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O T T A W A September 26th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1714.

Metallurgical Examination of Failed T-16 Universal Carrier Track Links.

(Copy No. 10.)

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Metallurgical Examination of Failed T-16 Universal Carrier Track Links.

Origin of Material and Object of Investigation:

On September 16th, 1944, five samples of T-16 Universal Carrier track links were submitted, for examination, by Capt. R. W. Hewitt, for O.C., No. 1 Proving Ground Detachment RCEME (CA), Department of National Defence (Army), Ottawa, Ontario.

In his covering letter, of that date, Captain Hewitt stated that the manner in which these links had broken was typical of defects encountered on a track pin test being run at the present time for the Inspection Board of United Kingdom and Canada. It was requested that the links be examined to determine whether these defects were due to faulty material or workmanship.

Description of Links and Nature of Defects:

No. 1. - #3 link on left track in blue section. At 958 miles the link broke across the barrel (see Figure 1).

No. 2. - #25 link on right track, blue section. At 1,434 miles the link broke across the barrel (also Figure 1).

No. 3. - #13 link on left track, unpainted section. At 1,247 miles, top broke off guiding lug (see Figure 2).

No. 4. - #145 link in red section. Failure as shown in Figure 2.

No. 5. - Link painted yellow. Failure as in Figure 2.

Figure 1.

TRACK LINKS NOS. 1 AND 2 FAILED IN THIS MANNER.

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Figure 2.

TRACK LINKS NOS. 3, 4 AND 5 FAILED IN THIS MANNER.

Arrow indicates failure on guiding lug.

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Chemical Analysis:

Results of chemical analysis of Links Nos. 1 and 2 are shown in Table I.

TABLE I.

	As Found, No. 1	As Found, No. 2
	- Per Cent -	
Carbon -	0.30	0.35
Manganese -	0.66	0.85
Silicon -	0.40	0.51
Phosphorus -	0.026	0.024
Sulphur -	0.042	0.038
Copper -	Nil.	0.03

Hardness:

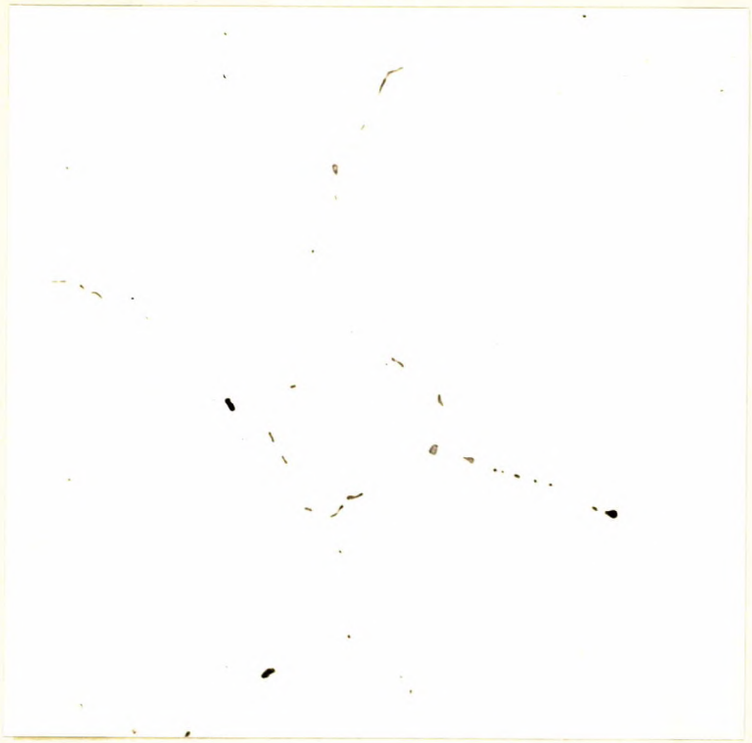
Hardness values determined at the points of failure were uniform for all the links and varied from 336 to 375 Vickers, 30-kg. load.

Microscopic Examination:

Microscopic examination of Links Nos. 1 and 2 at the points of failure disclosed a drawn martensitic microstructure, some areas of which contained numerous eutectic-type duplex inclusions outlining the grain boundaries. Photomicrographs of these areas, in the unetched and etched condition, are shown in Figures 3 and 4. The microstructure of the metal adjacent to the breaks in the guiding lugs of Links 3, 4 and 5 was uniformly drawn martensite. A typical example of this is shown in Figure 5.

(Continued on next page)

Figure 3.



X500, unetched.

EUTECTIC-TYPE INCLUSIONS, PROBABLY DUPLEXED SILICATES AND ALUMINIUM SULPHIDE.

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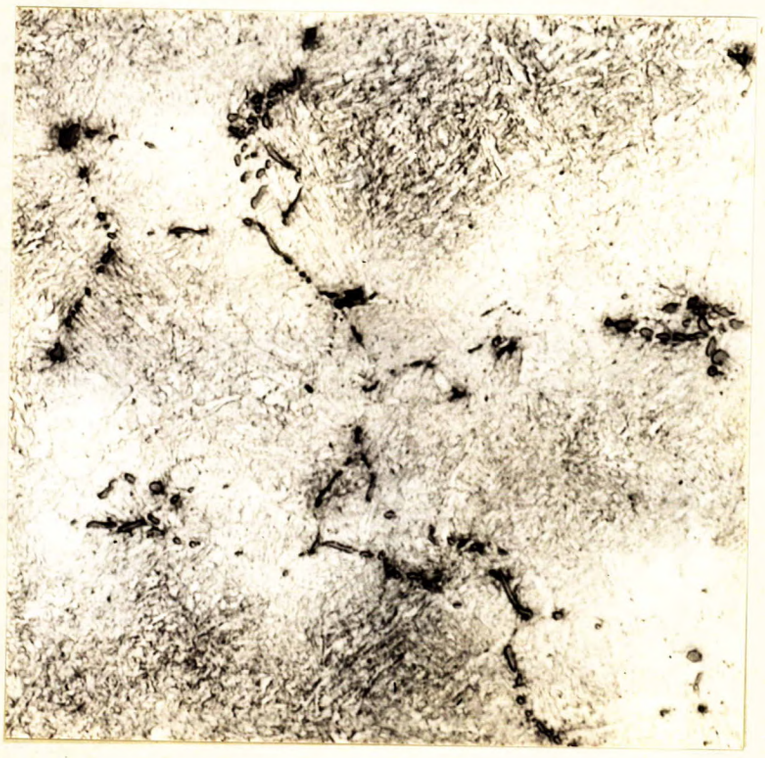
Figure 4.



X500, etched in 2 per cent nital.

DRAWN MARTENSITE CONTAINING EUTECTIC-TYPE, NON-METALLIC INCLUSIONS.

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Figure 5.

X500, etched in 2 per cent nital.

DRAWN MARTENSITIC MICROSTRUCTURE.

Discussion:

X-ray examination of one link proved its soundness. This might indicate that no chronic casting defects, such as shrinkage or porosity, were present.

The chemical composition of the links analysed is not in complete agreement with Ford No. 4 specification, but the difference is not significant.

The hardness (336-375 Vickers) is definitely higher than usually observed in satisfactory cast steel links.* The resultant lowering of impact strength would contribute to failure, particularly in the guiding lugs.

The presence of eutectic-type inclusions outlining the grain boundaries of Links Nos. 1 and 2 causes considerable loss of ductility and impact strength and explains early failure

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* See Report of Ore Dressing and Metallurgical Laboratories Investigation No. 1496, September 20th, 1943.

(Discussion, cont'd) -

at these points. This unfavourable arrangement of the non-metallic inclusions has originated from improper killing of the steel in the melting process.

Conclusions:

1. X-ray examination indicated freedom from casting defects which might cause early failure.

2. The hardness of the links is definitely higher than normally found in satisfactory cast steel links and is considered a contributary cause of failure, particularly in the guiding lugs.

3. Microscopic examination has shown eutectic-type inclusions outlining the grain boundaries in the metal adjacent to the points of failure in Links Nos. 1 and 2. This arrangement of non-metallic inclusions invariably lowers the ductility and impact strength, and is the most likely cause of failure in these links.

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