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O T T A W A May 1st, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1211.

(M. and S. No. 9/A).

Examination of Broken Universal Carrier Track Pins.

(Copy No. 10.)

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 April 22nd, 1942, Dr. C. W. Drury, Director of Metallurgy, the Department of Munitions and Supply, Ottawa, Ontario, submitted three broken Universal Carrier track pins for investigation. One of the pins was headed and the Canadian Acme Screw and Gear Company's trade-mark (A was stamped on it. The other two had no identifications as to where they were produced. It was requested that possible reasons for failure be determined.

Macroscopic Examination:

The three pins were broken at a point about three-quarters of their length. It could not be ascertained, however, that all three pins broke at exactly the same place with respect to their position in the track link, since only one pin was headed. This pin failed at three-quarters of its length measured from the head. This would be just before the edge of the outside eye on the three-eye side of the link. The surfaces of the pins were coated unevenly with a layer of rust due to exposure to the atmosphere for some time. It was impossible to determine from the fractures whether fatigue or impact caused the failure.

Chemical Analysis:

Drillings were taken from the cores of the three pins for chemical analysis:

- (Per cent) -

No. 1. - Headed Pin - Canadian Acme Screw and Gear Co.

		As Found	Specification S.A.E. 2115
Carbon	=	0.15	0.10 - 0.20
Manganese	=	0.41	0.30 - 0.60
Silicon	=	0.26	0.15 min.
Phosphorus	=	0.042	0.04 max.
Sulphur	=	0.033	0.05 max.
Nickel	=	1.59	1.25 - 1.75
Chromium	=	Not detected.	=

No. 2. - Source not reported.

		As Found	S.A.E. 3115
Carbon	=	0.21	0.10 - 0.20
Manganese	=	0.52	0.30 - 0.60
Silicon	=	0.31	0.15 min.
Phosphorus	=	0.041	0.040 max.
Sulphur	=	0.017	0.050 max.
Nickel	=	1.38	1.00 - 1.50
Chromium	=	0.62	0.45 - 0.75

(Continued on next page)

(Chemical Analysis, cont'd) -

- (Per cent) -

No. 3. - Source unknown.

		As Found	S.A.E. 3115
Carbon	-	0.19	0.10 - 0.20
Manganese	-	0.52	0.30 - 0.60
Silicon	-	0.24	0.15 min.
Phosphorus	-	0.036	0.040 max.
Sulphur	-	0.021	0.050 max.
Nickel	-	1.40	1.00 - 1.50
Chromium	-	0.62	0.45 - 0.75

Hardness Tests:

Hardness tests taken of the surface of the pins showed considerable variation due to the uneven layer of rust; consequently, they are not truly representative. An average taken from a number of surface tests is included in the depth-hardness relationship shown below. The hardness tests were carried out on the Vickers hardness machine, using the 10-kilogram load.

No. 1. -

Canadian Acme Screw and Gear.

Distance from the surface, in inches		V.P.N.
0.21	-	233
0.07	-	256
0.05	-	245
0.03	-	250
0.02	-	378
Surface	-	745

No. 2. -

0.21	-	376
0.07	-	366
0.05	-	380
0.035	-	380
0.02	-	421
Surface	-	750

(Continued on next page)

(Hardness Tests, cont'd) -

No. 3. -

Distance from the surface, in inches		V.P.N.
0.22	=	224
0.08	=	342
0.06	=	333
0.05	=	345
0.03	=	345
0.015	=	421
Surface	=	720

Microscopic Examination:

Microspecimens were cut from the pins at points about 0.1 inch from the fractured end. The specimens were examined both in the etched (nital) and unetched condition. The unetched specimens showed that the steel was quite clean. Figures 2 to 7 at the end of this report show the structures of the cores and the cases. The former were taken at X500 magnification and latter at X1000.

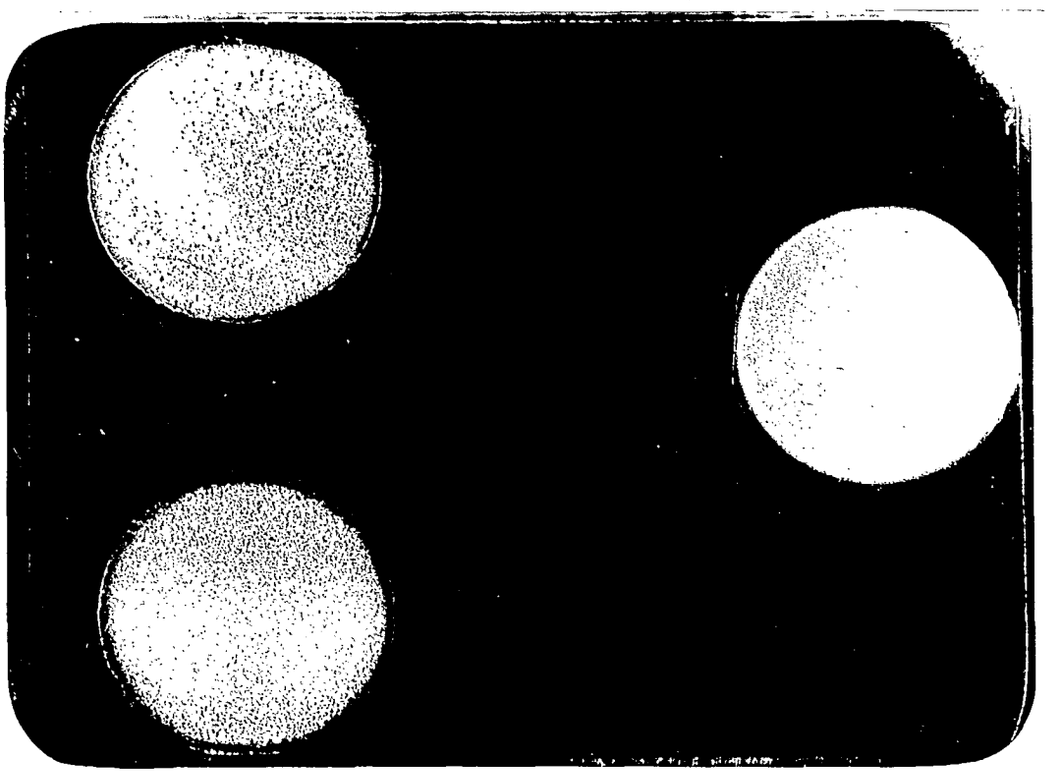
It will be noted from Figure 1, which is a macroscopic picture of the mounted and etched microspecimens, that the case of Sample No. 1 is worn unevenly. At the extreme right the case is completely worn away. The other two samples show that the pin has worn in a fairly uniform manner.

(Figure 1 appears on next page)

(Microscopic Examination, cont'd) -

Figure 1.

No. 3.



No. 1.

No. 2.

MACROGRAPH OF THE THREE ETCHED MICROSPECIMENS.

Discussion:

The chemical analysis shows that the two pins Nos. 2 and 3, whose source of production was not known, are from Allied Products Limited, Detroit, Michigan, since they conform to the specification limits of S.A.E. 3115 steel. This plant has been using 3115 steel for their Universal Carrier track pin production.

The macroscopic examination revealed that the three pins probably failed at approximately the same place (this could not be verified, due to the fact that only one pin was headed). It was impossible to determine from the

(Discussion, cont'd) -

fractures whether the pins failed due to fatigue or to impact.

Figure 1 shows that in Pin No. 1 (Canadian Acme Screw and Gear Co.) the case has been completely worn away at two points. This indicates that the pin was jammed in the link and this would consequently be the most probable reason for its failure. The Allied Products Limited pins, however, do not indicate jamming. The very fact that they did break shows that the pins as at present produced have a very low margin of safety.

It is reported that 1 or 2 per cent of the Universal Carrier pins are failing. It is felt that with this light vehicle, pin failure should be a rarity rather than a chronic occurrence. Steps should be taken to produce a better quality pin to increase the margin of safety beyond the point obtained at present.

In order to identify breakages with their causes, a field system should be instituted whereby all the available information regarding a pin prior to and at the time of actual failure will be recorded. This report, along with the broken pin (and, if necessary, the links in which the pin broke) should then be submitted to the metallurgical laboratory for investigation. In this way the cause of failure will be more readily identified and subsequent improvement of the pin can be expected.

CONCLUSIONS:

1. Pins Nos. 2 and 3 were produced at Allied Products Limited, Detroit, Michigan.

2. The failure of Pin No. 1 (Canadian Acme Screw and Gear Company) was due, in all probability, to jamming in the track link.

3. Pins as at present produced do not allow enough margin of safety.

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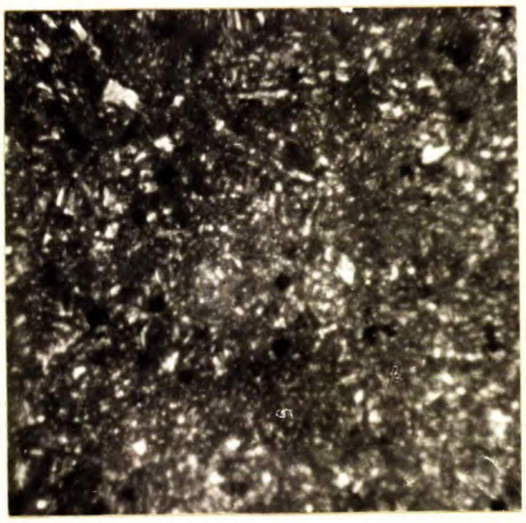
SLG:PES.

Figure 1.

X500, nital etch.
CORE OF CANADIAN ACME PIN.

Figure 2.



X1000, nital etch.
CASE OF CANADIAN ACME PIN.

Figure 3.

X500, nital etch.
CORE OF PIN NO. 2.

Figure 4.

X1000, nital etch.
CASE OF PIN NO. 2.

Figure 5.

X500, nital etch.
CORE OF PIN NO. 3.

Figure 6.

X1000, nital etch.
CASE OF PIN NO. 3.

SLG:GHB.