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OTTAWA May 4th, 1944.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1635.

Metallurgical Examination of Three SAE 3115 Universal Carrier Track Pins to Determine Whether Recent Failures are Due to Substandard Pins or Warped Track.

(Copy No. 17.)

Bureau of Mines
Division of Metallic
Minerals.
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Ore Dressing
and Metallurgical
Laboratories

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
Mines and Geology Branch

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Origin of Material and Object of Investigation:

On March 23rd, 1944, three (3) SAE 3115 cased Universal Carrier track pins, supplied by the Campbell, Wyant and Cannon Foundry Company, were submitted by Lieut.-Colonel A. V. Golding, Deputy Director of Tanks & M. T., Inspection Board of United Kingdom and Canada, Detroit, Michigan. One of the pins had broken in field test. The other two were thought to be cracked.

In the accompanying letter (File No. 56492), Lt.-Col. Golding explained that it was possible that these pin failures were caused by the pin rocking about the centre lug of the track. It had been reported that recent failures at Windsor had been eliminated by straightening the Ford, Windsor, links. It was requested that a metallurgical examination of these pins be carried out to determine (1) whether the pins met the O.A. 214 specification and (2) the probable cause of failure.

Chemical Analysis:

		AS FOUND Pin No. 1	Pin No. 2	Pin No. 3	SPECIFICATION SAE 3115*
			- Per Cent -		
Carbon	-	0.18	0.18	0.18	0.13-0.18
Manganese	-	0.42	0.50	0.52	0.40-0.60
Silicon	-	0.20	0.20	0.20	0.20-0.35
Nickel	-	1.30	1.28	1.30	1.10-1.40
Chromium	-	0.39	0.41	0.42	0.25-0.45

* Suggested purchasing specification.

Magnafluxing:

Magnafluxing transversely and longitudinally failed to show any cracks in the two unbroken pins.

Impact Tests:

One pin tested withstood the 45 foot-pound blow required by Specification O.A. 214.

Bend Test:

One of the unbroken pins was tested on the standard bend test machine. The first audible crack in the case occurred at a deflection of 0.70 inch. The minimum required by Specification O.A. 214 is 0.25 inch.

Case Depth:

The depth of case was measured with a Brinell microscope on polished specimens etched with 2 per cent nital. The following results were obtained:

Pin No.		
1 (Broken)	-	0.011 inch.
2	-	0.008 "
3	-	0.007 "

Hardness:

The Rockwell surface and core hardnesses are shown

(Hardness, cont'd) -

in Table I:

TABLE I.

Pin No.	CORE HARDNESS, Rockwell 'C'	CASE HARDNESS Rockwell 'A'	V.H.N., 10-kg. load
1	20-23	73	572-620
2	24-27	75-78	620
3	24-27	75-78	620

Microscopic Examination:

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

A typical example of the microstructure of the case is shown in Figure 2 (a photomicrograph at X500). It is composed of fine martensite.

Discussion of Results:

The chemical composition of the pins agrees with the SAE 3115 recommended purchasing specification. The core hardness for the two unbroken pins, Rockwell 'C' 24 to 27, is within the range required by Specification O.A. 214. The core hardness of the broken pin was 20 to 23 Rockwell 'C'.

The case hardness for the unbroken pins was 75 to 78 Rockwell 'A' and for the broken pin, 73 Rockwell 'A'. The case depth of the three pins ranged from 0.007 to 0.011 inch, which is below the minimum specified by O.A. 214. It should be remembered, however, that the case has been somewhat worn away in service.

The martensitic microstructure of both case and core indicates suitable heat treatment.

The broken pin has a core hardness below the specification limits. This would decrease the fatigue life and as

(Discussion of Results, cont'd) -

has been shown on numerous occasions, cause the impact strength to become marginal.

It is most probable that the pin was in a badly warped link and as a result was subject to more severe fatigue stresses. With the accompanying low core hardness, it would be more prone to failure.

CONCLUSIONS:

1. The chemical compositions of the pins agreed with the SAE 3115 recommended purchasing specification.

2. The core hardness of the two unbroken pins is within specification limits. The core hardness of the broken pin is below specification, which would have the effect of conferring a marginal resistance to impact.

3. The case hardness and the case depth of all three pins are below specification, probably the result of wear during service.

4. The pins had been suitably heat-treated.

5. Low core hardness of the broken pin would result in lowering the endurance limit. This, combined with the possibility that the pin was in a badly warped link, would account for early failure.

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Figure 1.

X500, etched in 2 per cent nital.

CORE STRUCTURE.

Low-carbon martensite.

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Figure 2.

X500, etched in 2 per cent nital.

CASE STRUCTURE.

Nodular tempered martensite.

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