quenching from below the upper critical temperature. Low core hardness means a lower hardness transition zone and consequently a lower pin fatigue life. It is now generally believed that fatigue often occurs at the transition zone. It has been shown on numerous occasions that low core hardness will cause impact strength to become marginal.

However, since this pin failed in a T-16 Carrier track, low core hardness cannot be considered the only probable cause of failure. Pins of this type have given satisfactory service up to 4,900 miles in Canadian Universal Carrier track,* but the Canadian vehicle is lighter than the T-16 carrier and field trials were carried out with the carrier unloaded. In field tests the T-16 carrier is run at a weight of 9,500 pounds. The Canadian carrier was operated at approximately 8,500 pounds. Although the pin may have been in a badly warped link or, due to some mechanical fault, subject to severe fatigue stress, it is thought that the cased pin is overstressed in the

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* O.D.M.L. Report of Investigation No. 1559, dated January 3, 1944.

(Discussion, cont'd) -

T-16 carrier and some breakages may be expected should it be subjected to any abnormal conditions.

CONCLUSIONS:

1. The chemical analysis agrees with the S.A.E. 3115 recommended purchasing specification, with the exception of the carbon content which is 0.20 per cent.

2. The case depth is 0.012 inch. The surface hardness is 75 Rockwell 'A'.

3. The core hardness is below specification. This will result in lowering the fatigue life of the pin and giving marginal impact strength properties.

4. Although the pin may have been in a badly warped link and subjected to severe fatigue stress which caused early failure, it is considered that the cased pin is overstressed in the T-16 carrier.

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