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O T T A W A January 21st, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1150.

Examination of a Universal Carrier Track Link.

(Copy No. 11.)

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 Material and Object of Investigation:

On January 12th, 1942, under Requisition No. O.T.13, Mr. R. Boult, of the Inspection Board of the United Kingdom and Canada, 58 Lyon Street, Ottawa, Ontario, sent in a Universal Carrier track link for examination. This link was reported to have been cast with Ford No. 4 steel by the Campbell, Wyant & Cannon Foundry Company, Muskegon, Michigan, and had broken in service after nine hundred miles. Since this track was on test for approval of production, it was requested that the cause of failure be determined.

Macroscopic and Magnaflux Examination:

The failure occurred diagonally at the base of one of the lugs. Figure 1 shows the appearance of the fractured surface. The link was allowed to remain on the track for some time after it was broken, since a good portion of the rough surface has been worn smooth by friction.

Further visual examination revealed a very slight crack near the opposite lug at a position similar to that where the actual failure occurred. This part of the broken casting was then magnafluxed and the actual length of the crack was revealed, as shown in Figure 2. The relative position of the crack with respect to the lug is shown in Figure 3.

Figure 1.

APPEARANCE OF FRACTURED CASTING.

(Approximately $\frac{1}{2}$ size).

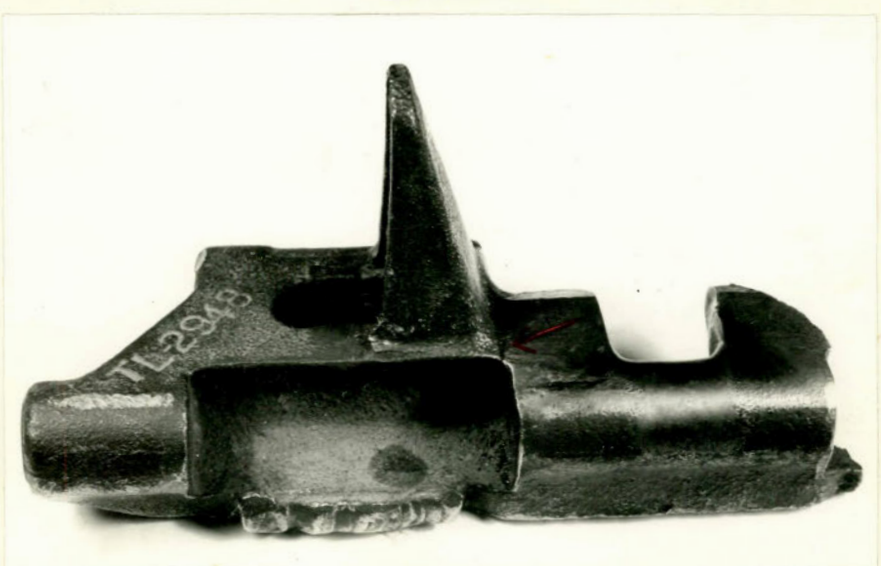
(Continued on next page)

Figure 2.

CRACK REVEALED BY MAGNAFLUX.

(Approximately 1½ times
actual size).

Figure 3.



Relative Position of Crack Shown
in Figure 2.

(Approximately to size).

X-Ray Examination:

An X-ray examination was made by Dr. G. C. Laurence of the National Research Council, Ottawa. Two shrinkage cavities were indicated. One of these, at the angular region at the base of the projecting lug, corresponds to the region where the break occurred and is evidently the cause for the appearance of the crack shown in Figure 2. Figure 4 reveals this shrinkage cavity. The other cavity shown by the X-ray is at an identical position on the opposite side of the bearing.

Figure 4.

SHRINKAGE CAVITY.

Chemical Analysis:

		As Found
Carbon, per cent	-	0.43
Manganese, per cent	-	0.79
Phosphorus, "	-	0.043
Sulphur, "	-	0.053
Silicon, "	-	0.36
Copper, "	-	0.54

Hardness Test:

An average Vickers hardness number of 403 was obtained, using the 5-kilogram load. The casting was hardened uniformly throughout.

Hammer Test - (Crack-free deformation of the bearing hole to two-thirds of its original diameter under hammer blow):

Figure 5 shows that the result of this test was excellent.

Figure 5.

Microscopic Examination:

A specimen was cut from the fractured surface and subjected to microscopic examination. Figure 6, at X1000 magnification, shows a structure characteristic of an alloy steel quenched and tempered to a fairly high hardness.

Figure 6.

X1000, nital etch.

SURFACE STRUCTURE.

Discussion of Results:

Metal -

Analysis and microstructure show the metal to be of a satisfactory grade of steel. The hardness obtained (403 Vickers) should give a good wear-resistant material. The photomicrograph, Figure 6, reveals that the casting has been adequately heat-treated.

The results of the hammer test would indicate that the steel possesses a fair degree of ductility.

(Continued on next page)

(Discussion of Results, cont'd) -

Shrinkage Cavities -

THE FLAWS REVEALED BY THE X-RAY ARE SHRINKAGE CAVITIES. THE CAVITY SHOWN IN FIGURE 4 OCCURS AT A POSITION IN THE CASTING SIMILAR TO THAT WHERE THE FAILURE OCCURRED. Shrinkage cavities are frequently encountered in castings and it is necessary to eliminate them by changing the casting technique, since they obviously reduce the strength of the casting. This can be done by:

(1) Gating, so as to supply hot liquid metal under pressure to the section while it is solidifying; or

(2) Using metal chills in the mould, so as to move the shrinkage to a point where Method (1) may be applied more easily.

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Conclusions:

1. The metal is of good quality and has received an adequate heat treatment.

2. The casting reveals flaws. These flaws are shrinkage cavities, which reduce the strength of the casting. They can be avoided by altering the casting technique.

3. The casting should give good wear resistance and shows a fair amount of ductility.

Recommendations:

1. X-rays of the cast links should be taken at certain time intervals, especially at the beginning of

(Recommendations, cont'd) -

a new contract, to detect any flaws which might give way in use.

2. A proof test should be applied, such as dropping a certain load on an assembly of a number of links and removing those which cannot withstand the load.

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